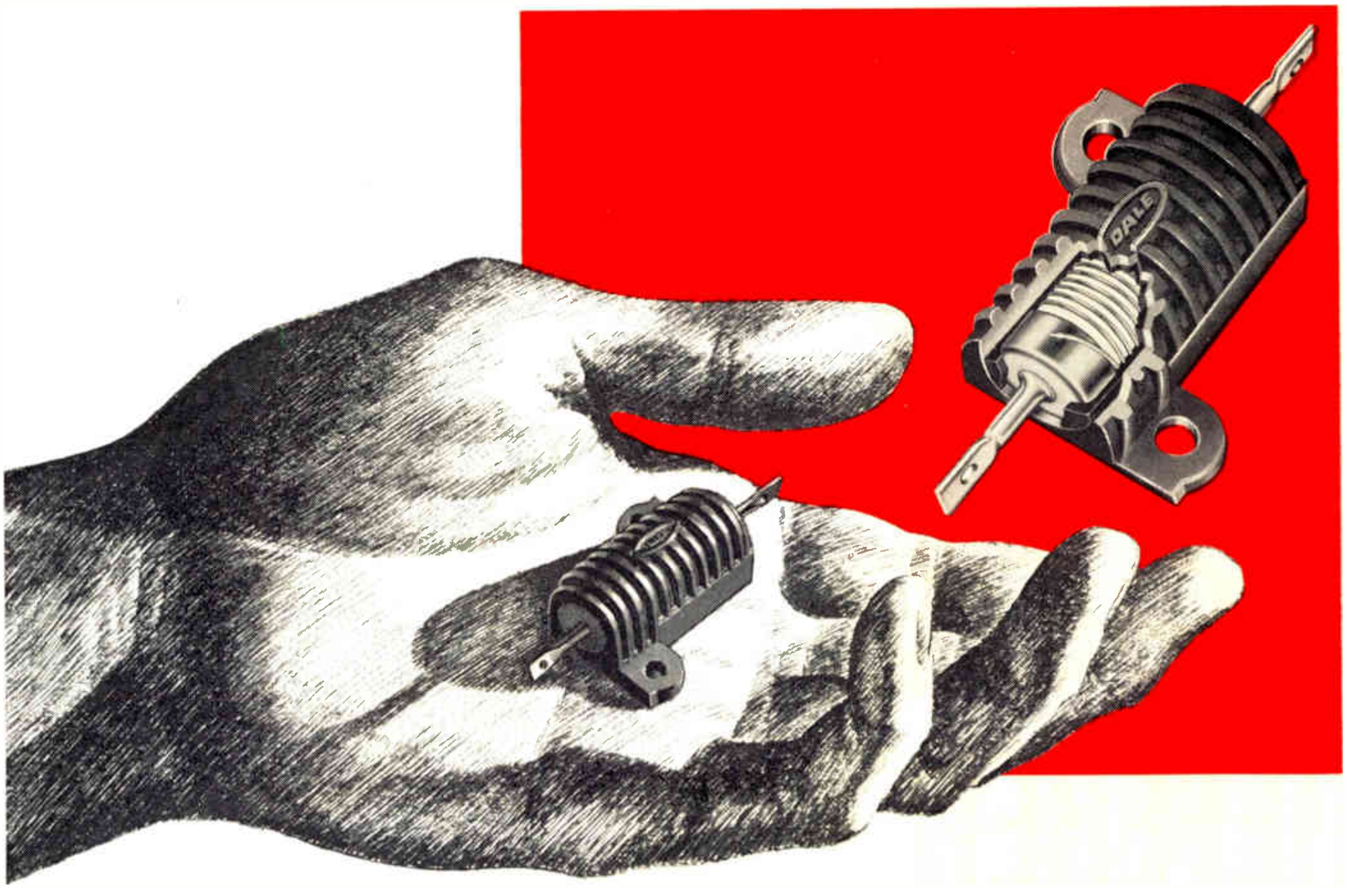
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

JUNE 1962

REFERENCE ISSUE

STABILITY IS INHERENT IN DALE ELECTRONIC COMPONENTS AND ASSEMBLIES



You will find DALE listed under the following EIC groups

Lightning Arrestors	EIC 0618
Ceramic Capacitors	EIC 0803
Metal Knobs	EIC 1812
Plastic Knobs	EIC 1813
Fractional HP Motors	EIC 4524
Hysteresis Motors	EIC 4525
Miniature Motors	EIC 4526
Phonograph Motors	EIC 4527
Etched Circuits	EIC 4803
Plated Circuits	EIC 4804
Printed Circuits	EIC 4805
Assembly and Industrial Services	EIC 5801
Encapsulation Services	EIC 5804
Calibration Services	EIC 5815
Attenuators	EIC 6801
Voltage Dividers	EIC 6802
Resistor Networks	EIC 6803
Precision Potentiometers	EIC 6806
***Wire Wound Potentiometers**	EIC 6807
***Printed Circuit Potentiometers**	EIC 6808
***Trimmer Potentiometers**	EIC 6810
***Deposited Carbon Resistors**	EIC 6811
***Encapsulated Resistors**	EIC 6812
***Metal Film Resistors**	EIC 6813
***Wire Wound Resistors**	EIC 6815
***High Temperature Resistors**	EIC 6819
***High Voltage Resistors**	EIC 6820
Negative Temperature Coefficient Resistors	EIC 6821
***Power Resistors**	EIC 6823
***Precision Resistors**	EIC 6824
***Printed Circuit Resistors**	EIC 6825
***Sub-Miniature Resistors**	EIC 6826
Cable Assemblies	EIC 7402

SIOUX DIVISION

Ferrite Core Antennas	EIC 0507
Antenna Coils	EIC 2204
Focusing Coils	EIC 2212
I-F Coils	EIC 2215
Oscillator Coils	EIC 2218
Printed Circuit Coils	EIC 2220
Relay Coils	EIC 2221
R-F Choke Coils	EIC 2222
R-F Receiving Coils	EIC 2223
Toroidal Coils	EIC 2226
Transformer Coils	EIC 2229
Variable Coils	EIC 2231
Video Peaking Coils	EIC 2232
Solenoid	EIC 2236
RF-IF Transformers	EIC 7020
Toroidal Transformers	EIC 7021
Transistor Transformers	EIC 7022

Bold face type indicates standard off-the-shelf items. Those marked with * are described in Dale Electronics advertisement in Section E of this issue. All other products and services are to customer specifications. Please request the Dale Facilities Report.

DALE ELECTRONICS, INC.

DALE

1304 28th Avenue, Columbus, Nebraska

A subsidiary of THE LIONEL CORPORATION

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

Circle 98 on Inquiry Card See also—pages E-26 & E-27

ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

June 1962 • Volume 21 • No. 6

1962-63 All Reference & Directory Issue

ELECTRONIC INDUSTRIES

Vol. 21, No. 6 JUNE, 1962

The New Reference Issue

THIS fifth annual All-Reference Issue includes our twentieth edition of the ELECTRONIC INDUSTRIES Directory. You will note a major change in presentation which we believe will increase its usefulness.

How to organize and correlate the immense volume of information in these annual All-Reference issues has been a continuing problem over the years. In this issue, the subject matter has been divided into a dozen categories. Eight of these deal with specific types of products and the other four are concerned with general areas of electronic interest.

We have grouped the editorial pages at the start of each section and included a topical index on the title page. Appropriate advertising follows the editorial material. We have listed in each section catalogs and technical bulletins manufacturers have reported to us as being available. You may send for these by circling the item number on any one of the six product inquiry cards contained in this issue.

Section A, immediately following, provides complete editorial and advertising content information for this 532 page issue. The editorial material has been cross-referenced into a quick finding index appearing on page A-3. Advertising has also been cross-referenced by product, and these listings start on page A-4.

Section L contains the Directory of Electronic Manufacturers and provides name, address, and product information. The listings are a machine print-out of data contained in the master ELECTRONIC INDUSTRIES census card deck, which is also used to develop market research information. This directory is the most accurate summary of the industry available from any source. It includes verified information on 6136 manufacturing plants based on mail survey questionnaires, telephone calls, and personal plant interviews.

We hope you will like this issue and find it useful. Your comments and suggestions will be welcomed.

BPA NBP

ELECTRONIC INDUSTRIES, June, 1962. Vol. 21, No. 6. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr., $18.00; 2 yrs. $30.00.

Section A

The Reference Issue

ELECTRONIC INDUSTRIES

ALL-REFERENCE ISSUE

SECTION I—DATA PROCESSING & AUTOMATION

SECTION J—MICROWAVE

SECTION K—SPACE ELECTRONICS

ELECTRONIC INDUSTRIES' DIRECTORY

FIND IT ON PAGE . . .

This index provides a quick survey of the reference material in the 1962 Directory and All-Reference Issue.

Products Advertised

In This Issue . . .

(Continued on page A7)

RECOGNIZED RELIABILITY

THE FIRST...

TWIN *Universal* POWER SUPPLY *with* AMBITROL®

TWO INDEPENDENT DC SOURCES EACH FURNISHING:

- CONSTANT VOLTAGE OUTPUT: 0-40 VDC, 0-0.5 A
- CONSTANT CURRENT OUTPUT: 25-500 MA, 40 Volts Max.
- REGULATION: .05% or 10 Millivolts (Voltage)
  .02% or 100 Microamps (Current)
- RIPPLE: 250 Microvolts RMS (Voltage)
  20 Microamps RMS (Current)
- AUTOMATIC TRANSFER from Voltage to Current Regulation at Any Operating Point.
- AUTOMATIC TRANSFER from Current to Voltage Regulation at Any Operating Point.
- CONSTANT VOLTAGE OUTPUT With Continuously Adjustable Current Limiting
- CONSTANT CURRENT OUTPUT With Continuously Adjustable Voltage Limiting
- SERIES Operation or PARALLEL Operation
- REMOTE VOLTAGE and REMOTE CURRENT Programming

®AMBITROL: Constant Voltage/Constant Current regulator system with automatic transfer to either mode at any preset level.
(PATS. APPLIED FOR)

MODEL TW-4005

0-40 VDC, 0-0.5 AMP, EACH
0-80 VDC, 0-0.5 AMP, SERIES
0-40 VDC, 0-1.0 AMP, PARALLEL

$297.50
F.O.B. FACTORY

POWER DESIGNS

POWER DESIGNS INC.
1700 Shames Dr., Westbury, L. I., N. Y. • 516 EDgewood 3-6200, • TWX: WBRY 350

Circle 144 on Inquiry Card

Products (cont.)

TOOLS

TUBES

WIRE AND CABLE

ELECTRONIC INDUSTRIES
All-Reference Issue
Advertisers

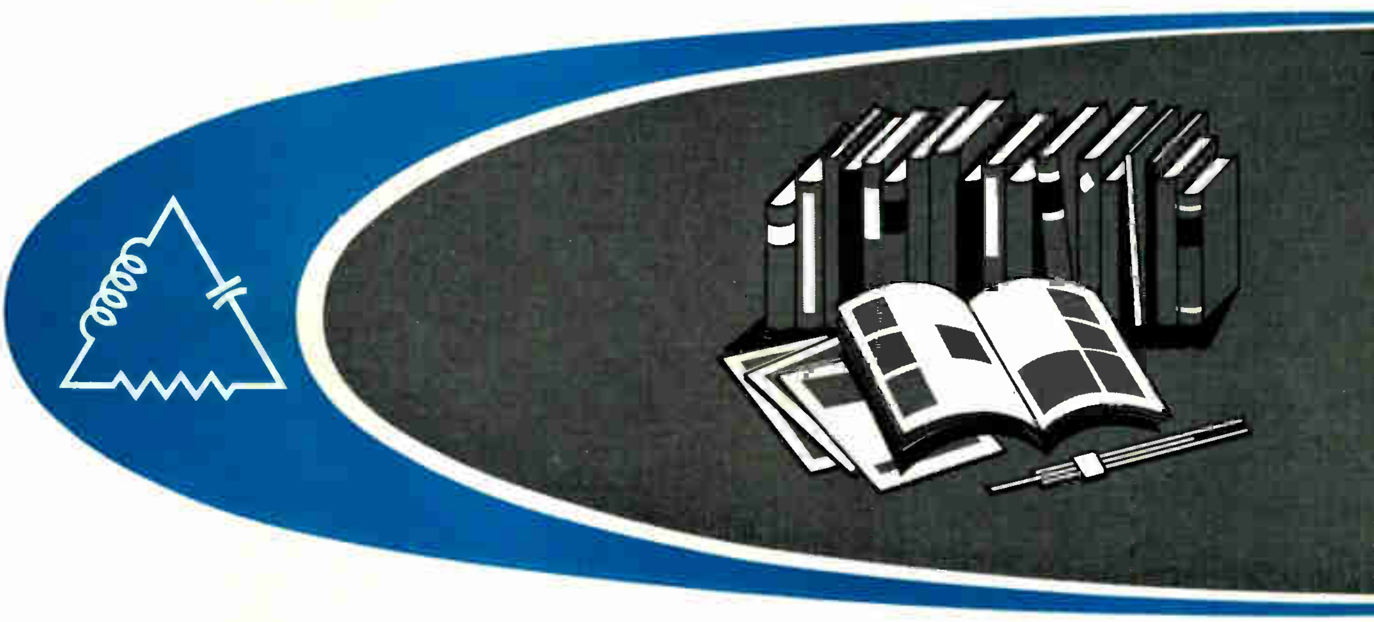
This index is published as a convenience. No liability is assumed for errors or omissions

(Continued on page A8)

Advertisers (cont.)

Section B

The Electronic Industry



1962 Coming Events Calendar

Portraying important electronic events for the next 7 months

A listing of meetings, conferences, shows, etc., occurring during the last half of 1962 that are of special interest to electronic engineers. The events are listed chronologically and by the area— East, Midwest, and West—in which they occur.

ONLY THE OPENING DAY OF EACH MEETING IS MARKED ON THE CALENDAR

JUNE

EAST

June 4-6: Lubrication Symp., ASME; Deauville Hotel, Miami Beach, Fla.

June 4-6: Edison Electric Inst., Annual Conv., Atlantic City, N. J.

June 4-7: 1962 Int'l Atomic Expos. & 7th Annual Nuclear Congress, EJC; Coliseum, New York, N. Y.

June 5-7: National Fuels Symp., ASME & Rutgers Univ.; Rutgers Univ., New Brunswick, N. J.

June 6-8: Soc. of Tech. Writers & Publishers Annual Mtg.; Sheraton Hotel, Phila., Pa.

June 11-12: Illuminating Eng'g Soc. Northeastern Regional Mtg.; Hotel U. S. Thayer, West Point, N. Y.

June 11-13: Brookhaven Nat'l. Lab., Molecular Beams Conf.; Brookhaven Nat'l. Lab., Upton, N. Y.

June 11-15: Annual Tech. Writers' Inst.; Rensselaer Polytechnic Inst., Troy, N. Y.

June 12: Mtg. of Ultrasonic Mfrs. Assoc.; Statler-Hilton Hotel, New York, N. Y.

June 12: Reinforced Plastics, Eastern New Eng. Sec., SPE; Statler-Hilton Hotel, Boston, Mass.

June 12-14: 16th Annual AFCEA Conv.; Sheraton-Park and Shoreham Hotels, Washington, D. C.

June 18-20: American Nuclear Soc. Annual Mtg.; Statler-Hilton Hotel, Boston, Mass.

June 18-22: Amer. Crystallographic Assoc. Annual Nat'l. Mtg.; Villanova Univ., Phila., Pa.

June 24-28: Nat'l. Assoc. of Music Merchants Trade Show & Conv.; Hotel New Yorker and N. Y. Trade Show Bldg., New York, N. Y.

June 24-29: ASTM Annual Mtg.; Statler Hotel, New York, N. Y.

June 24-29: Nat'l. Assoc. of Power Engineers Nat'l. Conv.; Statler-Hilton Hotel, Washington, D. C.

June 25-27: 6th Nat'l. Conv. Military Electronics (MIL-E-CON), IRE, PGMIL; Shoreham Hotel, Washington, D. C.

June 25-27: Annual Mtg., ASHR & ACE; Deauville Hotel, Miami Beach, Fla.

June 26-28: Aviation Conf., ASME; Univ. of Maryland, College Park, Md.

June 27-29: Joint Automatic Control Conf., IRE, AIEE, ISA; New York Univ., New York, N. Y.

MIDWEST

June 12: Regular AEP&EM Mtg.; Chicago, Ill.

June 13-16: Annual NSPE Mtg.; French Lick-Sheraton Hotel, French Lick, Ind.

June 18-19: Chicago Spring Conf. on Broadcast & TV Receivers, IRE (PGBTR); O'Hare Inn, Chicago, Ill.

June 19-21: Material Handling Inst. Great Lakes Show; Cobo Hall, Detroit, Mich.

June 19-21: Summer APS Mtg. in East; Evanston, Ill.

June 25-27: Amer. Assoc. of Cost Engineers Annual Mtg.; Edgewater Beach Hotel, Chicago, Ill

WEST

June 1-3: ARRL Southwestern Div. Conv.; Disneyland Hotel, Anaheim, Calif.

June 11-22: Topics in Geophysics; AFOSR & Univ. of New Mexico, Cloudcroft, N. Mex.

June 17-22: Summer Gen'l. Mtg., AIEE; Hotel Denver-Hilton, Denver, Colo.

June 18-21: 4th U. S. Congress, Theoretical & Applied Mechanics, ASME; Univ. of Calif., Berkeley, Calif.

June 18-22: Amer. Soc. for Eng'g. Education Annual Mtg.; Air Force Academy, Colo.

June 19-21: 2nd Annual San Diego Bio-Medical Eng'g. Symp. & Exhib.; Stardust Motor Hotel, San Diego, Calif.

June 19-22: Summer Mtg., IAS; Ambassador Hotel, Los Angeles, Calif.

June 27-28: 9th Annual Symp. on Computers & Data Processing, Denver Research Inst., Univ. of Denver; Elkhorn Lodge, Estes Park, Colo.

June 28-29: 4th Nat'l. Symp. on RFI, IRE, PGRFI; Dell Webb, Town House Hotel, San Francisco, Calif.

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East Midwest West

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JULY

EAST

July 8-14: Int'l. Congress on Glass, ACS; Sheraton-Park Hotel, Washington, D. C.

July 17-18: Data Acquisition & Processing in Medicine & Biology, IRE (PGBME), AIEE, ISA; Whipple Audit., Strong Memorial Hosp., Rochester, N. Y.

MIDWEST

July 1-20: Telephone Eng. Conf.; Michigan State Univ., E. Lansing, Mich.

July 17-19: Lunar Mission Mtg., ARS; Pick-Carter & Statler-Hilton Hotels, Cleveland, Ohio.

July 25-29: Int'l. Sound Fare, SORD, CMA, IHFM, ARMADA, MRIA; Cobo Hall, Detroit, Mich.

WEST

July 9-13: 5th Annual Institute in Tech. & Industrial Communications; Colorado State Univ., Ft. Collins, Colo.

July 13: Western Regional Conf., SAME; Seattle, Wash.

AUGUST

EAST

Aug. 5: Industrial Research Conf., Columbia Univ.; Arden House, Harriman, N. Y.

Aug. 27-29: Conf. on Metallurgy of Semiconductor Materials; Ben Franklin Hotel, Phila., Pa.

MIDWEST

Aug. 30-Sept. 5: Annual Conv., APA; Chase-Park Plaza Hotels, St. Louis, Mo.

Aug. 31-Sept. 9: 1st World's Fair of Music & Sound; McCormick Place, Chicago, Ill.

WEST

Aug. 5-8: 5th Nat'l. Heat Transfer Conf. & Exhib., ASME, AIChE, Houston, Tex.

Aug. 10-11: The Future of Manned Vehicles in Air & Space, IAS; Olympic Hotel, Seattle, Wash.

Aug. 13-16: Pacific Energy Conversion Conf., AIEE; Fairmont Hotel, San Francisco, Calif.

Aug. 14-16: 1962 Int'l. Conf. on Precision Electromagnetic Measurements, IRE(PGI), NBS, AIEE; NBS Boulder Labs, Boulder, Colo.

Aug. 14-16: Cryogenic Eng'g. Conf.; Univ. of Calif., Los Angeles, Calif.

Aug. 15-17: 3rd Electronic Packaging Symp.; Univ. of Colorado, Boulder, Colo.

Aug. 16-18: Joint Western Regional Aircraft & Missiles Conf., ASQC; Benjamin Franklin Hotel, Seattle, Wash.

Aug. 21-24: Western Electronics Show & Conf. (WESCON), IRE, WEMA; Memorial Sports Arena & Statler-Hilton Hotel, Los Angeles, Calif.

Aug. 23-24: AEEC Summer Mtg.; Hotel Benjamin Franklin, Seattle, Wash.

Aug. 26-29: Nat'l. Mtg., AICE; Denver-Hilton Hotel, Denver, Colo.

Aug. 27-29: Summer APS Mtg. in West; Seattle, Wash.

Aug. 28-30: 4th EIA Conf. on Maintainability of Electronic Equip., EIA & Dept. of Defense; Univ. of Colorado, Boulder, Colo.

Aug. 31-Sept. 3: ARRL Nat'l. Conv.; Portland-Sheraton Hotel & Memorial Coliseum, Portland, Ore.

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ABBREVIATIONS

ACM—Association for Computing Machinery
ACS—American Ceramic Society
AEC—Atomic Energy Commission
AEP&EM—Association of Electronic Parts and Equipment Manufacturers
AES—American Electroplaters Society
AES—Audio Engineering Society
AES—Aircraft Electrical Society
AFCEA—Armed Forces Communications & Electronics Association
AFOSR—Air Force Office of Scientific Research
AICE—American Institute of Consulting Engineers
AIChE—American Institute of Chemical Engineers
AIEE—American Institute of Electrical Engineers
AIME—American Institute of Mining, Metallurgical & Petroleum Engineers
ANS—American Nuclear Society
APS—American Physical Society
ARF—Armour Research Foundation
ARRL—American Radio Relay League
ARS—American Rocket Society
ASA—Acoustical Society of America
ASA—American Standards Association
ASCE—American Society of Civil Engineers
ASHR&ACE—American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME—American Society of Mechanical Engineers
ASQC—American Society for Quality Control
ASTM—American Society for Testing And Materials
ASTME—American Society of Tool and Manufacturing Engineers
AWS—American Welding Society
EIA—Electronic Industries Association
IAS—Institute of Aeronautical Sciences
IHFM—Institute of High Fidelity Manufacturers
IRE—Institute of Radio Engineers
ISA—Instrument Society of America
MRIA—Magnetic Recording Industry Association
NAB—National Association of Broadcasters
NACE—National Association of Corrosion Engineers
NASA—National Aeronautics & Space Administration
NBS—National Bureau of Standards
NSPE—National Society of Professional Engineers
OSA—Optical Society of America
ORSA—Operations Research Society of America
SAE—Society of Automotive Engineers
SAME—Society of American Military Engineers
SMPTE—Society of Motion Picture & TV Engineers
SPE—Society of Plastic Engineers
WEMA—Western Electric Manufacturers Association

COMING EVENTS CALENDAR

SEPTEMBER

EAST

Sept. 4-7: 1962 ACM Nat'l. Conf. & Int'l. Data Processing Exhib; Assoc. for Computing Machinery; Hotel Syracuse & War Memorial Audit., Syracuse, N. Y.

Sept. 4-8: Reaction Mech. Conf.; Brookhaven Nat'l. Lab., Upton, N. Y.

Sept. 9-14: 142nd Mtg. of American Chemical Soc.; Atlantic City, N. J.

Sept. 11-13: EIA Mtg.; Biltmore Hotel, New York, N. Y.

Sept. 13-14: 6th Nat'l. Symp. on Eng'g. Writing & Speech, IRE(PGEWS); Mayflower Hotel, Washington, D. C.

Sept. 16-20: Mtg. Electrochemical Soc.; Statler-Hilton Hotel, Boston, Mass.

Sept. 17-18: Hydrofoil & Air Cushion Vehicles, IAS; Shoreham Hotel, Washington, D. C.

Sept. 24-26: Nat'l. Power Conf., ASME, AIEE; Lord Baltimore Hotel, Baltimore, Md.

Sept. 26-29: Materials & Equip. & White Wares Div. Fall Mtg., ACS; Bedford Springs Hotel, Bedford, Pa.

Sept. 27: New Look at Thermosets, Binghamton Sec. SPE; Hotel Casey, Scranton, Pa.

Sept. 28-29: 12th Annual Fall Symp., PGB; Willard Hotel, Washington, D. C.

MIDWEST

Sept. 1-3: ARRL Delta Div. Conv.; Jung Hotel or Fountainbleu Motel, New Orleans, La.

Sept. 9-14: Petroleum Industry Conf., AIEE, ISA; Carter Hotel, Cleveland, Ohio

Sept. 9-14: Semi-Annual Mtg., ASP; Chase-Park Plaza Hotels, St. Louis, Mo.

Sept. 12-15: Enamel Div. Fall Mtg., ACS; French Lick-Sheraton Hotel, French-Lick, Ind.

Sept. 13-14: Joint Eng'g. Management Conf., ASME; Roosevelt Hotel, New Orleans, La.

Sept. 18-19: 1962 Conf. on Rectifiers in Industry, AIEE; Deshler-Hilton Hotel, Columbus, Ohio

Sept. 19-20: 11th Annual Industrial Electronics Symp., IRE, PGIE; Chicago, Ill.

WEST

Sept. 9-14: Nat'l. Tech. Conf., IES; Statler-Hilton Hotel, Dallas, Tex.

Sept. 13-14: Nat'l. Topical Mtg. on Plutonium as a Power Reactor Fuel; Richland, Wash.

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Sept. 18-20: Ordnance Environmental Symp. (unclassified), R&D Div., Dept of the Army; Granada Hotel, San Antonio, Tex.

Sept. 23-26: Peetroleum Mech. Eng'g. Conf., ASME; Sheraton - Dallas Hotel, Dallas, Tex.

Sept. 25-28: Power Systems Conf., ARS; Miramar Hotel, Santa Monica, Calif.

Sept. 30-Oct. 5: 4th Pacific Area Nat'l. Mtg.; Statler-Hilton Hotel, Los Angeles, Calif.

OCTOBER

EAST

Oct. 1-2: Annual Mtg., Engrs. Council for Professional Development; Bellevue Stratford Hotel, Phila., Pa.

Oct. 1-3: 8th Nat'l. Communications Symp., IRE; Municipal Audit. & Hotel Utica, Utica, N. Y.

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Oct. 1-4: Northeast Region Conf., NACE; Hotel Sheraton Ten Eyck, Albany, N. Y.

Oct. 2-4: Nat'l. Symp. on Space Electronics & Telemetry, IRE; Fontainebleau Hotel, Miami Beach, Fla.

Oct. 3-6: Annual Mtg., OSA; Manger Hotel, Rochester, N. Y.

Oct. 4-5: Fuels Conf., ASME, AIME; Penn Sheraton Hotel, Pittsburgh, Pa.

Oct. 4-6: Refractories Div. Fall Mtg., ACS; Bedford Spring Hotel, Bedford, Pa.

Oct. 9-12: Electronics Div. Fall Mtg., ACE; Statler-Hilton Hotel, Boston, Mass.

Oct. 12-13: Photographic Electronic Symp., SPSE; Washington, D. C.

Oct. 15-16: NAB Fall Conf.; Dinkler-Plaza, Atlanta, Ga.

Oct. 15-17: Conf. on Electrical Insulation, Nat'l. Academy Science & Nat'l. Research Council; Hershey Hotel, Hershey, Pa.

Oct. 15-19: 17th Int'l. Instrument-Automation Conf. & Exhib. & ISA Annual Mtg., ISA; New York Coliseum, New York, N. Y.

Oct. 16-18: Lubrication Conf., ASME, ASLE; Pittsburgh Hilton Hotel, Pittsburgh, Pa.

Oct. 16-18: Nat'l. Conf. on Standards, ASA; Biltmore Hotel, New York, N. Y.

Oct. 18-19: Regional Conf., AIIE; Hotel Lafayette, Buffalo, N. Y.

Oct. 18-19: NAB Fall Conf.; Biltmore Hotel, New York, N. Y.

Oct. 22-24: East Coast Conf. on Aerospace & Navigational Electronics (ECCANE), IRE, PGANE; Baltimore, Md.

Oct. 25-26: NAB Fall Conf.; Statler-Hilton Hotel, Washington, D. C.

Oct. 25-27: 1962 Electron Devices Mtg., IRE, PGED; Sheraton Park Hotel, Washington, D. C.

Oct. 29-31: Mtg. Soc. of Rheology; Johns Hopkins Univ., Baltimore, Md.

Oct. 29-Nov. 2: World Metal Show & 44th Nat'l. Metal Cong., ASM; Coliseum, New York, N. Y.

Oct. 29-Nov. 2: Annual Conv., Soc. for Nondestructive Testing: Hotel Commodore, New York, N. Y.

Oct. 30: Annual Dinner, AICE; Waldorf-Astoria Hotel, New York, N. Y.

MIDWEST

Oct. 1-4: Nat'l. Fall Mtg., AWS; Hotel Schroeder, Milwaukee, Wis.

Oct. 2-4: 3rd Symp. on Advanced Propulsion Concepts, Cincinnati, Ohio

Oct.—Midwest (Cont.)

Oct. 7-9: Basic Science Div. Fall Mtg., ACS; Battelle Memorial Inst., Columbus, Ohio
Oct. 7-12: Fall General Mtg., AIEE; Pick-Congress Hotel, Chicago, Ill.
Oct. 8-10: Nat'l. Electronics Conf., IRE, AIEE, EIA; McCormick Place, Chicago, Ill.
Oct. 8-12: ASCE Annual Mtg. & Nat'l. Transp. Eng'g. Conf.; Statler Hotel, Detroit, Mich.
Oct. 9-11: North Central Region Conf., NACE; Detroit, Mich.
Oct. 10-11: Magnetohydrodynamics Conf.; Mich. State Univ., E. Lansing, Mich.
Oct. 11-12: Southeast Regional Conf., NACE; Birmingham, Ala.
Oct. 15-18: Symp. on Space Phenomena & Measurements, IRE, AEC, NASA; Detroit, Mich.
Oct. 15-17: Materials Handling Conf., ASME; Cincinnati, Ohio
Oct. 18-19: Nat'l. Conf. on Industrial Hydraulics; Sherman Hotel, Chicago, Ill.
Oct. 21-26: Semi-Annual Conv. & Equip. Exhib., SMPTE; Drake Hotel, Chicago, Ill.
Oct. 22-23: NAB Fall Conf.; Edgewater Beach Hotel, Chicago, Ill.
Oct. 23-25: Symp. on Space Phenomena & Measurement, IRE; Chicago, Ill.
Oct. 24-25: Computer Applications Symp., ARF; Morrison Hotel, Chicago, Ill.
Oct. 24-26: Annual Mtg., Soc. for Experimental Stress Analysis; Schroeder Hotel, Milwaukee, Wis.
Oct. 29-31: 15th Conf. on Electrical Techniques in Medicine & Biology, ISA, AIEE, IRE; Edgewater Beach Hotel, Chicago, Ill.

WEST

Oct. 1-5: Semi-Annual Western Eng'g. Conf. & Tool Expos., ASTME; Pan Pacific Auditorium, Los Angeles, Calif.
Oct. 4-5: Weapons Systems Technical Panorama, IAS; Dallas, Tex.
Oct. 8-12: Nat'l. Aeronautic & Space Eng'g. Mtg., Mfg. Mtg. & Exhibit, SAE; Ambassador Hotel, Los Angeles, Calif.
Oct. 10-12: 20th Annual Aerospace Electronic Expos. Report, AES; Pan-Pacific Audit., Los Angeles, Calif.
Oct. 12-13: Regional Conf., AIIE; El Cortez Hotel, San Diego, Calif.
Oct. 15-20: Pacific Coast Regional Mtg., ACS; Olympia Hotel, Seattle, Wash.
Oct. 16-19: South Central Region Conf. & Exhib., NACE; Granada Hotel, San Antonio, Tex.
Oct. 26-27: Midwest Quality Control Conf., ASQC; Statler-Hilton Hotel, Denver, Colo.
Oct. 30-Nov. 1: Conf. on Eng'g. Techniques in Missile & Spaceborne Computers, IRE; Disneyland, Anaheim, Calif.

NOVEMBER

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EAST

Nov. 1-2: Regional Conf., AIIE; Deauville Hotel, Miami Beach, Fla.
Nov. 1-3: Regional Conf. AIIE; Shoreham Hotel, Washington, D. C.
Nov. 5-7: Northeast Res. & Eng'g. Mtg. (NEREM), IRE; Boston, Mass.
Nov. 8-9: Extrusion Fundamentals as related to Polymer Structure, Newark Sec. SPE; Hotel Essex House, Newark, N. J.
Nov. 8-9: Nat'l. Mtg., ORSA; Sheraton Hotel, Phila., Pa.
Nov. 12-15: Magnetism & Magnetic Materials Conf. & Exhib., AIEE, AIP; Penn-Sheraton Hotel, Pittsburgh, Pa.
Nov. 25-30: Winter Annual Mtg., ASME; Statler-Hilton Hotel, New York, N. Y.
Nov. 26-28: Winter Mtg. & Atom Fair, ANS & AIF; Sheraton-Park & Shoreham Hotels, Washington, D. C.

MIDWEST

Nov. 1-2: Annual Instrumentation Conf.; Louisiana Polytechnic Inst., Ruston, La.
Nov. 4-7: Annual Conf. on Electronic Techniques in Medicine & Biology. IRE, AIEE, ISA; Conrad-Hilton Hotel, Chicago, Ill.
Nov. 5-9: Fall Meeting, AIMM, PE, MS; Chicago, Ill.
Nov. 10-25: World Economic Progress Assembly & Expos.; McCormick Place, Chicago, Ill.
Nov. 12-13: NAB Fall Conf.; Muehlebach Hotel, Kansas City, Mo.
Nov. 23-24: Thanksgiving Mtg. of APS; Cleveland, Ohio
Nov. 26-28: Machine Tools Conf., AIEE; Statler-Hilton Hotel, Detroit, Mich.

WEST

Nov. 1-3: Fall Mtg., Nat'l. Soc. of Prof. Engrs.; Hotel Westward Ho, Phoenix, Ariz.
Nov. 7-10: Fall Mtg., ASA; Olympia Hotel, Seattle, Wash.
Nov. 8-9: NAB Fall Conf.; Sheraton Dallas Hotel, Dallas, Tex.
Nov. 12-18: Annual Mtg. & Astronautical Expos., ARS; Pan Pacific Audit., Los Angeles, Calif.
Nov. 14-16: Material Handling Inst. Southwest Show; Dallas, Tex.
Nov. 15-16: NAB Fall Conf.; Brown Palace, Denver, Colo.
Nov. 19-20: NAB Fall Conf.; Sheraton-Portland Hotel, Portland, Pre.
Nov. 27-29: EIA Mtg.; Jack Tar Hotel, San Francisco, Calif.

DECEMBER

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16	17	18	19	20	21	22
23/30	24/31	25	26	27	28	29

Midwest West

EAST

Dec. 4-6: Eastern Joint Computer Conf. (EJCC), IRE,(PGEC), AIEE, ACM; Bellevue-Stratford Hotel, Phila., Pa.
Dec. 17: Wright Bros. Lecture; Washington, D. C.
Dec. 26-31: Space Physics Conf., ARS; Phila., Pa.
Dec. 26-31: Annual Nat'l. Mtg. & Expos. of Science & Industry, Amer. Assoc. for the Advancement of Science; Phila., Pa.

MIDWEST

Dec. 2-6: Annual Mtg., AIChE; Conrad-Hilton Hotel, Chicago, Ill.
Dec. 5-7: Electric Furnace Conf., AIMM, PE, MS; Netherland-Hilton Hotel, Cincinnati, Ohio
Dec. 11-14: Winter Mtg., ASAE; Palmer House, Chicago, Ill.

WEST

Dec. 26-29: Winter APS Mtg.; Stanford, Calif.

1962 Roster of Associations Serving the Electronic Industries

A listing of the technical and fraternal organizations for the professionally employed in the electronic arts and sciences. Shown are the name of the organization; membership; mailing address; officers; date and location of the annual meeting, and objectives.

ACOUSTICAL SOCIETY OF AMERICA—3000 Members . . . 335 E. 45th St., New York 17, N. Y., MU 5-1940 . . . R. W. Leonard, Pres. . . . Meeting, Nov. 7-10, 1962, Seattle, Wash. . . . To increase and diffuse the knowledge of acoustics and to promote its practical applications.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.—84 Members . . . 610 Shoreham Bldg., Washington 5, D. C., DI 7-2315 . . . August C. Esenwein, Pres.; Samuel L. Wright, Sec.-Treas. . . . Fall Meeting, Mid November, Phoenix, Ariz. . . . National trade association of the manufacturers of air craft, guided missiles, spacecraft, and accessories.

AMERICAN ELECTROPLATERS' SOCIETY, INC.—8000 Members . . . American Bldg., 443-445 Broad St., Newark, N. J., HU 2-3400 . . . Chester G. Borlet, Pres.; John Nichols, Exec. Sec. . . . 50th Annual Convention, June 24-27, 1963, Ambassador Hotel, Atlantic City, N. J. . . . Advancement of the theory and practice of electroplating, metal finishing, and the allied arts.

AMERICAN GEOPHYSICAL UNION—700 Members . . . 1515 Massachusetts Ave., N. W., Washington, D. C., DU 7-0900 . . . Dr. Thomas F. Malone, Pres.; Waldo E. Smith, Exec. Secy. . . . 2nd Western Nat'l Meeting, late December 1962, Stanford Univ.; Eastern Nat'l Annual Meeting, April 1963, Washington, D. C. . . . To promote, coordinate and facilitate the study of problems concerned with the figure and physics of the Earth.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—60,000 Members . . . 345 E. 47th St., New York 17, N. Y., PL 2-6800 . . . Warren H. Chase, Pres.; Nelson S. Hibshman, Secy. . . . Winter General Meeting Jan. 27-Feb. 1, 1963, New York, N. Y. . . . To facilitate the exchange of technical information between the members of the Institute.

AMERICAN RADIO RELAY LEAGUE, INC.—100,000 Members . . . 38 LaSalle Rd., W. Hartford, Conn. (203)236-2535 . . . Goodwin L. Dosland, Pres.; A. L. Budlong, Secy. & Gen. Mgr. . . . National Conv., Sept. 1-3, 1962, Portland, Ore. . . . To promote interest in amateur radio communication and experimentation.

AMERICAN SOCIETY FOR QUALITY CONTROL, INC.—14,000 Members . . . 161 W. Wisconsin Ave., Milwaukee 3, Wisc., BR 2-3347 . . . A. V. Feigenbaum, Pres.; A. W. Wortham, Exec. Secy.; W. P. Youngclaus, Jr., Adm. Secy. . . . 17th Annual Conv. & Exhibit, May 21-23, 1963, Sherman House, Chicago, Ill. . . . To promote the science and profession of quality control.

AMERICAN SOCIETY FOR METALS—34,000 Members . . . Metals Park, Ohio, (216)338-5151 . . . Carl E. Swartz, Pres.; Merrill A. Scheil, Secy.-Trustee . . . World Metal Show and National Metal Congress, Oct. 29-Nov. 2, 1962, New York Coliseum, New York, N. Y. . . . Non-profit educational society working for improved technology in every area of metalworking's materials and process engineering.

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS—42,000 Members . . . 10700 Puritan Ave., Detroit 38, Mich., UN 4-7300 . . . Wm Nordland, Pres.; Arthur Cervenka, Secy . . . Western Tool Expos. & Engineering Conf., Oct. 1-5, 1962, Pan Pacific Auditorium, Los Angeles, Calif. . . . To further research in creative manufacturing and to advance the scientific and educational progress of tool and manufacturing engineering.

AMERICAN SOCIETY FOR TESTING AND MATERIALS—11,000 Members . . . 1916 Race St., Phila. 3, Pa., LO 3-5315 . . . T. A Marshall, Jr., Exec. Secy. . . . Meeting, Sept. 30-Oct. 5, 1962, Statler Hilton Hotel, Los Angeles, Calif. . . . Promotion of knowledge of the materials of engineering, and the standardization of specifications and the methods of testing.

AMERICAN STANDARDS ASSOCIATION, INC.—2300 Members . . . 10 E. 40th St., New York 6, N. Y., MU 3-3058 . . . Frank H. Roby, Pres.; Roger E. Gay, Managing Dir. & Secy. . . . 13th National Conf. on Standards, Feb. 18-20, 1963, Biltmore Hotel, New York, N. Y. . . . Coordination and integration of voluntary national standards work to establish uniform national standards approved by ASA.

AMERICAN VACUUM SOCIETY—1200 Members . . . P.O. Box 1282, Boston 4, Mass. . . . Donald J. Santeler, Pres.; Wilfred G. Mathesin, Secy. . . . 9th Annual National Vacuum Symposium, Oct. 31-Nov. 2, 1962, Statler Hilton, Los Angeles, Calif. . . . To increase and diffuse the knowledge of vacuum science and engineering and to promote its practical applications.

ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSOCIATION—12,000 Members . . . 1624 Eye St., N.W., Washington 6, D. C., EX 3-3033 . . . Frank A. Gunther, Pres.; Col. W. J Baird, USA (Ret.), Gen. Mgr. . . . Annual Conv., June 4-6, 1963, Sheraton-Park Hotel, Washington, D. C. . . . A non-political, patriotic, non-profit organization whose main objective is to support national security through the cooperation of the military-industry team.

ASSOCIATED PUBLIC-SAFETY COMMUNICATIONS OFFICERS, INC.—2000 Members . . . 51 Government St., Mobile, Ala. . . . Joseph T. Marshall, Pres.; Howard P. Black, Secy.-Treas. . . . Meeting, Aug. 8-11, 1962, Harrison Hotel, Clearwater, Fla. . . . Betterment of public-safety communications locally, state-wide and nationally.

ASSOCIATION FOR APPLIED SOLAR ENERGY—1650 Members . . . Campus, Arizona State Univ., Temple, Ariz., WO 7-1411, Ext 397 . . . H. Walmsley, Pres.; Frank L. Snell, Secy. . . . To gather, compile and disseminate information relating to solar energy and its use.

ASSOCIATION FOR COMPUTING MACHINERY—8700 Members . . . 14 E. 69th St., New York 21, N. Y., RH 4-1779 . . . Dr. Harry D. Huskey, Pres.; Bruce Gilchrist, Secy. . . . To advance the sciences and arts of information processing.

ASSOCIATION OF ELECTRONIC PARTS & EQUIPMENT MANUFACTURERS, INC.—150 Members . . . Suite 1710, 100 S. Wacker Dr., Chicago 6, Ill., FI 6-4800 . . . Bruce Vinkemulder, Pres.; Kenneth C. Prince, Exec. Secy. . . . To foster better understanding and business practices between the manufacturers and distributors of electronic parts, equipment and related items.

AUDIO ENGINEERING SOCIETY—2315 Members . . . P.O. Box 12, Old Chelsea Sta., New York 11, N. Y., OR 5-7820 . . . H. H. Scott, Pres.; C. J. LeBel, Secy. . . . Annual Fall Convention, Oct 15-19, 1962, Barbizon-Plaza Hotel, New York, N. Y. . . . The advancement of the theory and practice of audio engineering and its closely related arts, and the dissemination of important information in this field.

ELECTRONIC INDUSTRIES ASSOCIATION—350 Companies . . . 1721 DeSales St., N.W., Washington 6, D. C., NA 8-3902 . . . L Berkley Davis, Pres.; James D Secrest, Exec. V.P. & Secy. . . . Quarterly Conf., Sept. 11-13, 1962, Biltmore Hotel, New York, N. Y. . . . Trade association for the electronics industry which provides effective liaison between industry and government and collects and tabulates marketing data.

ELECTRONIC REPRESENTATIVES ASSOCIATION—850 Members . . . 600 S. Michigan, Chicago 5, Ill., HA 7-0100 . . . Charles E. Ault, Pres.; Harry Halinton, Secy.-Treas. . . . Annual Convention and Management Conf., Jan. 20-24, 1963, Hotel Mark Hopkins, San Francisco, Calif. . . . The improvement and advancement of electronic manufacturers representatives.

FORESTRY, CONSERVATION COMMUNICATIONS ASSOCIATION—P.O. Box 357, Columbia, S. C., 253-5321 . . . Raymond M. Littlejohn, Pres.; John Tomblin, Secy.-Treas. . . . Nat'l Convention, July 17-20, 1962, Portland, Maine . . . To foster the development and progress of the art of Forestry, Conservation Communications.

INSTITUTE OF THE AEROSPACE SCIENCES, INC.—15,972 Members . . . 2 E. 64th St., New York 21, N. Y., TE 8-3800 . . . L. Eugene Root, Pres.; Robert R. Dexter, Secy. . . . Annual Meeting, Jan. 28-30, 1963, Hotel Astor, New York, N. Y. . . . To advance the aerospace sciences by disseminating technical information covering the entire range of human and automated flight.

INSTITUTE OF HIGH FIDELITY MFRS., INC.—77 Members . . . 516 Fifth Ave., New York 36, N. Y., MU 2-5131 . . . Raymond V. Pepe, Pres.; Wybo Semmelink, Secy. . . . N. Y. High Fidelity Music Show, Oct. 2-7, 1962, N. Y. Trade Show Bldg., New York, N. Y. . . . Trade Association representing the component manufacturers of high fidelity equipment.

INSTITUTE OF PRINTED CIRCUITS—60 Companies . . . 27 E. Monroe, Chicago 3, Ill., (312)RA 6-3727 . . . R. G. Zens, Pres.; R. E. Pritchard, Exec. Secy. . . . Annual Technical Session, Oct. 2-3, 1962, Congress Hotel, Chicago, Ill. . . . Advance the interests of printed circuits manufacturers.

THE INSTITUTE OF RADIO ENGINEERS, INC.—97,000 Members . . . 1 E. 79th St., New York 21, N. Y., LE 5-5100 . . . Patrick E. Haggerty, Pres.; Haraden Pratt, Secy. . . . International Convention, March 24-28, 1963 . . . Waldorf-Astoria Hotel & New York Coliseum, New York City . . . Advancement of the theory and practice of electronics, radio, allied branches of engineering, and the related arts and sciences.

INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION—2100 Members . . . 130 W. 42nd St., New York 36, N. Y., CH 4-4663 . . . Kenneth W. Smith, Pres.; Irvin Shulsinger, Secy. . . . Annual Conf., Sept. 23-26, 1962, Montreal, Canada . . . To exchange technical information, to establish standards, to improve the art and practice of municipal signaling.

THE JOINT TECHNICAL ADVISORY COMMITTEE (JTAC)—8 Members . . . 1 E. 79th St., New York 21, N. Y., LE 5-5100 . . . Ralph L. Clark, Chairman; L. G. Cumming, Secy. . . . To evaluate Information relating to the radio art for the purpose of advising Government bodies and other professional and industrial groups.

LONG ISLAND ELECTRONICS MANUFACTURERS COUNCIL—70 Members . . . P.O. Box 453, Mineola, N. Y., PY 6-0990 . . . Franklin Meyers, Pres.; John Cammarata, Secy. . . . Cooperative effort on mutual problems affecting the electronics industry on Long Island.

METAL POWDER CORE ASSOCIATION—21 Members . . . 60 E. 42nd St., New York, N. Y., MU 7-2888 . . . Meeting, Sept. 27-30, 1962, Williamsburg Inn, Williamsburg, Va. . . . Kempton R. Roll, Exec. Secy. . . . Promotion, standards, statistics.

NATIONAL ALLIANCE OF TELEVISION & ELECTRONIC SERVICE ASSOC. (NATESA)—150 Members . . . 5908 S. Troy St., Chicago 29, Ill., GR 6-6363 . . . Ralph Woertendyke, Pres. . . . Meeting, Aug. 23-26, 1962, Pick-Congress Hotel, Chicago, Ill. . . . To upgrade the industry.

NATIONAL APPLIANCE & RADIO-TV DEALERS ASSOCIATION—5000 Members . . . 1141 Merchandise Mart, Chicago 54, Ill., MI 2-5505 . . . Meeting, Jan. 11-13, 1963, Pick-Congress Hotel, Chicago, Ill. . . . To build better dealers.

NATIONAL ASSOCIATION OF BROADCASTERS—2700 Members . . . 1771 N St., N.W., Washington 6, D. C., DE 2-9300 . . . LeRoy Collins, Pres.; Everett E. Revercomb, Secy.—Treas. . . . NAB Annual Convention, Mar. 31-Apr. 3, 1963, Chicago, Ill. . . . To foster and promote aural and visual broadcasting in all its forms.

NATIONAL ASSOCIATION OF RELAY MANUFACTURERS—30 Companies . . . P.O. Box 6, Stillwater, Okla., FR 2-6211, Ext. 326 . . . H. D. Steinback, Pres.; Prof. C. F. Cameron, Exec. Dir. . . . 11th National Conf. on Electromagnetic Relays, Apr. 23-25, 1962, Oklahoma State Univ., Stillwater, Okla. . . . To disseminate information and to promote the standardization of ratings, nomenclature, and testing.

NATIONAL COMMUNITY TELEVISION ASSOCIATION, INC.—550 Members . . . 535 Transportation Bldg., 17th & H Streets, N.W., Washington, D. C., DI 7-3440 . . . 12th Annual Convention, June, 1963, Seattle, Wash. . . . Representation of the community antenna television industry.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS—57,000 Members . . . 2029 K St., N.W., Washington 6, D. C., FE 7-2211 . . . Murray A. Wilson, Pres. . . . Annual Meeting, June 19-22, 1963, Sheraton-Cleveland Hotel, Cleveland, Ohio . . . Promote the social, professional, ethical, and economic aspects of engineering as a profession.

MANUFACTURING CHEMISTS' ASSOCIATION, INC.—198 Members . . . 1825 Connecticut Ave., N.W., Washington 9, D. C., 483-6126 . . . John E. Hull, Pres.; M. F. Crass, Jr., Secy. . . . Semi-annual Meeting, Nov. 20, 1962, New York, N. Y. . . . To represent the chemical manufacturing industry of the United States and Canada.

THE P.A.'s OF RADIO, TELEVISION, AND ELECTRONIC INDUSTRY—85 Members . . . Box 62, Rosedale 22, N. Y. . . . Milt Brody, Pres.; Abe Schneiderman, Treas. . . . To promote a better understanding among management, P.A., and industry.

PHOTOGRAPH MANUFACTURERS ASSOCIATION, INC.—11 Members . . . 37 W. 53rd St., New York 19, N. Y., CI 6-2940 . . . Joseph Dworken, Pres.; A. D. Adams, Exec. Secy. . . . To foster better trade relations among prime photograph manufacturers and their suppliers, customers and consumers.

PRECISION POTENTIOMETER MANUFACTURERS ASSOCIATION—26 Members . . . 27 E. Monroe St., Chicago 3, Ill., RA 6-3727 . . . Robert C. Chase, Pres.; Raymond E. Pritchard, Exec. Secy. . . . Symposium on Precision Potentiometers, Aug. 20, 1962, Los Angeles, Calif. . . . To advance standardization.

RADIO AND TELEVISION EXECUTIVES SOCIETY—1200 Members . . . 444 Madison Ave., New York 22, N. Y., PL 8-2450 . . . To create a lasting fraternity of persons professionally engaged in radio and television broadcasting and its allied fields.

RADIO TECHNICAL COMMISSION FOR AERONAUTICS—125 Members . . . 16th & Constitution Ave., Washington 25, D. C., ST 3-8984 . . . Dr. A. L. Lebel, Chairman; L. M. Sherer, Exec. Secy. . . . Fall Assembly Meeting, Sept. or Oct., Washington, D. C. . . . A cooperative association of all U. S. Government-Industry aeronautical telecommunication agencies which conducts studies of aeronautical telecommunication problems and relater matters.

SCIENTIFIC APPARATUS MAKERS ASSOCIATION—220 Members . . . 20 N. Wacker Dr., Chicago 6, Ill., ST 2-0277 . . . Ray G. Halversen, Pres.; Richard G. Hannan, Exec. Secy. . . . Pre-WESCON Panel Discussions, Aug. 20, 1962, Statler-Hilton, Los Angeles, Calif. . . . To provide management information and environment for the interchange of this information leading to more efficient research, production and distribution.

SOCIETY OF PLASTICS ENGINEERS, INC.—9500 Members . . . 65 Prospect St., Stamford, Conn., FI 8-7528 . . . James R. Lampman, Pres.; George P. Kovach, Secy. . . . To promote the development and dissemination of technical information relating to plastics materials and plastics products.

SOCIETY OF VACUUM COATERS—205 Members . . . P.O. Box 3095, Cleveland 17, Ohio, KE 1-5050, Ext. 286 . . . B. C. Hineline, Pres.; R. G. Lux, Secy.-Treas. . . . Vacuum Metallizing.

STANDARDS ENGINEERS SOCIETY—1200 Members . . . 170 Livingston Ave., New Providence, N. J., CR 3-0290 . . . Kenneth W. Truhn, Pres.; Robert F. Franciose, Secy. . . . Meeting Sept. 10-12, 1962, Hotel Ambassador, Los Angeles, Calif. . . . To further standardization as a means of enhancing general welfare.

ULTRASONIC MANUFACTURERS ASSOCIATION—19 Members . . . 271 North Ave., New Rochelle, N. Y., BE 5-4020 . . . James R. Fisher, Pres.; H. B. Foulkes, Jr., Secy. . . . To promote the growth of the ultrasonic industry on a firm and lasting basis.

WESTERN ELECTRONIC MANUFACTURERS ASSOCIATION—325 Companies . . . 1435 S. La Cienega Blvd., Los Angeles 35, Calif., OL 5-9640 . . . William J. Miller, Pres.; William H. Heflin, Secy. . . . Annual corporate meeting of WEMA members, Aug. 22, 1962, Statler Hilton, Los Angeles, Calif. . . . To encourage and promote the recognition and development of the electronics industry in the 11 Western states.

PROFESSIONAL ENGINEERING GROUPS OF THE INSTITUTE OF RADIO ENGINEERS

AEROSPACE AND NAVIGATIONAL ELECTRONICS—3200 Members . . . George M. Kirkpatrick, Chairman . . . East Coast Conf. on Aerospace & Navigational Electronics, Oct. 22-24, 1962 . . . Baltimore, Md. . . . The application of electronics to the operation and control of air and space craft and to the navigation of all craft.

ANTENNAS & PROPAGATION—3800 Members . . . Harry Fine, Chairman . . . Technical advances in antenna and wave propagation theory and the utilization of techniques or products of this field.

AUDIO—4200 Members . . Cyril M. Harris, Chairman . . . WESCON, Aug. 21-24, 1962, Sports Arena, Los Angeles, Calif. . . . Technology of communication at audio frequencies and of the audio-frequency portion of radio-frequency systems, and the recordings and reproduction from recordings.

AUTOMATIC CONTROL—400 Members . . . John M. Salzer, Chairman . . . Joint Automatic Control Conf., June 19-21, 1963, University of Texas, Austin, Tex. . . . The theory and application of automatic control techniques including feedback control systems.

BIO-MEDICAL ELECTRONICS—2700 Members . . . George N. Webb, Chairman . . . 15th Conf. on Electrical Techniques in Medicine & Biology, Nov. 5-7, 1962, Conrad Hilton Hotel, Chicago, Ill. . . . The use of electronic theory and techniques in problems of medicine and biology.

BROADCAST & TELEVISION RECEIVERS—1700 Members . . . John F. Bell, Chairman . . . Radio Fall Meeting, Nov. 12-14, 1962, King Edward Hotel, Toronto, Canada . . . The design and manufacture of broadcast and television receivers and components and activities related thereto.

BROADCASTING—1400 Members . . . Raymond F. Guy, Chairman . . . 12 Annual Broadcast Symp., Sept. 28-29, 1962, Willard Hotel, Washington, D.C. . . . Broadcast transmission systems engineering, including the design and utilization of broadcast equipment.

CIRCUIT THEORY—6800 Members . . . James H. Mulligan, Jr., Chairman . . . International Solid State Circuits Conf., Feb. 19-23, 1963, Univ. of Pa. & Sheraton Hotel, Phila., Pa. . . . Design and theory of operation of circuits for use in radio and electronic equipment.

COMMUNICATIONS SYSTEMS—4000 Members . . . Ralph L. Marks, Chairman . . . 8th Nat'l Communications Symp., Oct. 1-3, 1962, Hotel Utica & Municipal Auditorium, Utica, N. Y. . . . Radio and wire telephone, telegraph and facsimile in marine, aeronautical, radio-relay, coaxial cable and fixed station services.

COMPONENT PARTS—1800 Members . . . Floyd E. Wenger, Chairman . . . Electronic Components Conf., May 7-9, 1963, Marriott Twin Bridges Hotel, Washington, D. C. . . . Characteristics, limitation, applications, development, performance and reliability of component parts.

EDUCATION—900 Members . . . George E. Moore, Chairman . . . WESCON, Aug. 21-24, 1962, Sports Arena, Los Angeles, Calif. . . . To foster improved relations between the electronic and affiliated industries and schools, colleges and universities.

ELECTRON DEVICES—5300 Members . . . Willis A. Adcock, Chairman . . . Electron Devices Meeting, Oct. 25-27, 1962, Sheraton Hotel, Washington, D. C. . . . Electron devices including particularly electron tubes, solid state devices, integrated electronic devices and energy sources.

ELECTRONIC COMPUTERS—9300 Members . . . Arnold A. Cohen, Chairman . . . Eastern Joint Computer Conf., Dec. 4-6, 1962, Bellevue Stratford Hotel, Phila., Pa. . . . Activities devoted to design and operation of electron computers.

ENGINEERING MANAGEMENT—4300 Members . . . Theodore W. Jaramie, Chairman . . . 10th Annual Engineering Management Conf., Sept. 13-14, 1962, Hotel Roosevelt, New Orleans, La. . . . Engineering management and administration as applied to technical, industrial and educational activities in the field of electronics.

ENGINEERING WRITING & SPEECH—1800 Members . . . John M. Kinn, Jr., Chairman . . . Nat'l Symp. on Engineering Writing & Speech, Sept. 13-14, 1962, Mayflower Hotel, Washington, D. C. . . . The study, development, improvement and promotion of the techniques for preparing, organizing for use, processing, editing, collecting, conserving and disseminating any form of information in the electronics and related fields by and to individuals and groups by any method of communication.

GEOSCIENCE ELECTRONICS—Robert W. Olson, Acting Chairman . . . Research and development in electronic instrumentation for geophysics and geochemistry, especially gravity measurements, seismis measurements, magnetics, well-logging, space exploration, meteorology, oceanography.

HUMAN FACTORS IN ELECTRONICS—700 Members . . . Robert R. Riesz, Chairman . . . Development and application of human factors knowledge germane to the design of electronic equipment.

INDUSTRIAL ELECTRONICS—1800 Members . . . J. E. Eiselein, Chairman . . . 11th Annual Industrial Electronics Symp., Sept. 19-20, 1962, Chicago, Ill. . . . Activities devoted to electronics pertaining to conctrol, treatment and measurement, specifically in industrial processes.

INFORMATION THEORY—3500 Members . . . George L Turin, Chairman . . . Int'l Symp. on Information Theory, Sept. 3-7, 1962, Brussels, Belgium . . . Information theory and its application in radio circuitry and systems.

INSTRUMENTATION—3700 Members . . . Harvey W. Lance, Chairman . . . Int'l Symp. on Precision Electro-magnetic Measurements, Aug. 14-16, 1962, Nat'l Bureau of Standards, Boulder, Colo. . . . Measurements and instrumentation utilizing electronic techniques.

MICROWAVE THEORY & TECHNIQUES—5500 Members . . . Tore N. Anderson, Chairman . . . Nat'l Symp. on Microwave Theory & Techniques, May 20-22, 1963, Miramar Hotel, Los Angeles, Calif. . . . Activities devoted to microwave theory, microwave circuitry and techniques, microwave measurements and the generation and amplification of microwaves.

MILITARY ELECTRONICS—4400 Members . . . Willie L. Doxey, Chairman . . . 4th Winter Conv. on Military Electronics, Jan. 30-Feb. 1, 1963 . . . Activities devoted to electronic sciences, systems, activities and services germane to the requirements of the military.

NUCLEAR SCIENCE—1600 Members . . . Louis Costrell, Chairman . . . Symp. on Space Phenomena & Measurements, Oct. 15-18, 1962, Statler Hilton Hotel, Detroit, Mich. . . . Application of electronic techniques and devices to the nuclear field.

PRODUCT ENGINEERING & PRODUCTION—1100 Members . . . Alfred R. Gray, Chairman . . . 6th Nat'l Symp. on Product Engineering & Production, Nov. 1-2, 1962, San Francisco, Calif. . . . New advances in methods, processes, materials and components in design and manufacture of electronic equipment.

RADIO FREQUENCY INTERFERENCE—1000 Members . . . Harold E Dinger, Chairman . . . Origin, effect, control and measurement of radio frequency interference.

RELIABILITY & QUALITY CONTROL—Louis J. Paddison, Chairman . . . 9th Nat'l Symp. on Reliability & Quality Control, Jan. 21-24, 1963, Sheraton Plaza Hotel, San Francisco, Calif. . . . Techniques of determining and controlling the quality of electronic parts and equipment during their manufacture.

SPACE ELECTRONICS & TELEMETRY—4000 Members . . . Kenneth M. Uglow, Jr., Chairman . . . Nat'l Symp. on Space Electronics & Telemetry, Oct. 2-4, 1962, Fountanebleau Hotel, Miami Beach, Fla. . . . Space science and the measurement and recording of data from remote points by electromagnetic media.

ULTRASONICS ENGINEERING—1000 Members . . . Vincent Salmon, Chairman . . . Ultrasonics Symp., Nov. 29-30, 1962, New York, N. Y. . . . Ultrasonic measurements and communications, including underwater sound, ultrasonic delay lines and various chemical and industrial ultrasonic devices.

VEHICULAR COMMUNICATIONS—1700 Members . . . Richard P. Gifford, Chairman . . . Annual Vehicular Communications Conf., Dec. 6-7, 1962, Mayfair Hotel, Los Angeles, Calif. . . . Communications problems in the field of land and mobile radio services, including public safety, public utilities, railroads, commercial and transportation, etc.

New Electronic Standards

A listing of the electronic standards issued during the 12-month period, June 1961 to May 1962, by the American Society for Testing and Materials, the American Standards Association, the Electronic Industries Association, and the Institute of Radio Engineers are given. Copies of standards listed may be obtained by contacting the issuing group directly.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 257-61—Methods of Test for Electrical Resistance of Insulating Materials

D 1674-61—Methods of Testing Polmericable Embedding Compounds Used for Electrical Insulation

D 1825-61 T—Recommended Practice for Etching and Cleaning Copper-Clad Thermosetting Laminates for Electrical Testing

D 1867-61 T—Specifications for Copper-Clad Thermosetting Laminates for Printed Wiring

D 1930-61 T—Specification for Kraft Dielectric Tissue, Capacitor Grade

F 23-62 T—Recommended Practice for Temperature Measurement of Thermionic Emitters

F 128-61 T—Methods of Testing Sleeves and Tubing for Electron Tube Cathodes

F 238-61 T—Recommended Practice for Cathode Melt Prove-in Testing

F 239-62 T—Specification for Nickel Alloy Cathode Sleeves for Electronic Devices

F 278-61 T—Test for Sublimation Characteristics of Metallic Materials by Electrical Resistance

F 300-61 T—Methods of Measuring Cathode Interface Impedance Characteristics of Electron Tubes

F 7-61 T—Specification for Aluminum Oxide Powder

F 652-61 T—Methods for Measuring Mica Stampings Used in Electronic Devices and Incandescent Lamps

F 1-62 T—Specification for Clear Nickel-Clad and Nickel-Plated Steel Strip for Electron Tubes

F 2-62 T—Specification for Aluminum-Clad Steel Strip and Nickel-Steel-Aluminum Composite Strip for Electron Tubes

F 4-62 T—Specification for Carbonized Nickel Strip and Carbonized Nickel-Plated and Nickel-Clad Steel Strip for Electron Tubes

F 20-62 T—Specification for High Conductivity Composite Aluminum-Steel-Copper for Electron Tubes

F 16-61 T—Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps

F 288-61 T—Specification for Tungsten Wire for Electronic Devices and Lamps

F 290-62—Specification for Round Wire for Use as Grid Lateral Winding Wire in Electron Tube Grids

F 14-61 T—Recommended practice for Making and Testing Reference Glass - Metal - Band-Seal

F 15-61 T—Specifications for Iron-Nickel-Cobalt Sealing Alloy

F 18-61 T—Method for Evaluation of Glass-to-Metal Headers for Electron Devices

F 19-61 T—Method for Tension and Vacuum Testing Metallized Ceramic Seals

F 21-62 T—Test for Hydrophobic Surface Films: The Atomizer Test

F 24-62 T—Method for Measuring and Counting Particulate Contamination on Surfaces of Small Electronic Components

AMERICAN STANDARDS ASSOCIATION (ASA)

C16.13-1961—American Standard Methods of Testing Monochrome Television Broadcast Receivers

C16.33-1962—Method of Measurement of Differential Gain and Differential Phase (60 IRE 23.S1)

C83.22-1962—Polarized Dry Aluminum Electrolytic Capacitors for General Use (EIA RS-154-B)

C16.5-1954 (F1961)—Volume Measurements of Electrical Speech and Program Waves

C16.11-1949 (R1961)—Methods of Testing Antennas (48 IRE 2.S2)

C16.12-1949 (R1961)—Methods of Testing Frequency-Modulation Broadcast Receivers (47 IRE 17.S1)

C16.18-1951 (R1961)—Methods of Testing Vehicular Communications Receivers (49 IRE 16.-S1)

C16.19-1951 (R1961)—Methods of Testing Amplitude-Modulation Broadcast Receivers (48 IRE 17.S1)

C16.20-1951 (R1961)—Methods of Measurement of Television Signal Levels, Resolution, and Timing of Video Switching Systems

C16.23-1954 (1961)—Methods of Measurement of Aspect Ratio and Geometric Distortion of Television Cameras and Picture Monitors (54 IRE 23.S1)

C60.4-1950 (R1961)—Designation System for Metal Electron Tube Shells (RETMA ET-112; NEMA 508)

C60.8-1952 (R1961)—Rating Values of Interelement Capacitances (RETMA ET-114; NEMA 510)

C83.2-1949 (R1961)—Preferred Values for Components for Electronic Equipment (RETMA GEN 102)

C83.3-1951 (R1961)—Terminology for Piezoelectric Crystals (49 IRE 14.S1)

C83.6-1955 (R1961) — Recommendations for Fixed Wire Wound Resistors (RETMA REC-117)

C83.7-1955 (R1961)—Recommendations for Variable Control Resistors (RETMA REC-121-B)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

RS-206-A—Recommended Practice for Preparation of Basing or Terminal Diagrams July 1961, \$.60

RS-212-A—Numbering of Electrodes and Designation of Units in Electron Tubes, October 1961, \$.25

RS-217-A—Wound Cut Cores, July 1961, \$.70

RS-235-A—Color Code for Traveling Wave Tube Wired Leads, October 1961, \$.25

New Standards *(Concluded)*

RS-241—Outlines for Semiconductor Devices, July 1961, $.25
RS-242—Definitions for Electromagnetic Delay Lines, June 1961, $.40
RS-243—Color Coding for Stereo Pick-up Leads, July 1961, $.25
RS-244—Character codes for Numerical Machine Tool Control Perforated Tape, July 1961, $.50
RS-245—Letter Symbols and Abbreviations for Semiconductor Data Sheets and Specifications, July 1961, $.80
RS-246—Environmental Method of Life Testing Lead Mounted Semiconductor Power Rectifiers, July 1961, $.25
RS-247—Analog-to-Digital Conversion Equipment, October 1961, $.25
RS-248—Case Temperature Measurements by Manufacturers of Hex Base Silicon Rectifiers, October 1961, $.25
RS-249—Temperature Measurements by Users of Silicon Rectifiers, October, 1961, $.25
RS-250—Electrical Performance Standards for Television Relay Facilities, October 1961, $1.10
RS-251—Test to Determine Temperature Rise as a Function of Current in Printed Conductors, October 1961, $.50
RS-252—Baseband Characteristics of the Microwave Radio and Multiplex Equipment, October 1961, $1.70
RS-253—Temperatures for Electrical Measurement and Rating Specification Semiconductor Devices, December 1961, $.25
RS-254—Precision Reel for Instrumentation Use, December 1961, $.30
RS-255—Simulated Life Test Circuit for Semiconductor Rectifier Diodes, January 1962, $.25
RS-256—Deflecting Yokes for Cathode Ray Tubes, January 1962, $.80
RS-257—Mercury Warning Label, February 1962, $.25
RS-258—Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 ohms, March 1962, $.60
RS-259—Rigid Coaxial Transmission Lines and Connectors, 75 ohms, March 1962, $.60

INSTITUTE OF RADIO ENGINEERS (IRE)

61 IRE 14.S1—Piezoelectric Crystals: Measurements of Piezoelectric Ceramics
61 IRE 23.S1—Video Techniques: Definitions of Terms Relating to Television
61 IRE 23.S1—Solid State Devices: Definitions of Terms for Non-Linear Capacitors
61 IRE 28.S2—Solid State Devices: Measurement of Minority-Carrier Lifetime in Germanium and Silicon by the Method of Photoconductive Decay
61 IRE 27.S1—Radio Interference: Methods of Measurement of Conducted Interference Output to the Power Line from FM and Television Broadcast Receivers in the Range 300 KC to 25 MC
61 IRE 30.RP1—Recommended Practices on Audio and Electroacoustics: Loudspeaker Measurements
62 IRE 7.S1—Electron Tubes: Methods of Testing
62 IRE 28.S1—Solid State Devices: Definitions of Superconductive Electronics Terms
62 IRE 27.S1—Radio Interference: Measurement of Radio Noise, Generated by Motor Vehicles and Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MC

Statistics

U. S. Domestic Exports of Electronic Products, 1959-1961

(Value in thousands of dollars)

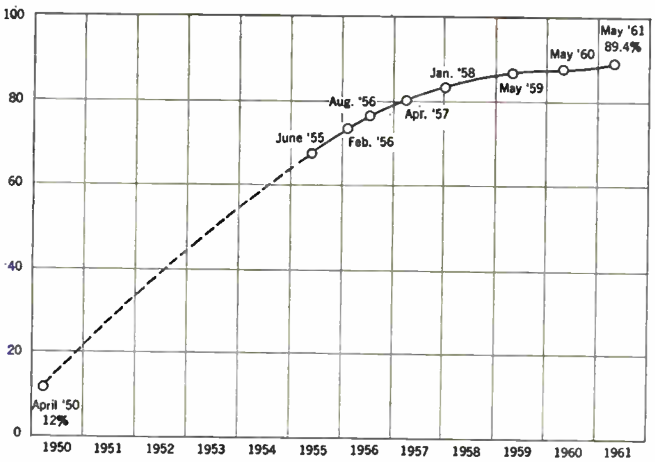
COMMODITY	1959	1960	1961[1]
Total	400,725	466,462	613,031
Consumer electronic products, total	76,394	71,382	81,384
Television receivers and chassis:			
Television receivers	17,631	14,713	16,809
Television receiver chassis	2,901	3,968	11,468
Radio receivers and chassis:			
Automobile receivers	1,782	1,395	2,015
Home-type receivers	4,086	2,861	3,616
Radio receiver chassis	935	876	735
Radio-phonographs	916	515	726
Phonographs, parts, and accessories:			
Coin-operated	13,164	12,419	12,409
Other	3,108	2,346	2,055
Parts and accessories	6,864	5,838	5,146
Phonograph records and blanks	10,704	10,682	8,176
Recorders, parts, and accessories	10,986	12,971	14,603
Other	3,317	2,798	3,626
Commercial, industrial, and military electronic equipment, total[2]	210,860	252,328	362,687
Radio and television broadcast equipment	18,456	20,838	23,455
Radio communication equipment (airborne, shipborne, land)	90,691	94,249	107,445
Detection and navigational equipment	45,809	50,538	72,268
Other	55,904	86,703	159,519
Components, total	113,471	142,752	168,960
Electron tubes and parts, total	49,326	64,091	66,019
Receiving	14,671	14,382	16,400
Television picture	13,757	21,304	21,320
Power and special purpose	15,911	21,609	22,028
Tube parts, except blanks	4,987	6,796	6,271
Semiconductor devices	9,148	15,973	20,788
Other	54,997	62,688	82,153

[1] Preliminary.
[2] Excluding exports to the U.S. armed forces and diplomatic missions abroad for their own use.
Source: Bureau of the Census: Report No. FT-410 and preliminary unpublished data.

of the Electronic Industries

GROWTH in TELEVISION PENETRATION

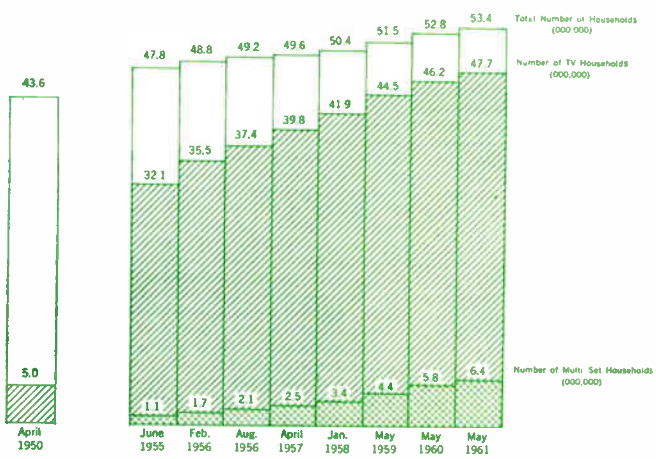
Percentage of households having TV, 1950-1961



Source: Estimates by Advertising Research Foundation based on data from U. S. Bureau of the Census.

GROWTH in TELEVISION HOUSEHOLDS

Number of homes having TV, 1950-1961



Source: Estimates by Advertising Research Foundation based on data from U. S. Bureau of the Census.

Electronic Output in 1947 and 1950-62[1]

(In millions of dollars)

Year	Consumer-type radio & TV receivers & related products[2]	All other electronic equipment[3]	Electron tubes	Semi-conductor devices	Electronic components other than tubes and semi-conductors
1961	1,780p	4,900p	850p	580p	2,120p
1960	1,850	4,570	860	540	2,000
1959	1,790	4,000	865	395	1,750r
1958	1,350	3,250	790	210	1,340
1957	1,500	3,100	820	150	1,450
1956	1,470	2,800	790	90	1,360
1955	1,500	2,500	770	40	1,360
1954	1,420	2,470	690	25	1,275
1953	1,593	2,503	734	25	1,445
1952	1,340	2,330	690	20	1,110
1951	1,296	843	473	(4)	788
1950	1,687	473	443	(4)	697
1947	810	469	122	(4)	349

p—Preliminary. r—Revised.

[1] Data cover manufacturers' shipments. The totals represent the factory value of production or shipments (output) of electronic products, whether incorporated in other products or used in maintenance and repair of end equipment.

[2] Not including sales of phonograph records and magnetic tape.

[3] Not including payments on research and development contracts or electronic services.

[4] Data for years prior to 1952 are included in "Electronic components other than tubes and semiconductors."

Source: Bureau of the Census; Electronic Industries Association Marketing Data Department; Electronic Division, BDSA; and other sources.

Financial obligations for basic research, by selected agency, fiscal years 1960, 1961, and 1962

Agency	Actual 1960	Estimates 1961	Estimates 1962
Total (millions of dollars)	$741	$969	$1,416
	Percent distribution		
National Aeronautics and Space Administration	29	34	48
Department of Defense	24	19	15
Atomic Energy Commission	14	13	10
Department of Health, Education, and Welfare	14	14	12
National Science Foundation	9	8	8
All other agencies	10	12	7

Note: Detail may not add to totals because of rounding.

ELECTRONIC INDUSTRIES

STATISTICS *(Continued)*

Imports of Electronic Products, Total, 1959-1961

(Value in thousands of dollars)

COMMODITY	1959	1960	1961[2]
Photocells and electron tubes and parts, except television, X-ray and radio	1,358	2,394	3,816
Television apparatus and parts, total	1,302	3,502	5,817
Cameras and parts	227	1,092	484
Tubes and parts[3]	387	464	1,428
Other	688	1,946	3,905
Radio apparatus and parts, total	72,724	92,653	111,188
Portable radios (except transistor)	n.s.s.	2,512	1,784
Transistor radios	n.s.s.	55,849	66,688
Other radios (except radio-phonographs)	n.s.s.	9,303	13,424
Radio tubes	n.s.s.	10,099	12,524
Other	n.s.s.	14,890	16,768
Phonographs, gramophones, graphophones, and similar articles, n.s.p.f.	1,813	1,329	647
Parts, n.e.s., for phonographs, etc.	963	573	376
Records for phonographs, etc.	3,551	3,714	4,119
Subtotal	81,711	104,165	125,963
New classes established January 1, 1960:[4]			
Electrical or electronic testing, recording, checking, analysing or automatically controlling instruments, apparatus and parts	—	8,767	6,878
Radar equipment	—	4,434	10,561
Sound equipment or devices and parts:			
Loudspeakers[5]	—	1,747	2,320
Radio-phonographs (complete units)	—	8,643	12,940
Record players and parts (including record changers, turntables, pick up cartridges, motor assemblies and other parts, except loudspeakers)	—	9,787	14,219
Other articles and parts utilizing an electronic transducer device (including microphones, amplifiers, megaphones, hi-fi equipment, etc., n.e.s.	—	4,842	6,387
Subtotal	n.a.	38,220	53,305
TOTAL	n.a.	142,385	179,268

[1] Items which can be separately identified in the U.S. import statistics; certain electronic products are reported in heterogeneous groups according to the material from which they are made and hence excluded, e.g. television picture tubes and semi-conductors.

[2] Preliminary.

[3] Excluding tube blanks and television picture tubes.

[4] Prior to 1960, these items were included in "basket classifications" not solely electronic products.

[5] Not including loudspeakers designated as and imported as parts of television and radio receivers.

n.e.s.—Not elesewhere specified.

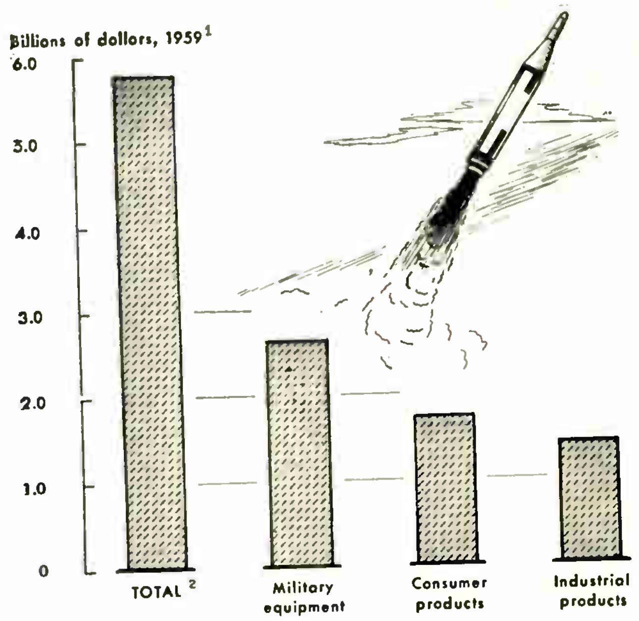
n.s.p.f.—Not specially provided for.

n.s.s.—No separate statistics.

Source: U. S. Bureau of the Census. Report No. FT-110 and preliminary unpublished data.

Electronics Manufacturing Occupations

Military Equipment Represents Almost One-Half of Total Electronics Output

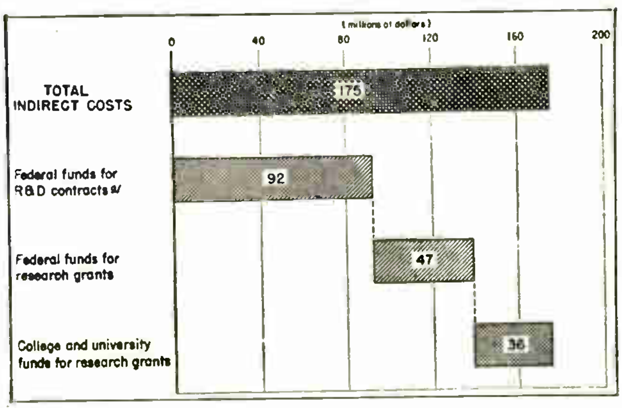


[1] Estimates of value of output based on data from the U. S. Department of Commerce. Business and Defense Services Administration.

[2] Excludes research and development expenditures, and sales of phonograph records and magnetic tape.

Military spending continues to dominate spending for electronic products, as it did in the recent year shown above. Since consumer and industrial spending for electronic products has continued to grow also, job opportunities in the electronics field should keep on increasing. The U. S. Department of Labor estimates job opportunities will be particularly good until 1970 for scientists, engineers, technicians and skilled craftsmen (1961 Occupational Outlook Report Series, Bulletin No. 1300-35, "Employment Outlook in Electronics Manufacturing Occupations").

Federal Research—Indirect Costs



Source: U. S. Bureau of the Budget.

a Generally, the indirect costs of R&D contracts are completely covered by Federal funds, except that slight variations may occur due to negotiation of individual contracts.

Graph shows indirect costs of federally sponsored research and development in colleges and universities, by source of support, fiscal year 1962. Indirect costs amount to about 30% of the direct costs of a project, according to Bureau of the Budget system for computing costs. Indirect costs are those which, because of their general or supporting nature, cannot be directly assigned to a particular service performed.

Cinch ELECTRONIC COMPONENTS

CONNECTORS, ENGINEERED FOR **SPECIFIC** RELIABILITY REQUIREMENTS.

TYKON EDGE CONNECTOR is what it's called.

TYKON is designed for double-sided .062" printed circuit boards.

TYKON is miniature in size. Contacts are spaced on .050" centers.

TYKON ribbon-type flexing action contacts guarantee a new plateau of reliability. (A flat surface yields more points of contact over an area than a round surface does on a line.)

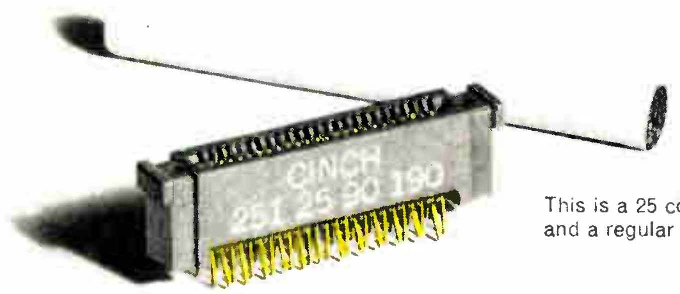
TYKON is ideal for all high density connection jobs including: diodes on insulating substrates; memory planes (standard and thin film types); and almost any type of modular plug-in unit.

TYKON is furnished with conventional wiring tails. It can also be made available with tails for wire wrapping or dip soldering.

TYKON is available in various sizes with 6 to 25 contact positions.

For additional information on this connector, or any connector requirement, write us at our Chicago office or contact your local Cinch representative.

HERE IT IS!
A NEW PLATEAU OF RELIABILITY FOR HIGH DENSITY CONNECTORS



This is a 25 contact position **TYKON** and a regular cigarette **in actual size**

FEATURES:

- **CONTACT MATERIAL**—PHOSPHOR BRONZE, FLAT RIBBON
- **CONTACT FINISH**—COPPER FLASH PLUS .00003 GOLD PLATE PER MIL-G-45204 TYPE II.
- **INSULATOR MATERIAL**—GLASS-FILLED ALKYD TYPE: MAI-30 PER MIL-M-14F

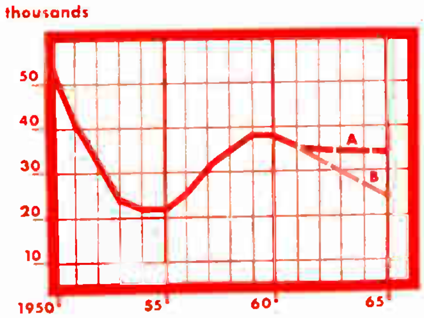
Circle 1 on Inquiry Card

CINCH MANUFACTURING COMPANY
1026 South Homan Avenue, Chicago 24, Illinois
Plants located at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

DOT A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

STATISTICS

FIRST ENGINEERING DEGREES

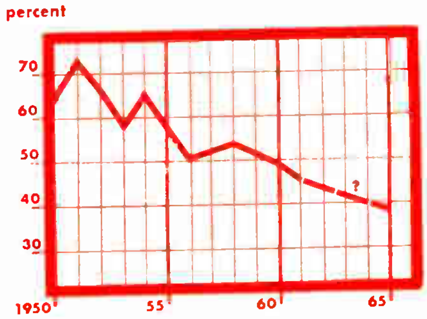


Source: Data obtained from Engineering Manpower Commission.

Above graph shows number of BS degrees awarded college engineering students since 1950 and projection to 1965 based on continuation of present rate of decrease (A) or stabilization at present level (B).

RETENTION RATES

First degrees as a % of freshmen enrolled four years earlier



Source: Data obtained from Engineering Manpower Commission.

Graph shows percentage of total freshman enrollment of all college engineering classes receiving BS degrees in their senior years since 1950. Projection is included to 1965, based on current retention rate decrease.

RESEARCH & DEVELOPMENT AGENCY OBLIGATIONS—FISCAL YEAR 1961

(millions of dollars)

Agency	Total Research	Basic Research	Development
TOTAL, ALL AGENCIES	2,295	969	6,701
Dept. of Defense	872	187	5,567
Dept. Health, Educ., Welf.	432	140	3
NASA	392	327	398
AEC	229	128	634
Dept. of Agric.	165	67	5
NSF	77	77	—
Dept. of Int.	67	26	9
FAA	7	—	60
Other	54	17	25

Includes $0.2 billion for pay and allowance of military personnel in research and development which have not been allocated to research or development.

Source: National Science Foundation.

EMPLOYMENT IN INDUSTRIES ENTIRELY ENGAGED IN PRODUCING ELECTRONIC PRODUCTS

(Thousands of employees)

Period		Total	Radio and TV receiving sets	Radio and TV communication equipment	Electron tubes	Electronic components n.e.c.
1960	January	591.8	119.5	244.7	79.3	148.3
	February	586.9	116.2	243.9	78.0	148.8
	March	579.8	110.4	243.6	77.9	147.9
	April	570.7	104.1	242.0	77.4	147.2
	May	570.3	107.6	238.8	76.3	147.6
	June	576.2	109.8	240.9	76.3	149.2
	July	575.5	109.1	243.0	74.7	148.7
	August	590.8	115.5	248.0	75.2	152.1
	September	597.5	119.1	250.3	75.3	152.8
	October	590.2	115.6	249.3	72.6	152.7
	November	591.9	112.0	254.6	74.1	151.2
	December	574.3	99.5	256.0	69.7	149.1
1961	January	578.0	102.9	253.1	72.5	149.5
	February	578.6	103.4	251.9	72.0	151.3
	March	575.2	100.3	250.1	71.8	153.0
	April	574.1	98.5	249.7	71.5	154.4
	May	580.5	104.2	249.5	71.6	155.2
	June	584.9	107.9	251.2	71.4	154.4
	July	583.1	111.7	248.5	70.8	152.1
	August	599.0	120.6	251.5	71.3	155.6
	September	609.3	125.8	254.9	71.6	157.0
	October	619.2p	128.2p	260.0p	72.0p	159.0p

p—Preliminary.

Source: Bureau of Labor Statistics.

The largest part of the electronics workforce is concentrated in the four industries shown above, which only produce electronic products. However, large numbers of workers engaged in electronic production are employed in the ordnance, office equipment, electrical instruments, and other industries.

Percentage Radio Sets Per Household in U. S.

1960 Census Study

Total number of radios per household: first response	Total number of radios per household, from intensive interview: Total	None	1	2	3	4	5	6 or more
Total	100.0	6.3	43.1	27.8	12.8	6.1	2.1	1.8
None	7.4	6.3	0.9	0.2				
1	49.9	—	42.1	6.5	0.9	0.3	0.1	—
2	25.6	—	—	21.1	3.4	0.8	0.2	0.1
3	10.0	—	—	0.1	8.2	1.2	0.3	0.2
4	4.6	—	—	—	0.1	3.7	0.5	0.3
5	1.3	—	—	—	—	—	1.1	0.2
6 or more	1.1	—	—	—	—	—	—	1.1

Includes radios not in working order. Based on households for which both first responses and results of intensive interviews are available. Only standard household and portable radios included. Excludes car radios, sending-receiving sets, short-wave and crystal sets.

Federal Research and Development Indirect Costs

(Operating Costs)

Source of support	(Dollar amounts in thousands) Amount: Total	Contracts	Grants	Percent distribution: Total	Contracts	Grants
Total	$362,529	$208,109	$154,420	100.0	100.0	100.0
Atomic Energy Commission	39,254	35,761	3,493	10.8	17.2	2.3
Department of Defense	154,487	153,829	658	42.6	73.9	0.4
Department of Health, Education, and Welfare	114,536	3,920	110,616	31.6	1.9	71.6
National Science Foundation	35,864	188	35,676	9.9	0.1	23.1
Other	18,388	14,411	3,977	5.1	6.9	2.6

Compiled above are the operating expenses for separately budgeted research and development projects for 93 large colleges and universities, according to source of Federal support, for fiscal year 1960. These operating expenses represent part of the indirect costs of running these projects, that is, the costs which cannot be charged against any particular service performed. They are expenses incurred for operating and maintaining the institutions' physical plants.

CONNECTORS, ENGINEERED FOR SPECIFIC RELIABILITY REQUIREMENTS

Multiple—contact and sub-miniature connectors and sockets . . . printed circuit board connectors and sockets . . . transistor sockets . . . tube sockets and shields . . . "Jones" plugs, sockets and barrier terminal strips . . . radio hardware.

HEAT DISSIPATING TUBE SHIELDS

Seven and nine pin miniature series for various applications. Designed to meet requirements of MIL-S-9372C (USAF); MIL-STD-242B (Ships); MIL-S-19786B (Navy); and SCL-6307/2 (Signal Corps.). **Details furnished on request.**

Under license arrangement with International Electronic Research Corporation.

TRANSISTOR SOCKETS

Cinch transistor sockets available include: miniature/sub-miniature types; power transistor sockets with integral mounting eyelets permitting easy assembly to chassis; universal types which accommodate .2" x .1" triangular bases and .048 x .192 three-contact in-line; and other types for various standard base configurations. **Details furnished on request.**

PRINTED CIRCUIT SOCKETS

Sockets accommodate these types of receiving tubes: Octal; miniature; sub-miniature, both flat press and button; transistor and numerous other types. **Details furnished on request.**

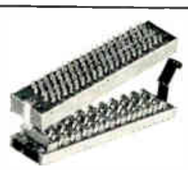
NUVISTOR TUBE SOCKETS

Designed for: low insertion force; contact protection; and minimum space. Tube cannot be inserted incorrectly, even by "feel." Socket saddle provides spring elements which effectively ground tube envelope to panel. Two types: rivet-mounted or crimp-mounted to chassis, eliminating screws and/or rivets (crimp-mounted socket is polarized by placement of cutout, facilitating automatic assembly). **Details furnished on request.**

ALL-MOLDED OCTAL SOCKET

Standard octal socket molded in a single Bakelite casting. Contacts are of brass, cadmium plated. Mica insulation with brass or phosphor bronze contacts can be made available. Choice of two contact layouts. **Details furnished on request.**

CINCH HINGE CONNECTORS



Eliminate contact damage caused by high insertion and extraction forces encountered with conventional multi-contact connectors. Available with 20-100 contacts.

Ingenious hinge-and-latch principle is foolproof, provides added reliability. Positive contact is maintained because of the unique wiping action of the contacts. Various companion hoods also available. **Details furnished on request.**

CINCH GOLDEN "D"* MONOBLOCK CONNECTORS

Monoblock insulators, probe-proof closed-entry socket contacts, mates with standard "D", available in 9, 15, 25, 37 and 50 contacts sizes. In general, meets requirements of MIL-C-8384B. Mark I utilizes solder pot contacts and Mark II has crimp-type snap-in contacts. Mating hermetically sealed plugs also available. **Details furnished on request.**

**Under license arrangement with Cannon Electric Company.*

TYKON EDGE CONNECTORS
for high-density application

Guaranteed high reliability. Designed for double-sided .062" printed circuit boards with contacts spaced on .050" centers. Flexing action ribbon-type contacts assure maximum contact. Ideal for memory planes and modular plug-in units. 6 to 25 contact positions. **Details furnished on request.**

BLUE Ribbon* AND MICRO-RIBBON* CONNECTORS

These versatile reliability-proven connectors utilize double-sided, flexing-action, self-wiping contacts to assure positive contact of both mating members. Both rack-and-panel types and cable-to-chassis types are available. Size (no. contacts): Micro-Ribbon—14, 24, 36, 50; Blue Ribbon—8, 16, 24, 32. **Details furnished on request.**

**Registered trademarks of Amphenol-Borg Electronics Corporation.*

BIFURCATED CONTACT EDGE CONNECTORS

Bifurcation provides two wiping contact surfaces, guaranteeing positive contact. Recommended for severe environmental conditions such as vibration; also overcomes effects of printed circuit board irregularities. Mounting hole styles; floating bushing, molded-in bushing and plain-hole types. Conventional wiring tail or dip solder termination in sizes from 6 to 25 contact positions, single or double row. Insulation is glass-filled diallyl phthalate. Meets applicable requirements of MIL-C-21097A. Polarizing keys available. **Details furnished on request.**

WRAPOST TERMINATION PRINTED CIRCUIT CONNECTORS

For 1/16" copper-clad laminated board. Similar in construction to bifurcated connector illustrated above except without bifurcation feature. Wiring tail consists of a long, rigid ribbon conditioned for wire-wrapping. Polarizing keys can be furnished as described above. **Details furnished on request.**

"JONES" PLUGS, SOCKETS, BARRIER TERMINAL STRIPS

"Jones" products have been an industry standard for over a generation. "300" series for light duty service, 2-33 contacts. "500" series for heavy duty to 5kv, 25 amps, 2-12 contacts. "2400" series designed for highest obtainable electrical and mechanical performance, 2-12 contacts. Also available: barrier terminal strips and fanning strips. **Literature furnished on request or see your local electronic component distributor.**

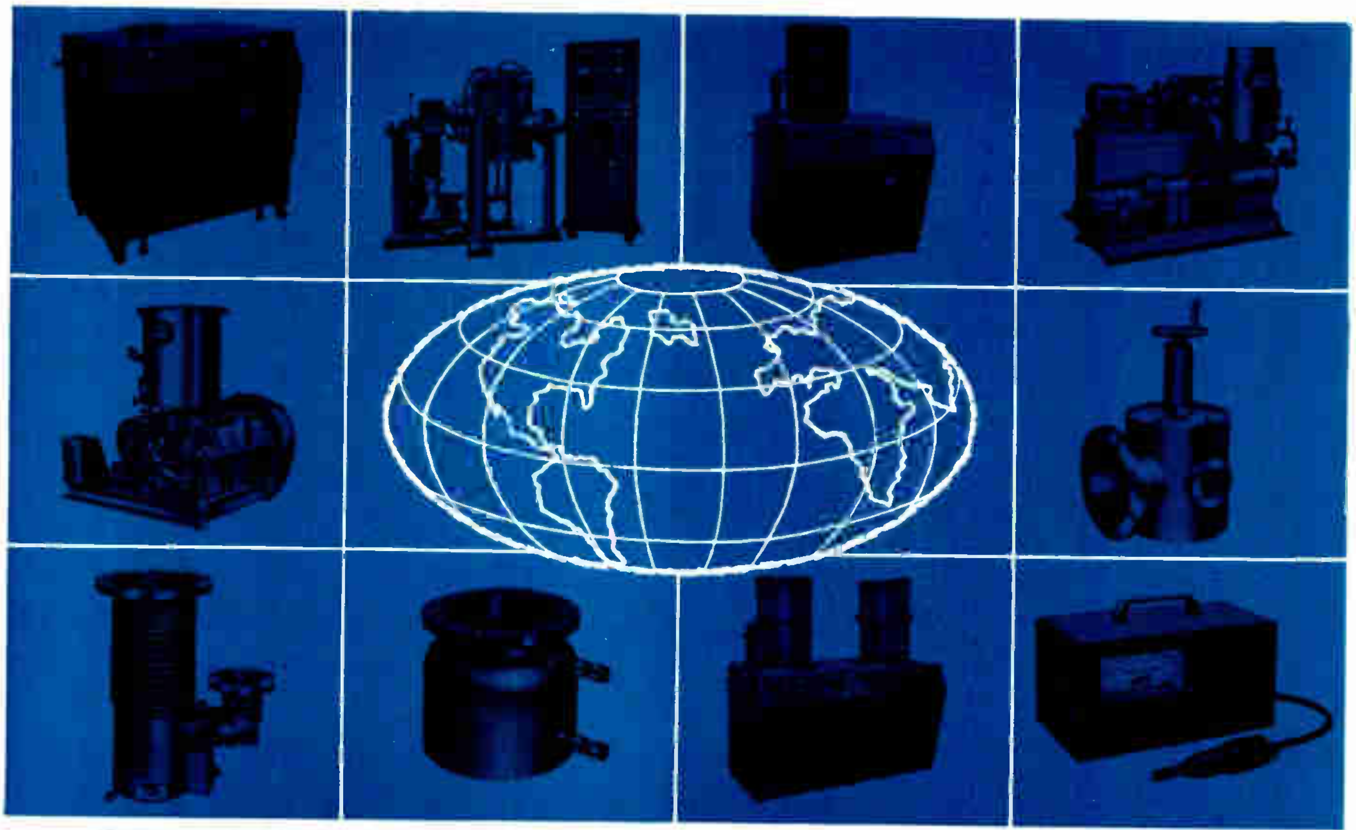
FOR FURTHER INFORMATION on above listings or any connector requirement, contact your nearest Cinch and Jones representative or United-Carr sales office. Address requests for literature to the Advertising Manager at the Chicago address below. Please reference product interests as outlined in the heading or above listings. Standard Cinch and Jones products are handled by leading electronic component distributors throughout the U.S.

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois

Plants located at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS



LEADERSHIP

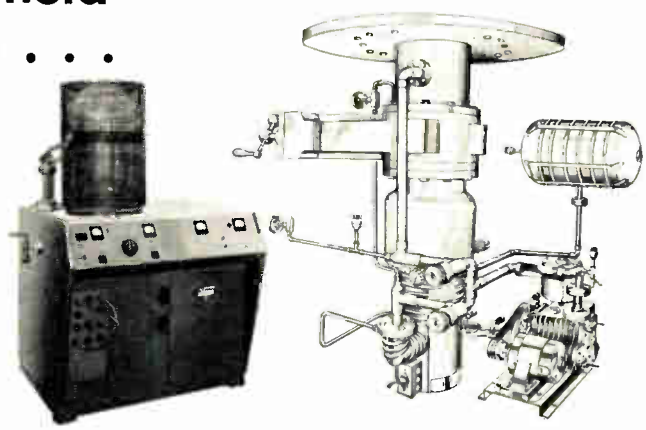
with a forward look in the field of high vacuum equipment . . .

Kinney Vacuum, the accepted leader in the manufacture of vacuum pumps is acknowledged foremost in research and development in the high vacuum industry.

This leadership is carefully guarded by constant and extensive research and development that produces the ultimate in mechanical pumps, diffusion pumps, valves, baffles, gauges, vacuum furnaces, space chambers, and complete vacuum systems.

The resources of the New York Air Brake Company and all of its divisions guarantee every Kinney Vacuum product to be efficient in operation, most modern in design, and constructed to give the maximum in service.

- PROVEN STABILITY
- EXTENSIVE RESOURCES
- DYNAMIC DEVELOPMENT



HIGH VACUUM EVAPORATORS . . . KSE-6, KSE-6H

This attractively packaged system delivers maximum performance, requires minimum floor space. Formica work surfaces, integral control panels with grouped controls for operating convenience. These units are built around flange connected components including new high speed oil diffusion pumps, water cooled baffle (also available with liquid nitrogen cooled baffle). Hydraulic bell jar hoist. Rapid evacuation to below 1×10^{-6} torr., ultimate pressure less than 5×10^{-7} torr. KSE-6H offers a pot-type base plate (Haas Chamber) to allow more freedom for location of monitoring devices and additional feed-throughs.

KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET • BOSTON 30, MASS.

Tech Data
for Engineers

Contamination Control

A 4-page, 2-color brochure is available from Central Vacuum Corp., 3008 E. Olympic Blvd., Los Angeles 23, Calif., on micro vacuuming. This method developed by Central Vacuum is for: vacuuming personnel prior to entry into "White Rooms"; keep them dust-free; and insure immaculate assemblies. Information includes: inlets; hoses; suction control valves; shoe cleaners; dual systems for large installations; and general plant maintenance.

Circle 301 on Inquiry Card

Optical Terminology

The first in a series of continuing terminology glossaries, "Glossary of Optical Terminology," covers a wide range of technical terms from "aberations" to "surface reflection." Available from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 302 on Inquiry Card

Chromatography

A comprehensive bibliography entitled, "Thin-Layer Chromatography" includes information on the technique of thin-layer chromatography, up-to-date as of December 1961, with a total of 167 entries. Research Specialties Co., 200 S. Garrard Blvd., Richmond, Calif. Request the bibliography by writing under company letterhead.

Circle 303 on Inquiry Card

Clean Rooms

"Keeping 'Clean Rooms' Clean with Spencer Vacuum," 4 pages, 2 color, is available from Spencer Turbine Co., 486 New Park Ave., Hartford, Conn. Need for a central system is explained and illustrated; photographs, description and specs. provided on one operator, two operator and larger systems.

Circle 304 on Inquiry Card

Photographic Emulsions

Tech. data is available on photographic emulsions, designed for use in studies in nuclear physics, called "Scientia NUC 3.07." This emulsion is particularly suitable for recording alpha particles, low-energy electrons and protons. Industrial Photo Products Dept., The Gevaert Co. of America, Inc., 321 W. 54th St., New York 19, N. Y.

Circle 305 on Inquiry Card

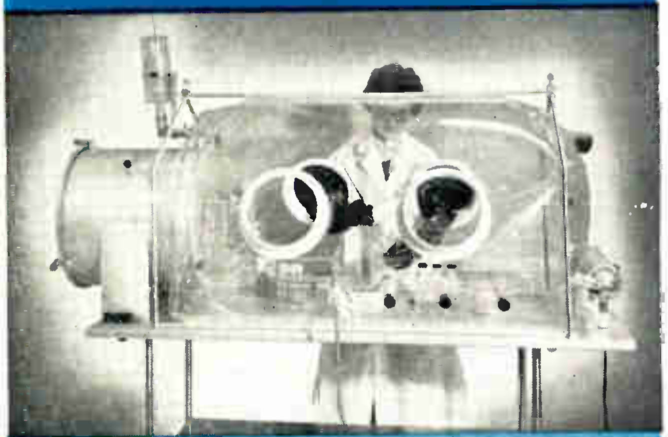
Flutter

A 12-page booklet entitled "FLUTTER: Its nature, cause, and avoidance" presents a study of the phenomenon of flutter and its associated disturbances: wow and drift. Basic theory is followed by a discussion of flutter measurement, causes, avoidance and anti-flutter maintenance. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

Circle 306 on Inquiry Card

Circle 6 on Inquiry Card

This is the PERFECT "Dust-free" Laboratory



AMSCO Flexible Film Laboratory Dry Box

This low-cost, transparent "self-contained laboratory" is designed for laboratory or production procedures demanding a controlled, isolated atmosphere . . . whether it be dust-free, moisture-free, toxic compound confining, inert gas atmosphere . . . an almost endless list.

Amsco's disposable Flexible Film Dry Box is ideal for delicate transistor and diode assembly, experimental metallurgy, missile sub-assembly work, instrument assembly . . . even Alpha radiation studies. The clear plastic canopy enables technicians to work comfortably and swiftly with no eye strain.

When not in use the "envelope" may be collapsed into a compact package for convenient storage. Upon completion of certain studies, the canopy may be disposed of and replaced quickly and economically. The chamber size is 48" long x 26" wide x 28" high and is provided with four "working" ports, a large interchange lock for introducing parts and several tubular ducts for service lines. Complete air filtration system is optional.

Won't this low-cost, disposable Dry Box fit into your laboratory or production plans? An Amsco man will be happy to discuss the matter in detail . . . or write for bulletin IC-607.

World's largest designer and manufacturer of Sterilizers, Surgical Tables, Lights and related technical equipment for hospitals, industry, research

SCIENTIFIC AND INDUSTRIAL DEPARTMENT

AMERICAN STERILIZER

ERIE • PENNSYLVANIA

Circle 8 on Inquiry Card

ELECTRONIC AND ELECTRICAL COMPONENTS

HAVING AXIAL LEADS
(such as capacitors, diodes, fuses and resistors)

ORGANICALLY FINISHED

at rates of up to

12,000 per HOUR

CM Model HD-3

Completely automatic

REMOTE MASKING SPRAY COATER

Applies a solvent and abrasion-resistant clear coating that protects color coding and labeling or a light-tight seal for silicon diodes. Coating is confined to desired area while racks, loaded with diodes move continuously through spray station. The diodes, while in the racks, are spun so as to assure an even coating and remain in the racks for both spraying and baking operations.

CM Model PR-1

POWDERED RESIN COATING MACHINE

Automatic Feed and Control
Adjustable Speed.

★

CM Model TL-1

AUTOMATIC TRAY LOADING MACHINE

★

CM Model ML-1

MAGAZINE-LOADER

★

Send for literature.

CONFORMING MATRIX CORP.

839 NEW YORK AVENUE
TOLEDO 11, OHIO

Circle 9 on Inquiry Card

Tech Data

for Engineers

Antenna Test Site

"TACO Long Range Antenna Test Site" describes Technical Appliance Corp's. antenna test site capabilities at their 2,870 ft. range located at Earlville, N. Y. Photographs and site layout included.

Circle 319 on Inquiry Card

Transducers

This short form brochure gives information on a wide range of pressure operated instruments, rectilinear potentiometers and associated equipment. Servonic Instruments, Inc., 1644 Whittier Ave., Costa Mesa, Calif.

Circle 320 on Inquiry Card

PC Drilling

Tech data is available on the Panto-Duplicator which is designed for production drilling of printed circuit boards (or any other similar multiple-hole drilling operation) with speed, accuracy and efficiency. Photographs and specifications are included. Coleman Machine Co., Inc., 321 Snyder Ave., Berkeley Heights, N. J.

Circle 321 on Inquiry Card

Tech Data

for Engineers

Test Chambers

Information is available on environmental and climatic test chambers and testing facilities for research, test engineering, quality control, and production uses. Associated Testing Laboratories, Inc., 200 Route 46, Wayne, N. J.

Circle 322 on Inquiry Card

Shaft Position Encoder

Mechanical and electrical design considerations in the selection of the proper shaft position encoder for the required application are discussed in bulletin 312-B. Also described are the various codes used and translation operations and equipment. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 323 on Inquiry Card

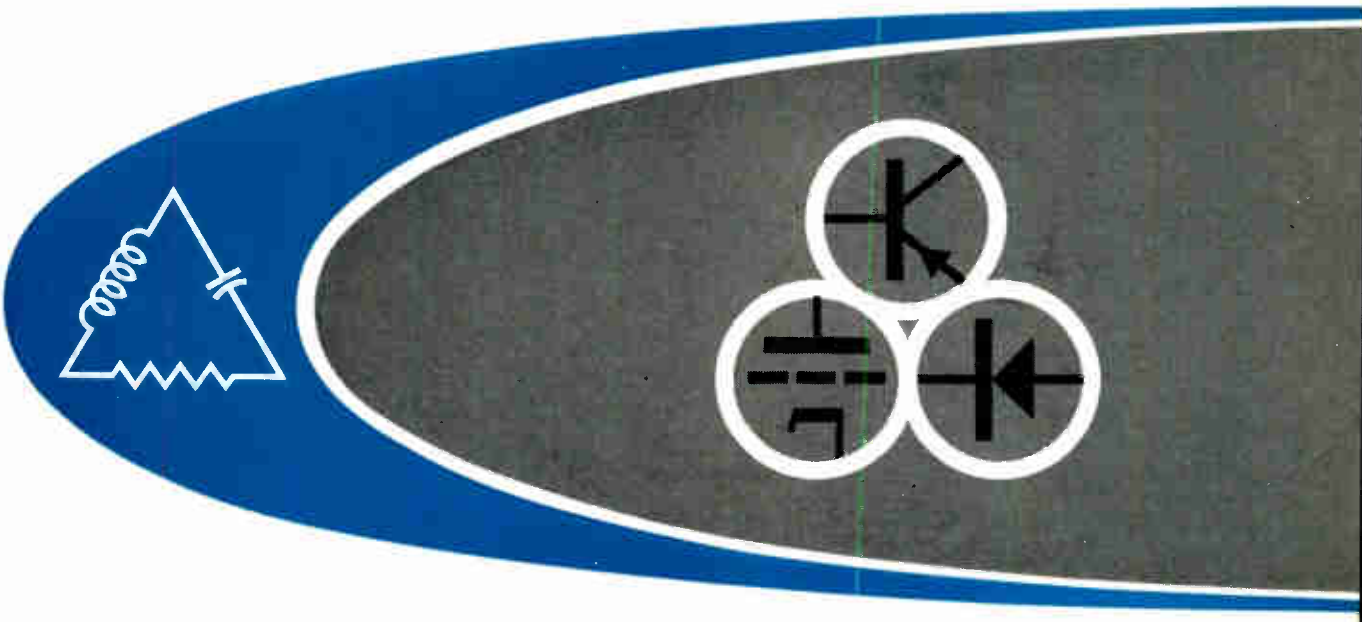
Flaw Detection

"Visible Penetrant Process — Procedures and Techniques," 8-pages, describes the use of the visible or dye penetrant inspection method for finding cracks and similar flaws. The Met-L-Chek Co., 11919 S. Western Ave., Los Angeles 47, Calif.

Circle 324 on Inquiry Card

Section C

Tubes & Semiconductors



PART ONE

High Frequency Semiconductors

—Technical specifications on the transistors, diodes and tunnel diodes available for operation above 100 megacycles.

The frequency spectrum is so crowded that there is only one direction to go for more room—and that's up! Nature's seeming paradox, however, is that while the upper microwave regions offer much more in spectrum space, bandwidth performance, smaller r-f component size and signal-beaming techniques they also pose severe problems in power generation, control of noise and reduction of transmission losses.

Until rather recently, worthwhile signal generation and amplification at Gc frequencies was confined almost entirely to the hot cathode tubes because of their high power handling capabilities and low noise performance. The need for lighter weight, reliable power sources in new communications systems, however, has spurred intensive experimental and developmental activity in the field of solid-state circuitry, and much progress has been made.

Semiconductor technology now has reached the stage where power levels of several hundred milliwatts are produced at X-band. Transistors are available with gain-bandwidth products which exceed those obtainable with tubes. Noise figures have been reduced to as low as 4, for example, at 2 Gc. And while the power obtained from the semiconductor is still relatively low, efficiencies compare favorably at microwave frequencies with those of the best tubes.

This report, prepared by our staff, documents the results of a recent ELECTRONIC INDUSTRIES' survey of 30 semiconductor manufacturers to determine the performance characteristics of available transistors and diodes at frequencies of 100 megacycles and higher. Functions include oscillators, amplifiers, switchers, detectors, mixers, harmonic generator and special purpose devices. From the data supplied and within the space allotted, what are thought to be the most significant parameters have been selected for each category. The values given are typical unless otherwise noted, and are not necessarily obtained simultaneously in any one set of parameters.

100 MC OSCILLATOR, AMPLIFIER TRANSISTORS

Type	App.	Freq. Gc	Gain db	P mw	NF db
AMPEREX, 230 Duffy Ave., Hicksville, L.I., N.Y.					
PADT28	ampl	.2	20		6
PADT28	osc	.7		83^2	
2N2084	ampl	.1	14	125^2	8
2N987	ampl	.1	14	86^2	8
PADT35	ampl	.1		200^2	
CLEVITE CORP., Waltham, Mass.					
2N707	ampl	.1	12^6	300	
COMPAGNIE GENERALE des Semiconductors 12, Rue de la Republique, Puteaux (Seine) France					
SFT358	ampl	.07–.1	14	120	7
SFT357	osc	.07–.1		120	
SFT357P	mix	.08–.1	6	120	10.5
2N384	ampl	.03–.1	20	120	
2N1225	ampl	.07–.1	20	120	
FAIRCHILD SEMICONDUCTOR, 545 Whisman Rd., Mountain View, Calif.					
2N918	ampl	.2–.9	15		6
2N918	osc	1.5		30^8	
2N917	ampl	.2–.5	9	10^8	
2N917	osc	1.1			
2N916	ampl	.1–.4	3^5	1.2w^2	
2N915	ampl	.1–.4	2.5^5	1.2w^2	
2N957	ampl	.2	2^5	$.8^2$	
GENERAL INSTRUMENT SEMICONDUCTOR, 65 Gouverneur St., Newark 4, N.J.					
2N499	ampl	.1	10	60^2	
2N588	ampl	.1	8	60^2	
HITACHI LTD., Tokyo, Japan. Represented by International Reporters, Inc., 2242 S. Western Ave., Chicago 8, Ill.					
2SA87	ampl	.1	35	80	
2SA88	ampl	.1	18	80	
2SA289	ampl	.1	20	80	
2SA288	ampl	.1–.3	18	80	
2SA289	ampl	.1–.5	20	80	
2SA290	ampl	.1–.8	21	80	
2SA234	ampl	.11	60^6	80	
2SA235	ampl	.12	80^6	80	
HUGHES, Semiconductor Div., 500 Superior Ave., Newport Beach, Calif.					
2N917	ampl	1.1	20^6		
2N917	ampl	.4	12^6	1w^2	
MOTOROLA Semiconductor Prods., 5005 E. Mc Dowell Rd., Phoenix, Ariz.					
2N700	ampl	.07–1	23	75^2	6
2N700	osc	.4		45	
2N700A	ampl	.07–.3	22	75	10
MOTOROLA Semiconductor Prods. — *(Continued)*					
2N741/A	ampl	.07–.3	14	200	
2N1141	ampl	.1–.5	12^5	300^2	4
2N1142	ampl	.1–.5	10^5	300	4.5
2N1143	ampl	.1–.5	8^5	300	5
2N1195	ampl	.1–.5	12^5	300	4
2N707	ampl	.1–.6	12^6	1w^2	
2N1561	ampl	.07–.3	12	3 w^2	
2N1562	ampl	.07–.27	11	3w^2	
2N1692	ampl	.07–.3	12	3w^2	
2N1693	ampl	.07–.27	11	3w^2	
NATIONAL SEMICONDUCTOR CORP., Danbury, Conn.					
NS731	ampl	.1	55^5		
NS732	ampl	.1	125^5		
NS733	ampl	.1	55^5		
NS734	ampl	.1	125^5		
PACIFIC SEMICONDUCTORS, INC., 12955 Chadron Ave., Hawthorne, Calif.					
PT720	ampl	.1	15	.2w	
2N707	ampl	.1	6	.2w	
2N1338	ampl	.07–.15	10	.5w	
2N1338	osc	.07–.15		.55w	
2N1505	ampl	.1–.2	7–10	1w	
2N1506	ampl	.1–.2	9-12	1w	
2N1709	ampl	.03–.15	10	5w	
2N1709	osc	.2			
2N1710	ampl	.03–.15	8	5w	
2N1342	ampl	.07–.1	13	.4w	
2N1342	osc	.25			
PHILCO CORP., Lansdale, Div., Lansdale, Pa.					
T2351	amp	2	6	10	10.5
T2351	osc	3–5		.4	
T2028	ampl	.3–.8	22		4.5
T2028	osc	1.6			
T2029	mix	.2–.8	19		6.5
T2030	osc	.2–.8		2.5	
2N1742	ampl	.2–.6	19	.5	5.5
2N1742	osc	1.3			
2N1743	mix	.2	16	15	10
2N1743	ampl	.6			
T2364	ampl	.06–.12	29	60	3
2N1158	osc	.2		35	
T2379	ampl	.1	21	60	5.5
2N502A	ampl	.2	10		7
2N502A	osc	.6			

SYMBOLS, ABBREVIATIONS AND NOTES

BV_r — Reverse breakdown voltage
C_{ob} -- Output capacitance
C -- Input capacitance
f_{co} -- Resistive cutoff frequency
f_T -- Gain bandwidth product: Freq. at which $\frac{I_c}{I_b} = 1$ (with output shorted)
h_{FE} -- Dc amplification factor
h_{fe} -- Ac amplification factor
I_o -- Forward current
I_p -- Peak current
I_p/I_v -- Peak-to-valley current ratio
L_c -- Conversion loss
L_{in} -- Insertion loss
NF -- Noise figure
N_s -- Shot noise constant = $20\, I_o R_o$, where: $I_o = ½ I_p$ and R_o = neg res @ $½ I_p$
Q -- Quality factor = $\frac{1}{2 f_{cps} C R_s}$, where C=voltage variable cap. in farads, R= series res. in ohms
R_E -- Rectification efficiency = ratio of DC load v. to peak rf input
R_s -- Series resistance
Z_{max} -- Load impedance

NOTES: 1. Min. 2. Max. 3. @3Gc 4. @10Gc 5. h_{fe} 6. h_{FE} 7. Overall noise figure 8. @500mc 9. @50mc

100 MC OSCILLATOR, AMPLIFIER TRANSISTORS – (Continued)

PHILCO CORP. – (Continued)

Type	App.	Freq. Gc	Gain db	P mw	NF db
T2399	osc	.12	14	125	
2N1745	ampl	.03–.2	28		
2N1868	ampl	.2	28		
2N1744	osc	.03–.6	33	2.5	
L5457	ampl	.42	15		5
T2352	ampl	.1	10		5

RADIO CORPORATION OF AMERICA
Semiconductor and Materials Div., Somerville, N. J.

Type	App.	Freq. Gc	Gain db	P mw	NF db
2N1491	ampl	.1	1.8[5]	.5[2]w	
2N1492	ampl	.1	1.8[5]	.5w[2]	
2N1493	ampl	.1	1.8[5]	.5w[2]	
2N1023	ampl	.1	18[9]	120[2]	
2N1066	ampl	.1	18[9]	120[2]	
2N1397	ampl	.12	18[9]	120[2]	
2N1177	ampl	.12	14		
2N1178	osc	.12			
2N1179	mix	.12	17		

WESTERN ELECTRIC CO., Laureldale Plant, Laureldale, Pa.*

Type	App.	Freq. Gc	Gain db	P mw	NF db
2N537	ampl	.07–.2	10	175	
2N537	osc	.2		.75	
2N1094	ampl	.25	10[5]	150[2]	
2N1195	ampl	.07–.2		300[2]	
2N1645	ampl	.25	10[5]	1.6w[2]	
2N1992	ampl	.15	10[5]	.35w[2]	

SPRAGUE ELECTRIC CO., North Adams, Mass.

Type	App.	Freq. Gc	Gain db	P mw	NF db
XT200	ampl	.16–1	8	1w[2]	
XT200	osc				
2N502A	ampl	.2–.6	9.5	75	
2N502A	osc	.6			
XT400	ampl	.16–.6	12	75[2]	
XT400	osc	.6			

TEXAS INSTRUMENTS, INC.
13500 N. Central Expressway, P.O. Box 5012, Dallas, Tex.

Type	App.	Freq. Gc	Gain db	P mw	NF db
TIX2000	ampl	1–2	12.4	90[2]	8
2N1405	ampl	1.1	10[5]	75[2]	
2N1406	ampl	1.1[2]	10[5]	75[2]	
2N1407	ampl	1.1[2]	7.5[5]	75[2]	
2N2363	ampl	1.1[2]	10[5]	75[2]	5.5[2]
2N1195	ampl	.5	15.5[5]	225[2]	
2N1141	ampl	.5	13.5[5]		6.5
2N1142	ampl	.4	11.5		
2N1143	ampl	.3	9.5		
2N2415	ampl	.2–.5	14*	75[2]	2.4
2N2416	ampl	.2–.5	12.5*	75[2]	3.4
2N2413	ampl	.1–.3	14	1w[2]	
2N2188	ampl	.15	3[5]	125[2]	
2N2190	ampl	.15	3.7[5]	125[2]	
2N2191	ampl	.15	3[5]	125[2]	
2N2417	ampl	.1	2[5]	300[2]	
2N2412	ampl	.1	2[5]	300[2]	

* @ .5 Gc

HIGH f_T SWITCHING TRANSISTORS

CLEVITE CORP., Waltham, Mass.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N706/A	25	40	.400	5	.5w[2]
2N706B	25	40	.400	4.5	.3w[2]
2N708	40	15[1]		6	.36w[2]
2N914	40	30[1]		6	.36w[2]

FAIRCHILD SEMICONDUCTOR, 545 Whisman Rd., Mountain View, Calif.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N709	15	10[1]	.8	2.5	.3w
2N2368	40	10[1]	.65	2.5	.36w
2N2369	40	20[1]	.65	2.5	.36w
2N708	40	15[1]	.45	6[2]	.36w
2N706	25	20[1]	.4	5	.3w
2N914	40	55	.35	4.5	.36w

GENERAL ELECTRIC CO.,
Semiconductor Prods. Dept., Electronics Park, Syracuse 1, N. Y.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N994	15	75	1	6	200
2N914	40	30	.6	6	360
2N705	15	25	.6		150
2N710	15	25	.5		150
2N711	12	30		5	150
2N711A	15	40[1]		6[2]	150
2N711B	18	40[1]		6[2]	150
2N725	15	20[1]	.6		150
2N781	15	45	.7	6[2]	150
2N782	12	40	.6	6[2]	150
2N828	15	45	.5	6[2]	150
2N706/A	25	20[1]	.4	5	300
2N708	40	15[1]		6	360
2N753	25	40[1]	.4	5[2]	300
2N834	40	25[1]	.5	4[2]	300
2N960	15	20[1]	.4	4[2]	150
2N961	12	20[1]	.4	4[2]	150
2N962	12	20[1]	.4	4[2]	150
2N964	15	40[1]	.4	4[2]	150
2N965	12	40[1]	.4	4[2]	150
2N966	12	40[1]	.4	4[2]	150

GENERAL INSTRUMENT SEMICONDUCTOR, 65 Gouverneur St., Newark 4, N.J.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N706/A	25	40	.4	5	1.2w[2]
2N706B	25	40	.4	5	1.2w[2]
2N753	25	40[1]	.4	5[2]	1.2w[2]
2N834	40	25[1]	.4	4[2]	360
2N835	25	20[1]	.3	4[2]	360
2N743	20	20[1]	.35	5[2]	360
2N744	20	40[1]	.35	5[2]	360
2N914	40	30[1]	.35	6[2]	360
2N2242	40	20[1]	.35	6[2]	360
2N708	40	15[1]	.35	6[2]	360

HUGHES, Semiconductor Div., 500 Superior Ave., Newport Beach, Calif.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N709	15	120	.8		
2N708	40	120	.4		
2N744	20	120	.4		
2N743	20	60	.4		
2N914	40	120	.4		
2N753	25	120	.3	5	1w[2]
2N706	25	20[1]	.3	5	1w[2]
2N706A/B	25	60	.3	5	1w[2]

MOTOROLA Semiconductor Prods., 500 E. Mc Dowell Rd., Phoenix, Ariz.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N705	15	40	.35	5	150
2N710	15	25	.6		150
2N711	12	30		5	150
2N695	15	40	.35	5	75
2N828	15	40	.4	3.5	150
2N960	15	40	.46	4[2]	150
2N961	12	40	.46	4[2]	150
2N962	12	40	.46	4[2]	150
2N964	15	70	.46	4[2]	150
2N965	12	70	.46	4[2]	150
2N966	12	70	.46	4[2]	150
2N963	12	20	.3	5	150
2N967	12	40	.3	5	150
2N968	15	35	.32	4	150
2N969	12	35	.32	4	150
2N970	12	35	.32	4	150
2N971	7	35	.32	4	150
2N972	15	75	.32	4	150
2N973	12	75	.32	4	150
2N974	12	75	.32	4	150
2N975	7	75	.32	4	150
2N706/A	25	40	.4	5	.5w
2N706B	25	40	.4	4.5	.3w
2N753	25	40[1]	.4	4.5	.5w
2N834	40	40	.5	4[2]	.5w
2N835	25	40	.45	4[2]	.5w
2N2217	60	20[1]	.4	4	.8w
2N2218	60	40[1]	.4	4	.8w
2N2219	60	100[1]	.4	4	.8w
2N2220	60	20[1]	.4	4	.5w
2N2221	60	40[1]	.4	4	.5w
2N2222	60	100[1]	.4	4	.5w

NATIONAL SEMICONDUCTOR CORP., Danbury, Conn.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
NS381		60	.4		300
NS382		120	.4		300
2N834	40	40	.4		300
2N835			.4		300
2N743		60	.4		300
2N744		120	.4		300
2N706/A		60	.3		300
2N753	25	120	.3		300

PACIFIC SEMICONDUCTORS, INC., 12955 Chadron Ave., Hawthorne, Calif.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N702	25	60	.35		.6w[2]
2N703	25	100	.35		.6w[2]
2N706/A	25	60	.4	5	1w[2]
2N706B	25	60	.4	4.5	1w[2]
2N753	25	120	.35		1w[2]
2N834	40	25[1]	.35		1w[2]
2N919	25	60	.4		1.2w[2]
2N920	25	120	.4		1.2w[2]
2N697	60	75		12	2w[2]
2N699	120[1]	40[1]			2w[2]

PHILCO CORP., Lansdale, Div., Lansdale, Pa.

Type	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
2N976	15	80	.9	1.5	100
T2594	15	40	1.2	4	150
T2444	12		.6		100
2N706/B	25	45			

HIGH f_T SWITCHING TRANSISTORS *(Continued)*

TYPE	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
PHILCO CORP., Lansdale, Div., Lansdale, Pa.					
2N834	40	40	.35		
T2425	40	20			
2N779B		50	.32		150
T2492	18	50	.25		150
RADIO CORPORATION OF AMERICA Semiconductor and Materials Div., Somerville, N.J.					
2N955	12	60[1]	1	4	150
2N828	15	25[1]	.3	6	150
2N834	40	25[1]	.35[1]	4	300
2N1708	25	20[1]		6	300
2N2205	25	20[1]		6	300
2N2206	25	40[1]		6	300
2N697	60	120[2]		20	600
2N706/A	25	20[1]	.4	5	300
2N708	40	15[1]		6	360
2N705	15	25[1]	.6	5	150
2N710	15	25[1]	.6	5	150
2N711	12	20[1]		5	150
2N914	40	120[2]	.6	6	360
RAYTHEON CO., Lexington 73, Mass.					
2N705A	15	40		8	
2N710A	15	34		8	150
2N711	12	30	.3	7.5	150
2N828	15	40	.3	3.5	150
2N781	15	45	.7	6[2]	150
2N782	12	40	.6	6[2]	150
SYLVANIA, Semiconductor Div., 100 Sylvan Rd., Woburn, Mass.					
2N706/A	25	20[1]		5	300
2N706B	25	60	.4	5	300
2N753	25	120	.3	5	300

TYPE	V_{CB}	h_{FE}	f_T Gc	C_{ob} pf	DISS mw
SYLVANIA, *(Continued)*					
2N783	40	80		3.5	300
2N784	30	25[1]		3.5	300
2N828	15	25[1]	.3	6	150
2N1962	40	80		3.5	400
2N1963	30	25[1]		3.5	400
2N2397	35	100	.3	2.5	300
2N781	15	45	.7	6[2]	150
2N782	12	40	.6	6[2]	150
2N697	90	40[1]		14	
TEXAS INSTRUMENTS, 13500 N. Cen. Expressway, P.O. Box 5012, Dallas, Tex.					
TIX895	5	20[1]	2.5	1.1	75[2]
2N797	20	85	.6	3	150[2]
2N743	20	10[1]	.4	5	1w[2]
2N744	20	20[1]	.4	5	1w[2]
2N2410	60	75	.3	9	2.5[2]
2N726	20	15		5	1w[2]
2N706/A	25	20[1]		5	1w[2]
2N706B	25	20[1]		5[2]	1w[2]
2N753	25	120[2]		3.5	1w[2]
TRANSITRON ELECTRONIC CORP., Wakefield, Mass.					
2N728	15	40		8	.3w
2N729	30	40		8	.3w
2N699	120	65		14	.6w
2N697	60	75		20	.6w
2N706	25	35		4.5	.3w
WESTERN ELECTRIC Laureldale Plant, Laureldale, Pa.					
2N559	15	45	.44	5.2	150
2N1195	30	22	.55	2.6	300
2N1645	10	35	.6	11.9	6w
2N1992	10	45	.43	3.9	.35w

MICROWAVE MIXER, DETECTOR DIODES

TYPE	Freq. Gc	L_c db	Z_{max} K - Ohms	NF db	R_E %
COMPAGNIE GENERALE des Semiconducteurs 12, Rue de la Republique, Puteaux (Seine)France					
SFD 117	.9–1	10.5		14[7]	
KEMTRON ELECTRON PRODS., INC., Newburyport, Mass.					
1N21B	4	6.5	.8	10[7]	
1N21C	4	5.5	.8	8.3[7]	
1N21D	4	5	.45	7.3[7]	
1N21E	4		.45	7[7]	
1N21F	4		.45	6[7]	
1N21WE	4	5.5	.45	7[7]	
1N23B	10	8.5	.6	11[7]	
1N23C	10	6	.47	9.8[7]	
1N23D	10	5	.45	8.2[7]	
1N23E	10		.46	7.5[7]	
1N23F	10		.47	7[7]	
1N23WE	10	6	.47	7.5[7]	
1N25	1	8	.4		
1N25A	1	7	.3		
1N25B	1	5.5	.3	8[7]	
K25A	1	6.5	.4		
K25B	1	5.5	.3	8[7]	
1N149	10	5.5	.47	8.3[7]	
1N150	7	6	.5	9.8[7]	
1N160	7	6.5	.5	11[7]	
1N831/A	4	5.5	.45	7[7]	
1N832	10	6	.45	10[7]	
1N832A	10	6	.45	8.5[7]	
MICROWAVE, ASSOCIATES, INC., Burlington, Mass.					
MA449B	4	6.5	.8	10	
MA449C	4	5.5	.8	8.3	
MA449D	4	5	.47	7.3	
MA449E	4	5.5	.45	7	
MA449F	4		.45	6	
MA421A	4		.45	6.5	
MA4127	4	5.5	.5	8.3	
MA4127A	4		.5	7	
MA4126	4	5.5	.8	18	
MA4126A	4	5.5	.8	15	
1N831	4	5.5	.45		
1N831A	4		.45	7	
1N150	7	6	.5	9.8	

TYPE	Freq. Gc	L_c db	Z_{max} K - Ohms	NF db	R_E %
MICROWAVE ASSOCIATES, INC. *(Continued)*					
1N160	7	6.5	.5	11.4	
MA451B	10	6.5	.6	11.4	
MA451C	10	6	.47	9.8	
MA451D	10	5	.45	8.2	
MA451E	10	6	.46	7.5	
MA451F	10		.46	7	
MA4133	10	6	.47	9.8	
MA4125	10	6	.6	23	
MA4125A	10	6	.6	20	
1N832	10	6	.47	10	
1N832A	10		.45	7.5	
MA445	16	7.5	.62		
MA445A	16	7	.56	9.8	
MA445B	16		.56	8.8	
1N78C	16	6	.56	8.3	
MA4124	16	7.5	.62	27	
MA4124A	16	7.5	.62	24	
1N26	24	8.5	.6		
1N53	35	8.5	.8	13.1	
1N53A	35	8.5	.8	13.1	
1N53B	35	6.5	.8	10.4	
PHILCO CORP., Lansdale, Div., Lansdale, Pa.					
1N26	24	8.5			
1N26A	24	7.5			
1N26B,C	24	7.5		10[7]	
1N78	16	7.5			
1N78A	16	7			
1N78B	16	6.5			
1N78C	16	6		9.5[7]	
1N78D	16	5.7		8.8[7]	
1N263	9.4	6		7.5[7]	
1N1838	13.5			32[7]	
1N2792	70	13.5		17[7]	
SEMI-ELEMENTS, INC., Saxonburg Blvd., Saxonburg, Pa.					
DC7	1				50*
DC7A	1		.25		60*
DC7B	1		.25		70*
DC7C	1				75*
DC7D	1				85*

* measured @ .1Gc

MICROWAVE TUNNEL OSCILLATOR, AMPLIFIER DIODES

TYPE	f_{co} Gc	I_p ma	I_p/I_v	R_s ohms	N_s
COMPAGNIE GENERALE des Semiconducteurs 12, Rue de la Republique, Puteaux (Seine) France					
SFD160	.1				
GENERAL ELECTRIC CO., Semiconductor Prods. Dept., Electronics Park, Syracuse 1, N.Y.					
MTD1	2.3	1	.131v	1.5	

TYPE	f_{co} Gc	I_p ma	I_p/I_v	R_s ohms	N_s
GENERAL ELECTRIC CO., *(Continued)*					
MTD2	2.5	2.2	.3(Iv)		
MTD3	2.6	4.7	.6(Iv)	.5	
MTD4	2.3	10	1.3(Iv)	.3	
TD1	2.3	1	.1(Iv)	1.5	

MICROWAVE TUNNEL OSCILLATOR, AMPLIFIER DIODES – *(Continued)*

Type	f_{co} Gc	I_p ma	I_p/I_v	R_s ohms	N_s
GENERAL ELECTRIC CO., Semiconductor Prods. Dept., Electronics Park, Syracuse 1, N. Y.					
TD1A	3.2	1	.1(Iv)	1.7	
TD2	2.2	2.2	.3(Iv)	1	
TD2A	3	2.2	.2(Iv)	1.1	
TD3	1.8	4.7	.6(Iv)	.5	
TD3A	3.4	4.7	.5(Iv)	.52	
TD4	1.6	10	1(Iv)	.3	
TD4A	2.8	10	.1(Iv)	.36	
TD5	1.6	22	3(Iv)	.2	
TD5A	2.6	22	2(Iv)	.22	
TD310	2.7	4.7	.6(Iv)	1.5	
TD310A	5.5	4.7	.6(Iv)	1.5	
TD311	2.7	10	1.3(Iv)	1	
1N3218		1	.13(Iv)	1.5	
1N3218A	3	1	.13(Iv)	1.5	
1N3219		2.2	.28(Iv)	.7	
1N3219A	3.4	2.2	.28(Iv)	.7	
GENERAL INSTRUMENT SEMICONDUCTOR, 65 Gouverneur St., Newark 4, N. J.					
TD5A		20	8	.75	
TD6A		10	8	1	
TD7A		5	12	1	
TD8A		1	8	2	
TD9A		20	12	.5	
TD10A		10	12	.5	
TD11A		5	12	1	
TD12A		1	12	2	
INTERNATIONAL MICROWAVE CORP., 1 Seneca Place, Greenwich, Conn.					
DGE1008	10	.8	5		
DGE1010	10	1	5		
DGE1012	10	1.2	5		
DGE1014	10	1.4	5		
DGE1016	10	1.6	5		
DGE1020	10	2	5		
DGE1508	15	.8	5		
DGE1510	15	1	5		
DGE1512	15	1.2	5		
DGE1514	15	1.4	5		
DGE1516	15	1.6	5		
DGE1520	15	2	5		
DGE2008	20	.8	5		

Type	f_{co} Gc	I_p ma	I_p/I_v	R_s ohms	N_s
INTERNATIONAL MICROWAVE CORP., – *(Continued)*					
DGE2010	20	1	5		
DGE2017	20	1.2	5		
DGE2014	20	1.4	5		
DGE2016	20	1.6	5		
DGE2020	20	2	5		
DGE3008	30	.8	5		
DGE3010	30	1	5		
DGE3012	30	1.2	5		
DGE3014	30	1.4	5		
DGE3016	30	1.6	5		
DGE3020	30	2			
MICRO STATE ELECTRONICS CORP., 152 Floral Ave., Murray Hill, N. J.					
MS232	2.5	1	16	4	.95
MS233	3.5	1	16	3	.85
MS234	4.5	3	20	3	.85
MS235	6^1	3	20	3	.85
MS225	71	3.5	10	2	
MS1100	10	3.5	10	3.5	
MS222	3.5	1.5	8	2	1.7
MS223	3.5	1.5	8	2	1.5
MS224	3.5	1.5	8	2	1.35
MS242	4.5	20	8	1	
PHILCO CORP., Lansdale Div., Lansdale, Pa.					
1N3560	1.3	1	5	1.5	
1N3561	1.3	1	8	1.5	
1N3562	.85	5	6	.7	
RADIO CORPORATION OF AMERICA Semiconductor and Materials Div., Somerville, N. J.					
1N3128*	.1**	5	11	1.5	
1N3129*	1**	20	11	1.5	
1N3130*	1**	50	11	1.2	
1N3138*	1**	50	20	2.6	
TEXAS INSTRUMENTS, INC., 13500 N. Cen. Expressway, P.O. Box 5012, Dallas, Tex.					
XA650		10	15		
XA651		10	10		
XA652		5	5		
XA653		5	5		

*Tunnel switching diodes; **Pulse repetition rate, max.

MICROWAVE SWITCHING DIODES

Type	Freq. Gc	L_{in} db	I_o ma	C pf	P mw
CONTINENTAL DEVICE CORP. 12515 Chadron Ave., Hawthorne, Calif.					
CD6111	$.5^2$	R_E=50@.1Gc	75	2	250
CD6112	$.5^2$		75	2	250
1N914/A	$.5^2$		75	4	250
1N916/A	$.5^2$		75	2	250
1N903	$.5^2$		10	2	250
1N903A	$.5^2$		20	1*	250
1N904	$.5^2$		10	2	250
1N904A	$.5^2$		20	1*	250
1N905	$.5^2$		10	2	250
1N905A	$.5^2$		20	1*	250
1N906	$.5^2$		10	2.5*	250
1N906A	$.5^2$		20		250
1N907	$.5^2$		10	2.5*	250
1N907A	$.5^2$		20	2.5*	250
1N908	$.5^2$		10	2.5*	250
1N908A	$.5^2$		20	2.5*	250
FAIRCHILD SEMICONDUCTOR, 545 Whisman Rd., Mountain View, Calif.					
FD192			10	1	
FD100			10	2^2	250^2
FD200			100	5^2	250^2
FD300			200	6^2	250^2
FD400			150	5^2	500^2
1N903			100^2	1.2	250
1N904			100^2	1.2	250
1N907			100^2	2.7	250
1N908			100^2	2.7	250
1N914			.01	4	250
1N914A			.02	4	250
1N916			.01	2	250
1N916A			.02	2	250
1N251	.1–1	R_E@.1=60%	75	.8	125
1N252			100	.8	150
1N811			40		150
1N812			60		150
1N813			75		150
1N814			60		150
1N815			120		150
GENERAL ELECTRIC CO., Semiconductor Prods. Dept., Electronics Park, Syracuse1, N. Y.					
MP1 }	R_E@.1Gc=45%		75	1	250
MP2 }			75	1.5	250
MQ1 }	R_E@.1Gc=45%		75	1	250
MQ2 }			75	1.5	250

* @–6 volts

Type	Freq. Gc	L_{in} db	I_o ma	C pf	P mw
GENERAL ELECTRIC CO. – *(Continued)*					
1N3605			75	2^2	250
1N3606			75	2^2	250
1N3608			75	2^2	150
1N3609			75	2^2	150
1N3604			75	2^2	250
1N3607			75	2^2	150
HUGHES, Semiconductor Div., 500 Superior Ave., Newport Beach, Calif.					
HD5000			5	1^2	75
HD5001			5	1^2	75
HD5002			2	1^2	75
HD5003			2	1^2	75
HD5004			2	1^2	75
1N914			5^1	1^1	
1N902			5^1	1^1	
1N995			100^1	4^2	
HD1800			100^1	1^2	
HD1610			3^1	3^2	
HD1640			3^1	3^2	
HD1670			3^1	3^2	
1N837			5^1	1^1	
PHILCO CORP., Lansdale Div., Lansdale, Pa.					
1N3093	9	1.6	85		500
1N3481	9	.75	60		10
1N3482	9	1	100		1.3w
MICROSEMICONDUCTOR CORP., 11250 Playa Court, Culver City, Calif.					
MC903			10	1	300
MC903A			20	1	300
MC904			10	1	300
MC904A			20	1	300
MC905			10	1	300
MC905A			20	1	300
MC906			10	2.5	300
MC906A			20	2.5	300
MC907			10	2.5	300
MC907A			20	2.5	300
MC908			10	2.5	300
MC908A			20	2.5	300
MC914			10	4	300
MC914A			20	4	300
MC916			10	2	300
MC916A			20	2	300
MC001			10	2	300
MC001A			20	2	300
MC002			100	5	300

MICROWAVE SWITCHING DIODES – (Continued)

Type	Freq. Gc	Lin db	Io ma	C pf	P mw
MICROSEMICONDUCTOR CORP. – (Continued)					
1N3206			10	4	300
1N3207			150	6	300
MICROWAVE ASSOCIATES, INC., Burlington, Mass.					
1N903			100[2]	1.2	250
1N904			100[2]	1.2	250
MA4413			100[2]	2	250
MA4414			100[2]	2	250
1N908			100[2]	2.7	250
1N907			100[2]	2.7	250
MA4121			30	.5	
1N914			.01	4	250
1N914A			.02	4	250
1N914B			.1	4	250
1N916			.01	2	250
1N916A			.02	2	250
1N916B			.03	2	250
MA4245			.03	2	500
1N920			.5	7.5	400
1N921			.5	7.5	400
MA4441			10	2	250
MA4442			20	2	250
MA4443			50	2	250
MA4444			100	2	250
MA4445			200	2	250
MA4446			500	8	500
MA4303			10	1.5	125
MA4304			10	1.5	200
MA4305			10	1.5	125
MA4306			10	1.5	200
MA4307			30	2	125
MA4308			30	2	200
TEXAS INSTRUMENTS, INC., 13500 N. Cen. Expressway, P.O. Box 5012, Dallas, Tex.					
1N251			75		250
1N914/A/B			75	4	250
1N915			75	4	250
1N916/A/B			75	2	250
1N917			75	2.5	250
TI254			50	4	100
TI255			50	4	100
TI256			50	2	100
TI257			50	2	100
1N3593			50	4	100
1N659			100	2.7	
1N660			100	2.7	
1N661			100	2.7	
A516				.75	
A517				.5	
TRANSITRON, Wakefield, Mass.					
TI5G	R ≈.1Gc=55%		80	.5	80
S570G			20		50
S555G			30		50

Type	Freq. Gc	Lin db	Io ma	C pf	P mw
TRANSITRON, Wakefield, Mass.					
1N251			14	.8	125
1N252	1	RE@.1Gc=60%	100	.8	150
S4G	1		40	.8	150
S5G	1		60	.8	150
S6G	1		75	.8	150
S9G	1		60	.8	150
S10G	1		120	.8	150
S266G			20		50
1N914			10	4[2]	250[2]
1N916			10	2[2]	250[2]
TMD50			20	4[2]	100
TMD914			20	4[2]	100
TMD916			20	2[2]	100
U.S SEMICONDUCTOR PRODS., INC., 3540 W. Osbom Rd., Phoenix, Ariz.					
GSC102			20	2[2]	
GSC052			20	2[2]	
GSC104			20	4[2]	
GSC054			20	4[2]	
GSC108			20	8[2]	
GSC058			20	8[2]	
GSB102			10	2[2]	
GSB052			10	2[2]	
GSB104			10	4[2]	
GSB054			10	4[2]	
GTB052			10	1[2]	
GTB042			10	1[2]	
GTB032			10	1[2]	
GTB034			10	2.5[2]	
GTB044			10	2.5[2]	
GTB054			10	2.5[2]	
GTC052			20	1[2]	
GTC042			20	1[2]	
GTC032			20	1[2]	
GTC034			20	2.5[2]	
GTC044			20	2.5[2]	
GTC054			20	2.5[2]	
GTB104			10	4[2]	
GTB102			10	2[2]	
GTC104			20	4[2]	
GTC102			20	2[2]	
GPA044			5	4[2]	
GPA044A			5	4[2]	
GPB074			10	4[2]	
GPB124			10	4[2]	
GFB102			10	2[2]	
GFC102			20	2[2]	
GFA010			5		
GFA020			5		
GTA052			5	.8	
GTC064			20	2	
1N251			5		
1N252			10		

MICROWAVE HARMONIC GENERATOR, PARAMETRIC AMPLIFIER DIODES

Type	fco Gc	BVr	Q	C pf	Rs ohms
BOMAC LABS., INC., Salem Rd., Beverly, Mass.					
BLV11	150	30		.5[1]	
BLV12	150	30		.55[1]	
BLV13	150	30		.75[1]	
BLV14	150	30		1.1[1]	
BLV15	150	30		2[1]	
BLV16	150	30		3.5[1]	
BLV17	150	30		6.8[1]	
BLV21	150	60		.5[1]	
BLV22	150	60		.55[1]	
BLV23	150	60		.75[1]	
BLV24	150	60		1.1[1]	
BLV25	150	60		2[1]	
BLV26	150	60		3.5[1]	
BLV27	150	60		6.8[1]	
BLV31	150	90		.5[1]	
BLV32	150	90		.55[1]	
BLV33	150	90		.75[1]	
BLV34	150	90		1.1[1]	
BLV35	150	90		2[1]	
BLV36	150	90		3.5[1]	
BLV37	150	90		6.8[1]	
BLV41	150	120		.5[1]	
BLV42	150	120		.55[1]	
BLV43	150	120		.75[1]	
BLV44	150	120		1.1[1]	
BLV45	150	120		2[1]	
BLV46	150	120		3.5[1]	
BLV47	150	120		6.8[1]	
HUGHES Semiconductor Div., 500 Superior Ave., Newport Beach, Calif.					
1N950	130	39[9]	6[1]		
1N951	80	36[9]	12[1]		
1N952	60	30[9]	20[1]		
1N953	25	23[9]	46[1]		
1N954	25	20[9]	14[1]		
1N955	25	20[9]	22[1]		
1N956	25	20[9]	32[1]		

Type	fco Gc	BVr	Q	C pf	Rs ohms
MICRO STATE ELECTRONICS CORP., 152 Floral Ave., Murray Hill, N.J.					
MS2501	80	6	6[4]	1.1	.3*
MS2502	105	6	8[4]	1.1	.3*
MS2503	130	6	10[4]	1.1	.3*
MS2504	160	6	12[4]	1.1	.3*
MS2505	200	6	15[4]	1.1	.3*
MS2602	40	30		1.1	15
MS2603	60	30		1.1	12
MS2604	10	30		1.1	10
MS2605	8	30		1.1	8
MS2606	6	30		1.1	6
MS2620	10	30		3–6	5
MS2621	20	30		3–6	25
MS2622	40	30		3–6	1.3
MS2623	60	30		3–6	1
MS2630	10	30		6–10	2.5
MS2631	20	30		6–10	1.3
MS2632	40	30		6–10	1

* mμh

Type	fco Gc	BVr	Q	C pf	Rs ohms
MICROWAVE ASSOCIATES, Burlington, Mass.					
MA4050A •		80		14	2[8]
MA4050B		80		7	3[8]

•20-watt UHF varactor consisting of two junctions packaged in either a power transistor or power diode case. Dual junction permits parallel or pushpull operation.

Type	fco Gc	BVr	Q	C pf	Rs ohms
MA4321A		6		.8	6[8]
MA4321B		6		1.6	3.5
MA4321C		6		3	2.3
MA4321D		6		6	1.7
MA4321E		6		12	1.3
MA4321F		6		25	1.2
MA4321G		6		50	1.1
MA4322A		12		.8	6
MA4322B		12		1.6	3.5
MA4322C		12		3	2.3
MA4322D		12		6	1.7
MA4322E		12		12	1.3

MICROWAVE HARMONIC GENERATOR, PARAMETRIC AMPLIFIER DIODES

TYPE	F_{co} Gc	BV_r	Q	C pf	R_s ohms
MICROWAVE ASSOCIATES, *(Continued)*					
MA4322F		12		25	1.2
MA4322G		12		50	1.1
MA4323A		18		.8	6
MA4323B		18		1.6	3.5
MA4323C		18		3	2.3
MA4323D		18		6	1.7
MA4323E		18		12	1.3
MA4323F		18		25	1.2
MA4323G		18		50	1.1
MA4324A		24		.4	11
MA4324B		24		.8	6
MA4324C		24		1.6	3.5
MA4324D		24		3	2.3
MA4324E		24		6	1.7
MA4324F		24		12	1.3
MA4324G		24		25	1.2
MA4325A		48		.4	11
MA4325B		48		.8	6
MZ4325C		48		1.6	3.5
MA4325D		48		3	2.3
MA4325E		48		6	1.7
MA4325F		48		12	1.3
MA4325G		48		25	1.2
MA4326A		60		.4	11
MA4326B		60		.8	6
MA4326C		60		1.6	3.5
MA4326D		60		3	2.3
MA4326E		60		6	1.7
MA4326F		60		12	1.3
MA4326G		60		25	1.2
MA4327A		90		.2	21
MA4327B		90		.4	11
MA4327C		90		.8	6
MA4327D		90		1.6	3.5
MA4327E		90		3	2.3
MA4337F		90		6	1.7
MA4337G		90		12	1.3
MA4328A		120		.2	21
MA4328B		120		.4	11
MA4328C		120		.8	6
MA4328D		120		1.6	3.5
MA4338E		120		3	2.3
MA4338F		120		6	1.7
MA450AR	30	6		6	
MA450BR	40	6		4	
MA450CR	50	6		3.6	
MA450DR	60	6		2.8	
MA450ER	70	6		2	
MA450FR	80	6		2	
MA450GR	90	6		2	
MA450HR	100	6		2	
MA4297	120	5		2	
MA4259		5		8	4
MA4260		5			3
MA4261		5			3
MA4298	150	5		2	
MA4552	140	5.5		2	
MA4553	120	5.5		2	
MA4554	100	5.5		2	
MA4555	60	5.5		2	
MA4556	60	5.5		2.5	
MA4557	40	5.5		4	
MA4280		30		.4	50[4]
MA4281		30		.8	30[4]
MA4282		30		1.6	15[4]
MA4283		30		2	12[4]
MA4284		30		3	8[4]
MA4285		30		5	6[4]
MA4286		30		7	4[4]
MA4287		30		10	3[4]
MA4288		30		15	3[4]
MA4289		30		20	3[4]
MA4290		30		25	3[4]
MA4291		30		30	3[4]
MA4292		30		35	3[4]
PACIFIC SEMICONDUCTORS INC., 12955 Chadron Ave., Hawthorne, Calif.					
PC107		30	150[9]	6.5	
PC112		80	50[9]	10	

TYPE	f_{co} Gc	BV_r	Q	C pf	R_s ohms
PACIFIC SEMICONDUCTORS INC., *(Continued)*					
PC113		80	50[9]	22	
PC114		80	50[9]	47	
PC115		100	100[9]	10	
PC116		100	100[9]	22	
PC117		100	100[9]	47	
PC122		100	75[9]	47	
PC123		25	50[9]	15	
PC124		50	125[9]	15	
PC125		80	50[9]	15	
PC126		100	100[9]	15	
PC127		25	50[9]	33	
PC128		50	125[9]	33	
PC129		80	50[9]	33	
PC130		100	100[9]	33	
PC132		25	50[9]	10	
PC133		25	50[9]	22	
PC134		25	50[9]	47	
PC135		50	150[9]	10	
PC136		50	125[9]	22	
PC137		50	100[9]	47	
PC138		25	75[9]	6.5	
PC139		50	150[9]	6.5	
PC140		80	75[9]	6.5	
PC141		100	125[9]	6.5	
V7		25	18[9]	7	
V10		25	18[9]	10	
V12		25	18[9]	12	
V15		25	18[9]	15	
V20		20	19[9]	20	
V27		20	16[9]	27	
V33		20	15[9]	33	
V39		20	14[9]	39	
V47		20	13[9]	47	
V56		15	11[9]	56	
V68		15	14[9]	68	
V82		15	13[9]	82	
V100		15	11[9]	100	
V7E		100	4.5[9]	7	
V10E		100	5.5[9]	10	
V12E		100	6.5[9]	12	
V15E		100	7.5[9]	15	
V20E		70	19[9]	20	
V27E		65	16[9]	27	
V33E		60	15[9]	33	
V39E		55	15[9]	39	
V47E		50	16[9]	47	
V56E		40	14[9]	56	
PHILCO CORP., Lansdale, Div., Lansdale, Pa.					
L4110	25	80		1	5
L4111	60	40		.35	6
L4112	100	20		.17	7
TEXAS INSTRUMENTS, 13500 N. Cen. Expressway, P.O. Box 5012, Dallas, Texas					
XD500	60[1]	6[1]	20[3]	.5[1]	.7*
XD501	81[1]	6[1]	27[3]	.5[1]	.7*
XD502	108[1]	6[1]	36[3]	.5[1]	.7*
XD503	144[1]	6[1]	48[3]	.5	.7*
A600/610		8	22	.7/.6	
A601/611		8	30	.7/.6	
A602/612		8	37	.7/.6	
*mμh @ 9.4Gc					
TRANSITRON ELECTRONIC CORP., Wakefield, Mass.					
SC1		22	35[9]	4.4	
SC2		22	30[9]	8	
SC3		18	25[9]	15	
SC5		11	20[9]	25	
SC7		9	18[9]	55	
SC11		6	15[9]	85	
SC15		6	12[9]	120	
SCH51	5	10	100[9]	.35	85
SCH52	5	7	100[9]	.8	43
WESTERN ELECTRIC, Laureldale Plant, Laureldale, Pa.					
1N3152	9	6	3.1	4.7	1.5
1N3153	9	6.8	3.1	4.7	1.65

*Western Electric semiconductors listed in these charts are available only to agencies of the U.S. Government and their contractors for Government end use.

MICROWAVE SPECIAL PURPOSE DIODES

TYPE	APP	FREQ Gc	SENS. dbm	R_E %	Z_{max} Kohms
KEMTRON ELECTRON PROD., Newburyport, Mass.					
1N32	video	3.3			22
1N32A	video	3.3			17
K408	video	9	-50v		.3
K408A	video	9	-51v		.3
K408B	video	9	-52v		.3
1N31	video	9.4			24
1N31A	video	9.4			17
1N76/C		9.4			
1N79		10			
1N833	video	9.4	-40		18
1N830/A		.1		65	
K20	det	0-10			
1N82/A	det	.7			

TYPE	APP	FREQ Gc	SENS. dbm	R_E %	Z_{max} Kohms
MICROWAVE ASSOCIATES, Burlington, Mass.				.6	
1N32	video	3.3			22
MA452	video	9	-50		3.1
MA4128	video	9	-50	(for high radiation)	
1N830	det	.1		65	
MA4123	det	4	-45		18
1N833	det	10	-40		18
MA437	mon	.1-1			.15
MA4135	mon	16			10
MA424	mon	10			10

New Semiconductors

—Registered during the period May 1961 to May 1962

(From data supplied by Electronic Industries Assoc., Engineering Dept., 11 W. 42nd St., NYC.)

TRANSISTORS

Type	Class	App.	Outline	V_{CB}	Power Dissipation
2N225	GPNP	S	TO-5	15v.	200mw.
2N315A	GPNP	S	TO-5	30v.	150mw.
2N315B, 2N316A – (Same as 2N315A)					
2N317A	GPNP	S	TO-5	25v.	150mw.
2N339A	SNPN	IF, RF	TO-11	60v.	.25w.
2N340A	SNPN	IF, RF	TO-11	85v.	.25w.
2N341A	SNPN	IF, RF	TO-11	125v.	.25w.
2N356A	GPNP	S	TO-5	30v.	150mw.
2N357A, 2N358A – (Same as 2N356A)					
2N398A	GPNP	AFO	TO-5	105v.	150mw.
2N428A	GPNP	S	TO-5	30v.	150mw.
2N444A	GNPN	GP	TO-5	40v.	150mw.
2N445A	GNPN	GP	TO-5	30v.	150mw.
2N446A, 2N447A – (Same as 2N445A)					
2N447B	GNPN	GP	TO-5	25v.	150mw.
2N470	SNPN	AF	TO-5	15v.	200mw.
2N471	SNPN	AF	TO-5	30v.	200mw.
2N472	SNPN	AF	TO-5	45v.	200mw.
2N473	SNPN	AF	TO-5	15v.	.2w
2N474	SNPN	AF	TO-5	30v.	.2w.
2N475	SNPN	AF	TO-5	45v.	.2w.
2N476	SNPN	AF	TO-5	15v.	.2w.
2N477	SNPN	AF	TO-5	30v.	.2w.
2N478	SNPN	IF, RF	TO-5	15v.	.2w.
2N479	SNPN	IF, RF	TO-5	30v.	.2w.
2N480	SNPN	IF, RF	TO-5	45v.	.2w.
2N489A	SPNP	OSC		65v.	450mw.
2N490A, 2N491A, 2N492A, 2N493A, 2N494A – (Same as 2N489A)					
2N499A	GNPN	IF, RF	TO-1	30v.	60mw.
2N502B	GPNP	RF	TO-9	30v.	75mw.
2N519A	GPNP	AFO	TO-5	25v.	150mw.
2N520A, 2N521A, 2N522A – (Same as 2N519A)					
2N523A	GPNP	AFO	TO-5	20v.	150mw.
2N541A	SNPN	AF	TO-5	15v.	.2w.
2N545	SNPN	AFO	TO-5	60v.	.6w
2N546	SNPN	AFO	TO-5	30v.	.6w.
2N547, 2N549, 2N551 – (Same as 2N545)					
2N548, 2N550, 2N552 – (Same as 2N546)					
2N694	GPNP	IF, RF		30v.	100mw.
2N698	SNPN	HV	TO-5	120v.	0.8w.
2N699A – (Same as 2N698)					
2N699B	SNPN	HV	TO-5	120v.	0.87w.
2N700A	GPNP	IF, RF	TO-17	25v.	75mw.
2N705A	GPNP	S	TO-18	15v.	150mw.
2N708	SNPN	S, HF	TO-18	40v.	.36w.
2N708A	SNPN	S, HF	TO-18	50v.	.36w.
2N709	SNPN	S	TO-18	15v.	.3w
2N710A	GPNP	S	TO-18	15v.	150mw.
2N711A – (Same as 2N710A)					
2N711B	GPNP	S	TO-18	18v.	150mw.
2N721	SPNP	GP	TO-18	50v.	.40w.
2N721A	SPNP	GP	TO-18	50v.	.5w.
2N722	SPNP	AFB	TO-18	50v.	.40w.
2N728	SNPN	S	TO-18	15v.	.3w.
2N729	SNPN	S	TO-18	30v.	.3w.
2N736A	SNPN	AFO	TO-18	80v.	500mw.
2N741A	GPNP	IF, RF	TO-18	20v.	300mw.
2N743	SNPN	S	TO-18	20v.	.3w.
2N743A	SNPN	S	TO-18	40v.	1.2w.
2N744 – (Same as 2N743)					
2N744A – (Same as 2N743A)					
2N754	SNPN	IF, RF	TO-18	60v.	.3w
2N755	SNPN	IF, RF	TO-18	100v.	.3w.
2N756A	SNPN	LP	TO-18	60v.	500mw.
2N757A, 2N759A, 2N760A – (Same as 2N756A)					
2N779A	GPNP	S	TO-18	15v.	60mw.
2N779B	GPNP	S	TO-18	15v.	150mw.
2N780	SNPN	AFO	TO-18	18v.	300mw.
2N781	GPNP	S	TO-18	15v.	150mw.
2N782	GPNP	S	TO-18	12v.	150mw.
2N783	SNPN	S	TO-18	40v.	300mw.
2N784	SNPN	S	TO-18	30v.	300mw.
2N785	GPNP	AFO	TO-23	12v.	50mw.
2N797	GNPN	S	TO-18	20v.	150mw.
2N828	GPNP	S	TO-18	15v.	150mw.
2N834	SNPN	S	TO-18	40v.	.3w.
2N835	SNPN	S	TO-18	25v.	.3w.
2N839	SNPN	IF, RF	TO-18	45v.	.3w.
2N840, 2N841 – (Same as 2N839)					
2N844	SNPN	IF, RF	TO-18	60v.	.3w.
2N845	SNPN	IF, RF	TO-18	100v.	.3w.
2N846B – (Same as 2N779B)					
2N849	SNPN	S		25v.	.3w.
2N850 – (Same as 2N849)					
2N851	SNPN	S		20v.	.3w.
2N852 – (Same as 2N851)					
2N869	SPNP	GP	TO-18	25v.	.36w.
2N870	SNPN	GP	TO-18	100v.	.5w.
2N871 – (Same as 2N870)					
2N909	SNPN	OSC	TO-18	60v.	.4w.
2N910	SNPN	AF	TO-18	100v.	.5w.
2N911	SNPN	GP	TO-18	100v.	.5w.
2N912 – (Same as 2N910)					
2N914	SNPN	HF	TO-18	40v.	.36w.
2N915	SNPN	HF	TO-18	70v.	.36w.
2N916	SNPN	HF	TO-18	45v.	.36w.
2N916A – (Same as 2N916)					
2N919	SNPN	S	TO-18	25v.	.36w.
2N920 – (Same as 2N919)					
2N921	SNPN	S	TO-18	50v.	.36w.
2N922 – (Same as 2N921)					
2N929	SNPN	AFO	TO-18	45v.	.3w.
2N930	SNPN	AFO	TO-18	45v.	.3w.
2N956	SNPN	GP	TO-18	75v.	.5w.
2N960	GPNP	S	TO-18	15v.	150mw.
2N961	GPNP	S	TO-18	12v.	150mw.
2N962 – (Same as 2N961)					
2N963	GPNP	S	TO-18	7v.	150mw.
2N964 – (Same as 2N960)					
2N965, 2N966 – (Same as 2N961)					
2N967 – (Same as 2N963)					
2N968 – (Same as 2N960)					
2N969, 2N970 – (Same as 2N961)					
2N971 – (Same as 2N962					
2N972 – (Same as 2N960)					
2N973, 2N974 – (Same as 2N961)					
2N975 – (Same as 2N963)					
2N976	GPNP	S	TO-18	15v.	100mw.
2N977 – (Same as 2N779B)					
2N979	GPNP	S	TO-18	20v.	60mw.
2N982	GPNP	S	TO-18	20v.	60mw.
2N983	GPNP	S	TO-18	15v.	60mw.
2N984 – (Same as 2N983)					
2N985	GPNP	S	TO-18	15v.	150mw.
2N988	SNPN	IF, RF	TO-18	20v.	.3w.
2N989 – (Same as 2N988)					
2N994	GPNP	S	TO-18	15v.	200mw.
2N995	SPNP	GP	TO-18	20v.	.36w.
2N1000	GNPN	S	TO-5	40v.	150mw.
2N1012 – (Same as 2N1000)					
2N1047B	SNPN	LRF		80v.	1w.
2N1048B	SNPN	LRF		120v.	1w.
2N1049B – (Same as 2N1047B)					
2N1050B – (Same as 2N1048B)					
2N1051	SNPN	RF, IF	TO-29	8v.	.5w.
2N1055	SNPN	AFO	TO-5	100v.	.6w.
2N1060	SNPN	S	TO-28	40v.	250mw.
2N1065	GPNP	GP	TO-9	40v.	120mw.
2N1072	SNPN	P		75v.	12.5w.
2N1078	SNPN	S	TO-46	25v.	300mw.
2N1094	GPNP	RF, IF	TO-28	30v.	150mw.
2N1097	GPNP	AF	TO-5	16v.	175mw.
2N1098 – (Same as 2N1097)					
2N1116	SNPN	AFO	TO-5	60v.	.6w.
2N1117 – (Same as 2N116)					
2N1131A	SPNP	S	TO-5	60v.	.75mw.
2N1132A – (Same as 2N1131A)					
2N1132B	SPNP	S	TO-5	70v.	.6w.
2N1139	SNPN	S	TO-5	15v.	.5w.
2N1141A	GPNP	RF, IF		35v.	.750w.
2N1142A	GPNP	AFO		30v.	.750w.
2N1143A – (Same as 2N1142A)					
2N1144	GPNP	AF		16v.	175mw.
2N1145 – (Same as 2N1144)					
2N1173	GNPN	S	TO-29	35v.	.25w.
2N1174 – (Same as 2N1173)					
2N1185	GPNP	AFO	TO-5	45v.	200mw.
2N1186	GPNP	AFO	TO-5	60v.	200mw.
2N1187, 2N1188 – (Same as 2N1186)					
2N1194	GPNP	AF	TO-5	40v.	200mw.
2N1196	SPNP	HF, OSC	TO-5	70v.	350mw.
2N1197 – (Same as 2N1196)					
2N1204A	GPNP	S	TO-9	20v.	200mw.
2N1208	SNPN	AFO		60v.	85w.
2N1209	SNPN	AFO		45v.	85w.
2N1210	SNPN	P		60v.	60w.
2N1211	SNPN	P		80v.	60w.
2N1212	SNPN	IF, RF		60v.	85w.
2N1250 – (Same as 2N1208)					
2N1254	SPNP	S	TO-5	30v.	.275w.
2N1255 – (Same as 2N1254					
2N1256	SNPN	S	TO-5	40v.	.275w.
2N1257 – (Same as 2N1256)					
2N1258	SPNP	S	TO-5	30v.	.275w.
2N1259	SPNP	S	TO-5	50v.	.275w.
2N1389	SNPN	HF	TO-5	50v.	300mw.
2N1391	GNPN	GP	TO-5	25v.	150mw.
2N1392	GPNP	PH		20v.	50mw.
2N1393	GPNP	PH		20v.	50mw.
2N1394	GPNP	PH		10v.	50mw.
2N1404A	GPNP	S	TO-5	25v.	150mw.
2N1405	GPNP	IF, RF	TO-12	30v.	.075w.
2N1406, 2N1407 – (Same as 2N1405)					
2N1408	GPNP	HV	TO-5	50v.	150mw.

ABBREVIATIONS

AF – Audio Amplifier
AFB – AF Amplifier, Class B
AFO – AF Power Amplifier
CD – Core Driver
GNPN – Germanium NPN
GP – General Purpose
GPNP – Germanium PNP
HF – High Frequency VHF, UHF Amp.
HV – High Voltage Applications
IF – If Amp.
LP – Low Power App.
LRF – Low Frequency Amp.
M – Mixer
OSC – Oscillator
P – Power Switch
PH – Phototransistor
RF – Rf Amp.
S – Switch
SNPN – Silicon NPN
SPNP – Silicon PNP

Type	Class	App.	Outline	V_{CB}	Power Dissipation
2N1444	SNPN	S	TO-29	60v.	500mw.
2N1494A	GPNP	S	TO-31	20v.	400mw.
2N1495	GPNP	S	TO-9	40v.	250mw.
2N1495A – (Same as 2N1495)					
2N1496	GPNP	S	TO-31	40v.	500mw.
2N1561	GPNP	IF, RF		25v.	3w.
2N1562 – (Same as 2N1561)					
2N1566A	SNPN	AFO	TO-5	80v.	600mw.
2N1613A	SNPN	GP	TO-5	75v.	1.0w.
2N1613B	SNPN	GP	TO-5	120v.	1.0w.
2N1615	SNPN	IF, RF	TO-5	100v.	0.6w.
2N1616 – (Same as 2N1210)					
2N1616A	SNPN	LRF		60v.	85w.
2N1617 – (Same as 2N1211)					
2N1617A	SNPN	LRF		80v.	85w.
2N1618	SNPN	P		100v.	60w.
2N1618A	SNPN	LRF		100v.	85w.
2N1620	SNPN	P		100v.	60w.
2N1622	GNPN	HV	TO-5	90v.	120mw.
2N1647	SNPN	IF, RF		80v.	40w.
2N1648	SNPN	P		120v.	40w.
2N1649 – (Same as 2N1647)					
2N1650 – (Same as 2N1648)					
2N1651	GPNP	AFO	TO-41	60v.	100w.
2N1652	GPNP	AFO	TO-41	100v.	100w.
2N1653	GPNP	AFO	TO-41	120v.	100w.
2N1654	SPNP	AFO	TO-5	100v.	250mw.
2N1655	SPNP	AFO	TO-5	150v.	250mw.
2N1656 – (Same as 2N1655)					
2N1672A	GNPN	HV	TO-5	40v.	120mw.
2N1692	SPNP	AF	TO-5	50v.	250mw.
2N1693	GPNP	IF,RF,HF		25v.	350mw.
2N1699	GPNP	IF, RF		40v.	100mw.
2N1700	SNPN	S	TO-5	60v.	5w.
2N1701	SNPN	P	TO-8	60v.	25w.
2N1702	SNPN	P		60v.	75w.
2N1703	SNPN	P	TO-36	60v.	75w.
2N1704	SNPN	GP	TO-5	45v.	500mw.
2N1708A	SNPN	S	TO-46	40v.	1w.
2N1711A–(Same as 2N1613A)					
2N1711B–(Same as 2N1613B)					
2N1714	SNPN	GP		90v.	0.8w.
2N1715	SNPN	GP		150v.	0.8w.
2N1716 – (Same as 2N1714)					
2N1717 –(Same as 2N1715)					
2N1718	SNPN	GP		90v.	2.0w.
2N1719	SNPN	GP		150v.	2.0w.
2N1719	SNPN	GP		150v.	2.0w.
2N1720 – (Same as 2N1718)					
2N1721 – (Same as 2N1719)					
2N1722	SNPN	GP		120v.	3w.
2N1724 – (Same as 2N1722)					
2N1753	GPNP	IF, RF	TO-1	30v.	30mw.
2N1755	GPNP	P		40v.	28w.
2N1756	GPNP	P		60v.	28w.
2N1757	GPNP	P		80v.	28w.
2N1758	GPNP	P		100v.	28w.
2N1759 – (Same as 2N1755)					
2N1760 – (Same as 2N1756)					
2N1761 – (Same as 2N1757)					
2N1762 – (Same as 2N1758)					
2N1768	SNPN	P		60v.	40w.
2N1769	SNPN	P		100v.	40w.
2N1809	SNPN	P		50v.	250w.
2N1810	SNPN	P		100v.	250w.
2N1811	SNPN	P		150v.	250w.
2N1812	SNPN	P		200v.	250w.
2N1813	SNPN	P		250v.	250w.
2N1814	SNPN	P		300v.	250w.
2N1816, 2N1823, 2N1830 – (Same as 2N1809)					
2N1817, 2N1824, 2N1831 – (Same as 2N1810)					
2N1818, 2N1825, 2N1832 – (Same as 2N1811)					
2N1819, 2N1826, 2N1833 – (Same as 2N1812)					
2N1841	SNPN	HF		100v.	2.0w.
2N1886	SNPN	IF, RF		60v.	40w.
2N1889	SNPN	GP	TO-5	100v.	.8w.
2N1890 – (Same as 2N1889)					
2N1893	SNPN	GP	TO-5	120v.	.8w.
2N1907	GPNP	GP	TO-3	100v.	150w.
2N1908	GPNP	GP	TO-3	130v.	150w.
2N1917	SPNP	AF	TO-5	25v.	250mw.
2N1918 –(Same as 2N1917)					
2N1919	SPNP	AF	TO-5	40v.	250mw.
2N1920 – (Same as 2N1919)					
2N1921	SPNP	AF	TO-5	50v.	250mw.
2N1922	SPNP	AF	TO-5	80v.	250mw.

Type	Class	App.	Outline	V_{CB}	Power Dissipation
2N1923	SNPN	AFO	TO-11	85v.	.750w.
2N1924	GPNP	AFO	TO-5	60v.	225mw.
2N1925, 2N1926 – (Same as 2N1924)					
2N1958	SNPN	S	TO-5	60v.	600mw.
2N1959 – (Same as 2N1958)					
2N1960	GPNP	S		15v.	150mw.
2N1961	GPNP	S		12v.	150mw.
2N1962	SNPN	S		40v.	400mw.
2N1963	SNPN	S		30v.	400mw.
2N1964	SNPN	S		60v.	400mw.
2N1965	SNPN	S		60v.	400mw.
2N1966	GPNPN	S	TO-5	35v.	120mw.
2N1969	GPNP	S	TO-5	30v.	150mw.
2N1970	GPNP	P	TO-36	100v.	93w.
2N1971	GPNP	P		80v.	37.5w.
2N1972	SNPN	OSC	TO-5	60v.	0.6w.
2N1973	SNPN	GP	TO-5	100v.	0.8w.
2N1974	SNPN	AF		100v.	0.8w.
2N1975	SNPN	AF	TO-5	100v.	0.8w.
2N1978	SNPN	RF		60v.	30w.
2N1980	GPNP	AFO	TO-36	50v.	
2N1981	GPNP	AFO	TO-36	70v.	
2N1982	GPNP	AFO	TO-36	90v.	
2N1983	SNPN	GP	TO-5	50v.	0.6w.
2N1984, 2N1985, 2N1986, 2N1987 – (Same as 2N1983)					
2N1988	SNPN	OSC	TO-5	100v.	0.6w.
2N1989, 2N1990 – (Same as 2N1988)					
2N1991	SPNP	GP	TO-5	30v.	0.6w.
2N1992	SNPN	S	TO-18	15v.	330mw
2N1993	GNPN	S	TO-5	30v.	150mw.
2N1994	GNPN	S	TO-5	30v.	150mw.
2N1995	GNPN	S	TO-5	25v.	150mw.
2N1996	GNPN	S	TO-5	20v.	150mw.
2N1997	GPNP	S	TO-5	45v.	250mw.
2N1998	GPNP	S	TO-5	35v.	250mw.
2N1999	GPNP	S	TO-5	30v.	250mw.
2N2000	GPNP	S	TO-5	50v.	300mw.
2N2001	GPNP	S	TO-5	30v.	300mw.
2N2004	SPNP	S	TO-5	50v.	250mw.
2N2012	SNPN	GP	TO-5	120v.	5w.
2N2017		GP	TO-5	60v.	1w.
2N2020	SNPN	P		150v.	40w.
2N2021	SNPN	P		200v.	40w.
2N2032	SNPN	AFO		45v.	85w.
2N2042	GPNP	AFO	TO-5	105v.	200mw.
2N2042A, 2N2043, 2N2043A – (Same as 2N2042)					
2N2048	GPNP	P	TO-9	20v.	150mw.
2N2049	SNPN	AF	TO-5	75v.	0.8w.
2N2059	GPNP	S	TO-1	10v.	60mw.
2N2060	SNPN	AF		100v/s	.6w/sec.(both)
2N2075	GPNP	LRF		80v.	170w.
2N2075A, 2N2079, 2N2079A – (Same as 2N2075)					
2N2076	GPNP	LRF		70v.	170w.
2N2076A, 2N2080, 2N2080A – (Same as 2N2076)					
2N2077	GPNP	LRF		50v.	170w.
2N2077A, 2N2081, 2N2081A – (Same as 2N2077)					
2N2078	GPNP	LRF		40v.	170w.
2N2078A, 2N2082, 2N2082A – (Same as 2N2078)					
2N2085	GNPN	LRF	TO-5	33v.	150mw.
2N2086	SNPN	S	TO-5	120v.	.6w
2N2087 – (Same as 2N2086)					
2N2101	SNPN	AFO		60v.	75w.
2N2104	SPNP	S	TO-5	50v.	0.8w.
2N2105 – (Same as 2N2104)					
2N2106	SNPN	AFO	TO-5	60v.	1w.
2N2107, 2N2108 – (Same as 2N2106)					
2N2109	SNPN	P		50v.	250w.
2N2110	SNPN	P		100v.	250w.
2N2111	SNPN	P		150v.	250w.
2N2112	SNPN	P		200v.	250w.
2N2113	SNPN	P		250v.	250w.
2N2114	SNPN	P		300v.	250w.
2N2116, 2N2133, 2N2130 – (Same as 2N2109)					
2N2117, 2N2124, 2N2131 – (Same as 2N2110)					
2N2118, 2N2125, 2N2132 – (Same as 2N2111)					
2N2119, 2N2126, 2N2133 – (Same as 2N2112)					
2N2137	GPNP	LRF	TO-3	30v.	62.5w.
2N2137A, 2N2142, 2N2142A – (Same as 2N2137)					
2N2138	GPNP	LRF	TO-3	45v.	62.5w.
2N2138A, 2N2143, 2N2143A – (Same as 2N2138)					
2N2139	GPNP	LRF	TO-3	60v.	62.5w.
2N2139A, 2N2144, 2N2144A – (Same as 2N2139)					
2N2140	GPNP	LRF	TO-3	75v.	62.5w.
2N2140A, 2N2145, 2N2145A – (Same as 2N2140					
2N2141	GPNP	LRF	TO-3	90v.	62.5w.

Type	Class	App.	Outline	V_{CB}	Power Dissipation
2N2141A, 2N2146, 2N2146A – (Same as 2N2141)					
2N2152	GPNP	LRF		45v.	170w.
2N2152A	GPNP	LRF	TO-36	45v.	170w.
2N2153	GPNP	LRF		60v.	170w.
2N2153A	GPNP	LRF	TO-36	60v.	170w.
2N2154	GPNP	LRF		75v.	170w.
2N2154A	GPNP	LRF	TO-36	75v.	170w.
2N2155	GPNP	LRF		90v.	170w.
2N2155A	GPNP	LRF	TO-36	90v.	170w.
2N2156 – (Same as 2N2152)					
2N2156A – (Same as 2N2152A)					
2N2157 – (Same as 2N2153)					
2N2157A – (Same as 2N2153A)					
2N2158 – (Same as 2N2154)					
2N2158A – (Same as 2N2154A)					
2N2159 – (Same as 2N2155)					
2N2159A – (Same as 2N2155A)					
2N2168	GPNP	S	TO-9	20v.	60mw.
2N2169	GPNP	S	TO-9	15v.	60mw.
2N2170 – (Same as 2N2169)					
2N2172	GPNP	S	TO-5	10v.	200mw.
2N2175	SPNP	AFO	TO-5	6v.	100mw.
2N2176	SPNP	AFO	TO-18	6v.	100mw.
2N2177 – (Same as 2N2175)					
2N2178 – (Same as 2N2176)					
2N2180	GPNP	S	TO-24	15v.	50mw.
2N2181	SPNP	S	TO-1	25v.	150mw.
2N2182	SPNP	S	TO-1	25v.	150mw.
2N2183	SPNP	S	TO-1	15v.	150mw.
2N2184 – (Same as 2N2183)					
2N2185	SPNP	S	TO-18	30v.	150mw.
2N2186, 2N2187 – (Same as 2N2185)					
2N2192	SNPN	S	TO-5	60v.	0.8w.
2N2193	SNPN	HF	TO-5	80v.	0.8w.
2N2193A, 2N2193B – (Same as 2N2193)					
2N2194	SNPN	HF	TO-5	60v.	0.8w.
2N2194A, 2N2194B – (Same as 2N2194)					
2N2195	SNPN	HF	TO-5	45v.	0.6w.
2N2195A, 2N2195B – (Same as 2N2195)					
2N2199	GPNP	OSC	TO-9	15v.	75mw.
2N2200 – (Same as 2N2199)					
2N2208	GPNP	IF, RF	TO-44	40v.	120mw.
2N2209	GPNP	S	TO-5	30v.	150mw.
2N2210	GPNP	P		100v.	70w.
2N2212	GPNP	GP	TO-41	120v.	60w.
2N2216	SPNP	GP	TO-5	150v.	0.8w.
2N2224	SNPN	S	TO-5	65v.	0.8w.
2N2226	SNPN	AFO		50v.	150w.
2N2227	SNPN	AFO		100v.	150w.
2N2228	SNPN	AFO		150v.	150w.
2N2229	SNPN	AFO		200v.	150w.
2N2230 – (Same as 2N2226)					
2N2231 – (Same as 2N2227)					
2N2232 – (Same as 2N2228)					
2N2233 – (Same as 2N2229)					
2N2239	SNPN	AFO		60v.	1w.
2N2242	SNPN	S	TO-18	40v.	36mw.
2N2243	SNPN	S	TO-5	120v.	0.8w.
2N2271	SPNP	AF	TO-5	20v.	250mw.
2N2282	GPNP	AFO	TO-37	60v.	5w.
2N2283	GPNP	AFO	TO-37	100v.	5w.
2N2284	GPNP	AFO	TO-37	200v.	5w.
2N2285	GPNP	AFO	TO-3	60v.	100w.
2N2286	GPNP	AFO	TO-3	100v.	100w.
2N2287	GPNP	AFO	TO-3	120v.	100w.
2N2288	GPNP	AFO	TO-3	40v.	60w.
2N2289	GPNP	AFO	TO-3	80v.	60w.
2N2290	GPNP	AFO	TO-3	120v.	60w.
2N2291 – (Same as 2N2288)					
2N2292 – (Same as 2N2289)					
2N2293 – (Same as 2N2290)					
2N2294	GPNP	P	TO-41	40v.	60w.
2N2295	GPNP	P	TO-41	80v.	60w.
2N2296	GPNP	P	TO-41	120v.	60w.
2N2330	SNPN	S	TO-5	30v.	0.8w.
2N2331	SNPN	S	TO-18	30v.	0.5w.
2N2349	SNPN	AFO	TO-5	15v.	150mw.
2N2374	SPNP	GP	TO-5	35v.	250mw.
2N2375, 2N2376 – (Same as 2N2374)					
3N47	GPNP	P	TO-15	40v.	75w.
3N48	GPNP	P	TO-15	60v.	75w.
3N49	GPNP	P		60v.	94w.
3N50	GPNP	P		80v.	94w.
3N51	GPNP	P		40v.	94w.
3N52	GPNP	P		60v.	94w.

SILICON CONTROLLED RECTIFIERS

Type	Class	App.	Outline	Sine Wave Input Voltage	Average DC Output Current	Reverse or Forward Leakage Current	Power Dissipation
2N1798	SPNPN	B		400v.	70a.	4.0 ma.	0.5w.
2N1842	SPNPN	B	TO-48	25v.	10a.	22.5ma.	
2N1843	SPNPN	B	TO-48	50v.	10a.	19.0ma.	
2N1844	SPNPN	B	TO-48	100v.	10a.	12.5ma.	
2N1845	SPNPN	B	TO-48	150v.	10a.	6.5ma.	
2N1846	SPNPN	B	TO-48	200v.	10a.	6.0ma.	
2N1847	SPNPN	B	TO-48	250v.	10a.	5.5ma.	
2N1848	SPNPN	B	TO-48	300v.	10a.	5.0ma.	
2N1849	SPNPN	B	TO-48	400v.	10a.	4.0ma.	
2N1850	SPNPN	B	TO-48	500v.	10a.	3.0 ma.	
2N1869	SPNPN	C	TO-9		1.25a.		
2N1869A – (Same as 2N1869)							
2N1870	SPNPN	C	TO-9		1.25a.		
2N1870A – (Same as 2N1870)							
2N1871	SPNPN	C	TO-9		1.25a.		
2N1871A – (Same as 2N1871)							
2N1872	SPNPN	C	TO-9		1.25a.		
2N1872A – (Same as 2N1872)							
2N1873	SPNPN	C	TO-9		1.25a.		
2N1873A – (Same as 2N1873)							
2N1874	SPNPN	C	TO-9		1.25a.		
2N1874A – (Same as 2N1874)							
2N1909	SPNPN	B	TO-49	25v.	70a.		
2N1910	SPNPN	B	TO-49	50v.	70a.		
2N1911	SPNPN	B	TO-49	100v.	70a.		
2N1912	SPNPN	B	TO-49	150v.	70a.		
2N1913	SPNPN	B	TO-49	200v.	70a.		
2N1914	SPNPN	B	TO-49	250v.	70a.		
2N1915	SPNPN	B	TO-49	300v.	70a.		
2N1916	SPNPN	B	TO-49	400v.	70a.		
2N1929	SPNPN	B		25v.	550a.	2.0ma.	
2N1930	SPNPN	B		50v.	550a.	2.0ma.	
2N1931	SPNPN	B		100v.	550a.	1.0ma.	
2N1932	SPNPN	B		150v.	550a.	.75ma.	
2N1933	SPNPN	B		200v.	550a.	.55ma.	
2N1934	SPNPN	B		250v.	550a.	.5ma.	
2N1935	SPNPN	B		300v.	550a.	.45ma.	
2N2023	SPNPN	B	TO-49	25v.	70a.		
2N2024	SPNPN	B	TO-49	50v.	70a.		
2N681	SPNPN	B		25v.	16a.	6.5ma.	
2N682	SPNPN	B		50v.	16a.	6.5ma.	
2N683	SPNPN	B		100v.	16a.	6.5ma.	
2N684	SPNPN	B		150v.	16a.	6.5ma.	
2N685	SPNPN	B		200v.	16a.	6.0ma.	
2N686	SPNPN	B		250v.	16a.	5.5ma.	
2N687	SPNPN	B		300v.	16a.	5.0ma.	
2N688	SPNPN	B		400v.	16a.	4.0ma.	
2N689	SPNPN	B		500v.	16a.	3.0ma.	
2N1595	SPNPN	A	TO-5	50v.	1a.		
2N1595A – (Same as 2N1595)							
2N1596	SPNPN	A	TO-5	100v.	1a.		
2N1596A – (Same as 2N1596)							
2N1597	SPNPN	A	TO-5	200v.	1a.		
2N1597A – (Same as 2N1597)							
2N1598	SPNPN		TO-5	300v.	1a.		
2N1598A – (Same as 2N1598)							
2N1599	SPNPN	A	TO-5	400v.	1a.		
2N1599A – (Same as 2N1599)							
2N1600	SPNPN	A		50v.	3a.		
2N1601	SPNPN	A		100v.	3a.		
2N1602	SPNPN	A		200v.	3a.		
2N1603	SPNPN	A		300v.	3a.		
2N1604	SPNPN	A		400v.	3a.		
2N1765	SPNPN	C	TO-29				1.0w.
2N1770A	SPNPN	B		25v.	4.7a.	4.5ma.	
2N1771A	SPNPN	B		50v.	4.7a.	4.5ma.	
2N1772A	SPNPN	B		100v.	4.7a.	4.5ma.	
2N1773A	SPNPN	B		150v.	4.7a.	4.0ma.	
2N1774A	SPNPN	B		200v.	4.7a.	3.0ma.	
2N1775A	SPNPN	B		250v.	4.7a.	2.5ma.	
2N1776A	SPNPN	B		300v.	4.7a.	2.0ma.	
2N1777A	SPNPN	B		400v.	4.7a.	1.0ma.	
2N1792	SPNPN	B		50v.	70a.	6.5ma.	0.5w.
2N1793	SPNPN	B		100v.	70a.	6.5ma.	0.5w.
2N1794	SPNPN	B		150v.	70a.	6.5ma.	0.5w.
2N1795	SPNPN	B		200v.	70a.	6.0ma.	0.5w.
2N1796	SPNPN	B		250v.	70a.	5.5ma.	0.5w.
2N1797	SPNPN	B		300v.	70a.	5.0ma.	0.5w.
2N2025	SPNPN	B	TO-49	100v.	70a.		5w.
2N2026	SPNPN	B	TO-49	150v.	70a.		5w.
2N2027	SPNPN	B	TO-49	200v.	70a.		5w.
2N2028	SPNPN	B	TO-49	250v.	70a.		5w.
2N2029	SPNPN	B	TO-49	300v.	70a.		5w.
2N2030	SPNPN	B	TO-49	400v.	70a.		5w.
2N2031	SPNPN	B	TO-49	50v.	70a.		5w.

CODE: A – Rectifier + Phase Control, B – Power Control + Switching, C – Pulse Applications, SPNPN – Silicon PNPN

SEMICONDUCTOR DIODES

Type	Class	App.	Outline	Continuous Average Forward Current	Maximium Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Power Dissipation
1N96A	GO	GP		70ma.				80mw.
1N98A	GO	GP		70ma.				80mw.
1N100A – (Same as 1N98A)								
1N118A – (Same as 1N96A)								
1N695A	GD	GP	00-7	150ma.				80mw.
1N781	GO	S	00-7	60ma.				80mw.
1N781A – (Same as 1N781)								
1N810	SO	S			1.0 μa		50v.	0.1w.
1N811	SD	S	00-7	40ma.			20v.	150mw.
1N812	SO	S	DO-7	60ma.			30v.	150mw.
1N813	SO	S	DO-7	75ma.			15v.	150mw.
1N814	SD	S	DO-7	60ma.			40v.	150mw.
1N815	SO	S	DO-7	120ma.			15v.	150mw.
1N816	SD	GP	DO-7	150ma.			20v.	80mw.
1N993	SO	S	DO-7					80mw.
1N994	GD	S	DO-7					80mw.
1N995	GD	S	DO-7					80mw.
1N996	GD	S	DO-7					
1N1150A	SD	PR					1600v.	
1N1199B	SD	PR	DO-4	12a.		50v.		

ABBREVIATIONS

GD – Germonium Diode
GP – Generol Purpose
LRF – Low Frequency Amplifier
MA – Microwove Amplifier
OSC – Oscillotor
PR – Power Rectifier
S – Switch
SD – Silicon Diode
SUD – Silicon Unijunction Diode

SEMICONDUCTOR DIODES (Cont'd.)

Type	Class	App.	Outline	Continuous Average Forward Current	Maximum Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Power Dissipation
1N1200B	SD	PR	DO-4	12a.		100v.		
1N1201B	SD	PR	DO-4	12a.		150v.		
1N1202B	SD	PR	DO-4	12a.		200v.		
1N1203B	SD	PR	DO-4	12a.		300v.		
1N1204B	SD	PR	DO-4	12a.		400v.		
1N1205B	SD	PR	DO-4	12a.		500v.		
1N2016	SD	PR	DO-4	12a.		600v.		
1N217B	SD	PR	DO-1	1.35a.		50v.		
1N1218B	SD	PR	DO-1	1.35a.		100v.		
1N1219B	SD	PR	DO-1	1.35a.		150v.		
1N1220B	SD	PR	DO-1	1.35a.		200v.		
1N1221B	SD	PR	DO-1	1.35a.		300v.		
1N1222B	SD	PR	DO-1	1.35a.		400v.		
1N1223B	SD	PR	DO-1	1.35a.		500v.		
1N1224B	SD	PR	DO-1	1.25a.		600v.		
1N1225A	SD	PR	DO-1	1.1a.		700v.		
1N1225B	SD	PR	DO-1	1.25a.		700v.		
1N1226A	SD	PR	DO-1	1.0a.		800v.		
1N1226B	SD	PR	DO-1	1.15a		800v.		
1N1443A	SD	PR	DO-1	.95a.		1000v.		
1N1443B	SD	PR	DO-1	1.1a.		1000v.		
1N1563A	SD	PR		1.5a.		100v.		
1N1564A	SD	PR		1.5a.		200v.		
1N1565A	SD	PR		1.5a.		300v.		
1N1566A	SD	PR		1.5a.		400v.		
1N1567	SD	PR		1.0a.		500v.		
1N1567A	SD	PR		1.5a.		500v.		
1N1568	SD	PR		1.0a.		600v.		
1N1568A	SD	PR		1.5a.		600v.		
1N1569	SD	PR		1.0a.		100v.		
1N1570	SD	PR		1.0a.		200v.		
1N1571	SD	PR		1.0a.		300v.		
1N1572	SD	PR		1.0a.		400v.		
1N1573	SD	PR		1.0a.		500v.		
1N1574	SD	PR		1.0a.		600v.		
1N1575	SD	PR		3.5a.		100v.		
1N1576	SD	PR		3.5a.		200v.		
1N1577	SD	PR		3.5a.		300v.		
1N1578	SD	PR		3.5a.		400v.		
1N1579	SD	PR		3.5a.		500v.		
1N1580	SD	PR		3.5a.		600v.		
1N2069A	SD	PR		750ma.			200v.	
1N2070	SD	PR		750ma.			400v.	
1N2071A	SD	PR		750ma.			600v.	
1N2146	SD	S			1.0μa.		120v.	1.0w.
2N2160	SUD	OSC						
1N2218	SD	PR	DO-4	0.4a.	3.0μa.	500v.		
1N2220	SD	PR	DO-4	0.4a.	3.0μa.	600v.		
1N2222	SD	PR	DO-4	0.3a.	3.0μa.	800v.		
1N2222A – (Same as 1N2222)								
1N2224	SD	PR	DO-4	0.3a.	3.0μa.	1000v.		
1N2224A – (Same as 1N2224								
1N2226	SD	PR	DO-4	0.3a.	3.0μa.	1200v.		
1N2226A – (Same as 1N2226)								
1N2228	SD	PR	DO-4	1.0a.	3.0μa.	50v.		
1N2228B	SD	PR	DO-4	1.6a.	3.0μa.	50v.		
1N2230	SD	PR	DO-4	1.0a.	3.0μa.	200v.		
1N2230A	SD	PR	DO-4	1.6a.	3.0μa.	200v.		
1N2232	SD	PR	DO-4	1.0a.	3.0μa.	300v.		
1N2232A	SD	PR	DO-4	1.6a	3.0μa.	300v.		
1N2234	SD	PR	DO-4	1.0a.	3.0μa.	400v.		
1N2234A	SD	PR	DO-4	1.6a.	3.0μa.	400v.		
1N2236	SD	PR	DO-4	1.0a.	3.0μa.	500v.		
1N2236A	SD	PR	DO-4	1.6a.	3.0μa.	500v.		
1N2238	SD	PR	DO-4	1.0a.	3.0μa.	600v.		
1N2238A	SD	PR	DO-4	1.6a.	3.0μa.	600v.		
1N2240	SD	PR	DO-4	1.5a.	3.0μa.	800v.		
1N2240A	SD	PR	DO-4	1.6a.	3.0μa.	800v.		
1N2242	SD	PR	DO-4	1.5a.	3.0μa.	1000v.		
1N2242A	SD	PR	DO-4	1.6a.	3.0μa.	1000v.		
1N2244	SD	PR	DO-4	1.5a.	3.0μa.	1200v.		
1N2244A	SD	PR	DO-4	1.6a.	3.0μa.	1200v.		
1N2246	SD	PR	DO-4	3a.	5μa.	50v.		
1N2246A	SD	PR	DO-4	3a.	3μa.	50v.		
1N2248	SD	PR	DO-4	3a.	5μa.	100v.		
1N2248A	SD	PR	DO-4	3a.	3μa.	100v.		
1N2250	SD	PR	DO-4	3a.	5μa.	200v.		
1N2250A	SD	PR	DO-4	3a.	3μa.	200v.		
1N2252	SD	PR	DO-4	3a.	5μa.	300v.		
1N2252A	SD	PR	DO-4	3a.	3μa.	300v.		
1N2254	SD	PR	DO-4	3a.	5μa.	400v.		
1N2254A	SD	PR	DO-4	3a.	3μa.	400v.		
1N2256	SD	PR	DO-4	3a.	5μa.	500v.		
1N2256A	SD	PR	DO-4	3a.	3μa.	500v.		
1N2258	SD	PR	DO-4	3a.	5μa.	600v.		
1N2258A	SD	PR	DO-4	3a.	3μa.	600v.		
1N2260	SD	PR	DO-4	3a.	10μa.	800v.		
1N2260A	SD	PR	DO-4	3a.	5μa.	800v.		
1N2262	SD	PR	DO-4	3a.	10μa.	1000v.		
1N2262A	SD	PR	DO-4	3a.	5μa.	1000v.		
1N2264	SD	PR	DO-4	3a.	10μa.	1200v.		
1N2264A	SD	PR	DO-4	3a.	5μa.	1200v.		
1N2266	SD	PR	DO-4	0.3a.	3μa.	50v.		
1N2268	SD	PR	DO-4	0.3a.	3μa.	500v.		
1N2270	SD	PR	DO-4	0.3a.	3μa.	600v.		
1N2272	SD	PR	DO-4				50v.	
1N2273	SD	PR	DO-4				100v.	
1N2274	SD	PR	DO-4				200v.	
1N2275	SD	PR	DO-4				300v.	
1N2276	SD	PR	DO-4				400v.	
1N2277	SD	PR	DO-4				500v.	
1N2278	SD	PR	DO-4				600v.	
1N2279	SD	PR	DO-4				800v.	
1N2280	SD	PR	DO-4				1000v.	
1N2281	SD	PR	DO-4				1200v.	
1N2282	SD	PR	DO-4				300v.	
1N2283	SD	PR	DO-4				400v.	
1N2284	SD	PR	DO-4				500v.	
1N2285	SD	PR	DO-4				600v.	
1N2286	SD	PR	DO-4				800v.	
1N2287	SD	PR	DO-4				1000v.	
1N2288	SD	PR	DO-4				1200v.	
1N2327	SD	GP			1.5μa		3300v.	1.0w.
1N2328 – (Same as 1N2327)								
1N2482	SD	PR		.750a.		200v.		
1N2483	SD	PR		.750a.		400v.		
1N2484	SD	PR		.750a.		600v.		
1N2485 – (Same as 1N2482)								
1N2486	SD	PR		.750a.		300v.		
1N2487 – (Same as 1N2483)								
1N2488	SD	PR		.750a.		500v.		
1N2489 – (Same as 1N2484)								
1N2490	SD	PR		.500a.		1600v.		
1N2610	SD	PR		.750a.		100v.		
1N2611	SD	PR		.750a.		200v.		
1N2612	SD	PR		.750a.		300v.		
1N2613	SD	PR		.750a.		400v.		
1N2614	SD	PR		.750a.		500v.		
1N2615	SD	PR		.750a.		600v.		
1N2616	SD	PR		.750a.		800v.		
1N2617	SD	PR		.750a.		1000v.		
1N2791	SD	GP			.012μa.		350v.	100mw.
1N2801	GD	S			2μa.		20v.	0.1w.
1N3062	SD	GP	DO-7				75v.	250mw.
1N3063, 1N3064, 1N3065, 1N3066 – (Same as 1N3062)								
1N3067	SD	GP	DO-7				30v.	250mw.
1N3068 – (Same as 1N3067)								
1N3069	SD	GP	DO-7				65v.	250mw.
1N3070	SD	GP	DO-7				200v.	500mw.
1N3071	SD	GP	DO-7					250mw.
1N3147	SD	GP	DO-7					250mw.
1N3152	SD	GP					5.5v.	
1N3153 – (Same as 1N3153)								
1N3158	SD	LRF					5.5v.	150mw.
1N3171	SD	PR		240a.	16ma.		700v.	
1N3172	SD	PR		240a.	16ma.		800v.	
1N3173	SD	PR		240a.	16ma.		900v.	
1N3174	SD	PR		240a.	16ma.		1000v.	
1N3189	SD	PR		1.0a.		200v.		
1N3190	SD	PR		1.0a.		400v.		
1N3191	SD	PR		1.0a.		600v.		
1N3193	SD	PR		.75a.		200v.		
1N3194	SD	PR		.75a.		400v.		
1N3195	SD	PR		.75a.		600v.		
1N3196	SD	PR		0.5a.		800v.		
1N3203	GD	S	DO-3	60ma.				
1N3208	SD	PR		15a.		50v.		
1N3209	SD	PR		15a.		100v.		
1N3210	SD	PR		15a.		200v.		
1N3211	SD	PR		15a.		300v.		
1N3212	SD	PR		15a.		400v.		
1N3218	GD	MA			2.4ma.			
1N3219	GD	MA			1.1ma.			
1N3227	SD	PR			250μa.	100v.		
1N3228	SD	PR			250μa.	200v.		
1N3229	SD	PR			250μa.	400v.		
1N3230	SD	PR			250μa.	600v.		
1N3231	SD	PR			250μa.	800v.		
1N3232	SD	PR			250μa.	1000v.		
1N3233	SD	PR			250μa.	1200v.		

SEMICONDUCTOR DIODES *(Con'd.)*

Type	Class	App.	Outline	Continuous Average Forward Current	Maximum Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Power Dissipation
1N3234	SD	PR			250µa			
1N3235	SD	PR			250µa.	1800v.		
1N3236	SD	PR			250µa.	2000v.		
1N3237	SD	PR			250µa.	50v.		
1N3238	SD	PR			250µa.	100v.		
1N3239	SD	PR			250µa.	200v.		
1N3240	SD	PR			250µa.	400v.		
1N3241	SD	PR			250µa.	600v.		
1N3242	SD	PR			250µa.	800v.		
1N3243	SD	PR			250µa.	1000v.		
1N3244	SD	PR			250µa.	1200v.		
1N3245	SD	PR			250µa.	1500v.		
1N3246 – (Same as 1N3237)								
1N3247 – (Same as 1N3238)								
1N3248 – (Same as 1N3239)								
1N3249 – (Same as 1N3240)								
1N3250 – (Same as 1N3241)								
1N3251 – (Same as 1N3242)								
1N3252 – (Same as 1N3243)								
1N3253	SD	PR		.75a.		200v.		
1N3254	SD	PR		.75a.		400v.		
1N3255	SD	PR		.75a.		600v.		
1N3256	SD	PR		0.5a.		800v.		
1N3260	SD	PR		160a.	12ma.		50v.	
1N3261	SD	PR		160a.	12ma.		100v.	
1N3262	SD	PR		160a.	12ma.		150v.	
1N3263	SD	PR		160a.	12ma.		200v.	
1N3264	SD	PR		160a.	12ma.		250v.	
1N3265	SD	PR		160a.	12ma.		300v.	
1N3266	SD	PR		160a.	12ma.		350v.	
1N3267	SD	PR		160a.	12ma.		400v.	
1N3268	SD	PR		160a.	12ma.		500v.	
1N3269	SD	PR		160a.	12ma.		600v.	
1N3277	SD	PR		.75a.			200v.	
1N3278	SD	PR		.75a.			400v.	
1N3279	SD	PR		.75a.			600v.	
1N3280	SD	PR		.75a.			800v.	
1N3281	SD	PR		.75a.			1000v.	
1N3282	SD	PR	DO–7	100ma.		1000v.		
1N3283	SD	PR	DO–7	100ma.		1500v.		
1N3284	SD	PR	DO–7	100ma.		2000v.		
1N3285	SD	PR	DO–7	100ma.		2500v.		
1N3286	SD	PR	DO–7	100ma.		3000v.		
1N3288	SD	PR	DO–8	100a.		100v.		
1N3289	SD	PR	DO–8	100a.		200v.		
1N3290	SD	PR	DO–8	100a.		300v.		
1N3291	SD	PR	DO–8	100a.		400v.		
1N3292	SD	PR	DO–8	100a.		500v.		
1N3293	SD	PR	DO–8	100a.		600v.		
1N3294	SD	PR	DO–8	100a.		800v.		
1N3295	SD	PR	DO–8	100a.		1000v.		
1N3296	SD	PR	DO–8	100a.		1200v.		
1N3297	SD	PR	DO–8	100a.		1400v.		
1N3353	GD	S						
1N3354	SD	PR		3a.		10v.		
1N3355	SD	PR		3a.		15v.		
1N3356	SD	PR		3a.		25v.		
1N3357	SD	PR		3a.		50v.		
1N3358	SD	PR		3a.		75v.		
1N3359	SD	PR		3a.		100v.		
1N3360	SD	PR		3a.		150v.		
1N3361	SD	PR		3a.		200v.		
1N3362	SD	PR		3a.		300v.		
1N3363	SD	PR		3a.		400v.		
1N3364	SD	PR		3a.		500v.		
1N3365	SD	PR		3a.		600v.		
1N3366	SD	PR		3a.		700v.		
1N3367	SD	PR		3a.		800v.		

Type	Class	App.	Outline	Continuous Average Forward Current	Maximum Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Power Dissipation
1N3368	SD	PR		3a.		900v.		
1N3369	SD	PR		3a.		1000v.		
1N3370	SD	PR		3a.		1200v.		
1N3371	SD	PR		3a.		1500v.		
1N3372	SD	PR		20a.		10v.		
1N3373	SD	PR		20a.		25v.		
1N3374	SD	PR		20a.		50v.		
1N3375	SD	PR		20a.		100v.		
1N3376	SD	PR		20a.		150v.		
1N3377	SD	PR		20a.		200v.		
1N3378	SD	PR		20a.		300v.		
1N3379	SD	PR		20a.		400v.		
1N3380	SD	PR		20a.		500v.		
1N3381	SD	GP			10µa.		15v.	500mw.
1N3382	SD	GP			10µa.		30v.	500mw.
1N3383	SD	GP			10µa.		50v.	500mw.
1N3384	SD	GP			15µa.		75v.	500mw.
1N3385	SD	GP			20µa.		100v.	500mw.
1N3386	SD	GP			20µa.		150v.	500mw.
1N3387	SD	GP			20µa.		200v.	500mw.
1N3388	SD	GP			25µa.		250v.	500mw.
1N3389	SD	GP			25µa.		300v.	500mw.
1N3390	SD	GP			25µa.		400v.	500mw.
1N3391	SD	GP			25µa.		500v.	500mw.
1N3456	SD	PR		.600a.			300v.	
1N3457	SD	PR		.600a.			400v.	
1N3458	SD	PR		.600a.			500v.	
1N3464	SD	PR		.10a.		8500v.		
1N3473	SD	PR		.75a.		200v.		
1N3474	SD	PR		.75a.		400v.		
1N3475	SD	PR		.75a.		600v.		
1N3476	SD	PR		.50a.		800v.		
1N3478	SD	GP			10µa.		200v.	400mw.
1N3479	SD	GP			10µa.		400v.	400mw.
1N3480	SD	GP			10µa.		600v.	400mw.
1N3486	SD	PR	DO–1			1000v.		
1N3487	SD	PR	DO–1			1200v.		
1N3491	SD	PR		18a.			50v.	
1N3492	SD	PR		18a.			100v.	
1N3493	SD	PR		18a.			200v.	
1N3494	SD	PR		18a.			300v.	
1N3495	SD	PR		18a.			400v.	
1N3544	SD	PR		.600a.			100v.	
1N3545	SD	PR		.600a.			200v.	
1N3546	SD	PR		.600a.			300v.	
1N3547	SD	PR		.600a.			400v.	
1N2548	SD	PR		.600a.			500v.	
1N3549	SD	PR		.600a.			600v.	
1N3560	GD	GP						
1N3561 – (Same as 1N3560)								
1N3562	GD	GP						
1N3568	SD	GP					80v.	250mw.
1N3569	SD	PR	DO–4	3.5a.		100v.		
1N3570	SD	PR	DO–4	3.5a.		200v.		
1N3571	SD	PR	DO–4	3.5a.		300v.		
1N3572	SD	PR	DO–4	3.5a.		400v.		
1N3573	SD	PR	DO–4	3.5a.		500v.		
1N3574	SD	PR	DO–4	3.5a.		600v.		
1N3575	SD	GP		150ma.			60v.	
1N3576	SD	GP		150ma.			125v.	
1N3577	SD	GP		150ma.			175v.	
1N3578	SD	GP		150ma.			225v.	
1N3579	SD	GP		150ma.			275v.	
1N3592	GD	GP	DO–7				25v.	
1N3593	SD	GP		50ma.			40v.	
1N3594	SD	GP					60v.	
1N3651	GD	S	DO–7	15ma.				
1N3652 – (Same as 1N3651)								

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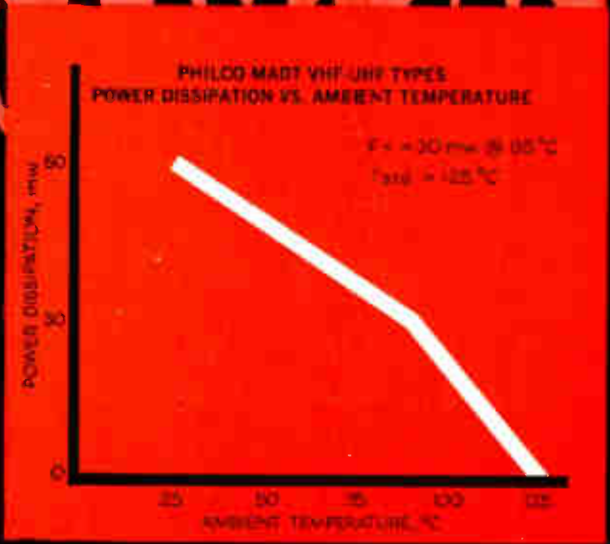

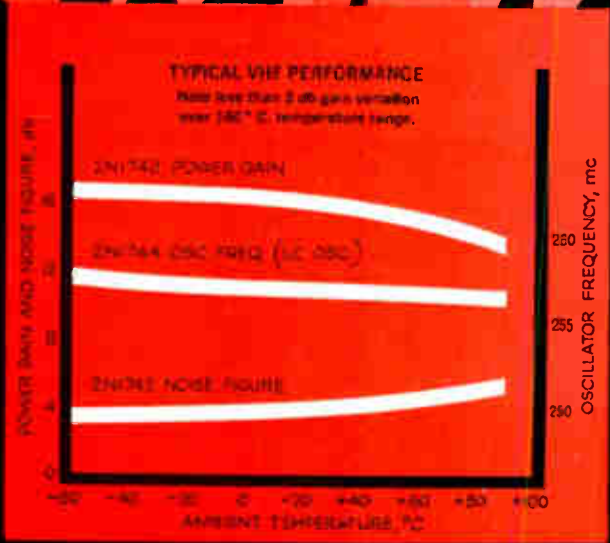

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*Micro Alloy Diffused-base Transistor

For complete data on high temperature germanium transistors, write Dept. E1662.

Types 2N1742-44 are immediately available from your Philco Industrial Semiconductor Distributor

PHILCO®

A SUBSIDIARY OF Ford Motor Company,

LANSDALE DIVISION, LANSDALE, PA.

SOLID-STATE CENTER U.S.A.

108

108 STANDARD DIODE QUADS

in six package styles for both germanium and silicon are available from Raytheon Distributors coast to coast — at off-the-shelf prices

We will be happy to send you the name of the Raytheon Distributor serving your area.

Please write: Raytheon, Distributor Products Division, 411 Providence Turnpike, Westwood, Massachusetts.

Raytheon Distributors include:

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Mobile
Forbes Electronic Distributors, Inc.
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Knoxville
Bondurant Brothers Company
3-9144

TEXAS
Fort Worth
SWIECO, Inc.
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EMerson 3-5821

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RAYTHEON

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Circle 17 on Inquiry Card

RAYTHEON DELIVERS 108 STANDARD DIODE QUADS

Raytheon now offers designers of ring and bridge modulators, discriminators, phase detectors, diode choppers and other balanced circuits the industry's most complete line of germanium and silicon diode quads.

Three PIV's and three forward match percentages in six package styles for both germanium and silicon provide maximum flexibility to meet a wide range of electrical and mechanical requirements.

Raytheon's long experience in circuit packaging techniques and quality diode manufacturing and matching assures you of proven reliability, extremely uniform electrical characteristics, and dependable mechanical stability. For details on the industry's most complete selection of high quality diode quads, plus off-the-shelf price and delivery information, please contact your Raytheon Distributor or Field Office.

ELECTRICAL DATA GERMANIUM QUADS

T = 25°C Each diode

Io — Average Rectified Current	65 mA
Peak Rectified Current	150 mA
Surge Current for 1 Second	500 mA
Ambient Temperature Range	−60 to +90 °C
Power Dissipation	80 mW
Maximum Forward Voltage @ 100 mA	1 V

Electrical Rating Code (ordering)	Degree of Forward Match @ 4 mA	PIV each Diode	Maximum Inverse Current @ −10 V
1	1%	35 V	20 μa
2	1%	75 V	10 μa
3	1%	100 V	10 μa
4	2.5%	35 V	20 μa
5	2.5%	75 V	10 μa
6	2.5%	100 V	10 μa
7	5%	35 V	20 μa
8	5%	75 V	10 μa
9	5%	100 V	10 μa

HOW TO ORDER: C707
PAK STYLE ┘ └ RATING CODE

ELECTRICAL DATA SILICON QUADS

T 25°C Each diode

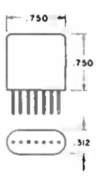
Io — Average Rectified Current	200 mA
Surge Current for 1 Second	1.5 A
Ambient Temperature Range	−60 to +150 °C
Power Dissipation	250 mW
Maximum Forward Voltage @ 100 mA	1 V
Maximum Reverse Current @ PIV	.025 μa
Maximum Reverse Current @ PIV (150°C)	5.0 μa

Electrical Rating Code (ordering)	Degree of Forward Match @ 4 mA	PIV each Diode
1	.5%	25 V
2	.5%	125 V
3	.5%	180 V
4	1.0%	25 V
5	1.0%	125 V
6	1.0%	180 V
7	2.5%	25 V
8	2.5%	125 V
9	2.5%	180 V

HOW TO ORDER: C708
PAK STYLE ┘ └ RATING CODE

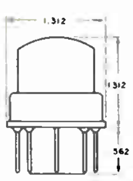
OUTLINE DIAGRAMS

PAK STYLE 1 — RS



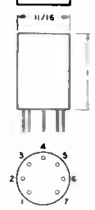
- 7 pin in-line basing
- Non polarized connected
- All welded connections
- Epoxy encapsulated with metal case
- Mates with socket — Elco type 790 BC or Cinch type 2H7 or equal

PAK STYLE 2 — MV



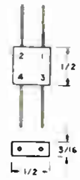
- Type MT-8 shell
- Soldered connections
- Plugs into standard 8 pin octal socket

PAK STYLE 3 — MP



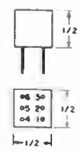
- All welded construction
- Epoxy resin encapsulant
- Basing shown bottom view
- Plugs into standard 7 pin miniature socket

PAK STYLE 4 — TK



- Pigtail leads
- Epoxy resin encapsulant
- Welded construction
- Leads 1.0" minimum length, .019" - .021" diam.

PAK STYLE 5 — TL



- Printed circuit pins
- Pin spacing on .100" grid
- Epoxy resin encapsulant
- Universal connections
- Welded connections

PAK STYLE 6 — TM

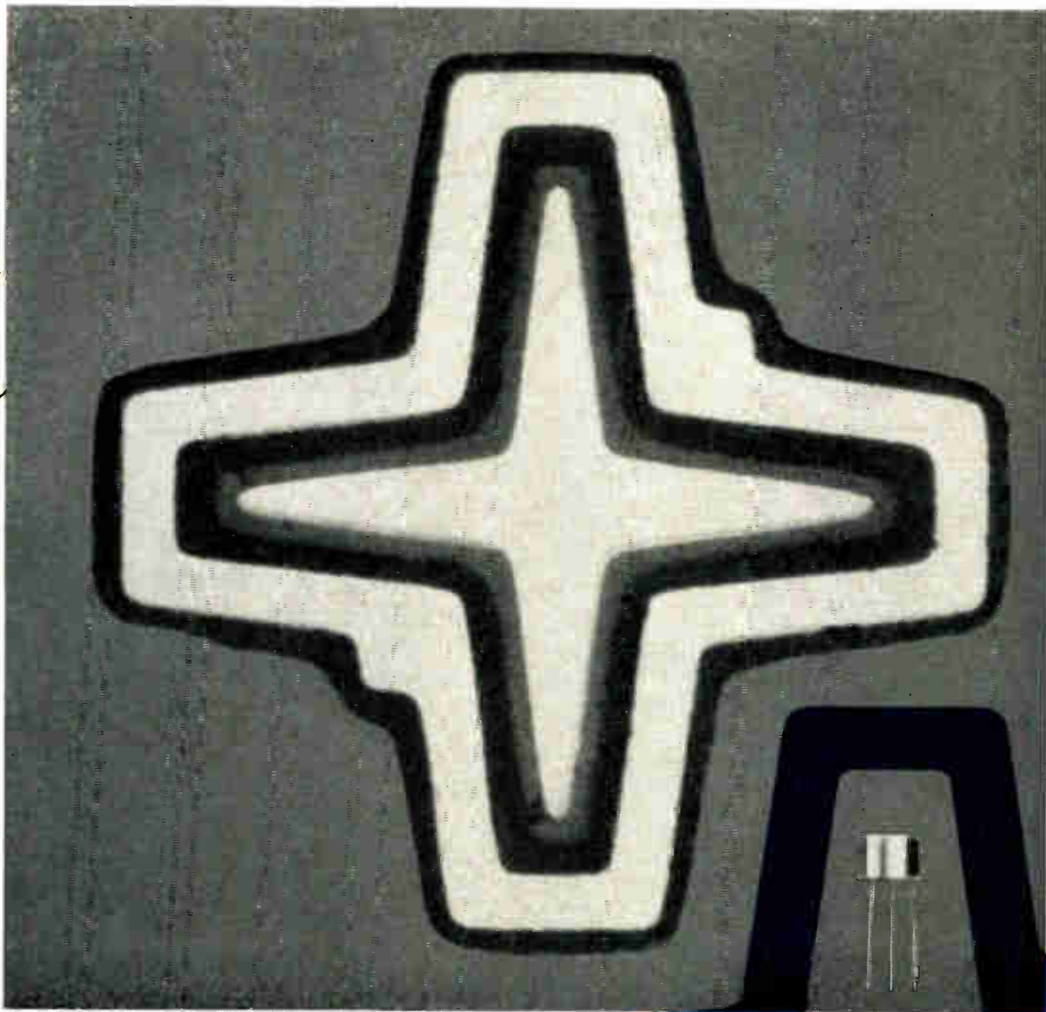
- Epoxy resin encapsulant
- All welded construction
- Each diode individually terminated
- Plugs into standard 9 pin miniature socket

SEMICONDUCTOR DIVISION

LOWELL, MASSACHUSETTS

RAYTHEON

Circle ... Card



For additional information on Motorola Star planar transistors contact your nearest Motorola District Office

BOSTON	IVanhoe 4-5070
CHICAGO	AVenue 2-4300
CLEVELAND	831-1440
DALLAS	LAkeside 6-8931
DAYTON	AXminster 3-4164
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ORLANDO	MIdway 7-2507
PHILADELPHIA	TUrner 7-7020 WAverly 7-6144
PHOENIX	273-6364
SAN DIEGO	297-4961
SAN FRANCISCO	DIamond 2-3228
SYRACUSE	GRanite 4-3321
WASHINGTON	JUniper 5-4485
CANADA (Toronto)	PLymouth 9-2222

OUTSIDE U.S.A. Motorola International Semiconductor Sales, Phoenix, Cable MOTSEM

2N2217

2N2218

2N2219

HERE ARE THE NEW MOTOROLA SILICON EPITAXIAL STAR PLANAR TYPES

2N2220

2N2221

2N2222

COMPARE THESE PERFORMANCE ADVANTAGES OVER OLD TYPE UNITS!

400% HIGHER GAIN BANDWIDTH PRODUCT
The "Star" geometry's smaller emitter area and Motorola's advanced diffusion techniques combine to improve high frequency performance.

ONE-FIFTH THE OUTPUT CAPACITANCE
The reduced area of the "Star," plus the high resistivity epitaxial layer combine to substantially lower collector capacitance.

ONE-SEVENTH THE SATURATION VOLTAGE
With the low substrate resistance of the epitaxial process, collector saturation voltage is greatly reduced.

EXTENDED BETA RANGE — 10 μA to .5 AMPS
Passivated to stabilize characteristics and eliminate surface recombination effects, the Motorola "Star Planar" provides more uniform gain at low and high current.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
h_{FE} @ $I_C = 150$ mA	20-60	40-120	100-300
$V_{CE(sat)}$ volts (max) $I_C = 500$ mA $I_B = 50$ mA	—	1.6	1.6
C_{ob} $I_E = 0$, $V_{CB} = 10$ V	8 picofarads (maximum)—All Types		
f_T $I_C = 20$ mA, $V_{CE} = 20$ V	250 mc (minimum)—All Types		
Switching Time (total) non-saturated	12 nsec (typical)—All Types		
Switching Time saturated t_{on} t_{off}	26 nsec (typical)—All Types 68 nsec (typical)—All Types		

All values at 25°C ambient

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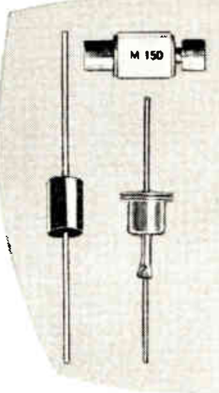
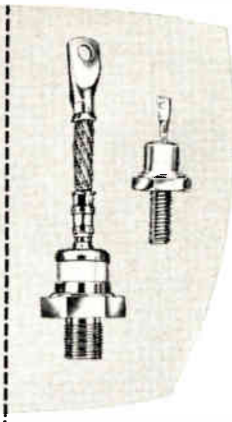


Low Current Silicon Rectifiers

22 types, with ratings from 0.15 amps to 1.50 amps; 100 to 2800 piv.
Send for Bulletin 62CC4.

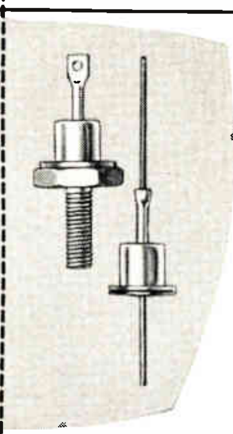


Hermetically Sealed Silicon Rectifiers

Ratings from 2 amps to 250 amps; 50 to 600 piv; choice of positive or negative base polarity in most styles.
Send for Bulletin 62CC4.

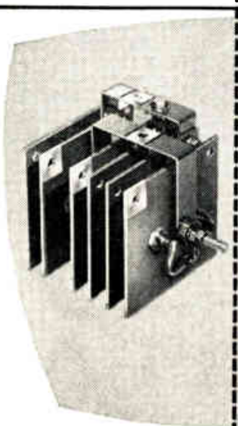
Controlled Silicon Rectifiers

Two series, 3 and 5 amps; 25 to 400 piv. Stud mounted and hermetically sealed.
Send for Bulletin 62SCR5.



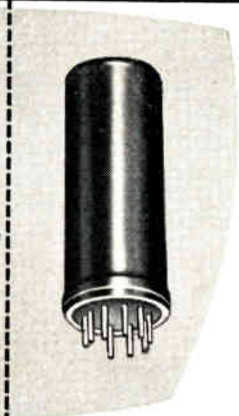
Silicon Voltage Regulators

Regular series: 93 types in ¼, 1, and 10-watt classifications; 5.6 to 100 volts breakdown. Special series: 17 types in 1-watt, 6 to 105 volts breakdown. Excellent performance at low cost. *Ask for Bulletin 61VR11.*



Silicon Rectifier Assemblies

336 types, ratings from 5 amps to 1250 amps; 50 to 500 piv. Configurations include single-phase bridge and center-tap, and three-phase half-wave, bridge, and full-wave center tap. *Ask for Bulletin 62SA3.*



Tube Replacement Silicon Rectifiers

Long life, cool-operating, compact units replace 95% of all popular vacuum tube rectifiers. Ratings from 1600 to 10,400 piv; 250 to 750 ma dc output current.
Send for Bulletin 62TR5.

7 invitations

to invention in circuit design... seven lines of Tarzian semiconductor products offering dependable performance at realistic prices, plus interested and informed application engineering service and production and development facilities to help you solve special problems or meet special requirements. Tell us your need or send for our newest catalogs, or both.

Klipvolt Surge Suppressors

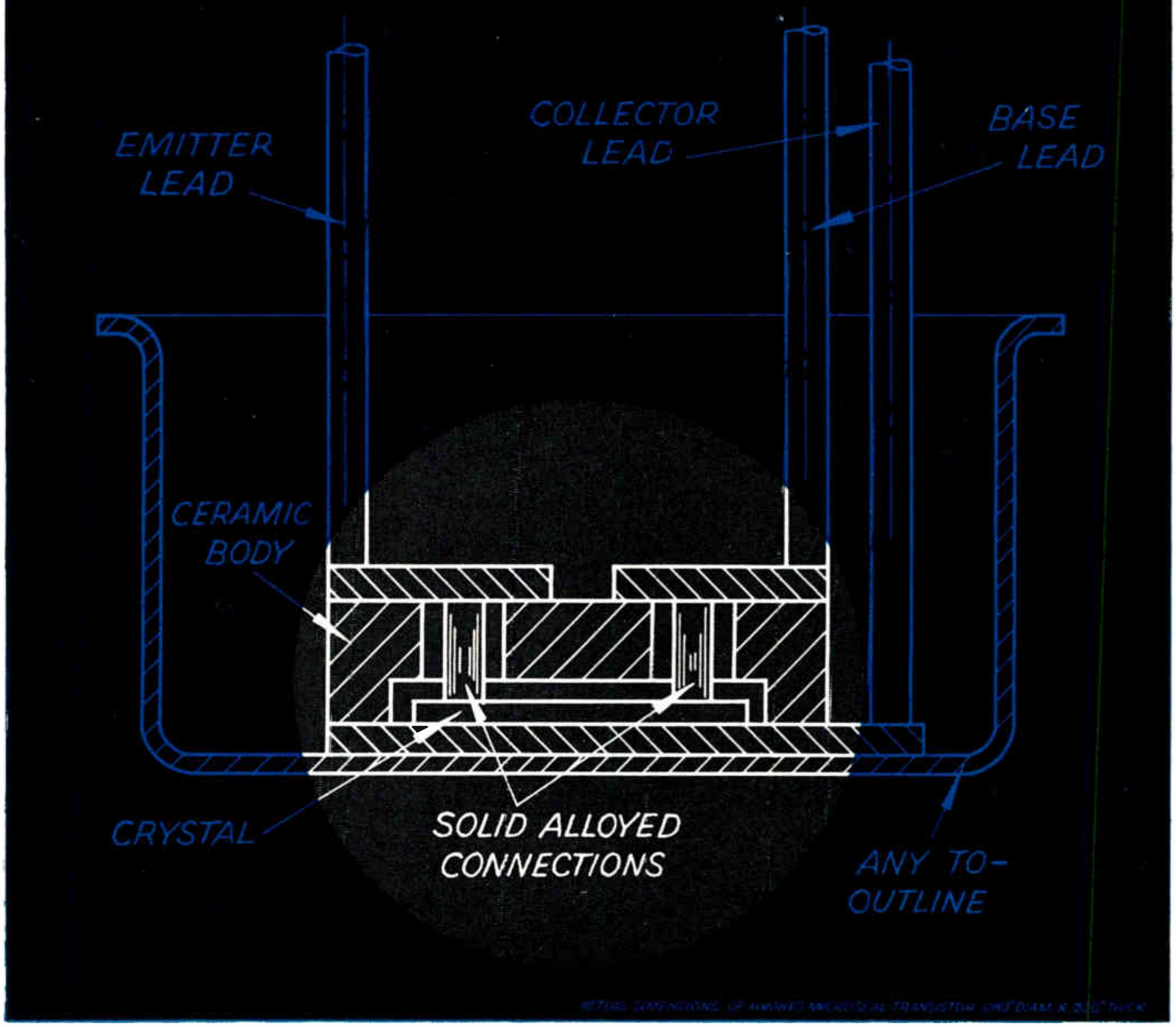
136 types, polarized, single phase and three-phase non-polarized; maximum discharge currents from 0.25 to 33 amps.
Ask for Bulletin 61KV10.

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

NEW—AND ONLY—FROM HUGHES



SOLID ALLOYED CONNECTIONS—NO BONDED WIRES—IN NEW HUGHES MICROSEAL* STANDARD PACKAGE TRANSISTOR

NEW DESIGN CONCEPT Solid alloyed connections—no bonded wires—mean a tremendous increase in environmental reliability, especially where a high degree of resistance to shock, acceleration and vibration is a critical factor. Hughes pre-selected MICROSEAL transistors—hermetically sealed—are now available in any industry standard package.

YOU DESIGN THE CIRCUITS Hughes MICROSEAL transistors are compatible with all known micro concepts. When your specifications call for a reduction in size, Hughes can supply transistors in just about any size package you want (TO-5, TO-18, TO-46, TO-51 and MICROSEAL packages).

HIGHER POWER RATINGS Regardless of transistor type and package, power ratings and current-handling capabilities are vastly superior to the standard transistors you are now using.

*Trade mark, Hughes Aircraft Company

RELIABILITY PLUS Stringent life and environmental tests are performed on MICROSEAL transistors prior to re-packaging.

ONE-WEEK DELIVERY Hughes can supply most transistor types in any industry standard package one week from the time your order is received. Types such as 2N706, 2N706A, 2N706B, 2N707, 2N726, 2N753, 2N708, 2N869, 2N1131, 2N1132, 2N1254, 2N1255, 2N1256, 2N1257, 2N1258, and 2N1259.

NO ADDITIONAL COST No additional cost to you for Hughes transistors with MICROSEAL elements, regardless of the package type ordered.

For further information, call your nearest Hughes representative; or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California. For export, write Hughes International, Culver City, California.

RELIABILITY PLUS

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DIVISION

DIODES • TRANSISTORS • RECTIFIERS • PACKAGED ASSEMBLIES • ELECTRONIC COMPONENTS

Tech Data

for Engineers

Transistors & Components

Texas Instruments Incorporated, P.O. Box 5012, Dallas 22, Tex., is offering a 32-page brochure, with complete specs, on their germanium transistors, silicon transistors, diodes and rectifiers, solid tantalum capacitors, materials and sensors, resistors, and semiconductor networks.

Circle 307 on Inquiry Card

Semiconductors

Monsanto Chemical Co., Inorganic Chemicals Div., 800 N. Lindberg Blvd., St. Louis 66, Mo., is offering a revised manual for the evaluation of III-V intermetallic semiconductors. The four main sections include methods for preparing crystals for evaluation; crystal orientation by X-rays; Hall coefficient and resistivity measurements; and dislocation density measurement. An additional 3 sections cover methods for crystal orientation optically; epitaxial layer thickness measurement by cross section staining; and epitaxial layer thickness measurement by infrared interference.

Circle 308 on Inquiry Card

Semiconductor Catalog

This 18-page condensed catalog includes more than 2500 separate semiconductor devices covering transistors, zener diodes, rectifiers, high-frequency silicon planar and mesa transistors. It also includes mechanical characteristics and outline drawings on all semiconductor devices. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 309 on Inquiry Card

Silicon Rectifiers

Complete tech. information is contained in a 6-page short form data folder on Bradley, JEDEC Type Silicon Rectifiers. Also included are dimensional drawings. Bradley Semiconductor Corp., 275 Welton St., New Haven 11, Conn.

Circle 310 on Inquiry Card

Photoconductors

"Sylvania Photoconductor Devices" outlines photoconductor characteristics and some of the techniques used to manufacture the devices. The pamphlet places special emphasis on the Sylvania 8100, a device whose spectral response approximates that of the human eye. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

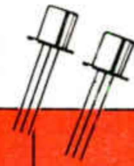
Circle 311 on Inquiry Card

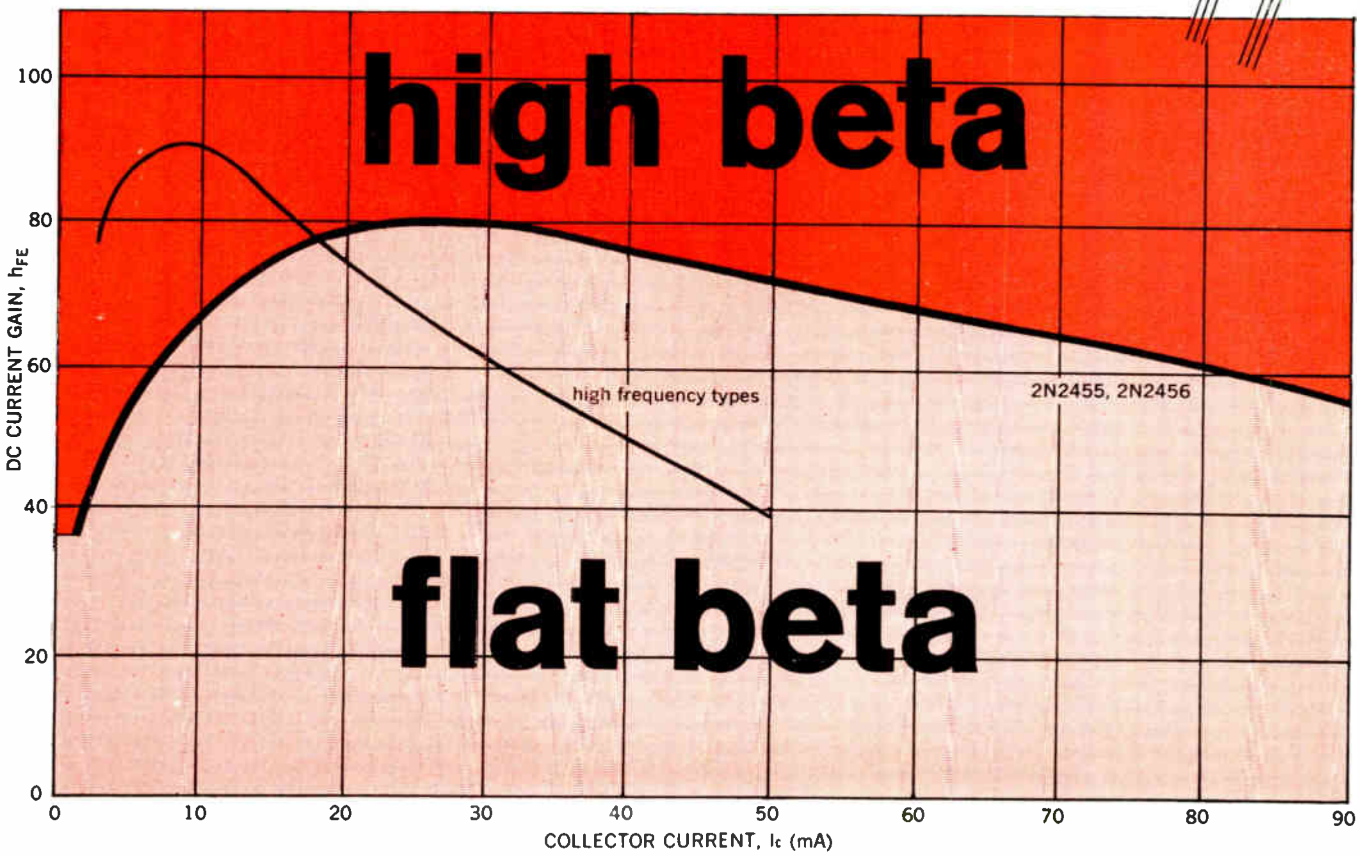
Transistor Brochure

An 8-page brochure on silicon planar epitaxial transistors is available from General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J. Bulletin PE-15 includes characteristics, performance curves, test results and storage life reliability tests.

Circle 312 on Inquiry Card

New Sylvania epitaxial Ge Mesas combine both!





...offer superior GBW (2N2456 typically 1200MC)

New 2N2455, 2N2456 provide high beta at low current and exhibit virtually linear beta over a *wide current range*. In this respect, as well as in current gain characteristics and GBW product, they far surpass performance of popular high-frequency types.

Packaged in TO-18, the 2N2455 and 2N2456 offer optimum performance in both PNP switching and amplifier applications. Both combine the well-known reliability and dissipation capabilities of the mesa structure with the reduced storage time, low saturation voltage and extraordinary uniformity inherent in Sylvania epitaxial process.

The full range coverage of Sylvania high beta types—at low current (2N2455, 2N2456)—at medium current (2N960 series)—and at high current (2N705, 2N781) offers wide design flexibility at optimum current levels. Your Sylvania Sales Engineer or Sylvania Franchised Semiconductor Distributor can give you full details. Ask him. Or, write for tech data to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

ABSOLUTE MAXIMUM RATINGS AT 25°C

Collector To Base Voltage, V_{CB}	—15 volts
Collector To Emitter Voltage, V_{CES}	—15 volts
Collector Current, I_C	200 ma
Storage Temperature, T_{stg}	—65°C to +100°C
Junction Temperature, T_J	—65°C to +100°C
Power Dissipation, P_J	150 mw

ELECTRICAL CHARACTERISTICS AT 25°C		Min.	Typ.	Max.	Unit
Current Gain, h_{FE} $I_C = 2.0$ ma, $V_{CE} = -.20$ V		20	52	100	—
Current Gain, h_{FE} $I_C = 30$ ma, $V_{CE} = -.40$ V		40	76	—	—
Gain Bandwidth Product, f_T $I_C = 10$ ma, $V_{CE} = -6.0$ V	2N2455	600	820	—	mc
	2N2456	1000	1200	—	mc
Output Capacitance, C_{ob} $I_E = 0$, $V_{CB} = -6$ V, f = 1 mc	2N2455	—	—	3.5	pf
	2N2456	—	—	3.0	pf
Input Capacitance, C_{te} $I_C = 0$, $V_{EB} = -1.0$ V, f = 1.0 mc		—	—	4.0	pf
Rise Time, t_r	2N2455	—	11	30	nsec
	2N2456	—	8.0	15	nsec
Off Time, t_{off}	2N2455	—	45	65	nsec
	2N2456	—	37	65	nsec
Storage Charge Factor, K_s		—	30	60	nsec

SYLVANIA

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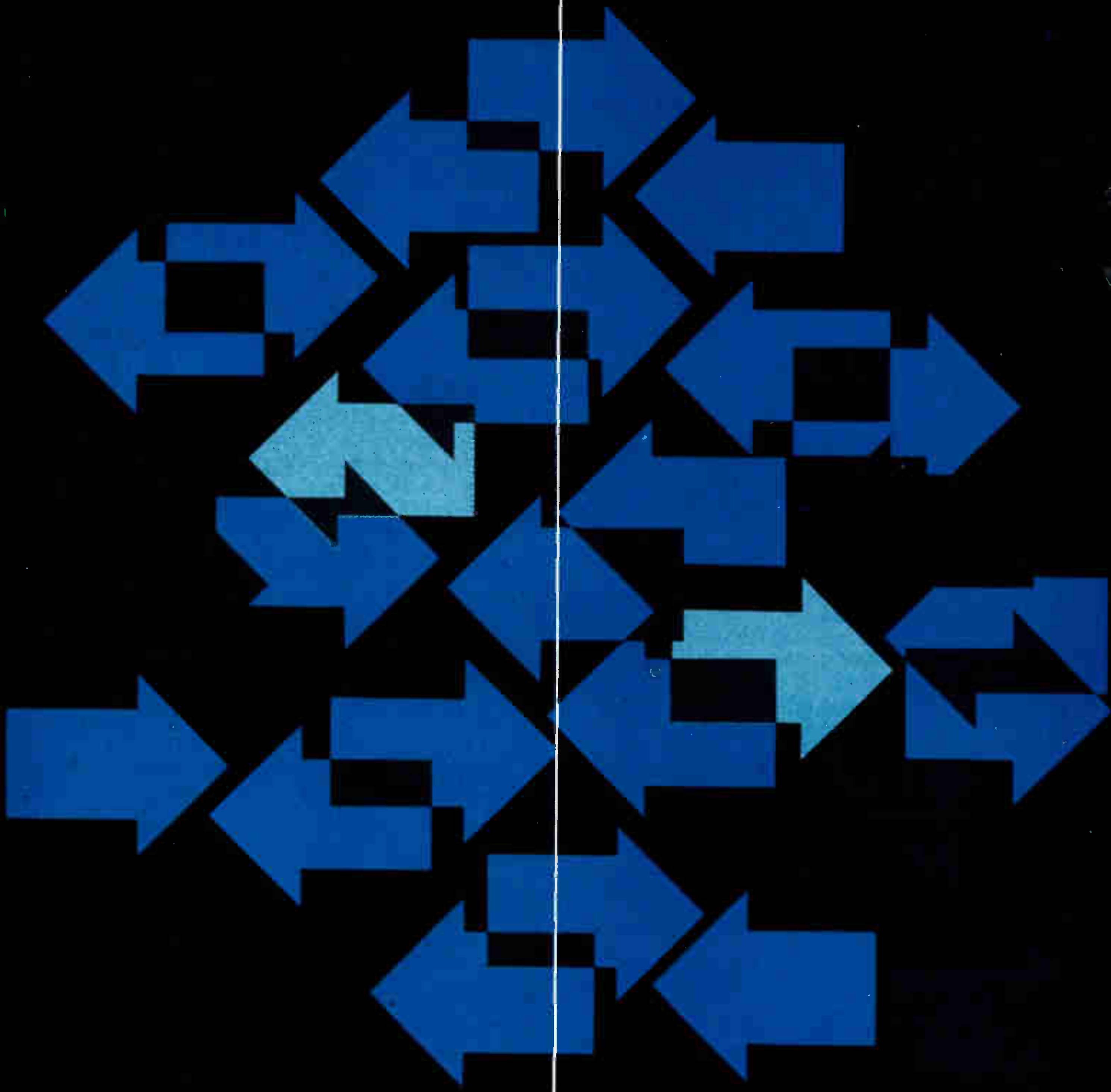
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Circle 37 on Inquiry Card

New HALLEFEX* generator cuts the air gap to 0.002″



Beckman introduces the first in an entirely new generation of Hall voltage generators–the 'Hallefex' Model 335. To increase the efficiency of magnetic circuits, Beckman reduces the effective magnetic air gap to under 0.002″. That's 10 times smaller than the gap required by most Hall generators. Beckman does it with a special manufacturing technique that sandwiches an indium antimonide film only 7 microns thick between two ferrite slabs. This same process sends input impedance up to 100-600 ohms; voltage output sensitivity up to 2.0 volts/amp.-Kilogauss, minimum; and drops outside dimensions to 0.25″ x 0.25″ x 0.04″.

HALLEFEX

What kind of job can this new member of the fast-growing Beckman 'Hallefex' line do–more efficiently, less expensively–for you? Get some ideas and complete specs by writing Beckman for Model 335 data file.

FOR APPLICATIONS ASSISTANCE OR AIR-MAILED EVALUATION UNITS... *write, wire or phone: Sales Manager, Special Products, Helipot Division. Phone: TRojan 1-4848. Teletype: FULLERTON CAL 5210. Complete 'Hallefex' application assistance is yours for the asking. Model 335 evaluation units in quantities of 1 through 9 are $35.00 each.*

Beckman® INSTRUMENTS, INC.

HELIPOT DIVISION
Fullerton, California
POTS : MOTORS : METERS

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*TRADEMARK B.I.I.

Tech Data
for Engineers

Silicon Rectifiers

Tech. data on silicon power rectifiers rated at 3, 5, 6 and 12a is available from The Bendix Corp., Semiconductor Div., Holmdel, N. J. Dimensional drawings and complete specs. are included.

Circle 313 on Inquiry Card

Silicon Slide Rule

This slide rule, for use with silicon and silicon dopants, contains scales for: fractional inch, millimeters, and decimal in. dia.; sq. millimeters and sq. in. areas; slice thickness; weight in grams; a table of silicon properties; and scales for figuring dopant concentration and resistivity. Available upon request under company letterhead. Hyper-Pure Silicon Div., Dow Corning Corp., Midland, Mich.

Circle 314 on Inquiry Card

Semiconductor Catalog

Semiconductor Div., Microwave Associates, Inc., Dept. HE, South Ave., Burlington, Mass., has available a 12-page short-form catalog describing it's complete line of microwave semiconductor products. Electrical and mechanical specs. plus outline drawings with dimensions cover varactor diodes, microwave mixer diodes, microwave r-f video detector diodes, an r-f power monitoring diodes.

Circle 315 on Inquiry Card

Rectifier Catalog

This 44-page, 2-color catalog describes standard silicon power rectifiers and rectifier stacks. The catalog is a composite of 12 data bulletins describing 8 basic silicon power rectifiers and their corresponding standard rectifier stack assemblies. Illustrations include complete tabulations of electrical data, characteristic curves and dimensional diagrams. Silicon rectifiers range from 6 to 240a. with max. PRV ranging from 50 to 600v. Ratings for the stacks are from 12 to 370a., 1ϕ, and from 18 to 520a., 3-phase. Available from Rectifier-Capacitor Div., Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 316 on Inquiry Card

Semiconductor Catalog

North American Electronics, Inc., 71 Linden St., W. Lynn, Mass., is offering a 12-page semiconductor catalog covering their complete line. Information includes type specs., dimensions, and operating characteristics.

Circle 317 on Inquiry Card

Semiconductor Products

A short form catalog #120B, 12 pages, 2 colors, describes a line of semiconductor products including solid-state modular power packs, laboratory power supplies, magnetic components, transistor test equipment, inverters, converters, and frequency changers. Electrical and physical data, specs, and prices are included. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J.

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MORE HIGH POWER
TRANSISTORS FROM BENDIX

71 NEW TYPES NOW AVAILABLE

The greatly expanded line of Bendix® High Power Transistors offers power switching capabilities up to 25 amps. Characteristics of typical types are listed in the table below. Together with improved design and increased ratings, you get higher gain and flatter beta curves. These high power transistors are categorized in gain and voltage breakdown to provide optimum matching, as well as to eliminate burn-out. They are capable of switching up to 1000 watts. Every Bendix Transistor is 'Dynamically Tested,' an exclusive Bendix quality control process to assure uniformity and maximum reliability. High power transistors also available with lugs. For complete data on the expanded line of Bendix Power Transistors and Power Rectifiers, write us in Holmdel, N. J.

Type Number	MAXIMUM RATINGS V_{CES} Vdc	I_C Adc	P_C W	CURRENT GAIN h_{FE}	@ I_C Adc
2N511-2,A,B	40-60	10-15	80	20-60	10-15
2N513-4,A,B	40-60	20-25	80	20-60	20-25
2N627-2N630	30-75	10	90	10-30	10
2N677,A,B,C	30-80	15	90	20-60	10
2N678,A,B,C	30-80	15	90	50-100	10
2N1031,A,B,C	30-80	15	90	20-60	10
2N1032,A,B,C	30-80	15	90	50-100	10
2N1120*	70	15	45	20-50	10
2N1146-7 A,B,C	30-75	15	87	30	15
2N1549-55,A	30-75	15	90	10-60	10
2N1557-60,A	30-75	15	90	50-100	10

*Also available per MIL-T-19500/68 (SigC)

Bendix Semiconductor Division THE Bendix CORPORATION

Main Office: South St., Holmdel, N.J —Ph: SH 7-5400 • New England Office: 114 Waltham, Lexington, Mass.—Ph: VO 2-7650 • Detroit Office: 12950 W. 8 Mile Rd., Detroit 37, Mich.—Ph: JO 6-1420 • Midwest Office: 1915 N. Harlem Ave., Chicago, Ill.—Ph: 637-6929 • West Coast Office: 117 E. Providencia Ave., Burbank, Calif.—Ph: VI 9-3961 • Canadian Affiliate: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ont. • Export Office: Bendix International, 205 E. 42nd Street, New York 17, N.Y. Stocking Distributors: Contact nearest sales office for name of local distributor.

4 SOLID REASONS WHY...

MOST CIRCUIT DESIGNERS SPECIFY

For more information on any of Motorola's more than 2,700 industrial and military type semiconductor devices and the exclusive Motorola "Meg-A-Life" program of certified reliability — contact your local Motorola Semiconductor Distributor or District Sales Office. Or, call or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

MOTOROLA POWER TRANSISTORS

1 HIGHEST POWER RATINGS

Motorola power transistors are available with power dissipation ratings up to 170 watts, and with collector voltages up to 120 volts . . . provide practical operation far beyond the operating limits of ordinary power transistors.

2 HIGHEST CURRENT RATINGS

In addition to the highest current ratings in the industry — up to 60 Amps — Motorola offers the most complete line of "diamond" (TO-3) and "doorknob" (TO-36) packages . . . 3, 5, 10, 15, 25, 30, and 60-Amp ratings.

3 BEST TECHNICAL LITERATURE

Typical of its leadership in power transistor technology, Motorola's Power Transistor Handbook is the accepted industry reference for theory, design, and applications information . . . Motorola data sheets are unsurpassed in format and content, clearly spelling out details on device voltages and other typical product traits such as temperature vs g_{FE}, h_{FE}, and I_{CBO} . . . also included are definitive curves showing safe operating areas as well as power derating characteristics.

4 BEST LOCAL SERVICE AND PRODUCT AVAILABILITY

Immediate customer service is available from 15 strategically located field offices, and Motorola devices are available from stock in sample or volume quantities (up to 999) from twenty-eight of the top semiconductor component distributors in the United States.

NEW CONDENSED CATALOG

For a concise reference to Motorola's complete line of quality semiconductor products, ask your Motorola distributor for a free copy of the new "Motorola Semiconductors, Condensed Catalog, March 1962."

POWER TRANSISTOR HANDBOOK

If you don't have this valuable reference book yet, copies are still available from your Motorola Distributor for only $2.00.

MOTOROLA
Semiconductor Products Inc.

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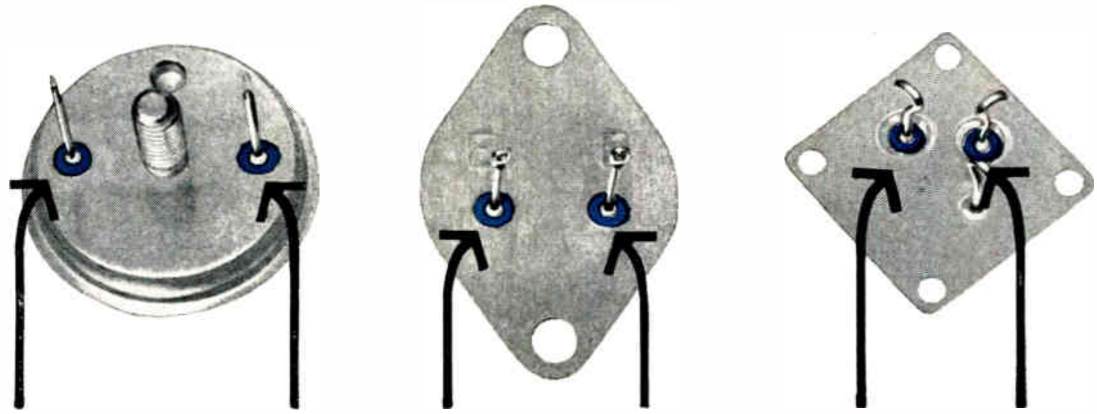
BEFORE YOU BUY ANY MORE TRANSISTORS,



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1 Soldering heat that causes ordinary glass to crack. **2** The problem of glass insulation cracking through shock or impact. **3** The problem of leakage due to glass insulation failure when bending or adjusting pins. Cerameterm terminals were specially developed for super reliability on severe high-performance applications for transistor bases, diodes, rectifiers, relays, and capacitors. Exceed Mil-Specs. Can take 11,000 psi shearing stress without failure. PROVE TO YOUR OWN SATISFACTION that Cerameterm terminals are everything users say they are. Take advantage of our free sample offer. Eatontown, New Jersey.

*Trademark for Bendix' practically indestructible, alumina-insulated, ceramic-metal terminal assembly.

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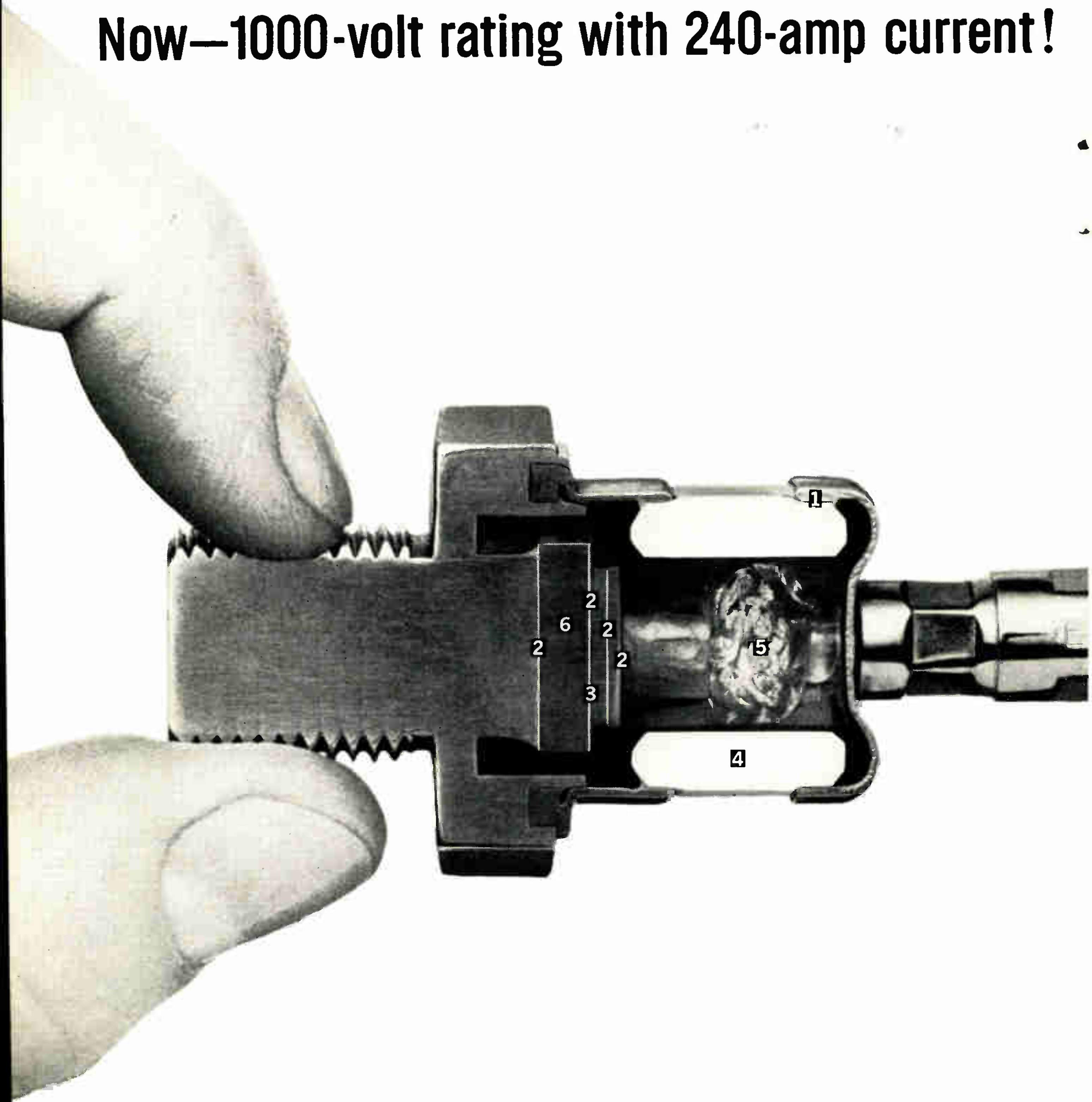
Now—1000-volt rating with 240-amp current!



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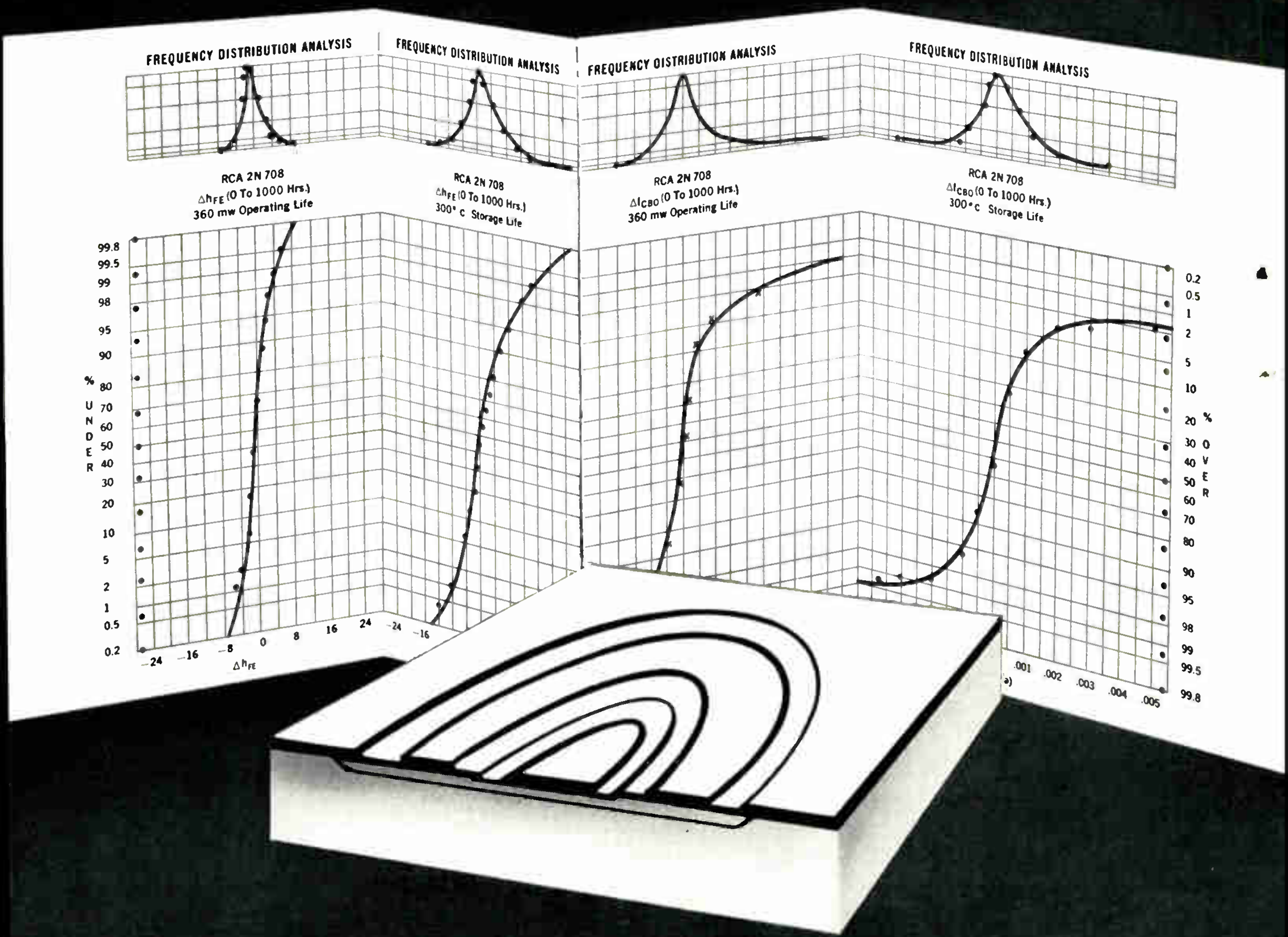

BRING NEW SILICON PLANAR STABILITY TO YOUR COMPUTER DESIGNS WITH THE RCA 2N708 TRANSISTOR FAMILY

All RCA 2N708, 2N706 and 2N706A silicon transistors—now in planar construction to assure a new degree of stability and reliability for your high-speed switching applications

Here's proof of the outstanding stability you get from RCA's 2N708 family. Check these curves which summarize the results of RCA production lot acceptance tests—a dramatic presentation of the actual production lot stability of the RCA 2N708.

In addition, here are some of the other outstanding advantages these high-speed silicon planar computer transistors will bring to your designs:

- Reduced collector cutoff current...by as much as 20 to 1 over mesa types.
- Uniform Beta over a wide current range.
- Storage temperatures up to 300°C.

RCA 2N708: Proved high-reliability for very-high-speed saturated switching and high frequency amplifier applications in military and industrial equipment—designed to offer the full advantages of planar construction in low I_{CBO} and in beta stability.

RCA 2N706: Very high speed silicon planar switching transistor designed to meet MIL Specifications, field proved in a wide range of switching applications and backed by a long history of life data.

RCA 2N706A: Improved version of 2N706 for more stringent high speed applications requiring lower collector capacitance and storage time.

Call your RCA Representative today for complete reliability information on RCA 2N708 silicon planar transistors. For additional technical information write RCA Semiconductor and Materials Division, Commercial Engineering, Section F-50-NN, Somerville, N. J.

RCA The Most Trusted Name in Electronics

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Now All RCA Silicon Computer Transistors Go Planar Epitaxial—Triple-Diffused—Double-Diffused

RCA expands line of silicon planar and planar-epitaxial switching transistors to meet the stringent reliability and performance requirements of today's computers

RCA SILICON DIFFUSED-JUNCTION PLANAR TRANSISTORS

In addition to the popular 2N708 family, here is a lineup of the many other high-speed silicon planar transistors now available from RCA, incorporating all the advantages of surface protection inherent in planar technology:

RCA 2N696... Specially designed and processed to assure stability of characteristics and reliable performance under conditions of severe thermal and mechanical stress. High switching speeds at high current makes RCA 2N696 especially suitable for core driving and other high current applications.

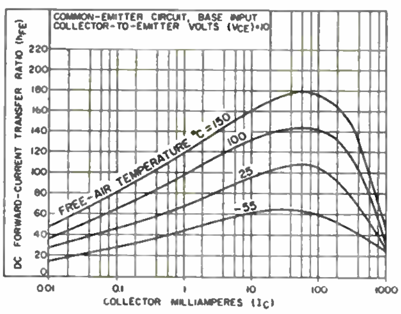
RCA 2N697... High Beta version of RCA 2N696.

RCA "Universal" 2N2102... First silicon n-p-n triple-diffused planar transistor specifically designed for widest possible application in military and industrial equipment. It features high switching speed, high pulsed beta (h_{FE}) at $I_C = 1$ amp, and controlled beta over 5 decades of I_C. It has high breakdown-voltage ratings, high dissipation ratings, low saturation voltages, and low output capacitance.

RCA 2N699... New triple-diffused-junction silicon n-p-n planar transistor especially useful for vhf and video applications. Triple-diffused-junction design makes possible lower saturation voltages, higher sustaining voltages and lower output capacitance.

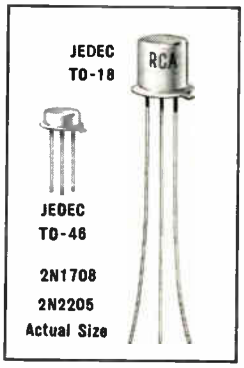
RCA 2N1613... Four-step beta control—specifically designed for wide application in military and industrial equipment. It features low noise and low leakage characteristics. Beta 40 min., BV_{CBO} 75 v min., I_{CBO} at 25°C equals 0.01 μa max.

RCA 2N2270... New economy version of the RCA "universal" triple-diffused silicon planar transistor for applications in military and industrial equipment. It features high breakdown voltages, low V_{CE} (Sat), low leakage characteristics, very low output capacitance. Minimum gain-bandwidth product = 60 Mc, in applications from dc to 20 Mc.



Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N2270.

RCA SILICON PLANAR-EPITAXIAL TRANSISTORS



RCA combines two of today's most advanced technologies, planar construction and the epitaxial process, to bring you silicon transistors with excellent stability, high reliability, low saturation voltage and improved switching times.

RCA 2N1708... First silicon planar-epitaxial computer transistor in the TO-46 miniature package offers a V_{CE} (sat) of 0.22v max., Beta(h_{FE}) 20 min., t_s 25 nsec max., BV_{CBO} = 25v min., I_{CBO} = 0.025 μa max. It is especially designed for use in very-high-speed applications in military and industrial equipment requiring high reliability and high packaging densities. See chart for beta stability versus current and temperature.

RCA 2N2205... Electrically identical to the 2N1708, but in the JEDEC TO-18 package. Like the 2N1708, its epitaxial structure insures low collector saturation voltage at high collector current. Planar construction insures low collector cutoff current (I_{CBO}) and exceptional stability throughout life.

RCA 2N2206... High-beta version of RCA 2N1708 in the TO-46 package. Minimum beta 40, Short storage time, 35 nsec. max.

RCA PACKAGING... Whatever your packaging requirements, from transistors and multiple devices in standard JEDEC packages, to special configurations or RCA Minimodules and RCA Micromodules, RCA Semiconductor and Materials Division packaging specialists are ready to work with you to meet your design requirements.

CALL YOUR RCA REPRESENTATIVE TODAY FOR COMPLETE INFORMATION ON RCA'S BROAD LINE OF SILICON PLANAR TRANSISTORS. For additional technical information, write RCA Semiconductor and Materials Division, Commercial Engineering, Section F-50-NN, Somerville, N. J.

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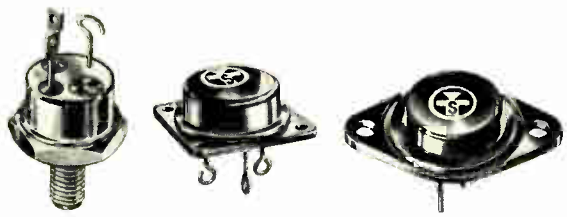
FROM STC THE FIRST...

PNP SILICON POWER TRANSISTORS



For Technical Data and prices, contact:

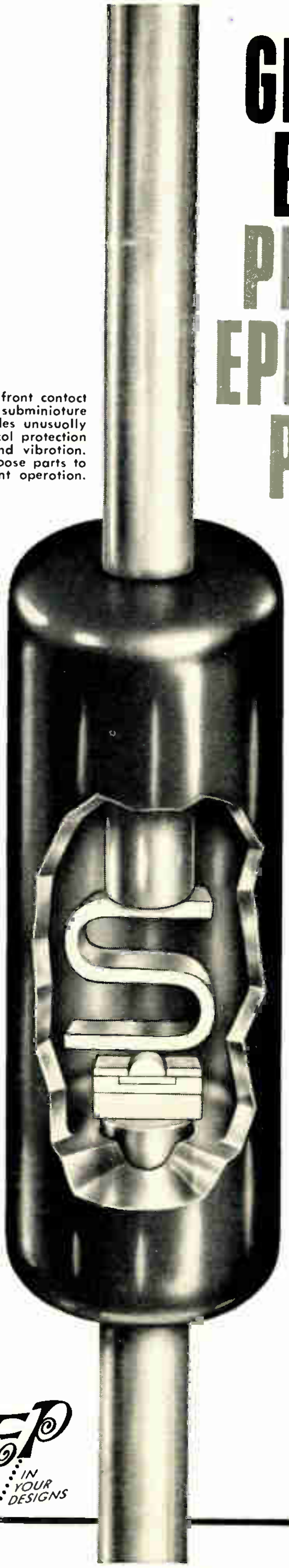
SILICON TRANSISTOR CORPORATION

CARLE PLACE, LONG ISLAND, NEW YORK   PIoneer 2-4100

Sixteen Different PNP Types:
11/16″ hex . . . 85 watts . . . STC5550 through STC5555
Square package . . . 85 watts . . . 2P389, 2P389A, 2P424, 2P424A
TO-3 . . . 75 watts . . . STC5080 through STC5085
Characteristics: h_{FE} 10 to 30 @ 2 amps . . . R_{CE} (sat) 0.5 ohms @ 2 amps . . . V_{CE} 80 volts . . . I_C max 5 amps

NPN Complements:
11/16″ hex 85 watts . . . STC1550 through STC1555
Square package 85 watts . . . 2N389, 2N389A, 2N424, 2N424A
TO-3 75 watts . . . STC1080 through STC1085

Circle 46 on Inquiry Card



Fused hemisphere front contact in the glass subminiature package provides unusually good mechanical protection against shock and vibration. There are no loose parts to cause intermittent operation.

GENERAL ELECTRIC PLANAR EPITAXIAL PASSIVATED DIODES

FEATURE CONTROLLED CONDUCTANCE

General Electric PEP silicon diodes bring you a unique design combination that allows ultra-fast switching speed combined with extremely tightly controlled conductance over a wide current range.

Gaseous *planar* diffused junction means high breakdown voltage with low capacitance.

Thin *epitaxial* layer on low resistivity substrate gives negligible body drop and increased uniformity from diode to diode.

Surface *passivation* is applied before the junction is formed for maximum protection against contamination.

FORWARD VOLTAGE CHARACTERISTICS

1N3605 1N3606 I_F (ma)	1N3608 1N3609 V_F (millivolts) Min.	Max.
0.1	485	555
0.250	525	595
1.0	580	680
2.0	625	725
10.0	710	840
20.0	750	900

	1N3605 1N3608	1N3606 1N3609
Breakdown Voltage (I_R = 5 μamps)	40 V min.	75 V min.
Leakage Current (25°C)	50 ηamps max. @ V_R = 30V	50 ηamps max. @ V_R = 50V
Leakage Current (150°C)	50 μamps max. @ V_R = 30V	50 μamps max. @ V_R = 50V

1N3605 AND 1N3606 ARE IN THE GLASS SUBMINIATURE PACKAGE ILLUSTRATED. 1N3608 AND 1N3609 ARE IN A MICROMINIATURE PACKAGE.

If your application does not require controlled conductance and exceptionally tight specifications, G-E also has available 1N3063. For complete details, call your Semiconductor District Sales Manager. Or write Semiconductor Products Department, Section 13F118, General Electric Company, Electronics Park, Syracuse, N.Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 159 Madison Ave., New York, N.Y.

PUT PEP IN YOUR DESIGNS

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GENERAL ELECTRIC

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New Tech Data for Engineers

Power Rectifiers

Standard Rectifier Corp., 620 E. Dyer Rd., Santa Ana, Calif., is offering Catalog No. 661-2, 46 pages, which contains outline drawings, characteristics charts, and complete specs. on their line of double diffused silicon top hats, silicon power rectifiers, varistack, and 250w. zener power regulator. Information includes descriptions, current ratings, peak inverse voltage, reverse current, junction temp. ratings and data on assemblies.

Circle 325 on Inquiry Card

Power Transistor

A 12-page technical data bulletin on 30a silicon power transistors is available from the Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa. The booklet, illustrated with over 30 charts and graphs, describes the electric characteristics, test circuits, and peak pulse power capabilities. Bulletin 54-662.

Circle 326 on Inquiry Card

Power Transistors

Tech data is available on 3 series of pnp germanium power transistors packaged in the new, low-outline TO-36 package. Series 2N1518 thru 2N-1523 feature P_T of 150w, I_C of 25 to 50a. Series 2N2075 thru 2N2082 feature P_T of 170w, I_C of 15a. Series 2N2152 thru 2N2159 feature a P_T of 170w, I_C of 30a. Semi-onics, Inc., 4 Broadway, Lowell, Mass.

Circle 327 on Inquiry Card

Transistor Bases

Tech data is available on both compression and strain-free types of transistor bases. Photographs, dimensional drawings and complete specs. are included. Electrical Industries, div. of Philips Electronics & Pharmaceutical Industries Corp., Murray Hill, N. J.

Circle 328 on Inquiry Card

Power Transistors

A tech. bulletin is available covering 6 silicon power transistor types; 2N1210, 2N1211, 2N1620, 2N1616, 2N1617 and 2N1618. These transistors are diffused junction, npn high power units suitable for use in power converters, power supply regulators, relay replacements and controls, and dc and servo amplifiers. Bulletin No. 11-2304. Silicon Transistor Corp., Carle Place, N. Y.

Circle 329 on Inquiry Card

Silicon Diodes

A brochure listing the characteristics of 86 conventional glass silicon diodes is available from Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J. Catalog D-100 contains information on hermetically encapsulate diodes now in stock. They comprise 35 general purpose silicon types and 51 silicon computer diode types.

Circle 330 on Inquiry Card

Transistor Noise

Technical Application Bulletin No. 2110, 12 pages, describes several methods of evaluating transistor low freq. noise characteristics. Complete with curves and formula derivations, covering applications for low noise amplifying devices which fall into the less than 100CPS portion of the freq. band, the brochure is available from Sperry Semiconductor, Norwalk, Conn.

Circle 331 on Inquiry Card

Instructional Films

Information is available on 16mm instructional films on printed circuits and semiconductors. These films can be purchased or rented. Titles include: "The Printed Circuit Story"; "Semi-Conductors, Part I"; and "Semi-Conductors, Part II." Bray Studios, Inc., 729 7th Ave., New York 19, N. Y.

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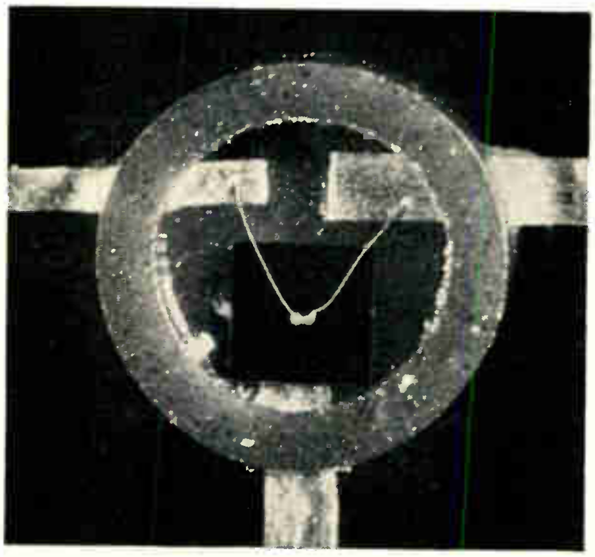
Now from Fairchild...

PLANAR FIELD EFFECT TRANSISTOR

high input impedance
low capacitance
low noise figure
low leakage current
TO-51 glass package*



MAGNIFIED 15 TIMES

Fairchild's new 2N2458 Field Effect Transistor features the ruggedness and stability of Fairchild Planar construction. Planar total surface passivation with patented metal-over-oxide techniques produces a device which is mechanically large enough for normal, reliable lead bonding techniques but at the same time electrically compact. Results: lower pinch-off voltage (V_p), lower leakage, and lower capacitance than any other field effect transistor. Complete specification sheet available on request.

*The Field Effect Transistor is also available in a standard TO-5 outline, designated the 2N2457.

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
BV_{DGO}	Drain to gate breakdown voltage	30	—	—	Volts	$I_D = 1.0\mu A$, $I_S = 0$
I_{DGO}	Drain to gate leakage current	—	—	0.1	mμA	$V_{DG} = 5.0V$, $I_S = 0$
I_{DGO} (150° C)	Drain to gate leakage current	—	—	0.1	μA	$V_{DG} = 5.0V$, $I_S = 0$
I_D	Saturation current	200	500	600	μA	$V_{DS} = 5.0V$, $V_{GS} = 0$
gm	Transconductance (f = 1 kc)	125	200	—	μmhos	$V_{DS} = 5.0V$, $V_{GS} = 0$
NF	†Noise figure	—	0.4	—	db	$V_{DS} = 5.0V$, $V_G = 0$
V_p	Pinch-off voltage	—	3.0	4.0	Volts	$I_D = 0.1m\mu A$
C_T	Total gate capacitance	—	0.7	1.0	pf	$V_{DGS} = 5.0V$
Z_{in}	Input impedance (f = 1 kc)	—	100	—	MΩ	$V_{DG} = 5.0V$, $V_G = 0$

†f = 1 kc, power bandwidth of 200 cps, R_S = 1 MEG Ω

FAIRCHILD SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. • YORKSHIRE 8-8161 • TWX: MN VW CAL 853

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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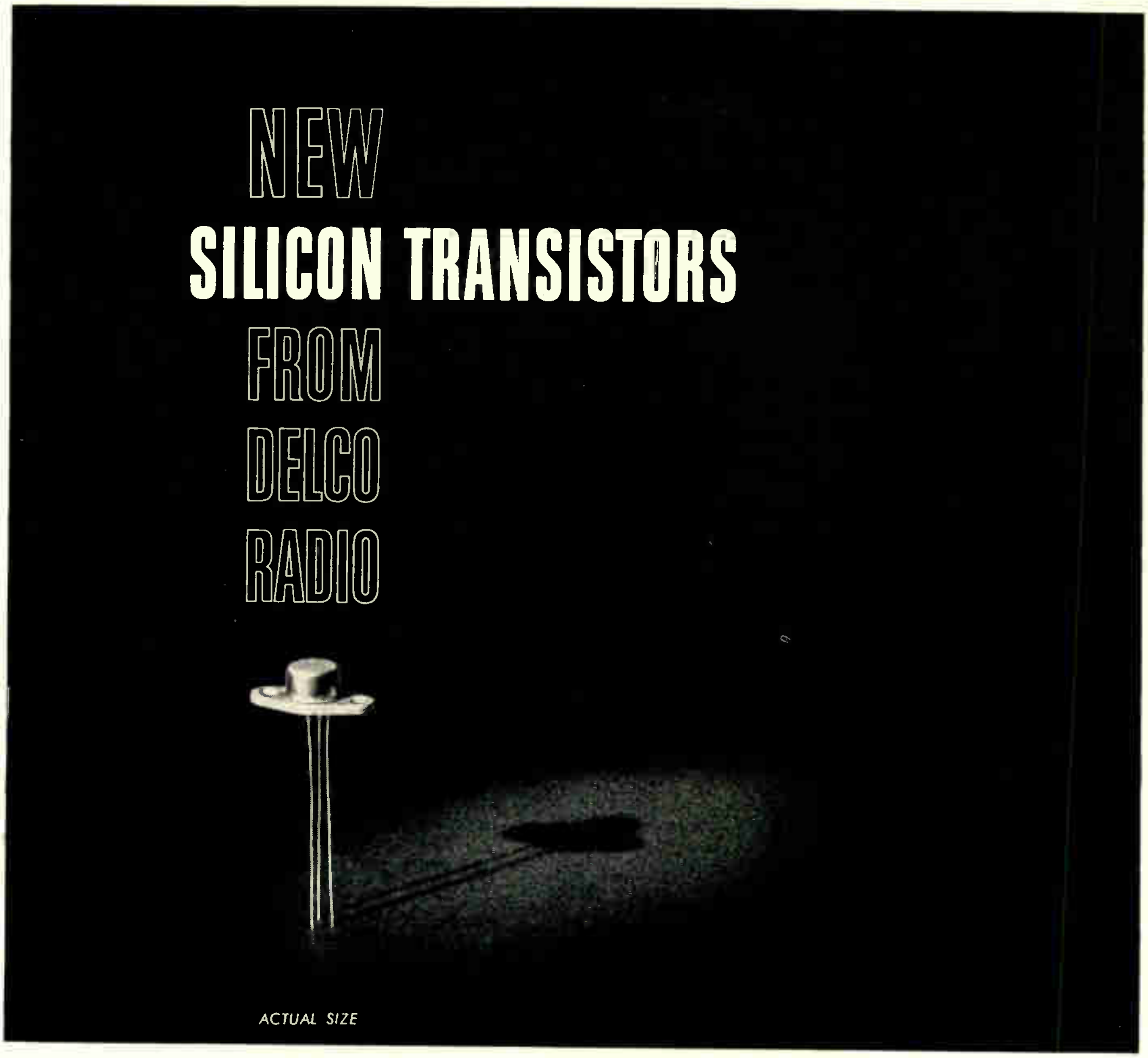

Silicon power transistors in a TO-37 package

Delco's unique new family of silicon NPN power transistors combines the benefits of miniaturization (TO-37) and light weight with the ability to withstand continuous junction temperatures of up to 175°C while operating at these absolute maximum ratings: collector diode voltage Vcb 100 volts; emitter diode voltage Vebo, 4 volts; collector current, 1 amp.; base current, .2 amp. This entire 2N2340 family is particularly useful where moderate power handling capabilities are required in a miniature package. The units have just two mounting holes and may be mounted with leads up, down or sideways on either side of the heat sink. Available in either single or matched units, they're characterized by low saturation voltage and high switching speeds. The transistors in this family are especially well suited for military or industrial applications in regulated power supplies, square wave oscillators, servo amplifiers and core driver circuitry. For complete engineering data, or applications assistance, write or call our nearest Sales Office or your nearest Delco Radio Semiconductor Distributor.

Number	IC Max.	Vcbo	Vceo	Sat. V @ IC Max.	Gain Min.—Max. @ IC	fae @ 250 ma IC (typical)
2N2340	1A	50V	40V	4V @ .75A	10— 40 @ .75A	900 kc
2N2341	1A	50V	40V	4V @ .75A	40—100 @ .75A	550 kc
2N2342	1A	100V	60V	3V @ .75A	10— 40 @ .75A	900 kc
2N2343	1A	100V	40V	2.5V @ .75A	40—100 @ .75A	550 kc

Thermal resistance of 8°C/watt max. Typical Alpha cutoff of 15 Mc

Rise Time of .2μ seconds—.75A, IB = 40 ma (Vce = 12V), Fall Time of .5μ seconds (IC = 0 Veb = 2v Reb = 37Ω)

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726 Santa Monica Blvd.
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CRYSTAL DIODES

- Tube Cutting
- Lead Beading
- Crystal Growing
- Crystal Refining
- Crystal Mounting
- Body Forming
- Welding
- Final Sealing

TRANSISTORS

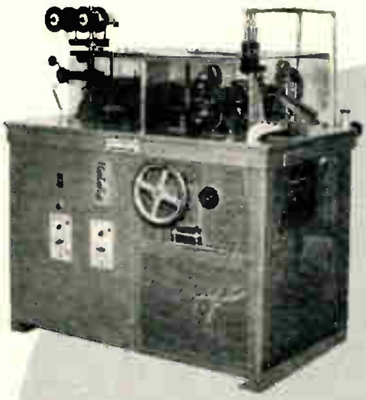
- Header Forming
- Crystal Mounting
- Welding
- Exhausting
- Sealing

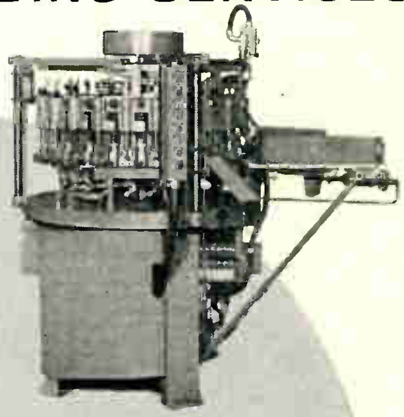
ELECTRON TUBES

- Stem Forming
- Bulb Making
- Tubulating
- Lead Welding
- Lead Beading
- Grid Winding
- Heat Treating
- Degassing
- Exhausting
- Sealing
- Bombarding
- Testing
- Flaring

COMPLETE DEVELOPMENT, DESIGN AND MACHINE BUILDING SERVICES.

AUTOMATIC GRID-FRAME WELDER #3770

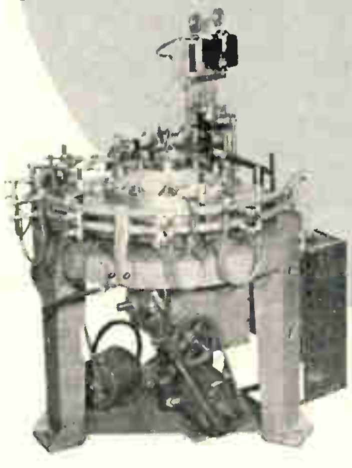


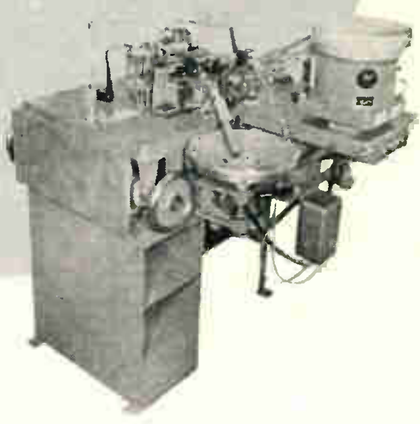


AUTOMATIC DIODE FINAL SEAL MACHINE #3383

AUTOMATIC EQUIPMENT & METHODS
FOR MANUFACTURING TRANSISTORS
CRYSTAL DIODES & ELECTRON TUBES

AUTOMATIC LEAD-BEADING MACHINE #3808





AUTOMATIC CAT-WHISKER WELDER #3711

KAHLE SERVICES ENCOMPASS THE COMPLETE RESPONSIBILITY FOR SPECIAL MACHINE PROJECTS FROM DESIGN & DEVELOPMENT TO FINAL TESTING. FOR 30 YEARS, KAHLE HAS DESIGNED AND BUILT RELIABLE, EFFICIENT PRODUCTION MACHINES FOR MANUFACTURING A WIDE VARIETY OF PRODUCTS. SHOWN HERE, ARE SOME RECENT EXAMPLES OF KAHLE AUTOMATIC PRODUCTION EQUIPMENT

KAHLE ENGINEERING COMPANY

DESIGNERS AND BUILDERS OF PRODUCTION MACHINERY

3318 HUDSON AVE., UNION CITY, N. J. TELEPHONE UN 7-6500

Circle 45 on Inquiry Card

New From Sprague!


TO-18 CASE

ECDC® Type XT-300 LOGIC TRANSISTOR





"NON-UNIVERSAL" SWITCH!

- Specifically designed to meet your challenging ultra-high-speed needs for "next generation" computers!
- No need to compromise on any key parameters!
- Combines the best of diffused collector and electro-chemical technology in one superlative logic device!

Compare the XT-300 with Present-day Selected "Bests"...

CHARACTERISTICS	2N779A	2N964	XT-300
BV_{CES} @ I_C = 100 μA	15 V min.	15 V min.	**25** V min.
BV_{CEO} @ I_C = 1mA	**12** V min.	6 V min.	**12** V min.
I_{CBO} @ V_{CB} = 6V	**3** μA max.	**3** μA max.	**3** μA max.
h_{FE} @ I_C = 50 mA, V_{CE} = 1V	**40** min.	**40** min.	**40** min.
V_{CE} (SAT) @ I_C = 50 mA, I_B = 5 mA	**.18** V min.	.35 V min.	**.18** V min.
V_{BE} @ I_C = 50 mA, I_B = 5 mA	**.6** V max.	.75 V max.	**.6** V max.
f_T @ I_C = 20 mA, V_{CE} = 1V	200 mc min.	**300** mc min.	**300** mc min.
t (on) @ I_C = 10 mA, R_L = 300 ohms; I_{B_1} = 1 mA, V_{BE} (off) = 1.25 V	60 nsec max.	**50** nsec max.	**50** nsec max.
t (off) @ I_C = 10 mA, R_L = 300 ohms; I_{B_1} = 1 mA, I_{B_2} = .25 mA	120 nsec max.	**85** nsec max.	**85** nsec max.

For complete information, write Product Marketing Section, Transistor Division, Sprague Electric Company, Concord, New Hampshire.

SPRAGUE COMPONENTS

TRANSISTORS
CAPACITORS
MAGNETIC COMPONENTS
RESISTORS
MICROCIRCUITS

INTERFERENCE FILTERS
PULSE TRANSFORMERS
PIEZOELECTRIC CERAMICS
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HIGH TEMPERATURE MAGNET WIRE
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS
ELECTRIC WAVE FILTERS

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and ②® are registered trademarks of the Sprague Electric Co.

4S-131

NPN OR PNP SMALL SIGNAL SILICON PLANAR TRANSISTORS IN TO-46 AND TO-18 CASE STYLES

A practical achievement available today for use in complementary circuits — enables use of single polarity power supplies in direct-coupled amplifier designs — maintains original signal phase with fewer amplifier stages for transistor economy — and simplifies design of differential amplifiers. They're reliability proven — life tested at 300°C storage life and 500MW operating life — plus an extra margin of safety which provides true design flexibility. Write for complete technical data and specifications.

SPECIFICATIONS FOR SMALL SIGNAL SILICON PLANAR TRANSISTORS

- Tight beta spreads with controlled design centers
- High F_T: $>$ 100 mc
- High BV_{CEO}: $>$ 80 volts
- Low I_{CBO}: $<$ 2nA for NPN
  $<$ 25nA for PNP
- Low Capacitance: 5pf @ 10 volts

SPERRY

SEMICONDUCTOR

DIVISION OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

Circle 48 on Inquiry Card

SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*), ALLOY SILICON TRANSISTORS AND DIODES

SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; BETHPAGE, L. I., NEW YORK

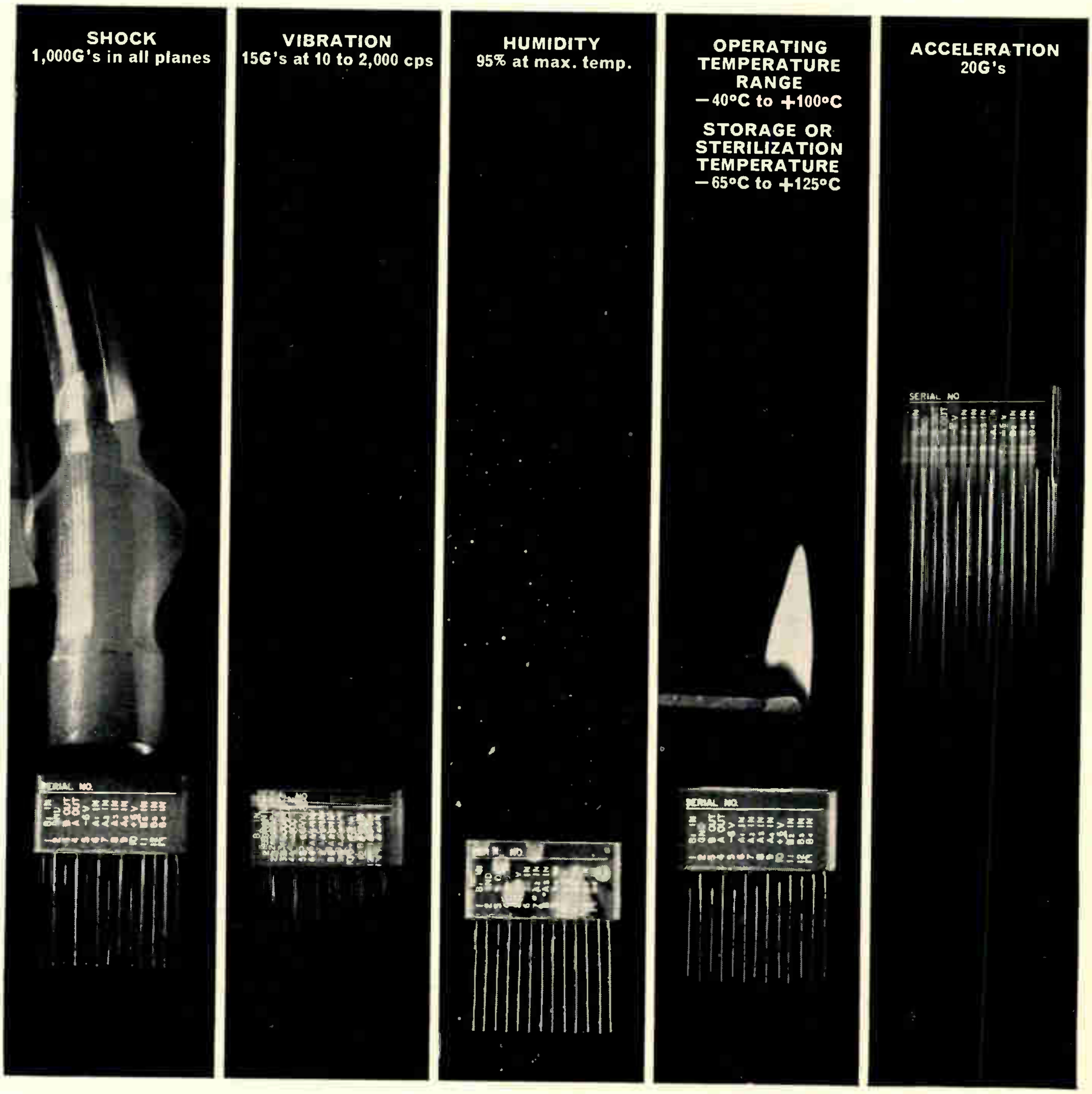
SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

LOW POWER SILICON DIGITAL MODULES

ENVIRONMENTALLY PROVED . . . AVAILABLE NOW!

Delco Radio's new silicon digital modules operate on less than 4 mw. of power per logic stage. They are rugged enough to withstand extreme environmental conditions and are small and lightweight. Encapsulated in light foamy epoxy, each module weighs less than 12 grams and occupies less than one-half cubic inch. The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. From these basic units larger computer subassemblies can be assembled, such as shift registers, adders, binary counters, decimal counters and timing devices. A range of applications—from small scale switching circuits to large computers can be satisfied with these modules. Environmentally proved to:



Data sheets are available. Just write or call our Military Sales Department.

Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of General Motors • Kokomo, Indiana

Circle 49 on Inquiry Card

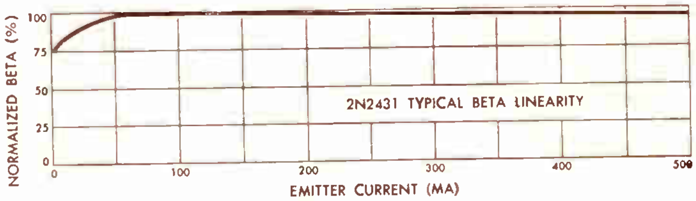
who cares about audio transistors today?

As a cost conscious, quality-hungry designer of audio equipment you know that for nearly a decade—despite spectacular advances in other design areas—little has changed with audio transistors. You know because your design possibilities and the quality of your end products have been severely limited by the absence of improved audio types.

Yes, you care! And because you care, Amperex cares.

Indeed, Amperex cared enough to develop an entirely new process, the Uniform Low Frequency Technique, for manufacturing quality audio frequency transistors. The advantages of this technique—measured in terms of beta linearity and exceptional uniformity without a corresponding increase in price—could scarcely be more impressive.

To take but one example from among the first five U.L.T. types available in production quantities: The 2N2431, a PNP medium power transistor designed for Class A and B audio output stages, is capable of up to 2 watts power output per pair. It is available in a TO-1 case, as are all five U.L.T. transistors. The exceptional linearity of its beta is dramatically shown in the curve reproduced at right where beta remains substantially constant up to the maximum rated current of 500 ma. Further, the 2N2431 offers high gain with a beta of 50 to 180, 550 mw maximum dissipation and a collector-to-emitter breakdown voltage of 32 volts.



Here, then, are five great new transistors—as economical as they are excellent—to open new doors for you in the design of • Portable Radios • AM-FM Receivers • Car Radio Audio Drivers • Audio applications in communications systems • Slow-speed switching in computer applications.

ULT Transistor Type No.	Case	Application	Breakdown Voltages	Beta	Peak Current	Collector Dissipation
2N2428 PNP	To-1	Preamps, drivers and low wattage output devices	−32 volts	80-160	100 ma	165 mw
2N2429 PNP	To-1	Preamps, drivers and low wattage output devices	−32 volts	130-300	100 ma	165 mw
2N2430 NPN	To-1	Preamps, drivers and low wattage output devices	−15 volts	65-190	100 ma	165 mw
AC127/132 NPN PNP	To-1	Matched pair, NPN-PNP for 200 mw output stage using complementary-symmetry circuits.	15 volts	65-190	100 ma	165 mw
2N2431 PNP	To-1	Class A & B audio output stages up to 2 watts.	−32 volts	50-180	500 ma	550 mw

Write for complete data on the U.L.T. types that will make the big difference in your particular audio frequency application. Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, L. I., N. Y.

IN CANADA: PHILIPS ELECTRON DEVICES LTD., 116 VANDERHOOF AVENUE, TORONTO 16, ONTARIO

Ask Amperex

Tech Data

for Engineers

Germanium Diode

Nanosecond Germanium Diode Types CGD-1092 and 1093 are described in tech. data available from Clevite Transistor Products, 200 Smith St., Waltham, Mass. Tech. rating for the 1092 include a reverse recovery time of 8.0nsec. max.; max. capacitance of 1.5pf @ 3.0v; and an average power dissipation of 80mw. Specs on the 1093 include a reverse recovery time of 3.0nsec. max.; max. capacitance of 2.0pf @ 3.0v; and i_{surge} for 1 sec. of 150ma.

Circle 333 on Inquiry Card

Activation Analysis

A bulletin for the semiconductor industry explains the activation analysis technique, and listing applications including research and quality control is available from General Atomic Div., General Dynamics Corp., P. O. Box 608, San Diego 12, Calif. This ultra-sensitive analytical technique can be used to determined the amounts of phosphorus, antimony, arsenic, indium, gold and gallium in semiconductor components.

Circle 334 on Inquiry Card

Rectifier Assemblies

Bulletin 106 describes a line of high voltage rectifier assemblies which are single junction silicon diodes with PIV ratings in excess of 100v. The typical reverse leakage ratings of these devices are 10na at 1000v and 25°C. Also available is Bulletin 107 which contains information on passivated silicon dice that will not degrade when subjected to Mil-S-19500 testing. Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif.

Circle 335 on Inquiry Card

Microwave Diode Guide

Containing electrical characteristics and performance ratings of a wide range of microwave mixer, detector, varactor, tunnel and switching-diodes, this 26-page illustrated brochure is available from Sylvania Electric Products Inc., Semiconductor Div., 100 Sylvan Rd., Woburn, Mass. Also featured is a 4-page replacement guide insert, complete listing of mechanical and environmental test procedures, and more than 6 pages, of microwave diode applications notes.

Circle 336 on Inquiry Card

Silicon Diodes

Tech. data describing a line of Silicon Double Diffused Alloy Diodes for use in core driving, clamping, gating and similar circuits in high speed digital computers, is available from National Transistor Mfg., Inc., 500 Broadway, Lawrence, Mass. Catalog B-101 lists conductances of the order of 500ma at 1.0v and switching speeds of 500ma at 15nsec. typical.

Circle 613 on Inquiry Card

New Tech Data
for Engineers

UHF Power Oscillator

Maxson Instruments Div., Maxson Electronics Corp., 475 Tenth Ave., New York 18, N. Y., is offering tech data on their uhf wide range power oscillator and power supply. Features are power at 40 w.; stability of a precision coaxial cavity and a range of 200 to 2500 mc, continuously variable in 2 bands.

Circle 337 on Inquiry Card

Silicon Rectifiers

Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif., is offering tech data on their Subminiature High Voltage Silicon Rectifiers, SC series including the 15, 20, 25, 30, 40, 50. 75, and 100 units. The PIV respectively is 1500, 2000, 2500, 3000, 4000. 5000, 7500 and 10,000v. Body dimensions including end seals from 15 to 30 types is 0.140 in dia. x 0.310 in. long and from 40 to 100 types is 0.140 in dia. x 0.410 long. Operating temp. is −65 to +175°C.

Circle 338 on Inquiry Card

Power Tubes

A summary catalog of power tubes and accessories is available from Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif. Information includes specs. and prices for the Penta line of beam pentodes, power tetrodes, power triodes, high-voltage rectifiers and vacuum switches.

Circle 339 on Inquiry Card

Semiconductor Wire

Secon Metals Corp., 9 Intervale St., White Plains, N. Y., is offering a revised edition of its comprehensive semiconductor wire catalog. Included are newly developed wires of pure metals, alloys, and coatings for the semiconductor industry. Other sections of the catalog include information on a variety of doped gold, silver and aluminum alloys, pure metals including platinum, titanium and aluminum as well as the more commonly used metals.

Circle 340 on Inquiry Card

Solid State Inverters

Electrosolids Corp., 12740 San Fernando Rd., North, Sylmar, Calif., is offering tech data on ZERO to ZERO power factor solid state inverters. The new design is available either as an inverter or coupled with a transformer rectifier for freq. and/or voltage conversion.

Circle 341 on Inquiry Card

Rectifiers

Bulletin 101, 8 pages, describes selenium rectifiers covering ranges from microamps to kiloamps and voltages from millivolts to kilovolts. Edal Industries, Inc., 4 Short Beach Rd., East Haven, Conn.

Circle 342 on Inquiry Card

Sweeping Oscillators

Tech data is available on the Kay all electronic Wide-Sweep Video through UHF Sweeping Oscillator, with a sweep width variable to 300-MC plus and a freq. range of 0.025 to 1050MC. Also included is information on a dc to 500MC coaxial electronic switch and dc to 1000MC, 10db switched attenuator pads. Kay Electric Co., Maple Ave., Pinebrook, N. J.

Circle 343 on Inquiry Card

Microwave Tube Catalog

Raytheon Co., Microwave & Power Tube Div., Waltham 54, Mass., is offering a 70-page microwave tube catalog. The catalog lists 201 active, unclassified microwave tubes of all types, as well as ferrite devices, magnetic components, high power test modulators and infrared detectors. The catalog is color-tabbed, with descriptive 'specs,' for sections including magnetrons, klystrons, amplitrons and stabilotrons, BWOS, TWTS, crossed field amplifiers and associated components.

Circle 344 on Inquiry Card

Electron Tube Catalog

Litton Industries, Electron Tube Div., San Carlos, Calif., is offering their Electron Tube Condensed Catalog for 1962. The catalog contains information on Pulse Magnetrons, CW Magnetrons, M-Type BWOs, Crossed Field Forward Wave Amplifiers, BARRATRON® Transmitting Tubes, Klystrons, TWTs, Switch Tubes, Millimeter Wave Tubes, Display Devices, Equipment and Accessories, and a Tube Cross Reference. Included are photographs and tables of specs.

Circle 345 on Inquiry Card

Transistor Devices

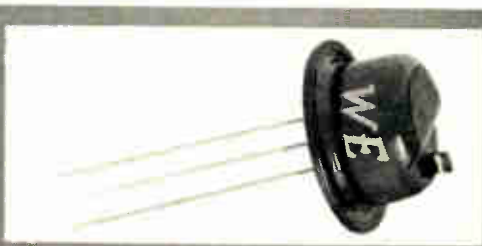
This short-form catalog of transistor devices contains spec. of power supplies, audio amplifiers, i-f amplifiers, transformers and converters. Ferrotran Electronics Co., Inc., 693 Broadway, New York 12, N. Y.

Circle 346 on Inquiry Card

To Contractors and Subcontractors on U. S. Government Projects

HIGH CURRENT SWITCHING TRANSISTOR 2N1072

TO-38 PKG.



1½ times actual size

12.5 WATTS, 75 VOLTS, 2 AMPERES

Western Electric's 2N1072 is an NPN diffused silicon mesa transistor, designed by Bell Telephone Laboratories for high current switching and core driver applications. Typical turn-on time is 80 nanoseconds. Typical turn-off time is 200 nanoseconds. One ampere may be switched at rise and fall times of 50 nanoseconds. The maximum power dissipation at a case temperature of 100°C is 5 W.

ABSOLUTE MAXIMUM RATINGS (T_C=25°C)

P_C	V_{CES}	V_{EBO}	V_{CBO}	I_C &-I_E
12.5 W	75 Vdc	6.0 Vdc	75 Vdc	2.0 A

ELECTRICAL CHARACTERISTICS

	h_{FE}	V_{CE} (sat)	V_{BE} (sat)	$t_d + t_r$	$t_s + t_f$
	(V_{CE}=5 Vdc) (I_C=750 mAdc)	(I_C=750 mAdc) (I_B=75 mAdc)	(I_C=750 mAdc) (I_B=75 mAdc)	(V_{CC}=20 Vdc)	(R_C=25 ohms)
				($I_{B(1)}$=75 ma)	
				($V_{BE(0)}$=0)	($I_{B(2)}$=−75 ma)
Min.	20	—	0.70 Vdc	—	—
Max.	—	2.0 Vdc	1.8 Vdc	100 nsec	300 nsec

The 2N1072 transistor may be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, address your request to Sales Department, Room 105, Western Electric Company, Incorporated, Laureldale, Pa. Telephone — Area Code 215 — 929-5811.

LAURELDALE PLANT

MAKER OF ELECTRON PRODUCTS

Western Electric

MANUFACTURING AND SUPPLY · BELL SYSTEM · UNIT OF THE BELL SYSTEM

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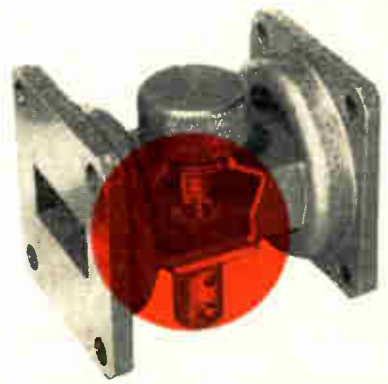
SWITCHES >1 watt IN 1 nsec



PHILCO 1N3482
MICROWAVE DIODE SWITCH
IN P-901 HOLDER

Now you can design faster microwave switching, higher frequency modulation, and pinpoint-output pulsing—in smaller, more reliable packages. The Philco 1N3482 microwave diode switch—**world's fastest**—can modulate an X-Band wave or produce an extremely narrow RF output pulse.

The Philco 1N3482, as a result of the Philco microetch process, has many unusual capabilities ■ Only 100 mw turns on this 1.25W switch ■ Typically maintains 22 db isolation at 1.25W, with isolation values as high as 30 db attainable ■ Dissipation life tests show the device meets advertised performance even after 1600 hours ■ Requires **no** tuning or adjustment ■ Philco simplified holder design enables **you** to replace diodes in the same holder ■ Availability is excellent ■ For complete data on the Philco family of solid state microwave switches, circle reader service card.

For special report, "Theory of Operation of Solid State Diodes as Microwave Switches," write on your letterhead to Dept. EI662S.

SPECIAL PRODUCTS OPERATION

PHILCO®

A SUBSIDIARY OF *Ford Motor Company*

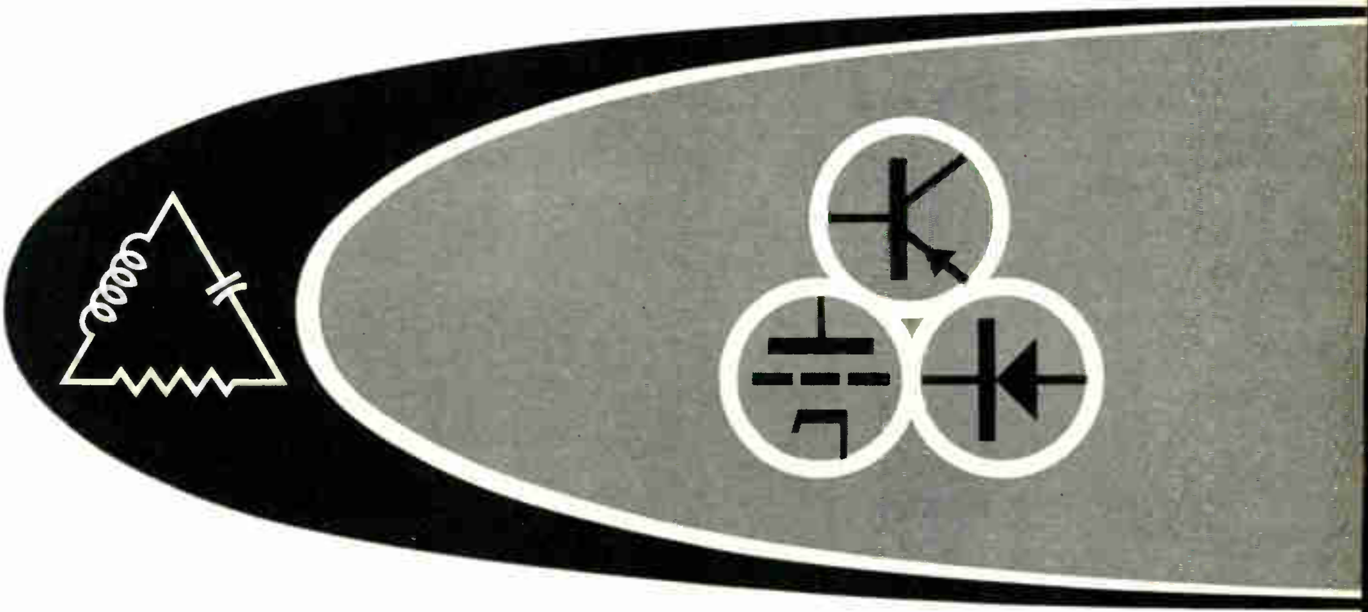
LANSDALE DIVISION, LANSDALE, PA.

SOLID-STATE CENTER U.S.A.

Circle 60 on Inquiry Card

Section C

Tubes & Semiconductors



PART TWO

New Receiving Tubes & Special Purpose Tubes

—registered during the Period May 1961 to May 1962

(From data supplied by Engineering Dept., Electronic Industries Assoc., 11 W. 42nd St., N.Y.C.)

MAGNETRONS

Tube	Sponsor	Operating Band	Type	Power Output	Remarks
6249A	Raytheon	8500 – 9600 Mcs.	Internal Magnet	240 kw.	Forced Air Cooled
6517	Raytheon	1250 – 1350 Mcs.		1.3 meg. w.	Forced Air Cooled
6841	Raytheon	16500 Mcs.		50 kw.	Forced Air Cooled
6959	Raytheon	9330 – 9420 Mcs.		500 kw.	Forced Air Cooled
7156	Raytheon	5450 – 5825 Mcs.	Internal Magnet	250 kw.	
7208B	Western Electric	15500 – 17500 Mcs.		130 kw.	Unilaterally Interchangeable With 7208
7444	Bomac Labs	5400 – 5900 Mcs.		1 kw.	Air Cooled
7452	Raytheon	15840 – 16160 Mcs.		70 kw.	
7521	Raytheon	8900 – 9400 Mcs.			
7541	Westinghouse	8500 – 9600 Mcs.			Forced Air Cooled
7547	Raytheon	406 – 450 Mcs.	Internal Magnet	2.0 meg. w.	Liquid Cooled
7578	Raytheon	5400 – 5900 Mcs.		800 – 1200 w.	
7589	Western Electric	8500 – 9600 Mcs.		425 kw.	Air Cooled
7619	Sylvania	Ka Band			Ruggedized Version of 5789
7630	Raytheon	15840 – 16160 Mcs.		70 kw.	
7692	Sylvania	9200 – 9550 Mcs.		220 kw.	Forced Air Cooled
7692A	Sylvania	8550 – 9650 Mcs.		220 kw.	
7718	Raytheon	Fixed		1 meg. w.	Liquid Cooled
7794	Westinghouse	4200 – 4400 Mcs.	CW	10 w.	Air Cooled
7795	Sylvania	C–Band	CW	5 w.	
7796	Sylvania	4200 – 4400 Mcs.		1.5 w.	
7950	Western Electric	8500 – 9600 Mcs.		265 kw.	Air Cooled
7976	Western Electric	13600 – 15600 Mcs.		135 kw.	Forced Air Cooled
8079	Western Electric	17400 – 19500 Mcs.		135 kw.	Forced Air Cooled

MULTIPLIER PHOTOTUBES

Tube	Sponsor	Const.	Application	Max. Response	Remarks
8049	Tung – Sol	Cesium – Antimony Head-On		4000 ± 500 Å	Spectral Response: S–4
8054	RCA	10-Stage Head-On – 3" Dia. Face	Scintillation Counter	3000 - 6500 Å	
8062	A.B. Dumont Labs	10-Stage – Flat End Window	Infrared Spectroscopy		Luminous Sensitivity – 19-μa./lumen
8100	Sylvania	Cadmium Sulfide		6100 Å	
8142	Sylvania	Cadmium Sulfide	Relays	6100 Å	
8143	Sylvania	Same as Type 8142			
8053	RCA	10-Stage – Head-On	Scintillation Counter	4400 Å	Spectral Response: S–11
8055	RCA	10-Stage – Head-On – 5" Dia. Face	Scintillation Counter	4400 ± 500 Å	Spectral Response: S–11

THYRATRONS

Tube	Sponsor	Anode Voltage Drop	Peak Anode Voltage	Construction	Application	Remarks
6901	Tung-Sol	10 v.	1250 v.	7–Pin Octal		Inert Gas & Mercury Vapor Filled
8043	Westinghouse			3–Electrode	Power Supplies	Negative Control Characteristics
8063	Mullard, Ltd.	10 v.	1500 v.		Power Control	Inert Gas Filled

TRAVELING WAVE TUBES

Tube	Sponsor	Heater Ratings	Power Output	Range	Application	Construction	Remarks
6698	Sylvania	6.3 v./2.7 a.	1 kw.	2.0 – 4.0 Gcs.	Airborne Amplifier		
6752	Sylvania	6.3 v./1.5 a.	2 w.	1.0 – 2.0 Gcs.	CW or Pulsed Amplifier (Airborne)		
6753	Sylvania	6.3 v./0.96 a.	15 m.w.	1.0 – 2.0 Gcs.	Broadband Amplifier		
7393	G.E.		5 m.w.	4000 – 8000 Mcs.	Microwave Relay Systems	Metal & Ceramic	
7394	G.E.		5 m.w.	8000 – 12000 Mcs.	Microwave Relay Systems	Metal & Ceramic	
7642	M–O Valve Co. Ltd.		18 w.	1700 – 2300 Mcs.	Telecommunications		
7847	ITT	6.3 v./2.2 a.	10 w.	5000 – 6000 Mcs.	CW Operation		Air or Water Cooled
8154	G.E.			7000 – 11000 Mcs.	Military Systems		

RECTIFIERS

Tube	Sponsor	Type	Heater Ratings	PIV	D.C. Output Current	Construction	Application
2AH2	G.E.	Heater-Cathode Diode	2.5 v./0.3 a.	24 kv.	1.5 ma.		H.V. – T.V. Rectifier
5AZ3	C.B.S.	Full-Wave	5.0 v./3.0 a.	1700 v.	1.0 a.	High Vacuum	Power Rectifier
5BC3	R.C.A.	Full-Wave	5 v./3 a.	1700 v.			Power Supplies
6AY3	R.C.A.	Half-Wave		5000 v.	1.1 a.	9-Pin Min.	Damper Diode for T.V.
6BH3	R.C.A.	Half-Wave		5500 v.	1.1 a.	9-Pin Min.	Damper Diode for T.V.
12AY3 & 17AY3	Same as 6AY3						
17BH3 & 22BH3	Same as 6BH3						
25DK4	G.E.	Half-Wave	25 v./0.15 ± .01 a.	330 v.	100 ma.	7-Pin Min.	
6982	Electrons, Inc.	Full-Wave	2.5 v./11.5 ± 1 a.	725 v.		Lug-Type Base	
6983	Electrons, Inc.	Half-Wave	2.5 v./21 a.	920 v.		Lug-Type Base	
6984	Electrons, Inc.	Grid Control	2.5 v./17 ± 2 a.	1700 v.			
6985 & 6986	Same as 6984						
6987	Electrons, Inc.	Grid Control	2.5 v./24 ± 2a.	4000 v.			
6988	Electrons, Inc.	Grid Control	2.5 v./21 ± 2 a.	1250 v.			
6989	Same as 6988						
7631	Brimar	Duo-Diode		360 v.		7-Pin Min.	Pulse Shaping
7789	Tung-Sol	Half-Wave	5.25 v./9.3 a.	15 kv.		Hydrogen-Filled	High Voltage Rectifier
7792	Tung-Sol	Half-Wave	12.0 v./10.5 a.	25 kv.		Hydrogen-Filled	High Voltage Rectifier
7869	ITT		15.0 v./36 a.				
8034	ITT		7.5 v./51 a.				
8065 & 8066	Same as 6984						
8094	Machlett Labs			110 kv.		High Vacuum	Pulse Circuits

NEW RECEIVING TUBES

TUBE	SPONSOR	TYPE	CONSTRUCTION	APPLICATION	Section 1 Ep(v)	Ip(ma)
7698	Machlett Labs	Planar Triode		R-F Osc., R-F Pwr. Amp.		
7815	Machlett Labs	Planar Triode		R-F Osc., R-F Pwr. Amp.		
8081	G.E.	Planar Triode	Metal – Ceramic	A-F Amp.		
8082	G.E.	Planar Triode	Metal – Ceramic	VHF, UHF Osc.		
8083	G.E.	Planar Triode	Metal – Ceramic	R-F Amp.		
3FS5	G.E.	Pentode	Same as 6FS5 Exc. Heater Ratings (2.9 v./0.45 a.)			
3HS8	G.E.		Same as 6HS8 Exc. Heater Ratings (3.15 v./0.6 a.)			
4FS7	Mullard, Ltd.	Triode-Pentode	9-Pin Min.	Freq. Changer	125	14
4GK5	Sylvania	Triode	Same as 4GK5 Exc. Heater Ratings			
4HS8	Tung-Sol	Twin Pentode	Same as 6HS8 Exc. Heater Ratings (4.2 v./0.45 a.)			
6AG11	G.E.	Duo-Diode-Twin Triode		F.M Stereo Multiplex		
6AR11	G.E.	Twin Pentode		I-F Amp.		
6AV11	G.E.	Triple Triode		General Purpose		
6BF8	G.E.	Sextuple-Diode	9-Pin Min.	Shunt Detector		11
6DR4	C.B.S.	Triode	7-Pin Min.	Voltage Amp., Phase Inverter		
6DS4	RCA	Triode		R-F Amp.		
6EL7	Siemens Edison Swan, Ltd.	Pentode	9-Pin Min.		250	
6FR7	Sylvania	Duo-Triode		Vert. Osc & Amp.	330	
6FV8A	Westinghouse	Triode-Pentode	9-Pin Min.	T.V. Receivers	330	12
6GB5	Amperex	Pentode		TV Output	275	440
6GE5	G.E.	Pentode		Horiz. Amp.		
6GF5	G.E.	Pentode		Horiz. Amp.		
6G11	G.E.	Duo-Pentode		FM Detector, A-F Amp.		
6GJ5	RCA	Beam-Power		Horiz. Amp.		
6GM5	Sylvania	Pentode		Power Output	500	
6GM8	Rogers	Duo-Triode	9-Pin Min.	R-F Amp., Self Osc. Mixer		
6GT5	RCA	Beam-Power		Horiz. Amp.		
6GW8	Amperex	Triode-Pentode	7-Pin Min.	Sound Output	300	
6GX6	RCA	Pentode	7-Pin Min.	FM Detector	300	
6HB6	Raytheon	Pentode	9-Pin Min.	Vert. Amp.	350	
6HQ6	Radio Valve Co., Ltd.	Pentode	7-Pin Min.	I-F Amp.		15
6HU8	Standard Elektrik Lorenz	Pentode	9-Pin Min.	General Purpose	300	
6HW8	G.E.	Sheet-Beam	9-Pin Min.			30
6HZ8	Philco	Triode-Pentode		Voltage Amp. & Video Amp.	200	3.5
6JE8	Philco	Triode-Pentode	9-Pin Min.	Voltage Amp.	200	4.5
6JH9	G.E.	Sheet-Beam	9-Pin Min.	Color TV	330	
6J11	G.E.	Twin Pentode		I-F Amp.		
6JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners		
7EK7	Siemens Edison Swan, Ltd.	Twin Triode	9-Pin Min.	R-F Amp.	250	
8HG8	Mullard, Ltd.	Triode-Pentode	Same as 6HG8 Exc. Heater Ratings (8.0 v./0.3 a.)			
8JE8	Philco	Triode-Pentode	Same as 6JE8 Exc. Heater Ratings (8.2 v./600 ma.)			
8JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners		
10FR7	Sylvania	Duo-Triode		Vert. Osc. & Amp.		
10GN8	Tung-Sol	Triode-Pentode	Same as 6GN8 & 8GN8 Exc. Heater Ratings (10.5 v./.450 a.)			
11JE8	Philco	Triode-Pentode	Same as 6JE8 Exc. Heater Ratings (10.9 v./450 ma.)			
12AX3	G.E.	Diode	Same as 6AX3 Exc. Heater Ratings (12.6 v./0.6 a.)			
12DJ8	Sylvania	Duo-Triode	Same as 6DJ8 Exc. Heater Ratings (12.6 v./180 ma.)			
12FV7	RCA	Twin-Triode	9-Pin Min.	TV Tuners		
12GE5	G.E.	Beam Pentode	Same as 6GE5 Exc. Heater Ratings (12.6 v./0.6 a.)			
12GJ5	RCA	Beam-Power		Horiz. Amp.		
12HU8	Standard Elektrik Lorenz	Pentode	9-Pin Min.	General Purpose	300	
13FR7	Sylvania	Duo-Triode		Vert. Osc. & Amp.	330	
14JG8	G.E.	Duo-Diode-Triode		Voltage Amp.	330	2
16GK6	Sylvania	Pentode	Same as 6GK6 Exc. Heater Ratings (16.0 v./300 ma.)			
16GK8	Siemens Edison Swan, Ltd.	Triode-Tetrode	9-Pin Min.		250	
17GK5	RCA	Beam Power		Horiz. Amp.		
17GT5	RCA	Beam Power		Horiz. Amp.		
17JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners		
17W6GT	Westinghouse	Pentode	Same as 6W6GT Exc. Heater Ratings (16.8 v./45 ma.)			
19HV8	G.E.	Triode-Pentode	9-Pin Min.	Radio Receivers	330	
19JN8	G.E.	Triode-Pentode	9-Pin Min.			
27GB5	Amperex	Pentode	Same as 6GB5 & 28GB5 Exc. Heater Ratings (27 v./300 ma.)			

Heater Ratings	Gm	Amp. Factor	Rp (Ω)	Section 2 Ep(v)	Section 2 Ip(ma)	Gm	Amp. Factor	Rp (Ω)	REMARKS	TUBE
6.3 v./1.3 a.	30000 µ Mhos	80							Conduction & Convection Cooled	7698
6.0 v./1.0 a.	2500 µ Mhos	100							Conduction & Convection Cooled	7815
6.3 v./0.22 a.									Plate Dissipation – 0.85 w.	8081
6.3 v./0.24 a.									Plate Dissipation – 1.0 w.	8082
6.3 v./0.24 a.									Plate Dissipation – 1.1 w.	8083
										3FS5
										3HS8
4.6 v./600 ma.	5500µ Mhos			250	10	12000µ Mhos			Plate Dissipation–T-15 w., P-2 w.	4FS7
										4GK5
										4HS8
6.3 v./0.75 a.	7800µ Mhos	66	8.5 K.						Plate Dissipation – 2.0 w.	6AG11
6.3 v./0.8 a.	10500µ Mhos		.2 meg.						Plate Dissipation – 3.1 w.	6AR11
6.3 v./0.6 a.	2200µ Mhos	17	7.7 K.						Plate Dissipation – 2.75 w.	6AV11
6.3 v./0.45 a.										6BF8
6.3 v./0.15 a.	1600µ Mhos	100	62.5 K.						Plate Dissipation – 1.2 w.	6DR4
6.3 v./0.135 a.	9000µ Mhos	62	6.9 k.						Plate Dissipation – 1 w.	6DS4
6.3 v./0.3 a.	9200µ Mhos	64							Plate Dissipation – 3 w.	6EL7
6.3 v./925 ma.	1600µ Mhos	68	40 k.	330		7200µ Mhos	5.4	750	Plate Dissipation–#1-1.5w., #2-10w	6FR7
6.3 v./0.45 a.	8000µ Mhos	45	5.6 k.	330	12	6500µ Mhos		2 meg.	Plate Dissipation – T-2.0 w., P-2.3w	6FV8A
6.3 v./1.38 a.										6GB5
6.3 v./1.2 a.		4.1	20 k.						Plate Dissipation – 17.5 w.	6GE5
	4700µ Mhos	4.2	260 k.						Plate Dissipation – 9.0 w.	6GF5
6.3 v./1.2 a.	7500µ Mhos		10 k.			1000µ Mhos		.5 meg.	Plate Dissipation–#1-6.5w., #2-1.7w	6G11
6.3 v./1.2 a.	7100µ Mhos	4.4	15 k.						Plate Dissipation – 17.5 w.	6GJ5
6.3 v./0.8 a.	10200µ Mhos		29 k.						Plate Dissipation – 19 w.	6GM5
6.3 v./330 ma.	2600µ Mhos	14							Plate Dissipation – 0.6 w.	6GM8
6.3 v./1.2 a.		4.4				7100µ Mhos		15 k.		6GT5
6.3 v./700 ma.	10000µ Mhos	100		300		1600µ Mhos	21		Plate Dissipation – T-0.5 w., P-9 w	6GW8
6.3 v./0.45 ±6%a	3700µ Mhos		.14 meg.						Sharp Cutoff	6GX6
6.3 v./760 ma.	20000µ Mhos	33	24 k.						Plate Dissipation – 10 w.	6HB6
6.3 v./300 ma.	10500µ Mhos		.22 meg.						Semi-Remote Cutoff	6HQ6
6.3 v./0.55 a.	6000µ Mhos		.08 meg.						Plate Dissipation – 12 w.	6HU8
6.3 v./0.3a									Plate Dissipation – 2.0 w.	6HW8
6.3 v./1.125 a.	4000µ Mhos	70		250	29	12600µ Mhos		.14 meg.		6HZ8
6.3 v./780 ma.	4200µ Mhos	70		250	22	12000µ Mhos		.14 meg.		6JE8
6.3 v./0.3 a.									Plate Dissipation – 3.0 w.	6JH9
6.3 v./0.8 a.	13000µ Mhos		.2 meg.						Plate Dissipation – 3.1 w.	6J11
6.3 v./400 ma.	6800µ Mhos	55	8 k.			1300µ Mhos	70	5.4 k.		6JK8
7.0 v./0.3 a.	9000µ Mhos	26							Plate Dissipation – 2.0 w.	7EK7
										8HG8
										8JE8
8.4 v./300 ma.	6800µ Mhos	55	8 k.			1300µ Mhos	70	5.4 k.		8JK8
9.7 v./600 ma.	1600µ Mhos	68	40 k.			7200µ Mhos	5.4	750	Plate Dissipation #1-1.5w.,#2-10w.	10FR7
										10GE5
										11JE8
										12AX3
										12DJ8
12.6 v./.45 a.	9600µMhos	21.5	2.25 k.							12FV7
										12GE5
12.6 v./0.6 a.	7100µ Mhos	4.4	15 k.						Plate Dissipation – 17.5 w.	12GJ5
12.6 v./.300 a.	6000µ Mhos		.08 meg.						Plate Dissipation – 12 w.	12HU8
13.0 v./450 ma.	1600µ Mhos	68	40 k.	330		7200µ Mhos	5.4	750	Plate Dissipation-#1-1.5w,#2-10w.	13FR7
14 v./.15±.009 a.	2200µ Mhos	90	41 k.	330	2	2200µ Mhos		41 k.	Plate Dissipation – 1.1 w.	14GJ8
										16GK6
16.0 v./0.3 a.	3400µ Mhos	18							Plate Dissipation – Tr-1.0w., Te-7w.	16GK8
16.8 v./0.45 a.	7100µ Mhos	4.4	15 k.						Plate Dissipation – 17.5 w.	17GK5
		4.4				7100µ Mhos		15 k.		176GT5
16.8 v./150 ma.	6800µ Mhos	55	8 k.			1300µ Mhos	70	5.4 k.		17JK8
										17W6GT
18.9v/0.15±.009a	1300µ Mhos	70	54 k.	330		6500µ Mhos		200 k.	Plate Dissipation – T-.55w.,P-3.0w.	19HV8
18.9 v./0.15 a.	7500µ Mhos		200 k.			8500µ Mhos	46	5.4 k.	Sharp Cutoff Pentode	19JN8
										27GB5

NEW RECEIVING TUBES

TUBE	SPONSOR	TYPE	CONSTRUCTION	APPLICATION	Section 1	
					Ep(v)	Ip(ma)
28GB5	Amperex	Pentode	Same as 6GB5 & 27GB5 Exc. Heater Ratings (28 v./300 ma.)			
34GD5A	RCA	Beam-Power	7-Pin Min.	Audio Output Amp.		
35NF5	Campagnie Industrielle Francais	Pentode	Same as 6FN5 Exc. Heater Ratings (35 v./0.3 a.)			
50HC6	G.E.	Pwr. Pentode	7-Pin Min.	A-F Power	150	
50 HK6	G.E.	Pwr. Pentode	7-Pin Min.	Audio Power Amp.		
6146A	Sylvania	Beam Pentode				
6159A	Sylvania	Beam Pentode				
6263A	RCA	Triode	Unilaterally Interchangeable With 6263			
6398	ITT	Pwr. Triode		R-F Amp. or Osc.		
6872	Raytheon	Pentode			165	
6883A	Sylvania	Beam Pentode				
7079	Raytheon	Twin-Triode		UHF Amp. & Osc.		
7083	Raytheon	Pentode		VHF Amp.		
7246	Raytheon	Triode	Filament Type	VHF-UHF Amp., Class C Osc.	150	
7328A	Westinghouse	Triode		A-F Amp.		
7489	Brimar	Duo-Triode	9-Pin Min.	A-F & Control Amp.	330	14.5
7490	Brimar	Duo-Triode	9-Pin Min.	A-F Control, DC Amp.	300	8.5
7492	Brimar	Duo-Triode	9-Pin Min.	R.F. & Computer	380	3.2
7494	Standard Telephones & Cables	Duo-Triode	9-Pin Min.	A-F & Control	330	1.75
7495	Standard Telephones & Cables	Tetrode	9-Pin Min.	VHF Amp.	300	57
7496	Brimar	Pentode	7-Pin Min.	R-F, I-F Amp.	330	13.5
7498	Brimar	Pentode	7-Pin Min.	R-F, I-F Amp.	300	12.2
7499	Brimar	Pentode	9-Pin Min.	Video Amp.	300	50
7500	Standard Telephones & Cables	Tetrode	9-Pin Min.	A-F Power	350	7.5
7502	Standard Telephones & Cables	Heptode	7-Pin Min.	Freq. Changer	330	4.1
7527	Amperex	Tetrode		VHF Amp, Osc., or Mod.		
7548	CBS	Hexode	9-Pin Min.	Pulse Amp.	1000	
7581A	G.E.	Beam Pentode	Unilaterally Interchangeable With 7581 & 6L6GC			
7587	RCA	Tetrode		R-F, I-F Video Amp. & Mixer	250	11.5
7604	Westinghouse	Triode		General Purpose		
7757	Bendix	Beam Power	9-Pin Min.	High Voltage	3000	
7763	G.E.	Sheet Beam	9-Pin Min.	I-F Amp.	330	
7768	G.E.	Triode		R-F Amp.		
7788	Amperex	Pentode	9-Pin Min.	Broad-Band Amp.	250	
7800	Amperex	Triode	Ex. Plate	R-F, I-F Amp. & Osc.		
7802	Tung-Sol	Duo-Triode		Power Supplies		
7837	ITT	Triode		R-F Amp & Osc., Class B Mod.		
7838	ITT	Triode		R-F Amp. & Osc., Class B Mod.		
7839	ITT	Triode		R-F Amp. & Osc., Class B. Mod.		
7851	Tung-Sol.	Tetrode	7-Pin Min.		12	16
7855	Machlett Labs	Triode		Osc., Freq. Multiplier		
7868	RCA	Pwr. Pentode	9-Pin Min.	Audio Output Amp.		
7861	G.E.	Duo-Triode	Same as 5670 Exc. Heater Ratings			
7892	Tung-Sol	Duo-Triode		Pulse Amp. & Osc.	175	
7899	Amperex	Triode		Pulsed R-F Amp.		
7900	Amperex	Triode		TV Transmitter		
7962	Sylvania	Duo-Triode		UHF Amp.	100	15
7963	Sylvania	Duo-Triode		UHF Amp.	165	22
7979	Raytheon	Triode	Neon Filled	Grid Control Device	118	11
7983	Amperex	Duo-Tetrode	9-Pin Min.	Output Amp., Driver, Freq. Mul.		
7994	Raytheon	Triode		Wide-Band Amp.	100	15
7995	Raytheon	Pentode		R-F, I-F Amp.	150	8.0
8032	CBS	Beam Power	Same as 6883 Exc. Heater Ratings (13.5 ± 10% v./.625 a.)			
8042	Amperex	Beam Tetrode		R-F Amp. & Osc.		
8044	Westinghouse	Triode		Modulator		
8058	RCA	Triode				
8064	Sylvania	Pentode		R-F, I-F Amp.	165	
8068	G.E.	Beam		Series Regulator		
8070	Sylvania	Triode		R-F Amp.		
8077	RCA	Pentode	9-Pin Min.	Mobile Communications		
8078	Assoc. Electrical Ind.	Triode		R-F Transmitting		
8136	G.E.	Pentode	7-Pin Min.	I-F Amp.		

Heater Ratings	Gm	Amp. Factor	Rp (Ω)	Section 2 Ep(v)	Section 2 Ip(ma)	Gm	Amp. Factor	Rp (Ω)	REMARKS	TUBE
										28GB5
3.4 v./0.1 a.	5700μ Mhos		13 k.						Plate Dissipation – 5 w.	34GD5A
										35NF5
50 v./0.15±.009a	14600μ Mhos		11 k.						Plate Dissipation – 5.5 w.	50HC6
50 v./0.15 a.	7500μ Mhos		10 k.						Plate Dissipation – 5.5 w.	50HK6
6.3 v./1.25 a.	7000μ Mhos	4.5							Plate Dissipation – 25 w.	6146A
26.5 v./200 ma.	7000μ Mhos	4.5							Plate Dissipation – 25 w.	6159A
										6263A
15.5 v./420 a.		21							Water Cooled	6398
6.9 v./217 ma.	4800μ Mhos		.34 meg.						Plate Dissipation – 1.1 w.	6872
12.6 v./625 ma.	7000μ Mhos	4.5							Plate Dissipation – 25 w.	6883A
6.3 v./300 ma.	5000μ Mhos	20	4 k.							7079
6.3v./200 ma.	5000μ Mhos		340 k.						Plate Dissipation – 1.1 w.	7083
1.25±12%v/150ma	2700μ Mhos	22							Plate Dissipation – 0.7 w.	7246
7.0 v./245 a.									Forced Air Cooled	7328A
6.3 v./0.3 a.	2650μ Mhos	18.5		330	14.5	2650μ Mhos	18.5		Plate Dissipation – 3.0 w.	7489
6.3 v./0.6 a.	3000μ Mhos	37		300	8.5	3000μ Mhos	37		Plate Dissipation – 5.0 w.	7490
6.3 v./0.3 a.	6500μ Mhos	70		380	3.2	6500μ Mhos	70		Plate Dissipation – 2.8 w.	7492
6.3 v./.3 a.		175		330	1.75		175		Plate Dissipation – 1.1 w.	7494
6.0 v./0.75 a.	9000μ Mhos	20							Plate Dissipation – 12 w.	7495
6.3 v./0.3 a.	5200μ Mhos	32							Plate Dissipation – 3.3 w.	7496
6.3 v./0.3 a.	9250μ Mhos	89							Plate Dissipation – 3.0 w.	7498
6.3 v./0.75 a.	13500μ Mhos	32							Plate Dissipation – 12 w.	7499
6.3/0.45 a.	5200μ Mhos								Plate Dissipation – 13.2 w.	7500
6.3 v./0.3 a.	9000μ Mhos	25							Plate Dissipation – 1.1 w.	7502
5 v./14.1 a.	4000μ Mhos	5.1							Air Cooled	7527
6.3 v./700 ma.	26000μ Mhos								Plate Dissipation – 3.5 w.	7548
										7581A
6.3 v./0.15 a.	12200μ Mhos								Sharp Cutoff	7587
5.0 v./8.0 a.		20							Forced Air Cooled	7604
6.3 v./0.6 a.									Plate Dissipation – 14 w.	7757
6.3±0.6v/0.3 a.									Plate Dissipation – 0.75 w.	7763
6.3 v./0.4 a.										7768
6.3v±5%v/340 ma	5000μ Mhos	58							Plate Dissipation – 5 w.	7788
8 v./130 a.									Forced Air Cooled	7800
6.3 v./2.5 a.	200000μ Mhos	9				20000 μ Mhos				7802
									Water Cooled	7837
									Forced Air Cooled	7838
									Forced Air Cooled	7839
2.5 v./.200 a.	40μ Mhos	5	1.7 μ							7851
6.0 v./1.0 a.									Forced Air Cooled	7855
6.3v./0.80 a.	10 200μ Mhos		29 k.						Plate Dissipation – 19 w.	7868
										7861
6.3±.3v/450 ma.				175					Plate Dissipation – 7.5 w.	7892
8 v./130 a.									Forced Air Cooled	7899
12.6 v./32 a.	15000μ Mhos	32							Forced Air Cooled	7900
6.3 v./235 ma.	9500μ Mhos	20							Plate Dissipation – 0.8 w.	7962
6.3 v./350 ma.	13000μ Mhos	40							Plate Dissipation – 1.1 w.	7963
1.25±5%v/250 ma										7979
3.15 v./1.65 a.	3000μ Mhos								Radiation & Convection Cooled	7983
6.3 v./0.3 a.	18000μ Mhos	43	25 k.							7994
6.3 v./0.3 a.	13000μ Mhos		.1 meg.						Sharp Cutoff	7995
										8032
1.6./3.2 a.	7000μ Mhos	4.5							Plate Dissipation – 25 w.	8042
8 v./185 a.		20							Forced Air Cooled	8044
6.3 v./0.135 a.	125μ Mhos	70	5.6 k.						High-Mu Nuvistor	8058
26.5 v./45 ma.	4500μ Mhos								Plate Dissipation – 1.1 w.	8064
6.3 v./.9 a.	5200μ Mhos		54.5 k.						Plate Dissipation – 35 w.	8068
6.3 v/125 ma.	11000μ Mhos	58							Plate Dissipation – 1.0 w.	8070
13.5 v./0.275 a.	11500μ Mhos		.1 meg.						Plate Dissipation – 5 w.	8077
5.0 v./32.5 a.									Forced Air Cooled	8078
6.3 v./0.3 a.	9800μ Mhos								Sharp Cutoff	8136

ELECTRON TUBE INTERCHANGEABILITY CHART

By C. P. MARSDEN, W. J. KEERY, and J. K. MOFFITT

National Bureau of Standards
Washington 25, D. C.

Part Three A:

Domestic to Foreign
Foreign to Domestic

As part of the function of the Electron Devices Data Service of the National Bureau of Standards, these tables were prepared as a service to the engineers, procurement and service personnel engaged in the field of electronics. All information was taken from manufacturer's published specifications and every effort has been made to assure accuracy and completion. However, the Bureau cannot assume responsibility for omissions nor for results obtained with these data.

No degree of interchangeability is indicated, as in most cases the geometrical shape or method of mechanical attachment vary considerably between manufacturers. In general, these types are stated as being similar to, a frequency variant of or a prototype of a given type. However, in most cases, a minor modification of the voltages, electrical connections and/or mechanical attachment will permit direct substitution of the similar type. Furthermore, old and developmental type numbers which have been assigned a new type number by the manufacturer are included.

CODE:

The following alphabetical code is used to describe the Kind and Type:

A—Argon gas and Mercury
AHG—Argon gas and Mercury
BEA—Beam Pentode
DIO—Diode
GAS—Gas-filled
H—Hydrogen-filled
HG—Mercury vapor
IGN—Ignitron
PND—Pentode
SIN—Single e.g., single triode
TET—Tetrode
THY—Thyratron
TRI—Triode
TWN—Twin with separate cathodes e.g., twin triode
XE—Xenon gas-filled

To indicate the country of manufacture, the following letters are used. They are preceded by the symbol "@" to eliminate confusion as to whether the letter is a postfix on the type number

E—England G—Germany I—Italy
F—France H—Holland J—Japan

Finally, the following symbols are used to indicate:
* Type number registered with EIA by a foreign manufacture.
\# Equivalent type, usually a direct replacement

Domestic vs. Foreign Microwave Tubes

No.	Type/Similar to or Interchangeable With
0A2	DIO GAS #150C2 @E.G. #0S1207 @E. #STV150/30 @G DA2 @E.F.G.H. CV1832
0A3	DIO GAS #KD21 @E. #0S1205 @E. 0S75/40 @E. CV3796
0A4G	TRI GAS #PL1267 @G.H. Z300T @G.H. #1267 @G CV752
0B2	DIO GAS #108C1 @E.G. #STV108/30 @G. #0S1208 @E. 0B2 @E.F.G.H. CV1833
0B3	DIO GAS 90C1 @E.G.H. EEVR90 @E. #M8206 @E. M8207 @E. CV3799
0C3	DIO GAS #KD24 @E. #0S1206 @E. M8098 @E. M8142 @E. DC3 @E.F. #VR105/30 @E. CV686
0D3	DIO GAS #KD25 @E. #150C3 @E. #0S150/40 @E. 0D3 @E. #VR150/30 @E. CV216
0E3	DIO GAS #85A1 @E.G.H. 0E3 @G.H
0G3	DIO GAS #85A2 @E.G.H. 0S83/3 @E. #STV85/10 @G. CV449
1A3	DIO SIN #DA90 @E.G.H. #1D13 @E. 1A3 @E.F.G.J. CV753
1A5GT	PND SIN DL35 @E. CV756
1A7GT	PTG SIN DK32 @E. 1A7GT @E. CV1800
*1AB6	PTG SIN #DK96 @E.G.H 1AB6 @E.G.H.
*1AC6	PTG SIN #DK92 @E.F.G. X18 @E. #1C2 @E. 1AC6 @E.F.G
1AD4	PND SIN #DF62 @E.G.H. 1AD4 @F.G.H. CV2237
1AF4	PND SIN DF92 @E.G.H
*1AH5	DIO PND #DAF96 @E.G. 1FD1 @E. 1AH5 @E.G.H
*1AJ4	PND SIN #DF96 @E.G. 1F1 @E. #W25 @E. 1AJ4 @E.G.H.
1B3	DIO SIN #U41 @E. E2004 @E. 1B3 @I.J. 1G3 @I.J. CV2115
1C3	TRI SIN #DC90 @E.G.H. 1C3 @E
1C5GT	PND SIN #DL35 @E. 1C5GT @E. CV1805
*1E3	TRI SIN DC70 @E.G.H. 1E3 @G.H
1G3	DIO SIN U41 @E. E2004 @E. 1B3 @I.J. 1G3 @I.J
1H5GT	DIO TRI #DAC32 @E. 1H5GT @E. CV1818
1L4	PND SIN #DF92 @E.G.H. 1L4 @F.G.J. 1F2 @E
*1M3	TRI IND #DM70 @E.F.G.H. 1M3 @G.H.I. DM71 @E.F.G.H
*1N3	TRI IND #DM71 @E.F.G.H. 1N3 @C.G.H.J. DM70 @E.F.G.H
1N5GT	PND SIN #DF33 @E. 1N5GT @E. #Z14 @E. CV1823
1Q5GT	BEA SIN #DL36 @E. 1Q5GT @E. CV1826
1R5	PTG SIN #DK91 @E.G.H. X17 @E. #1C1 @G. 1R5 @C.E.FJ
*1S2A	DIO SIN DV86 @G. 1S2A @C.G.H
1S5	DIO PND #DAF91 @E.G.H. #ZD17 @E. #1FD9 @E. 1S5 @C.E.I.J. CV784
*1T2	DIO SIN U37 @E. 1T2 @E
1T4	PND SIN #DF91 @E.G.H. #W17 @E. 1F3 @E. 1T4. @E.F.J
1U4	PND SIN #DF904 @G. 1U4 @J. CV2507
1U5	DIO PND #DAF92 @E. 1U5 @E.J. CV3912
1X2A	DIO SIN #DY80 @G. DV86 @G. CV5032
2C51	TRI TWN 2C51L @S. CV2831
2021	TET GAS #PL2021 @G.H. #PL21 @G. #EN91 @E.G.H. 2021 @E.F.G.H.J. CV797
*2J2	DIO SIN U26 @E. 2J2 @E
*2L2	DIO SIN U25 @E. 2L2 @E
3A4	PND SIN #DL93 @E.H.G. 3A4 @F.G.J. CV807
3A5	TRI TWN #DCC90 @E.G.H. 3A5 @J. CV808
3B4	BEA SIN #DL98 @E. 3B4 @E.F.J. CV2240
*3C4	PND SIN #DL96 @E.G.H. 1P1 @E. 3C4 @E.G.H
3Q4	PND SIN #DL95 @E.G.H. 3Q4 @E.F.G.H.J. CV818
3Q5GT	BEA SIN #DL33 @F.G.H. #N16 @E. 3Q5GT @E. CV819
3S4	PND SIN #1P10 @E. #DL92 @E.G.H. #N17 @E. 3S4 @C.E.F.J
3V4	PND SIN #N19 @E. #DL94 @E.G.H. #1P11 @E. 3V4 @E.J. CV2983
*4CM4	TRI SIN #PC86 @G.H. 4CM4 @G
*5AR4	DIO TWN GZ34 @E.G.H. 5AR4 @C.G.H
5T4	DIO TWN U52 @E. GZ34 @E.G.H. CV1846
5U4G	DIO TWN GZ34 @E.G.H. #U52 @E. 5U4G @E.I.J
5V4G	DIO TWN #GZ32 @E.F.G. GZ34 @E.G.H. 5V4G @E.F. CV729
5X4G	DIO TWN GZ34 @E.G.H. 5X4G @E.I. CV1851
5V3G	DIO TWN #U50 @E. 5V3G @E. CV1854
5Z4GT	DIO TWN #GZ30 @E. GZ34 @F.G.H. 5Z4GT @E.
6A8GT	PTG SIN EK32 @E. 6A8GT @F. CV579
6AB4	TRI SIN #EC92 @F.F.G.H. 6AB4 @F
*6AB8	TRI PND #ECL80 @E.F.G.H. 6AB8 @E.F.G.H.
*6AE8	TRI HEX #X79 @E. 6AE8 @A
*6AF7G	TRI IND EM34 @E.G.F. 6AF7G @F
6AG7	PND SIN EF55 @E.G.H. CV1882
6AH6	PND SIN E83F @E.G.H. CV2521
*6AJ8	TRI PTG #ECH81 @E.F.G.H. 6AJ8 @E.F.I.J. #6C12 @E
6AK5	PND SIN #EF95 @E.G.H. #M8100 @E. 6AK5 @F.J.S. CV4010
6AK6	PND SIN EL91 @E.G.H. 6AK6 @E.F. CV1762
*6AK8	TRD TRI #EABC80 @E.F.G.H. #6LD12 @E DH719 @E 6AK8 @E.F.G.H
6AL5	DIO TWN #D77 @E. #DD6 @F. #6D2 @E. #EB91 @E.F.G.H. #EAA901S @G. #EAA91 @G.H
*6AM5	PND SIN #709 @E. #EL91 @E.G.H. 6AM5 @C.E.
*6AM6	PND SIN #8D3 @E. #PM07 @F. #6F12 @E. #Z77 @E.F. #EF91 @E.G.H. 6AM6 @E.F
*6AQ4	TRI SIN #EC91 @E.G.H. 6L34 @E. 6AM6 @E.F
6AQ5	BEA SIN #EL90 @E.F.G.H. N727 @E. 6AQ5 @E.F.G.I.S. CV1862
*6AQ8	TRI TWN #ECC85 @E.G.H. #B719 @E. 6L12 @E. 6AQ8 @C.E.G.H.J
6AS7G	TRI SIN A1834 @E. CV2523
6AT6	OWD TRI #DH77 @E. #EBC90 @E. 6AT6 @C.F.J
6AU6	PND SIN #EF94 @F.G. 6AU6 @C.E.G.H.I.J.S. CV2524
6AV6	DIO TWN #EBC91 @E.F.G. 6AV6 @C.F.G.H.I.J. CV2526
6BA6	PND SIN #EF93 @E.F.G.H. #W727 @E. 6BA6 @C.E.F.I.J.S
6BE6	PTG SIN #EK90 @E.F.G.H. #X727 @E. 6BE6 @E.F.I.J.S
*6BE7	PTG SIN #EQ80 @E.G.H. 6BE7 @G.H

Domestic vs. Foreign Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With
6BH6	PND SIN #E90F @G.H
*6BJ5	PND SIN #N78 @F. 6BJ5 @A
6BJ6	PND SIN #E99F @G.H
*6BK8	PND SIN EF86 @E.G.H. Z729 @A.E
*6BL8	TRI PND #ECF80 @E.G.H. #6C16 @E. 6BL5 @C.G.H
*6BM8	TRI PND #ECL82 @E.G.H. 6PL12 @E. 6BM8
*6BN5	PND SIN #EL85 @E.G.H. 6BN5 @G.H. CV3526
*6BQ5	PND SIN #6P15 @E. #EL84 @E.F.G.H. #N709 @E. 6BQ5 @C.E.F.G.H.I.J
6BQ7A	TRI TWN ECC84 @E.G.H. 6BQ7A @E.F.I.J
*6BR5	TRI IND #EM80 @E.G.H. Y119 @E. 6BR5 @C.G.H
*6BR7	PND SIN #8D5 @E. 6BR7 @E. CV2137
6BT4	DIO TWN EZ40 @E.F.G. 6BT4 @G.H
*6BW7	PND SIN EF80 @E.F.G. 6BW7 @E
*6BX6	PND SIN #EF80 @E.F.G.H. #Z719 @E. 6BX6 @F.E.G.H
*6BY7	PND SIN #6F19 @E. #EF85 @E.G.H. #W719 @E. 6BY7 @E.GVH
6C4	TRI SIN #L77 @E. #EC90 @E.G.H. 6C4 @E.J. CV2842
*6CA4	DIO TWN #EZ81 @E.G.H. #UU12 @E. 6CA4 @C.G.H.J
*6CA7	PND SIN #EL34 @E.G.H. 6CA7 @G.H
6CB6	PND SIN EF91 @E.G.H. 6CB6 @C.E.F.I.J
*6CD7	TRI SIN #EM34 @E.F.G.H. 6CD7 @C.G.H
*6CH6	PND SIN #EL821 @F. #7D10 @E. 6CH6 @E
*6CJ5	PND SIN 6F16 @E. EF41 @E.G.H. 6CJ5 @G.H
*6CJ6	PND SIN #EL81 @E.F.G.H. 6CJ6 @E.F.G.H.
*6CK5	PND SIN EL41 @E.F.G.H. 6CK5 @G.H
*6CK6	PND SIN #EL83 @F.G.H. EL803 @G. 6CK6 @F.G.H. CV2726
*6CM4	TRI SIN #EC86 @E.G.H. 6CM4 @G
*6CM5	PND SIN #EL36 @E.G.H. 6CM5 @C
*6CN6	BEA SIN #EL38 @E.G.H. 6CN6 @E
*6CQ6	PND SIN #6F21 @E. 9D6 @E. W77 @E. EF92 @E.G.H. 6CQ6 @E.F
*6CR4	TRI SIN #A2521 @E. EC88 @G.H. 6CR4 @E
6CS6	PTG SIN #EH90 @E.G.H
*6CT7	DIO PND #EAF42 @E.F.G.H. 6CT7 @G.H
*6CU7	TRI HEX #ECH42 @E.G.H. 6C10 @E. 6CU7 @G.H
*6CV7	DWD TRI EBC41 @E.F.G.H. 6LD3 @E. 6CV7 @G.H
*6CW5	PND SIN EL86 @E.G.H. 6CW5 @C.G.H
6D4	TRI GAS AFX212 @E. 6D4 @E. CV1949
*6DA5	TRI IND #EM81 @E.G.H. Y119 @E. 6DA5 @C.G.H.
*6DA6	PND SIN #EF89 @E.G.H. 6DA6 @E.G.H.
*6DC8	DWD PND #EBF89 @E.G.H. #6FD12 @E. 6DC8 @C
6DE6	PND SIN EF91 @E.G.H
*6DJ8	TRI TWN #ECC88 @E.G.H. E88CC @E.G.H. 6DJ8 @C.G.H
*6DL5	PND SIN #EL95 @G.H. 6DL5 @C
*6DR8	DWD PND EBF83 @E.G.H. 6DR8 @C
*6DS8	TRI PTG ECH83 @E.G.H. 6DS8 @C
6DT8	TRI TWN ECC85 @E.G.H. 6DT8 @J
*6DX8	TRI PND #ECL84 @G.H. 6DX8 @C.G.H
*6EC7	PND SIN #6F18 @E. EF89 @E.G.H. 6EC7 @E
6EH7	PND SIN #EF183 @E.G.H. 6F29 @EX 6EH7 @C.G.H
*6EJ7	PND SIN #EF184 @E.G.H. 6F30 @E. 6EJ7 @C.G.H
6EL7	PND SIN 6F23 @E. 6EL7 @E
6ES6	PND SIN EF97 @E.G.H. 6ES6 @C
*6ES8	TRI TWN #ECC189 @E.G.H. 6ES8 @C.G.H
*6ET6	PND SIN #EF98 @E.G.H. 6ET6 @C
6EU7	TRI TWN ECC83 @E.F.G.H
6EW6	PND SIN EF184 @E.G.H. 6EW6 @E.J
6F6	PND SIN #KT63 @E.J. CV1912
*6FC7	TRI TWN #ECC89 @E. 6FC7 @E
*6FG6	TRI IND #EM84 @E.G.H. EM84A @G. 6FG6 @C.G.H
*6GA8	TRI TWN #6/30L2 @E 6GA8 @E
6GK6	PND SIN EL84 @E.F.G.H
*6GM8	TRI TWN #ECC86 @E.G.H. 6GM8 @C.G.H
6GW8	TRI PND #ECL86 @E.G.H. 6GW8 @G.H
*6HG8	TRI PND #ECF86 @E. 6HG8 @E
*6HU8	PND TWN #ELL80 @G. 6HU8 @G
6J5GT	TRI SIN #L63 @C.E. 6J5GT @E.J
6J6GT	TRI TWN ECC91 @E.G.H. M8081 @E. 6J6GT @E.F.I.S
6J7GT	PND SIN Z63 @E. KTZ63 @E. EF37A @E.G. 6J7GT @E
6L6G	BEA SIN EL37 @E. KT66 @E. 6L6G @E.I.J
*6N8	DWD PND #EBF80 @E.F.G.H. 6N8 @E.F.G.H
*6Q4	TRI SIN #EC80 @G.H. 6Q4 @G.H. CV1886
6Q7GT	DWD TRI EBC33 @E. DH63 @E. 6Q7G @E
*6R3	DIO SIN EY81 @E.F.G.H. 6R3 @C
*6R4	TRI SIN #EC81 @G.H. 6R4 @G.H. CV1865
*6S2	DIO SIN #EY86 @E.G.H. 6S2 @C
6SL7GT	TRI TWN ECC35 @E. 6SL7GT @E.J. CV1985
6SN7GT	TRI TWN ECC33 @E. #B65 @E. 6SN7GT @C.E.J
*6U3	DIO SIN #EY80 @G.H. 6U3 @G.H.
6U5	TRI IND #Y63 @E
6U8	TRI PND #ECF82 @E. ECF80 @E.G.H. 6U8 @E.I.J. CV5065
*6V4	DIO TWN #EZ80 @E.F.G.H. 6V4 @E.F.G.H
6X2	DIO SIN #EY51 @E.F.G.H. 6X2 @E.F.G.H
6X4	DIO SIN #U78 @E. #EZ90 @E.G.H. 6X4 @E.F.J.H
6X5GT	DIO TWN #EZ35 @E.G.H. 6X5GT @I
*7AN7	TRI TWN #PCC84 @E.G.H. B319 @E. 30L1 @E. 7AN7 @C.E.G.H
*7DJ8	TRI TWN #PCC88 @E.G.H. 7DJ8 @C
*7ED7	PND SIN #30F5 @E. 7ED7 @E
*7EK7	TRI TWN 30L15 @E. 7EK7 @E
*7ES8	TRI TWN PCC189 @G.H. 7ES8 @C
*7FC7	TRI TWN PCC89 @E. 7FC7 @E
*7HG8	TRI PND #PCF86 @E.G.H. 7HG8 @E
*9A8	TRI PND #30C1 @E. #PCF80 @E.G.H. #LZ329 @E. LN329 @E. 9A8 @C.E.G.H
*9AK8	TRD TRI #PABC80 @E.G.H. 9AK8 @C
*9AQ8	TRI TWN #PCC85 @E.G. 9AQ8 @C
*9EN7	TRI PND #30C15 @E. 9EN7 @E
*9GB8	TRI BEA #30FL1 @E. 9GB8 @E
*9U8	TRI PND #PCF82 @E.G. 9U8 @E
*12AC5	PND SIN #UF41 @E.F.G.H. 12AC5 @G.H
12AJ8	TRI PTG ECH81 @E.F.G.H. 12AJ8 @F.I
12AT6	DWD TRI #HBC90 @E. 12AT6 @C.E.J.S
12AT7	TRI TWN #ECC81 @E.F.G.H. #B152 @E. B309 @E. 12AT7 @E.F.G.H.I.J
12AU6	PND SIN #HF94 @E.12AU6 @C.F.I.J.S. CV1961
12AU7	TRI TWN #ECC82 @E.F.G.H. ECC802S @G. 12AU7 @E.G.H.J
12AV6	DWD TRI #HBC91 @G. 12AV6 @C.F.J.S
12AX7	TRI TWN #6L13 @E. #ECC83 @E.F.G.H. B339 @E. #ECC803S @G. 12AX7 @E.F.G.H.I.J
12BA6	PND SIN #HF93 @E. 12BA6 @C.E.F.I.J.S
12BE6	PTG SIN #HK90 @E. 12BE6 @E.F.I.J.S
12FB5	TET SIN #30P12 @E. 12FB5 @E
*12HU8	PND TWN #PLL80 @G. 12HU8 @G
12SN7GT	TRI TWN #B36 @E. 12SN7GT @I. CV925
*13EC7	PND SIN 10F18 @E. UF89 @E.G.H. 13EC7 @E
*13GC8	TRI TET #30PL1 @E. 13GC8 @E
*14K7	TRI HEX #UCH42 @E.F.G.H
*14L7	DWD TRI #10LD3 @E. #UBC41 @G.H. 14L7 @G.H
*15A6	PND SIN #PL83 @E.F.G.H. #N309 @E. 15A6 @E.F.G.H
15CW5	PND SIN #30P18 @E. N379 @E. PL84 @E.G.H. 15CW5 @C
*15DQ8	TRI PND 15DQ8 @C. PCL84 @E.G.H. 15DQ8 @C
*16A5	PND SIN #PL82 @E.F.G.H. #N329 @E. #30P16 @E. 16A5 @E.F.G.H
*16A8	TRI PND #PCL82 @E.G.H. 30PL12 @E. 16A8 @C
*16GK8	TRI BEA #30PL13 @E. 16GK8 @E
*17C8	DWD PND UBF80 @E.G.H. 17C8 @C
*17Z3	DID SIN #PY81 @E.F.G.H. 17Z3 @E.F.G.H
*19AQ5	BEA SIN #HL90 @E. 19AQ5 @E
*19CS4	DIO SIN #U191 @E. 19CS4 @E
*19D8	TRI PTG #UCH81 @E.G.H. #10C14 @E. 19D8 @C
19T8	TRD TRI HABC80 @E. 19T8 @I.J
*19X3	DIO SIN #PY80 @E.G.H. 19X3 @G.H
*19Y3	DIO SIN #PY82 @E.F.G.H. #U192 @E. #U319 @E. 19Y3 @E.F.G.H
*25E5	PND SIN #PL36 @E.G.H. 25E5 @C.E
*25GF6	BEA SIN #30P4 @E. 25GF6 @E
28GB5	BEA SIN PL500 @G
*30A5	PND SIN #HL94 @G.H. 30A5 @C.J
35C5	BEA SIN HF94 @G. 35C5 @J.S
35W4	DIO SIN HY90 @E. 35W4 @E.F.I.J.S
35Z5GT	DIO SIN U74 @E. 35Z5GT @E.J. CV568
*38A3	DIO SIN #U381 @E. UY85 @E.G.H. 38A3 @C
*45A5	PND SIN #UL41 @E.F.G.H. 45A5 @G.H
*45B5	BEA SIN UL84 @E.G.H. 10P18 @E. 45B5 @C.G.H
*50BM8	TRI PND #10PL12 @E. 50BM8 @E.J. #UCL82 @E.G.H
50C5	BEA SIN #HL92 @E. 50C5 @E.J. CV1959
50L6GT	BEA SIN 50L6GT @E.J. CV571
417A	TRI SIN #E2754 @E. 417A @E.S. 5842 @E.G.H.S. CV2642
CK512AX	PND SIN #DF66 @E.G.H. CV2107
1267	TRI GAS #Z300T @E.G.H. #PL1267 @G.H. CV1992
5636	PND SIN #EF730 @E. 5636 @E.F.G.
5641	DIO SIN EY70 @E. CV5211
5642	DIO SIN DY70 @E.G.H
5643	TET GAS #EN70 @E. 5643 @F. CV5079
5647	DIO SIN EA76 @E.G. CV469
5651	DIO GAS 85A2 @E.G.H. QS83/3 @E. #QS1209 @E. 5651 @C.E.G.H.J. CV2573
5654	PND SIN #E95F @E. 5654 @E.F.G.H.J. CV4010
5672	PND SIN #DL620 @E. 5672 @E.F.G.H.J
5676	TRI SIN XFR3 @E. DL68 @G.H. 5676 @E.F.G.J
5678	PND SIN XFR2 @E. XFR5 @E. #DF60 @E. 5678 @E.F.G.H CV2254
5687	TRI TWN E182CC @E.G.H. 5687 @F. CV5188
5696	TET GAS #EN92 @E. 5696 @G. CV3512
5718	TRI SIN EC70 @E. 5718 @E.F.G.H. CV468
5725	PND SIN 5725 @F.J. CV4011
5726	DIO TWN #EAA91 @G.H. #D77 @E. #6D2 @E. #EAA901 @G EB91 @E.F.G.H. 5726 @E.F.G.H.J. CV5189
5727	TET GAS #M8204 @E. 5727 @E.G.H. CV4018
5749	PND SIN #EF93 @E.F.G.H. #W727 @E. 5749 @E.F.J
5750	PTG SIN X727 @E. EK90 @E.F.G.H. 5750 @E.J
5751	TRI TWN E283CC @G. 5751 @F.J. CV4017
5783	DIO GAS #M8190 @E. 5783 @C.F
5800	TET SIN ME1402 @E.
5802	TRI SIN ME1401 @E
5814	TRI TWN #ECC186 @G.H. CV5146
5823	TRI GAS Z50T @G.H. #Z900T @E. QT1251 @E 5823 @E.G.H.J
5840	PND SIN #EF72 @E. 5840 @E.F.G. CV3929
5842	TRI SIN #F7004 @F. 5842 @E.G.H.S. CV3789
5847	PND SIN 5847 @G.H.S. CV3905
5879	PND SIN EF86 @E.G. Z729 @A.E. CV2901
5881	BEA SIN EL37 @E. KT66 @E. CV2796
5889	PND SIN ME1403 @E. 4068 @G. CV2348
5899	PND SIN #EF71 @E. 5899 @E.F.G.
5915	PTG SIN #EH900S @G.
5916	PND SIN EF730 @E
5920	TRI TWN #E90CC @E.G.H. #ECC960 @G. 5920 @G.H.
5932	BEA SIN EL37 @E. KT66 @E. CV3899
6007	PND SIN #DL67 @G.H. 6007 @G.H
6008	PND SIN #DF67 @G.H
*6067	TRI TWN #ECC186 @G.H. ECC802S @G. #ECC82 @E.F.G. 6067 @E
6073	DIO GAS #OA2WA @E.F.G.H. #150C2 @E.G. QS1207 @E. STV150/30 @G. 6073 @F. CV2963
6074	DIO GAS #108C1 @E.G. STV108/30 @G. #QS1208 @E. 6074 @F
*6084	PND SIN #E80F @E. 6084 @G.H
*6085	TRI TWN ECC40 @E.F.G.H. #E80CC @E.G.H. 6085 @G.H
*6086	PND SIN #18042 @G.H. 6086 @G.H
*6132	PND SIN #EL821 @E. CV4055
6186	PND SIN E99F @G.H
6189	TRI TWN #ECC802S @G. ECC186 @G.H
6201	TRI TWN ECC85 @E.G.H. #ECC801S @G. 6201 @G.H.J CV3508
6205	PND SIN EF732 @E.G. 6205 @E. CV3929
*6218	BEA SIN #E80T @G. 6218 @C.G.H.
*6227	PND SIN #E80L @E.G.H. 6227 @C.G.H.
*6267	PND SIN EF86 @E.G.H. Z729 @A.E. EF806S @G. 6267 @C
*6354	DIO SIN #150B2 @E.G.H. #M8163 @E. 6354 @E.G.H. CV2225
*6373	PND SIN DL70 @E. 6373 @E. CV2105
*6374	DIO SIN EY84 @E.G.H. 6374 @E. CV2235
*6375	TRI SIN #DC70 @E.G.H. 6375 @E.G.H
6386	TRI TWN 2C51L @S
*6487	PND SIN #EF70 @E

Domestic vs. Foreign Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With
*6488	PND SIN EF73 ●E, CV466
*6489	DIO SIN EA76 ●E,G, CV469
6550	PND SIN EL34 ●E,G,H, KT88 ●E
*6574	TET GAS EN32 ●E, 6574 ●E,G, CV2253
6611	PND SIN DF61 ●E,G
6626	DIO GAS 150C2 ●E,G, #QS1207 ●E, #STV150/30 ●G
6627	DIO GAS #108C1 ●E,G, #STV108/30 ●G, #QS1208 ●E
6661	PND SIN #E90F ●G,H
6662	PND SIN #E99F ●G,H
6680	TRI TWN #ECC802S ●G'
6681	TRI TWN #ECC803S ●G
*6686	PND SIN #E81L ●E,G,H, 6686 ●C
*6687	PTG SIN #EH91H ●E,G,H, EH900S ●G, 6687 ●C,G,H
*6688	PND SIN #E180F ●E,G,H, 6688 ●C,E,G,H, CV3998
*6689	PND SIN #E83F ●E,G,H, 6689 ●C,G,H
*6778	TRI SIN #EC70 ●E, 6778 ●E, CV468
*6779	DIO GAS #Z803U ●E,G,H, 6779 ●E
*6922	TRI TWN #ECC88 ●E,G,H, #E88CC ●E,G,H, 6922 ●C,G,H
*6923	DIO SIN #EA52 ●E,H,G, 6923 ●C
6977	TRI IND #DM160 ●G,H# 6977 ●G,H
*7001	BEA SIN #F7001 ●E
7059	TRI PND ECF82 ●E
*7062	TRI TWN #E180CC ●E,G,H, 7062 ●C
*7119	TRI TWN #E182CC ●E,G,H, 7119 ●C
7308	TRI TWN #E188CC ●G,H, 7308 ●G,H
7316	TRI TWN #ECC186 ●G,H, 7316 ●G,H
*7320	PND SIN #E84L ●G, 7320 ●F
7534	PND SIN #E130L ●G, 7534 ●G,H
7643	TRI PND #E80CF ●E,G,H, 7643 ●G,H,
7693	PND SIN #E90F ●G,H, 7693 ●G,H
7694	PND SIN #E99F ●G,H, 7694 ●G,H,
7721	PND SIN D3A ●E,G
7722	PND SIN #E280F ●G
7737	PND SIN E186F ●G,H
7788	PND SIN #E810F ●E,G,H, 7788 ●G,H,
*7971	BEA SIN #S11E12 ●E, 12E1 ●E, 7971 ●E
*7972	BEA SIN #13E1 ●E, 7972 ●E
*7973	BEA SIN #S2P20 ●E, 7973 ●E

Foreign vs. Domestic Microwave Tubes

No.	Type/Similar to or Interchangeable With
1C1	PTG SIN #1R5
1C2	PTG SIN #1AC6
1D13	DIO SIN #1A3
1F1	PND SIN 1AJ4
1F2	PND SIN 1L4
1F3	PND SIN 1T4
1FD1	DIO PND 1AH5
1FD9	DIO PND #1S5
1P1	PND SIN 3C4
1P10	PND SIN #3S4
1P11	PND SIN #3V4
PL2D21	TET GAS #2D21
S2P20	BEA SIN #7973
XFR2	PND SIN 5678
2C51L	TRI TWN 2C51, 6386
D3A	PND SIN 7721
XFR3	TRI SIN 5676
XFR5	PND SIN 5678
DD6	DID TWN #6AL5
6C10	TRI HEX 6CU7
6C12	TRI PTG #6AJ8
6C16	TRI PND #6BL8
6D2	DID TWN #6AL5, #5726
6F12	PND SIN #6AM6
6F16	PND SIN 6CJ5
6F18	PND SIN #6EC7
6F19	PND SIN #6BY7
6F21	PND SIN #6CQ6
6F23	PND SIN 6EL7
6F29	PND SIN 6EH7
6F30	PND SIN 6EJ7
6FD12	DWD PND #6DC8
6L12	TRI TWN 6AQ8
6L13	TRI TWN #12AX7
6L34	TRI SIN 6AQ4
6LD3	DWD TRI 6CV7
6LD12	TRD TRI #6AK8
6P15	PND SIN #6BQ5
6PL12	TRI PND 6BM8
6/30L2	TRI TWN #6GA8
PMD7	PND SIN #6AM6
7D9	PND SIN #6AM5
7D10	PND SIN #6CH6
8D3	PND SIN #6AM6
8D5	PND SIN #6BR7
9D6	PND SIN 6CQ6
10C14	TRI PTG #19D8
10F18	PND SIN 13EC7
10LD3	DWD TRI #14L7
10P18	BEA SIN 4585
10PL12	TRI PND #50BM8
S11E12	BEA SIN #7971
UU12	DID TWN #6CA4
12E1	BEA SIN 7971
13E1	BEA SIN #7972
Z14	PND SIN #1N5GT
N16	BEA SIN #3Q5GT
N17	PND SIN #3S4
W17	PND SIN #1T4
X17	PTG SIN 1R5
ZD17	DID PND #1S5
X18	PTG SIN 1AC6
N19	PND SIN #3V4
KD21	DID GAS #OA3
PL21	TET GAS #2D21
KD24	DIO GAS #OC3
KD25	DIO GAS #OD3
U25	DIO SIN 2L2
W25	PND SIN #1AJ4
U26	DID SIN 2J2
GZ30	DID TWN #5Z4GT
30C1	TRI PND #9A8
30C15	TRI PND #9EN7
30F5	PND SIN #7ED7
30FL1	TRI BEA #9GB8
30L1	TRI TWN 7AN7
30L15	TRI TWN 7EK7
30P4	BEA SIN #25GF6
30P12	TET SIN #12FB5
30P16	PND SIN #16A5
30P18	PND SIN #15CW5
30PL1	TRI TET #13GC8
30PL12	TRI PND 16A8
30PL13	TRI BEA #16GK8
DAC32	DIO TRI #1H5GT
DK32	PTG SIN 1A7GT
EK32	PTG SIN 6A8GT
EN32	TET GAS 6574
GZ32	DID TWN #5V4G
DF33	PND SIN #1N5GT
DL33	BEA SIN #3Q5GT
EBC33	DWD TRI 6Q7GT
ECC33	TRI TWN 6SN7GT
EL34	PND SIN #6CA7, 6550
EM34	TRI IND #6CD7, 6AF7G
GZ34	DIO TWN 5AR4, 5U4G, 5T4, 5V4G, 5X4G, 5Z4GT
DL35	PND SIN 1A5GT, 1C5GT
ECC35	TRI TWN 6SL7GT
EZ35	DIO TWN #6X5GT
B36	TRI TWN #12SN7GT
DL36	BEA SIN #1Q5GT
EL36	PND SIN #6CM5
PL36	PND SIN #25E5
EF37A	PND SIN 6J7GT
EL37	BEA SIN 6L6G, 5881, 5932
U37	DID SIN 1T2
EL38	BEA SIN #6CN6
ECC40	TRI TWN 6085
EZ40	DIO TWN 6BT4
EBC41	DWD TRI 6CV7
EF41	PND SIN 6CJ5
EL41	PND SIN 6CK5
U41	DID SIN #1B3, 1G3
UBC41	DWD TRI #14L7
UF41	PND SIN #12AC5
UL41	PND SIN #45A5
EAF42	DID PND #6CT7
ECH42	TRI HEX #6CU7
UCH42	TRI HEX #14K7
U50	DIO TWN #5Y3G
Z50T	TRI GAS 5823
EY51	DIO SIN #6X2
EA52	DID SIN #6923
U52	DID TWN 5T4, 5U4G
EF55	PND SIN 6AG7
DF60	PND SIN #5678
DF61	PND SIN 6611
DF62	PND SIN #1AD4
DH63	DWD TRI 6Q7GT
KT63	PND SIN #6F6
KTZ63	PND SIN 6J7GT
L63	TRI SIN #6J5GT
Y63	TRI IND #6U5
Z63	PND SIN 6J7GT
B65	TRI TWN #6SN7GT
DF66	PND SIN #CK512AX
KT66	BEA SIN 6L6G, 5932, 5881
DF67	PND SIN #6008
DL67	PND SIN #6007
DL68	TRI SIN 5676
DC70	TRI SIN 1E3, #6375
DL70	PND SIN 6373
DM70	TRI IND #1M3, 1N3
DY70	DIO SIN 5642
EC70	TRI SIN 5718 ,#6778
EF70	PND SIN #6487
EN70	TET GAS #5643
EY70	DIO SIN 5641
DM71	TRI IND #1N3
EF71	PND SIN #5899
EF72	PND SIN #5840
EF73	PND SIN 6488
U74	DIO SIN 35Z5GT
QS75/40	DIO GAS OA3
EA76	DID SIN 5647, 6489
D77	DID TWN #6AL5, #5726
DH77	DWD TRI #6AT6
L77	TRI SIN #6C4
W77	PND SIN 6CQ6
Z77	PND SIN #6AM6
N78	PND SIN #6BJ5
U78	DIO SIN #6X4
X79	TRI HEX #6AE8
DY80	DIO SIN #1X2A
E80CC	TRI TWN #6085
E80CF	TRI PND #7643
E80F	PND SIN #6084
E80L	PND SIN #6227
E80T	BEA SIN #6218
EABC80	TRD TRI #6AK8
EBF80	DWD PND #6N8
EC80	TRI SIN #6Q4
ECF80	TRI PND #6BL8, 6U8
ECL80	TRI PND #6AB8
EF80	PND SIN 6BW7, #6BX6
ELL80	PND TWN #6HU8

Foreign vs. Domestic Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With
EM80	TRI IND #6BR5
EQ80	PTG SIN #6BE7
EY80	DIO SIN #6U3
EZ80	DIO TWN #6V4
HABC80	TRD TRI 19T8
PABC80	TRD TRI #9AK8
PCF80	TRI PND #9A8
PLL80	PND TWN #12HU8
PY80	DIO SIN #19X3
UBF80	DWD PND 17C8
E81L	PND SIN #6686
EC81	TRI SIN #6R4
ECC81	TRI TWN #12AT7
ECH81	TRI PTG #6AJ8, 12AJ8
EL81	PND SIN #6CJ6
EM81	TRI IND #6DA5
EY81	DIO SIN 6R3
EZ81	DIO TWN #6CA4
PY81	DIO SIN #17Z3
UCH81	TRI PTG #19D8
ECC82	TRI TWN #12AU7, #6067
ECF82	TRI PND #6U8, 7059
ECL82	TRI PND #6BM8
PCF82	TRI PND #9U8
PCL82	TRI PND #16A8
PL82	PND SIN #16A5
PY82	DIO SIN #19Y3
UCL82	TRI PND #50BM8
E83F	PND SIN 6AH6, #6689
EBF83	DWD PND 6DR8
ECC83	TRI TWN 6EU7, 12AX7
ECH83	TRI PTG 6DS8
EL83	PND SIN #6CK6
PL83	PND SIN #15A6
QS83/3	DIO GAS 0G3, 5651
E84L	PND SIN #7320
ECC84	TRI TWN 6BQ7A
ECL84	TRI PND #6DX8
EL84	PND SIN #6BQ5, 6GK6
EM84	TRI IND #6FG6
EM84A	TRI IND #6FG6
EY84	DIO SIN 6374
PCC84	TRI TWN #7AN7
PCL84	TRI PND 15DQ8
PL84	PND SIN 15CW5
UL84	BEA SIN 4585
ECC85	TRI TWN #6AQ8, 6DT8, 6201
EF85	PND SIN #6BY7
EL85	PND SIN #6BN5
PCC85	TRI TWN #9AQ8
UY85	DIO SIN 38A3
85A1	DIO GAS #0E3
85A2	DIO GAS 0G3, 5651
STV85/10	DIO GAS #0G3
DY86	DIO SIN 1S2A, 1X2A
EC86	TRI SIN #6CM4
ECC86	TRI TWN #6GM8
ECF86	TRI PND #6HG8
ECL86	TRI PND #6GW8
EF86	PND SIN 6BK8, 5879, 6267
EL86	PND SIN #6CW5
EY86	DIO SIN #6S2
PC86	TRI SIN #4CM4
PCF86	TRI PND #7HG8
E88CC	TRI TWN 6DJ8, #6922
EC88	TRI SIN 6CR4
ECC88	TRI TWN #6DJ8,#6922
KT88	PND SIN 6550
PCC88	TRI TWN #7DJ8
ECC89	TRI TWN #6FC7
EBF89	DWD PND #6DC8
EF89	PND SIN #6DA6, 6EC7, #6ET6
PCC89	TRI TWN 7FC7
UF89	PND SIN 13EC7
DA90	DIO SIN #1A3
DC90	TRI SIN #1C3
DCC90	TRI TWN #3A5
E90CC	TRI TWN #5920
E90F	PND SIN #6BH6, #6661, #7693
EBC90	DWD TRI #6AT6
EC90	TRI SIN #6C4
EEVR90	DIO GAS 0B3
EH90	PTG SIN #6CS6
EK90	PTG SIN #6BE6, 5750
EL90	BEA SIN #6AQ5
EZ90	DIO SIN #6X4
HBC90	DWD TRI #12AT6
HK90	PTG SIN #12BE6
HL90	BEA SIN #19AQ5
HY90	DIO SIN 35W4
90C1	DIO GAS 0B3
DAF91	DIO PND #1S5
DF91	PND SIN #1T4
DK91	PTG SIN #1R5
EAA91	DIO TWN #6AL5, #5726
EB91	DIO TWN #6AL5, 5726
EBC91	DIO TWN #6AV6
EC91	TRI SIN #6AQ4
ECC91	TRI TWN 6J6GT
EF91	PND SIN #6AM6, 6CB6, 6DE6
EH91H	PTG SIN #6687
EL91	PND SIN 6AK6, #6AM5
EN91	TET GAS #2D21
HBC91	DWD TRI #12AV6
DAF92	DIO PND #1U5
DF92	PND SIN 1AF4, #1L4
DK92	PTG SIN #1AC6
DL92	PND SIN #3S4
EC92	TRI SIN #6AB4
EF92	PND SIN 6CQ6
EN92	TET GAS #5696
HL92	BEA SIN #50C5
DL93	PND SIN #3A4
EF93	PND SIN #6BA6, #5749
HF93	PND SIN #12BA6
DL94	PND SIN #3V4
EF94	PND SIN #6AU6
HF94	PND SIN #12AU6, 35C5
HL94	PND SIN 30A5
DL95	PND SIN #3Q4
E95F	PND SIN #5654
EF95	PND SIN #6AK5
EL95	PND SIN #6DL5
DAF96	DIO PND #1AH5
DF96	PND SIN #1AJ4
DK96	PTG SIN #1AB6
DL96	PND SIN #3C4
EF97	PND SIN 6ES6
DL98	BEA SIN #3B4
EF98	PND SIN #6ET6
E99F	PND SIN #6BJ6, 6186, 6662, #7694
VR105/30	DIO GAS #0C3
STV108/30	DIO GAS #OB2, 6074
108C1	DIO GAS #0B2, #6074
Y119	TRI IND 6BR5, 6DA5
E130L	PND SIN #7534
QS150/40	DIO GAS #OD3
STV150/30	DIO GAS #OA2, 6073, #6626
VR150/30	DIO GAS #OD3
150B2	DIO SIN #6354
150C2	DIO GAS #0A2, #6073, 6626
150C3	DIO GAS #OD3
B152	TRI TWN #12AT7
DM160	TRI IND #6977
E180CC	TRI TWN #7062
E180F	PND SIN #6688
E182CC	TRI TWN 5687, #7119
EF183	PND SIN #6EH7
EF184	PND SIN #6EJ7, 6EW6
E186F	PND SIN 7737
ECC186	TRI TWN #5814, #6067, 6189, #7316
E188CC	TRI TWN #7308
ECC189	TRI TWN #6ES8
PCC189	TRI TWN 7ES8
U191	DIO SIN #19CS4
U192	DIO SIN #19Y3
AFX212	TRI GAS 6D4
E280F	PND SIN #7722
E283CC	TRI TWN 5751
Z300T	TRI GAS OA4G, #1267
B309	TRI TWN 12AT7
N309	PND SIN #15A6
B319	TRI TWN 7AN7
U319	DIO SIN #19Y3
LN329	TRI PND 9A8
LZ329	TRI PND #9A8
N329	PND SIN #16A5
B339	TRI TWN 12AX7
N379	PND SIN 15CW5
U381	DIO SIN #38A3
PL500	BEA SIN 28GB5
DL620	PND SIN #5672
N709	PND SIN #6BQ5
B719	TRI TWN #6AQ8
DH719	TRD TRI 6AK8
W719	PND SIN #6BY7
Z719	PND SIN #6BX6
N727	BEA SIN 6AQ5
W727	PND SIN #6BA6, #5749
X727	PTG SIN #6BE6, 5750
Z729	PND SIN 6BK8, 5879, 6267
EF730	PND SIN #5636, 5916
EF732	PND SIN 6205
ECC801S	TRI TWN #6201
ECC802S	TRI TWN 12AU7, 6067, #6189, #6680
ECC803S	TRI TWN #12AX7, #6681
EL803	PND SIN 6CK6
Z803U	DIO GAS #6779
EF806S	PND SIN 6267
E810F	PND SIN #7788
EL821	PND SIN #6CH6, #6132
EH900S	PTG SIN #5915, 6687
Z900T	TRI GAS #5823
EAA901	DIO TWN #5726
EAA901S	DIO TWN #6AL5
DF904	PND SIN #1U4
ECC960	TRI TWN #5920
QS1205	DIO GAS #0A3
QS1206	DIO GAS #0C3
QS1207	DIO GAS #DA2, #6073, #6626
QS1208	DIO GAS #DB2, #6074, #6627
QS1209	DIO GAS #5651
QT1251	TRI GAS 5823
PL1267	TRI GAS #0A4G, #1267
1267	TRI GAS #0A4G
ME1401	TRI SIN 5802
ME1402	TET SIN 5800
ME1403	PND SIN 5889
A1834	TRI SIN 6AS7G
E2004	DIO SIN 1B3, 1G3
A2521	TRI SIN #6CR4
E2754	TRI SIN #417A
4068	PND SIN 5889
F7001	BEA SIN #7001
F7004	TRI SIN #5842
M8081	TRI TWN 6J6GT
M8098	DIO GAS OC3
M8100	PND SIN #6AK5
M8142	DIO GAS OC3
M8163	DIO SIN #6354
M8190	DIO GAS #5783
M8204	TET GAS #5727
M8206	DIO GAS #0B3
M8207	DIO GAS 0B3
18042	PND SIN #6086

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New Tech Data for Engineers

Display Storage Tubes

Complete information including photographs, schematics, and operations data on the Iatron Display Storage Tubes is available from the Industrial Laboratories Div., International Telephone and Telegraph Corp., 3700 E. Pontiac St., Ft. Wayne, Ind.

Circle 347 on Inquiry Card

L-F Oscillators

The Electronics Div., of Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside, N. Y., is offering tech data on a number of low freq. crystal controlled oscillators for use as high stability freq. sources of high accuracy timer references. The oscillators range from 1CPS to 20KC, stabilities from 2pp 10^6 to 1pp 10^8 for an hour's operation.

Circle 348 on Inquiry Card

DC Power Modules

Technical Bulletin TP-660 describes ACDC's TP Series of 'Transistor Power Modules.' These compact, plug-in, dc power supplies are available in 8 models ranging from 5 to 41v and up to 3.5 amperes output. Regulation is 0.01% and ripple does not exceed 500µv. ACDC Electrons. Inc., 2979 N. Ontario St., Burbank. Calif.

Circle 349 on Inquiry Card

Solid State Time Delay

Shockley Transistor unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif., has tech. data available describing simple, variable time delay circuits, using a small number of components which can be designed with the Shockley 4-layer diode as the active element.

Circle 350 on Inquiry Card

Thermoelectric Devices

A 6-page catalog illustrating and describing a new line of single, 2 and 3 stage thermoelectric cooling/heating devices and a Peltier chamber, which operate on up to 90% less current than other thermoelectric devices is available from Jepson Thermoelectrics, Inc., 139 Nevada St., El Segundo, Calif.

Circle 351 on Inquiry Card

Thermistors

Victory Engineering Corp., 124-28 Springfield Ave., Springfield, N. J., is offering their 11th Edition Catalog V 680. Included is information on high quality thermistors and varistors, with full specs., outline drawings, and characteristic curves.

Circle 352 on Inquiry Card

Subcarrier Oscillator

Model MVO-20, silicon transistorized, low level subcarrier oscillator features high temp. stability, high input impedance and low power consumption. Standard IRIG channels are available with ±7.5% deviation with signals of ±10mv or 0 to +20mv input. Linearity is better than 0.5% of design bandwidth from best straight line. Dorsett Electronics, Inc., 119 W. Boyd, Norman, Okla.

Circle 353 on Inquiry Card

Tube Handbook

A 40-page reference handbook describing the English Electric Valve line of communication and microwave tubes is available from Calvert Electronics, Inc., 220 E. 23rd St., New York 10, N. Y. The book lists complete information on more than 350 EEV tubes as well as interchangeability data on comparable American and European tube types. Available by writing under company letterhead.

Solar Heat

"Solar Heat Simulation," 6 pages, discusses problems encountered in simulating the heating effects of solar radiation on satellites and other space vehicles. Typical space-environment chambers and infrared heat sources are described with emphasis on the use of programmed controls in reproducing flight path conditions. Research Inc., Box 6164, Minneapolis 24, Minn.

Circle 355 on Inquiry Card

Transistorized Chopper

Tech data is available from Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif., describing its Model 65 Plug-in Chopper. The unit has a transformer-coupled isolated drive network so that it can, for example, be driven from a 400CPS power line or from a drive source that is common to the dc voltage being chopped.

Circle 356 on Inquiry Card

Klystrons

Microwave klystron tubes are presented in a 4-page Quick Selector booklet. The booklet lists 18 tube types in 3 groups: fixed frequency, fixed frequency trimmable, and tunable. In addition to freq. range and power output information, the booklet lists similar tube types for each of the klystrons described. A copy of Reflex Klystron Quick Selector booklet ET-1309 can be obtained from the Westinghouse Electronic Tube Div., Box 284, Elmira, N. Y.

Circle 357 on Inquiry Card

Transistor Nomograph

A transistor transformer load impedance and dissipation nomograph for use in design of Class A and Class B transformer coupled transistor audio and servo amplifiers, is included in Catalog 621 "Miniaturized Transformers" available from Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. The 35-page catalog also contains information on audio, converter, driver, interstage, isolation 400CPS, pico-miniature, subminiature audio, transistor-output interstage, and veri-miniature audio transformers. Also included is a dbm vs power level chart, Mil-T-27A information, photographs, and spec. tables.

Circle 358 on Inqury Card

Constant Firing Diode

Engineering Data Release Issue No. 37, entitled, "Constant Firing Regulating Diode" contains information on the Bendix® TD-36A, a miniature cold cathode inert gas filled diode. It is designed for use as a constant firing diode in overvoltage protection circuits, RC timing circuits and energy transfer circuits. Photographs, schematics, characteristics, charts, and a typical oscilloscope trace are included. The Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 359 on Inquiry Card

Ceramic Tubes

Complete compilation of information on ceramic receiving tubes is contained in 2 new volumes from General Electric's Receiving Tube Dept., Owensboro, Ky. Bulletin ETD-2713, 213 pages, contains full tech. data on G-E's entire line of 20 registered and 15 developmental ceramic tube types. Graphs, diagrams, illustrations, a tube selection chart and typical socket data are included. Bulletin ETD-2134, 52 pages, contains extensive application information as well as data on design, materials, manufacturing UHF-VHF performance, and reliability, of small ceramic receiving tubes.

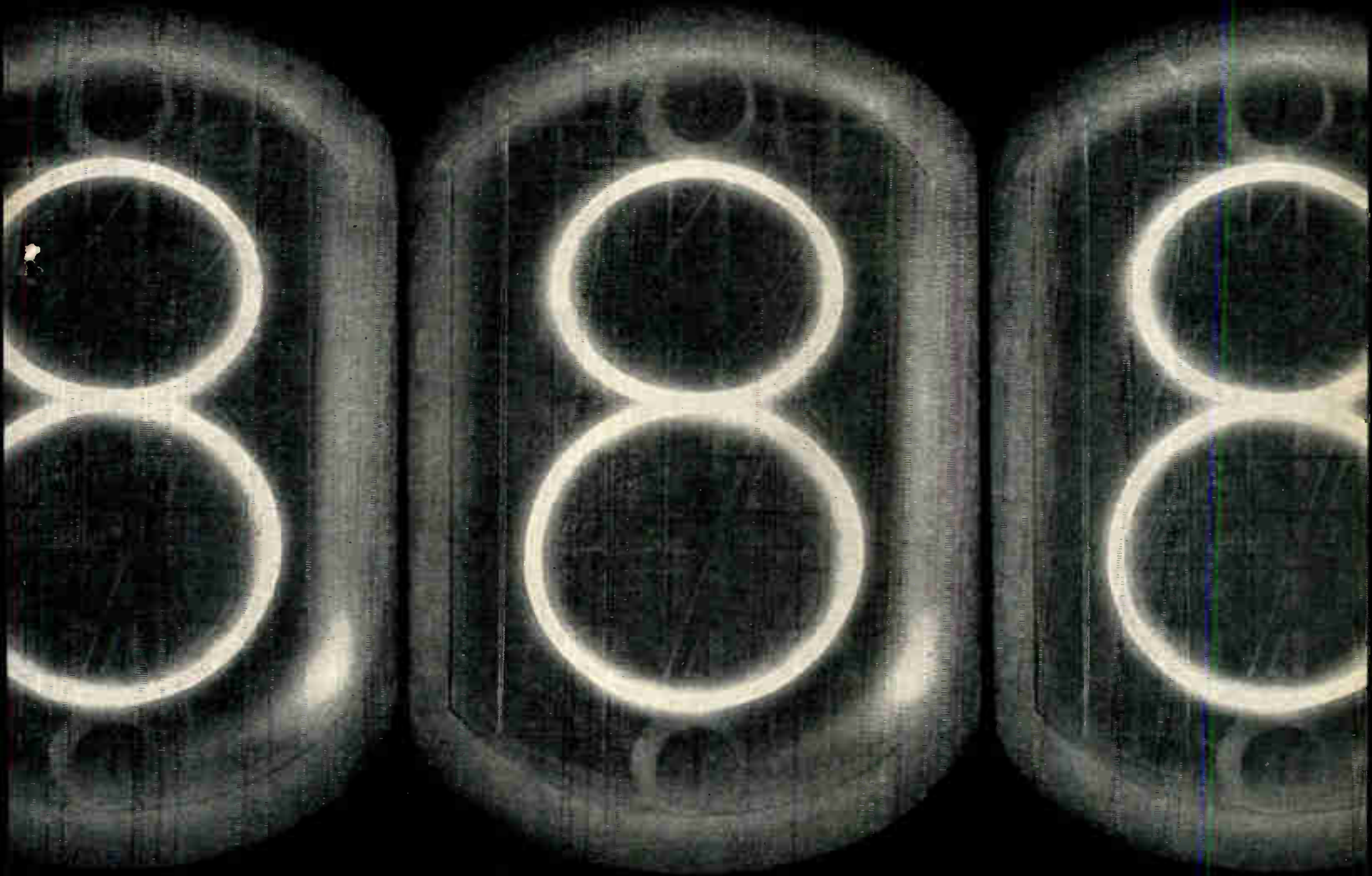
Crcle 360 on Inquiry Card

Indicator Tube Catalog

Burroughs Corp., Electronic Components Div., P. O. Box 1226, Plainfield, N. J., is offering a new NIXIE® Indicator Tube Catalog, describing the new Wide Viewing Angle Series of NIXIE tubes. The Catalog covers circuit design criteria and contains detailed suggested circuits for using NIXIES in various types of electromechanical and electronic systems.

Circle 361 on Inquiry Card

Circle 59 on Inquiry Card →



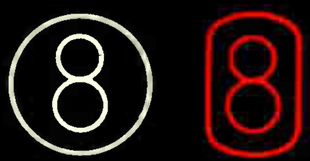
the new rectangular NIXIE® tube

There's a new addition to the Nixie Tube Line . . . the Rectangular Nixie Indicator Tube. This latest advance in Nixie Tube design provides a major reduction in the over-all width and depth of the readout, but the same character size is maintained.

To the design engineer this means: Greater freedom for equipment miniaturization • Design flexibility, including the use of smaller drive circuits • The ability to add features without increasing space.

And the new Rectangular Tube retains all of the advantages which have made Nixie Tubes industry's most popular readout . . . longest life, lowest cost, smallest size (now smaller than ever!), and greatest readability.

Write today for complete technical information on the entire line of Nixie Indicator Tubes . . . including the new Rectangular Nixie Tube.



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Systems and components assembly is performed in strict clean-room environment.

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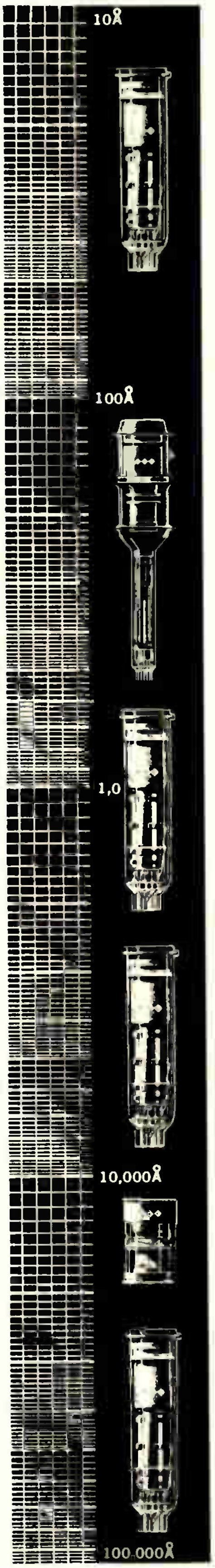
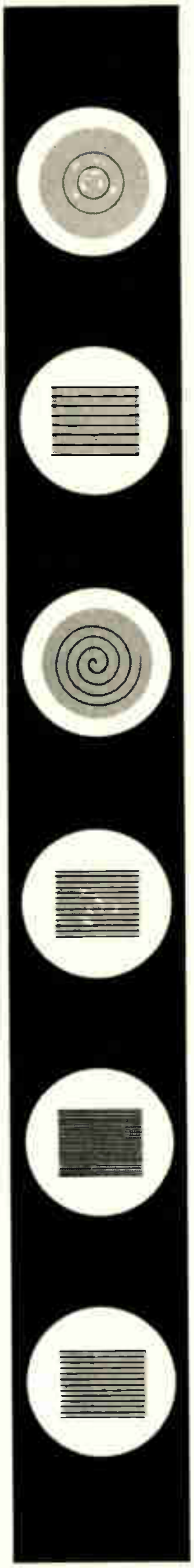


GEC vidicon camera tubes

GEC offers the highest sensitivity image pick-up tubes having the widest coverage of the spectrum.

Available are a variety of Ubicons, Ebicons, Vidicons, and far infrared imaging tubes.

A wide choice of other tube parameters including slow scan characteristics, magnetic focus and deflection, electrostatic focus and deflection, electrostatic focus and magnetic deflection and return beam multiplication is available from GEC.



GEC scan conversion systems

Transistorized with printed circuit modular components, GEC Scan Conversion Units incorporate the most advanced technological developments available for controlled conversion from one scanning mode to any other.

Conversion of PPI to TV, TV standards conversion, storage and integration of video information, time-coordinate transformation, digital to analog, TV conversion, and conversion of slow scan narrow band systems to standard TV or vice versa are available.

Information on GEC Monoscope Video Signal Generators, monitoring systems and slow scan TV cameras for use with GEC Scan Converters is available on request.

For integrated systems employing either optics, sensors or processing electronics, or any combination to meet your requirements, write or call

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New Pentode-Diode 6GA7 — A horizontal amplifier and damping rectifier, the 6GA7 utilizes a 12-pin integral all-glass base. It delivers performance equivalent to separate 6DQ6B and 6AX4B tubes along with space, socket, and other savings.

Horizontal Amplifiers 6GE5, 12GE5, 17GE5 — New 12-pin integral all-glass base types are equivalents of "-DQ6B" types with greater reliability and uniformity, plus exceptional performance on low-to-high line voltage variations.

For special engineering assistance on your specific application as well as technical data on these tube types, please contact: Raytheon Company, Receiving Tube Operation, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

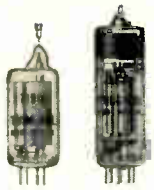
For small order and prototype requirements
see your local franchised Raytheon Distributor.

INDUSTRIAL COMPONENTS DIVISION

RAYTHEON

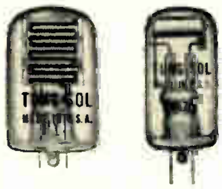
NEWTON 58, MASSACHUSETTS

NEW "HIGH ENVIRONMENTAL" TUBES



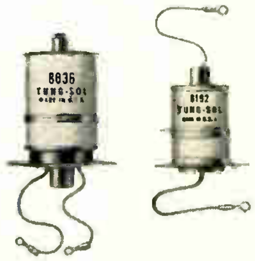
Tung-Sol's "High Environmental" transmitting, series regulator and modulator tubes —including hard-glass miniature—are designed and built to withstand the toughest extremes of shock, vibration and temperature with highest standards of performance and reliability.

PHOTOTUBES



Tung-Sol's new series of experimental photo-emissive and photo-conducting devices offer reliable full-spectrum coverage from infra-red to far ultra-violet in any of countless control applications.

CERAMIC HYDROGEN THYRATRONS



This new Tung-Sol family of ceramic hydrogen thyratrons includes the 8191, 8192, and 8036 which deliver peak output powers of 135 KW., 450 KW., and 6.5 MW., respectively. All are flange-mounted, with flying leads, to permit easy installation and good electrical connections, consistent with minimum tube size as demanded by airborne radar and other highly compact applications.

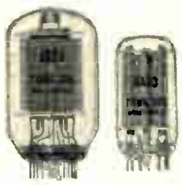
HYDROGEN DIODES

Tung-Sol has expanded its hydrogen diode family to include tubes with ratings up to 2 amperes average at 25KV peak inverse voltage. These tubes, the 7789, 7790, 7791 and 7792 serve as charging diodes or clippers in radar modulators and as general-purpose, high voltage rectifiers.

SUBMINIATURE TUBES

Now greatly expanded, the Tung-Sol line of rugged subminiatures is designed to highest performance standards, including MIL specs, for exacting industrial and military uses. Included are pentodes, triodes, diodes, VR tubes, reference tubes and thyratrons.

COMPACTRONS

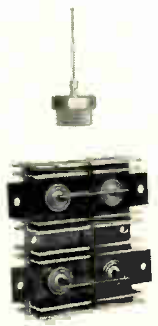


Tung-Sol compactrons offer definite advantages, both engineering and economic, to equipment manufacturers. Basic design considerations include careful attention to tube usage from a functional standpoint. The 12-pin configuration provides the versatility necessary to produce multi-purpose, multiple structure tubes.

NEW 5000-VOLT SILICON RECTIFIER

This uniquely designed 5000-volt unit features a special double-seal to assure maximum reliability in the toughest high-voltage industrial and military applications. These rectifiers are smaller than competitive devices and less expensive. They are furnished with clip-mounting terminals for ease of installation.

PRESS-FIT DIODES AND ASSEMBLIES



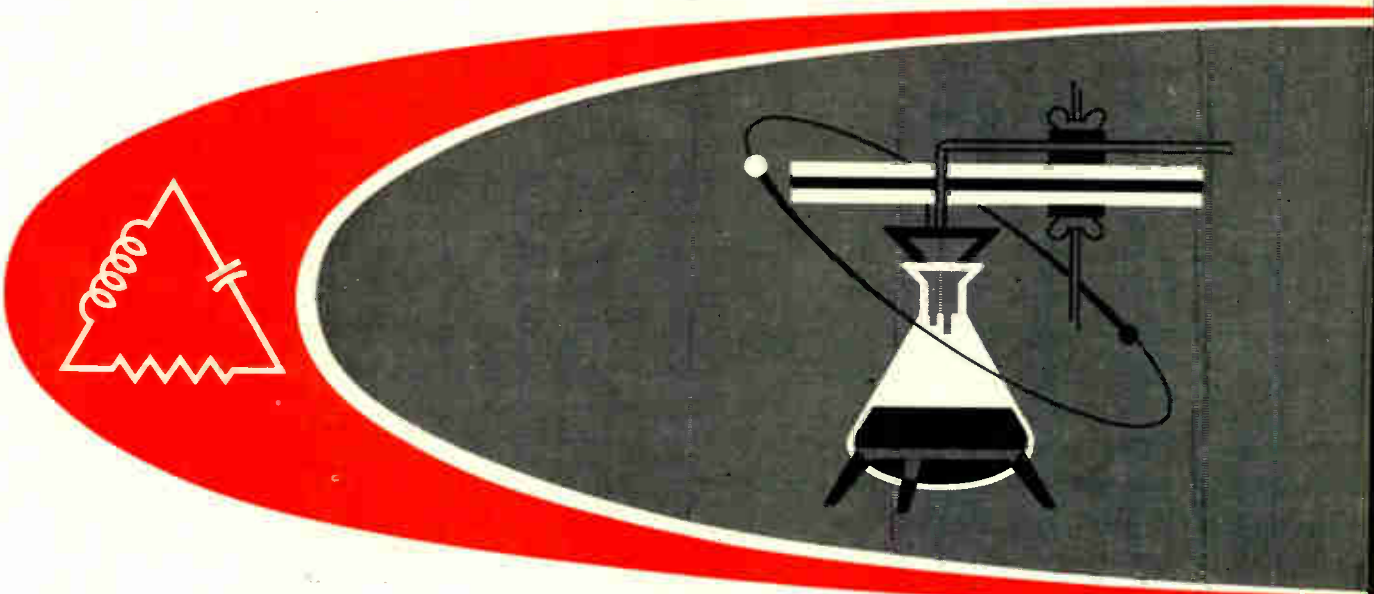
Tung-Sol premium-quality press-fit diodes offer electrical characteristics that are equal to or exceed those delivered by the stud-mounted 1N2154-1N2160 series. These economical units make practical the use of a single device for applications requiring from 1 to 30 amperes. Also available: a wide line of standardized rectifier modular assemblies in a variety of voltage ratings. The assemblies are the smallest made today for the 2 to 50 ampere range.

Foreign vs. Domestic Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With
CV216	DIO GAS OD3
CV449	DIO GAS OG3
CV466	PND SIN 6488
CV568	DIO SIN 35Z5GT
CV571	BEA SIN 50L6GT
CV579	PTG SIN 6A8GT
CV686	DIO GAS OC3
CV729	DIO TWN 5V4G
CV752	TRI GAS OA4G
CV753	DIO SIN 1A3
CV756	PND SIN 1A5GT
CV784	DIO PND 1S5
CV797	TET GAS 2D21
CV807	PND SIN 3A4
CV808	TRI TWN 3A5
CV818	PND SIN 3Q4
CV819	BEA SIN 3Q5GT
CV925	TRI TWN 12SN7GT
CV1762	PND SIN 6AK6
CV1800	PTG SIN 1A7GT
CV1805	PND SIN 1C5GT
CV1818	DIO TRI 1H5GT
CV1823	PND SIN 1N5GT
CV1826	BEA SIN 1Q5GT
CV1830	DIO SIN 1B3
CV1832	DIO GAS OA2
CV1833	DIO GAS OB2
CV1846	DIO TWN 5T4
CV1851	DIO TWN 5X4G
CV1854	DIO TWN 5Y3G
CV1862	BEA SIN 6AQ5
CV1865	TRI SIN #6R4
CV1882	PND SIN 6AG7
CV1886	TRI SIN 6Q4
CV1912	PND SIN 6F6
CV1949	TRI GAS 6D4
CV1959	BEA SIN 50C5
CV1961	PND SIN 12AU6
CV1985	TRI TWN 6SL7GT
CV1992	TRI GAS 1267
CV2105	PND SIN 6373
CV2107	PND SIN CK512AX
CV2115	DIO SIN 1B3
CV2137	PND SIN 6BR7
CV2225	DIO SIN 6354
CV2235	DIO SIN 6374
CV2237	PND SIN 1AD4
CV2240	BEA SIN 3B4
CV2253	TET GAS 6574
CV2254	PND SIN 5678
CV2348	PND SIN 5889
CV2507	PND SIN 1U4
CV2521	PND SIN 6AH6
CV2523	TRI SIN 6AS7G
CV2524	PND SIN 6AU6
CV2526	DIO TWN 6AV6
CV2573	DIO GAS 5651
CV2642	TRI SIN 417A
CV2726	PND SIN 6CK6
CV2796	BEA SIN 5881
CV2831	TRI TWN 2C51
CV2842	TRI SIN 6C4
CV2901	PND SIN 5879
CV2963	DIO GAS 6073
CV2983	PND SIN 3V4
CV3508	TRI TWN 6201
CV3512	TET GAS 5696
CV3526	PND SIN 6BN5
CV3789	TRI SIN 5842
CV3798	DIO GAS OA3
CV3799	DIO GAS OB3
CV3899	BEA SIN 5932
CV3905	PND SIN 5847
CV3912	DIO PND 1U5
CV3929	PND SIN 5840, 6205
CV3930	TRI SIN 5718
CV3998	PND SIN 6688
CV4010	PND SIN 5654, 6AK5
CV4011	PND SIN 5725
CV4017	TRI TWN 5751
CV4018	TET GAS 5727
CV4020	DIO SIN OA2WA
CV4028	DIO SIN OB2WA
CV4055	PND SIN 6132
CV5032	DIO SIN 1X2A
CV5065	TRI PND 6U8
CV5079	TET GAS 5643
CV5146	TRI TWN 5814
CV5188	TRI TWN 5687
CV5189	DIO TWN 5726
CV5211	DIO SIN 5641

Section D

Materials & Hardware



Magnetic Materials Selection Charts

By J. E. MITCH
Chief Electrical Eng
The Arnold Engineering Co
P. O. Box G
Marengo, Ill

MAGNETIC materials, in one form or another, are used in such varied components as transformers, relays, solenoids, filters, computer cores, motors, synchros, etc.

INDEX OF CHARTS

IF YOUR PRIMARY CONSIDERATION IS	AND YOUR REQUIREMENT IS	SEE CHART
Core loss at low or intermediate frequencies	Laminated or wound cores of silicon steel	A
Core loss at low or intermediate frequencies	Laminated or wound cores of nickel alloys	B
High permeability	Laminated or wound cores of nickel alloys	C
Low retentivity or low coercive force	Material for relay cores or pole pieces	D
High frequency operation	Powder, wound, or laminated cores	E

There are many types of magnetic materials, each of them generally having certain specific applications. The materials come in various forms—laminated, tape wound, rolled, or pressed powder, and they are available in shapes to suit various applications.

The charts presented here list magnetic materials that are of a non-permanent magnet nature. An index chart is given to aid in rapidly finding the "lettered" chart that contains the particular application of interest. The "lettered" charts list the application, recommended material and the necessary properties of the material. Also included is a summary chart that lists the major types of material and their properties, both physical and dc magnetic.

CHART A

Grade		AISI Type M-43	AISI Type M-36	AISI Type M-27	Super Dynamo	AISI Type M-22	AISI Type M-19	AISI Type M-6	AISI Type M-7
General Applications		Intermittent duty rotating machines, pole pieces, relays	Rotating machines, including ac-dc motors	High efficiency motors, small transformers	Designs requiring improved low density permeability	Stators of induction motors and high efficiency rotating equipment	Large rotating machines, communication transformers	Power and distribution transformers, large turbogenerators, small power and audio transformers	
Nominal silicon content, percent Cold rolled		.50	1.75	3.00	3.00	3.00	3.00	3.25	3.25
Core loss, WPP max									
10,000B 60 cps	.014 in.	1.30	1.17	1.01	.95	.82	.72		
	.0185 in.	1.55	1.35	1.14	1.08	.94	.83		
	.025 in.	1.98	1.70	1.30	1.25	1.10	.97		
15,000B 60 cps	.014 in.	3.50	3.00	2.46	2.35	2.00	1.75	.66	.73
	.0185 in.	3.70	3.20	2.66	2.54	2.20	2.00		
	.025 in.	4.60	3.85	3.05	2.93	2.60	2.35		
Saturation induction (B_s) gausses		20 500	20 000	19 000	19 000	19 000	19 000	19 700	19 700
Specific gravity		7.75	7.75	7.65	7.65	7.65	7.65	7.65	7.65
Electrical resistivity microhm-cm		28	37	47	47	47	47	50	50

A brief comprehensive description of magnetic materials is given here to aid designers in their selection. The material is presented in an easy-to-follow tabular form.

CHART B

Grade	AISI Type M.7 Wound Core, .012 in.	AISI Type M-7 Strip, .014 in.	AISI Type M-7 E-1 Laminations, 1x1 interleaved	Mumetal .014 in.	50% Nickel-Iron, .014 in. (non-oriented)	4-79 Moly-Permalloy, .014 in.	Oriented 50% Nickel-Iron, .005 in.	Non-Oriented cold-rolled silicon steel, .007 in
General Applications	Distribution transformers	Power transformers	Power and audio transformers	Shields, audio transformers and filters	Audio transformers and filters	Audio transformers and filters	Magnetic amplifiers	High frequency rotating machinery
Nominal composition, percent								
Silicon	3.25	3.25	3.25	—	—	—	—	3.25
Nickel	—	—	—	77.00	48.00	79.00	50.00	—
Core loss, WPP								
10,000B 60 cps	.30 max	.32	.40	.033	.20	.026	.20	.50
400 cps	6.00 max	6.50	7.30	1.00	5.50	.90	1.20	8.00 max
15,000B 60 cps	.71 max	.73	.90	—	.50	—	—	—
400 cps	13.00 max	16.00	19.00	—	13.00	—	—	—
Saturation induction (B_s) gausses	19 700	19 700	19 700	7 500	15 500	8 000	16 000	19 700
Specific gravity	7.65	7.65	7.65	8.50	8.20	8.74	8.25	7.65
Electrical resistivity microhm-cm	50	50	50	60	50	55	45	50

CHART C

Grade	AISI Type M-7 Wound Cores, .012 in.	Silectron Laminations .014 in.	Mumetal .014 in.	Molybdenum Permalloy .014 in.	4750 .014 in.	Oriented 50% Nickel-Iron, .002in.	Supermalloy, .004in.
General Applications	Power distribution transformers	Power and audio transformers	Low induction filters and audio transformers		Servo and synchro motors, audio transformers	Magnetic amplifiers	Magnetic amplifiers, specialty transformers
Nominal composition, percent							
Molybdenum	—	—	—	4.00	—	—	5.00
Silicon	3.25	3.25	—	—	—	—	—
Nickel	—	—	77.0	79.00	48.00	50.00	79.00
DC permeability							
μ max	50 000	—	100 000	200 000	80 000	100 000	700 000
B at μ max	8 000	—	2 500	3 000	5 000	12 000	3 000
μ at 40B	4 000	—	25 000	30 000	8 000	500	75 000
μ at 100B	6 500	—	30 000	45 000	12 000	2 000	80 000
AC permeability 60 cps							
μ at 40B	3 500	—	20 000	26 000*	8 000*	500	70 000
μ at 200B	6 500	—	30 000	32 000*	13 500*	1 000	90 000
μ at 2,000B	15 000	—	40 000	54 000*	30 000*	20 000	160 000
Saturation Induction (B_s) gausses	19 700	19 700	7 500	8 000	15 500	16 000	7 800
Specific Gravity	7.65	7.65	8.5	8.74	8.20	8.25	8.77
Electrical resistivity microhm-cm	50	50	60	55	45	45	65

Magnetic Materials Selection Charts *(Continued)*

CHART D

Grade	Similar To AISI Type M-36	Similar To AISI Type M-37	4750	Mumetal	Stainless Steels 400 Series	2V Permendur; 2V, 49Co, 49Fe
General Applications	Relays, armatures, solenoids, magnetic clutches, pole pieces					
Nominal composition, percent						
Silicon	1.25	2.50	—	—	—	—
Nickel	—	—	48.00	77.00	—	—
Chromium	—	—	—	1.50	12.00-18.00	—
Molybdenum	—	—	—	—	—	—
Cobalt	—	—	—	—	—	49.00
DC Hysteresis						
B_{max} (gausses)	10 000	10 000	10 000	5 000	10 000	20 000
B_r (gausses)	6 000	6 000	8 000	3 000	—	15 000
H_c (oersteds)	.7	.5	.03	.015	3.0	1.0
Saturation induction (B_s) gausses	20 500	19 500	15 500	7 500	15 500 to 17 500	23 000
Specific gravity	7.75	7.65	8.20	8.50	7.65	8.15
Electrical resistivity microhm-cm	25	40	50	60	55-120	38

CHART E

Grade	Monimax; 3Mo, 47Ni, 50Fe	2-81Moly-Permalloy Powder Cores	Non-oriented Cold Rolled Silicon-Steel, 7 Mil	Oriented Silicon-Steel 4 Mil	Oriented Silicon-Steel 2 Mil	Oriented Silicon-Steel 1 Mil	Ultra Thin Nickel-Irons: Square Permalloy	Ultra Thin Nickel-Irons: Oriented 50% Nickel Iron	Ultra Thin Nickel-Irons: Supermalloy
General Applications	Pulse transformers, high frequency transformers	Loading coils, filters	High frenquency rotating machinery	Pulse transformers, high frequency transformers, magnetic omplifiers			Magnetic amplifiers, computer cores		
Nominal composition, percent									
Nickel	47.00	81.00	—	—	—	—	79.00	50.00	79.00
Silicon	—	—	3.25	3.25	3.25	3.25	—	—	—
Molybdenum	3.00	2.00	—	—	—	—	4.00	—	5.00
Nominal frequency range	Audio range	Audio to low R.F.	400 cps 800 cps	400 cps Audio range	Pulse .5 to 10 microsec	Pulse under .50 microsec	Pulse at repetition rates up to 1 megacycle		
Specific gravity	8.25	—	7.65	7.65	7.65	7.65	8.74	8.25	8.77
Saturation induction (B_s) gausses	14 500	7 800	19 700	19 700	19 700	19 700	8 000	16 000	8 000
Electrical resistivity microhm-cm	65 min	high	50	50	50	50	55	45	65

TYPICAL PHYSICAL AND DC MAGNETIC PROPERTIES

Magnetic Material	Specific Gravity	Resistivity microhm-cm	Saturation Induction (B_s), gausses	Initial Permeability μ_o	Permeability at 200 gausses	Maximum Permeability μ_m	Induction at μ_m gausses	Coercive Force (H_c) oersteds
AISI Type M-43	7.75	28	20 500	280	500	3 000	8 000	.90
AISI Type M-36	7.75	37	20 000	280	900	5 000	6 000	.80
AISI Type M-27	7.65	47	19 000	290	1 100	7 000	8 000	.70
Super Dynamo	7.65	47	19 000	290	1 100	7 000	8 000	.70
AISI Type M-22	7.65	47	19 000	290	1 100	9 000	7 000	.60
AISI Type M-19	7.65	47	19 000	300	1 500	10 000	7 000	.20 —.50
AISI Type M-6	7.65	50	19 700	350	8 000	50 000	9 000	.08 —.12
AISI Type M-7, 4 mil	7.65	50	19 700	1 000	3 500	20 000	10 000	.40 —.60
AISI Type M-7, 2 mil	7.65	50	19 700	1 000	2 200	15 000	9 000	.50 —.70
AISI Type M-7, 1 mil	7.65	50	19 700			—		.60 —.80
AISI Type M-36	7.75	25	20 500			5 000	8 500	.50 —.90
AISI Type M-37	7.65	40	19 500			9 500	7 500	.20 —.60
2V Permendur	8.15	40	23 000	800		4 900	13 500	.40 —1.20
Type 406	7.41	120	15 500					2.00 —5.00
Type 416	7.65	57	17 500			900	10 000	2.00 —5.00
4750	8.20	50	15 500	3 500	15 000	40 000–130 000	5 000	.02 —.10
Monimax	8.25	65 min	14 500	3 500	10 000	40 000–100 000	5 000	.02 —.10
Oriented 50% Nickel-Iron	8.25	45	16 000	500	3 000	100 000–200 000	14 000	.04 —.16
Mumetal	8.50	60	7 500	20 000	50 000	70 000–300 000	3 000	.01 —.03
4-79 Molybdenum Permalloy	8.74	55	8 000	25 000	60 000	100 000–400 000	3 000	.01 —.03
Supermalloy	8.77	65	7 800	60 000	95 000	300 000–900 000	3 500	.003—.009

Permeability values were measured on samples cut parallel to the rolling direction except for Rotosil where the sample was cut half parallel and half at right angle to the rolling direction.

STANDARD MAGNETIC TEST SYMBOLS

a	Cross sectional area of *B* coil (mean area of turns in square centimeters)
A	Cross sectional area of specimen in square centimeters
B	Magnetic induction; Normal induction; Magnetic flux density
B_b	Biased induction
B_d	Remanent induction; values of induction on the demagnetization curve
B_i	Intrinsic induction
B_m	Maximum induction in a hysteresis loop
B_r	Residual induction
B_{rs}	Retentivity
B_s	Saturation induction
B_Δ	Incremental induction
B_H	Demagnetizing coefficient
$\mathcal{F}$	Magnetomotive force; Magnetic potential difference
f	Frequency
ff	Form factor
H	Magnetizing force; Magnetic intensity
H_b	Biasing magnetizing force
H_c	Coercive force
H_{ci}	Intrinsic coercive force
H_{cr}	Relaxation coercive force
H_{cs}	Coercivity
H_d	Demagnetizing force
H_Δ	Incremental magnetizing force
H_m	Maximum magnetizing force in a hysteresis loop
I_e	In-phase component of exciting current
I_q	Quadrature component of exciting current
L	Self inductance
L_m	Mutual inductance
l	Mean length of magnetic circuit
N	Total number of turns
n	Turns per centimeter
ρ	Electrical resistivity
$\mathcal{P}$	Permeance
P_a	Apparent core loss
P_c	Core loss
P_e	Eddy current loss
P_{B1}	Specific core loss
P_h	Hysteresis loss
P_q	Reactive power
P_Δ	Incremental core loss
$\mathcal{R}$	Reluctance
S	Lamination factor
T_c	Curie temperature
μ	Permeability; Normal permeability (DC)
μ_d	Differential permeability
μ_i	Intrinsic permeability
μ_L	Alternating current permeability based on comparison of the magnetic material to a capacitor or inductor in a bridge circuit
μ_m	Maximum permeability
μ_o	Initial permeability
μ_p	Alternating current permeability based on peak exciting current
μ_r	Reversible permeability
μ_v	Space permeability
μ_z	Alternating current permeability based on the rms exciting current
μ_Δ	Incremental permeability
ν	Reluctivity
ϕ	Magnetic flux
$\mathcal{L}$	Flux linkage

Fuel cells and their potential are being investigated by more than 60 governmental and industrial projects in the U. S. alone. What are fuel cells? Why this interest in them? What progress has been made? These and other questions pertaining to this "power source of the future," are answered.

FUEL CELLS—A Status Report

By **SMEDLEY B. RUTH**
Assistant Editor
Electronic Industries

Fig. 1. Dr. B. Agruss, electrochemist at the Allison Div. of General Motors, is shown with regenerative liquid metal fuel cell he invented. Lab model is encased in small furnace in the foreground.

WELL over a century ago, an Englishman, Sir William Grove, demonstrated a fuel cell using hydrogen and oxygen. Until fairly recently little was done to develop fuel cells further. Why was this true? There are several answers to this question—sources of energy have been both plentiful and relatively cheap; present power systems have been able to fill the population's demands; and, means and materials to perfect the fuel cell were not available.

How and why has the picture changed in the last fifteen years? We have come to realize that our fossil fuel supply is not unlimited. The possibility of an exhausted fuel supply has been accentuated by the current population explosion. Also, we have found electrical energy useful for an increasing number of applications. Availability of improved materials has contributed to current fuel cell activity, but the greatest impetus has no doubt come from military and space agencies. The fuel cell has advantages over conventional power systems which are of special interest to the military.

Even though governmental contracts have spurred interest in fuel cell R&D, industry is also contributing. Company-funded R&D, in 1961, was estimated at $15 million. This attests to the tremendous possibilities of the fuel cell.

Advantages

Some fuel cell power advantages should make obvious the reason for the increasing attention being afforded this device.

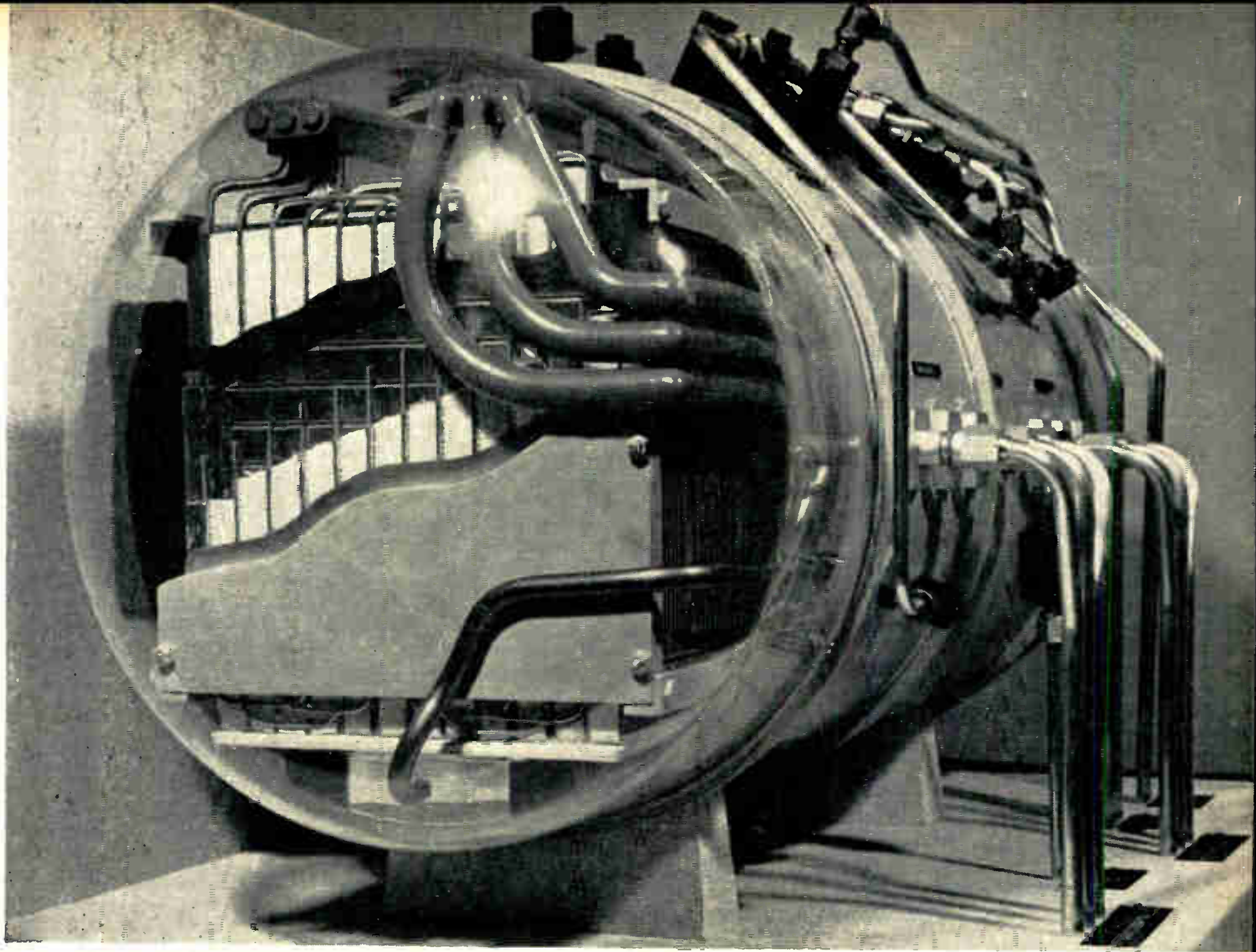


Fig. 2. Cut-away mockup of G.E. fuel cell that will be used as primary power sources in Gemini spacecraft being developed by McDonnell Aircraft. Cell will deliver a peak load of almost 2 KW of dc. It will also provide drinking water as a by-product of operation.

Estimates of attainable fuel cell efficiencies up to 90%—in theory and 70% in practice—have been made. When compared to the 25-35% efficiencies of gasoline and diesel engines or the 40% efficiencies of steam equipment, the advantage of the fuel cell is apparent. Fuel cells have no moving parts except for control. They do not produce obnoxious fumes, are silent, operate at ambient temperatures, and can (in theory) be built in any size and capacity. Low manufacturing costs are promised for some cells since precise tolerances are not necessary.

They are rugged, require a minimum of maintenance, and are efficient in all sizes. They use common fuels. Electrochemical action in some cells yields water which may be used for drinking (most desirable for space applications). The power pack need not be placed in one location, thus, more design flexibility. High power-to-weight and power-to-volume ratios are possible. When a load is not connected, no energy is consumed. Within material limitations, they can be run continuously without replacement or recharging.

Not all systems will include all of these advantages. Some will apply to certain types and some to others. Needs of the user will dictate which system must be selected.

Disadvantages

Fuel cells (at this time) cannot be used to generate large amount of power. Some systems require a large amount of auxiliary equipment for operation. Power output is limited to direct current. Conversion equipment is needed to obtain alternating current. Cost of present systems is prohibitive except for special industrial or military applications.

What is it?

The fuel cell may be defined as an electrochemical device that converts chemical energy directly into electrical energy. It is a primary battery in which the fuel and oxidizer are stored outside the battery and are fed to it on demand. A major difference between a fuel cell and a battery is that a fuel cell's electrodes are not consumed, as are a battery's.

The thermal cycle is eliminated, which is the secret

Main Industrial U. S. Fuel Cell Investigators

ALLIS CHALMERS	LEESONA MOOS LABS.
CHRYSLER CORP.	LOCKHEED
CONSOLIDATION COAL	MSA RESEARCH CORP.
ELECTRIC AUTO LITE	R.C.A.
ESSO RESEARCH	STANDARD INDIANA
EXIDE	STUDEBAKER
FORD	UNION CARBIDE
GENERAL ELECTRIC	UNITED AIRCRAFT
GENERAL MOTORS	WESTINGHOUSE

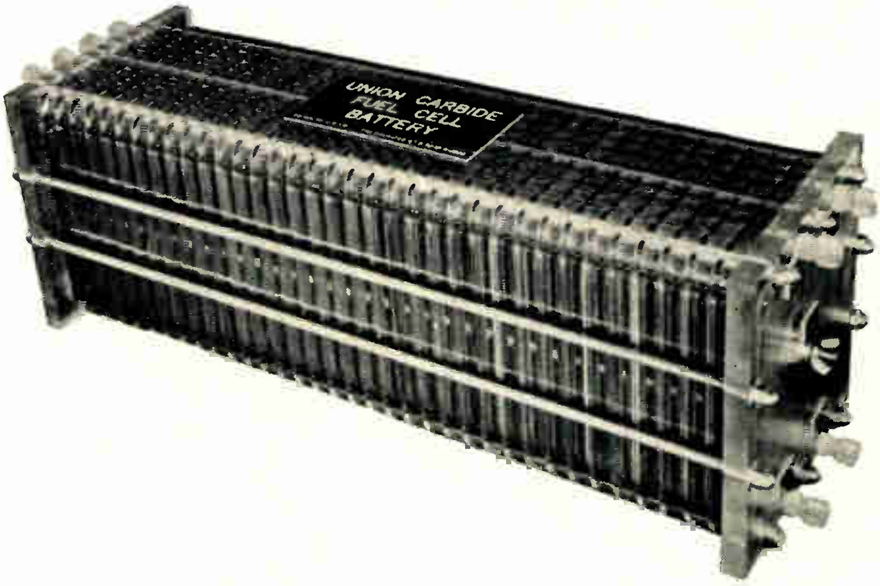
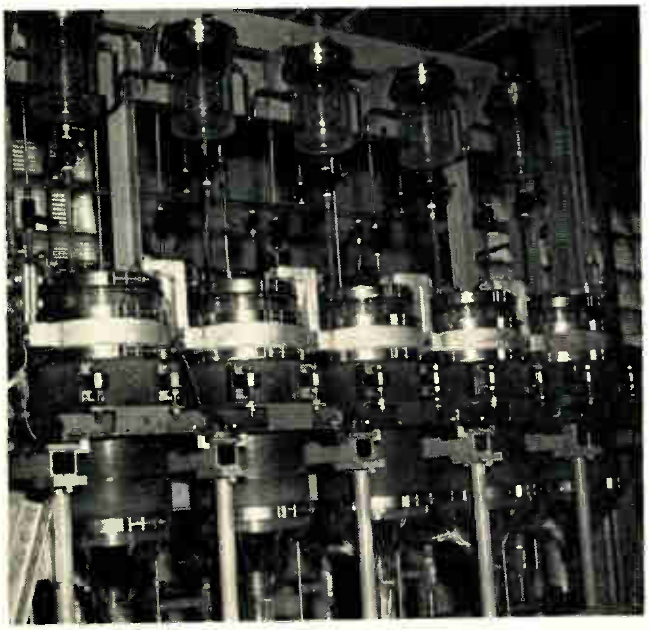


Fig. 3. Union Carbide multicell, flat-plate cell battery is designed to deliver up to 600 watts at good voltage levels. It consists of 36 hydrogen cells in series. This battery is particularly effective where operation at atmospheric pressure and utilization of atmospheric oxygen in place of processed oxygen supplies are important.

of the high efficiencies obtainable by fuel cells. Fuel cells are not subject to the Carnot Limitation as are heat engines. The basic law of thermodynamics dictates that only a fraction of the heat can be converted into mechanical or electrical energy at technically feasible temperatures. About twice as much useful work may be extracted from a pound of fuel when it is consumed in a fuel cell as when it is burned in the most efficient heat engines in operation today. Fuel cells contain, in addition to the fuels, two electrodes, one positive, one negative, and an electrolyte which serves as the electrochemical connection between the electrodes. Catalysts are used to promote the reaction.

Fig. 4. Fuel cell pilot power plant being developed by The M. W. Kellogg Co. for the U.S. Navy Bureau of Ships. Plant consists of five cells in series, each cell having approximately 10.4 sq. ft. of effective area. It uses sodium amalgam and oxygen as the reactants.



The electrodes act as mechanical devices for bringing the reactants in contact with the electrolyte in a controlled way. They act as catalysts or as catalyst carriers and serve to carry the current generated by the reaction to the load.

Some of the electrode materials used are silver, nickel, palladium, mercury, platinum, carbon, rhodium, and treated forms of carbon.

The anode is the electrode at which the fuel gives up electrons for delivery to the external circuit.

The cathode is the electrode which gives up electrons to the oxidizer.

The electrolyte, in addition to providing the medium for ionic conduction and electron insulation, prevents transfer of the fuel gases away from their respective electrodes where the formation of explosive mixtures can occur.

Some electrolytes in use are potassium hydroxide, sea water, fused mixture of alkali carbonates, phosphates and zirconates, alkali halides and ion-exchange membranes.

At least two fuels are necessary for operation of a cell. One is known as an oxidant, the other as a reductant. They are classified on the basis of the electron donor and electron acceptor characteristics of the reactants in any given system. Some oxidants in use or proposed are oxygen, air, chlorine, and bromine. Some reductants are hydrogen, carbon monoxide, natural gas, methane, ethane, coal, formaldehyde, alcohol, zinc, magnesium, sodium, lithium and ammonia.

In order for practical outputs to be obtained, it will be necessary to connect a number of cells in series and/or parallel. This necessitates the use of additional equipment. This equipment is needed for fuel storage, supply and distribution, temperature and pressure regulation; and reactions product renewal.

Fuels cells may be classified as hydrogen-oxygen, molten salt electrolyte, redox (reduction-oxidation), regenerative, consumable electrode and special types. These categories are subject to change as technological advances are made. No attempt will be made to explain the operation of the various types. However, as the major portion of fuel cell research has been concentrated on the hydrogen-oxygen type, its operation will be discussed for purposes of illustration.

How it Works

The least complicated of all fuel cells typically employs hydrogen and oxygen as fuels, concentrated alkaline solution as an electrolyte, and electrodes made of such materials as treated nickel and carbon.

Oxygen is fed in at the cathode. It is activated there by the proper catalyst and combines with water and an electron from the external circuit to form hydroxyl ions.

These ions move across the electrolyte to the anode. Hydrogen is fed in at the anode where it is activated by the proper catalyst. The hydrogen reacts with hydroxyl ions in the electrolyte to produce water and an electron. The electron is released to the external circuit. In order for the chemical reaction to proceed, a load must be connected to the cell. Thus when the load is not connected, chemical energy is not consumed.

The electrochemical reaction which takes place may be written as:

$$\text{Cathode} = O_2 + 2H_2O + 4e \longrightarrow 4OH$$
$$\text{Anode} = 2H_2 + 4OH^- \longrightarrow 4H_2O + 4e$$
$$\text{Overall cell reaction} = 2H_2 + O_2 \longrightarrow 2H_2O$$

Developments

Chrysler Corporation's present program is aimed at seeking new knowledge and principles. Although Chrysler's work on fuel cells has been with basic research, they have built several very efficient units of the hydrogen-oxygen type. Other types are planned, as hydrogen and oxygen can be a dangerous mixture making them undesirable as a power source for a car. Other hydrocarbons are not so explosive and are widely available. Air would be used to create the required mixture.

Engineers at the corporation's research laboratories are using a ten-inch long engineless car to demonstrate fuel cells in action. They visualize the growth of the tiny car into a full size model powered by fuel cells.

A feature of fuel cell power for autos is that a power plant can be contained within the very framework of the vehicles. It is not difficult to visualize them contained in the door, side panels, in the floor or even in the roof.

Leesona Moos Laboratories (LML) are currently doing research and development work on fuel cell systems which operate at temperatures below 450° F.

Fundamental research is being conducted on fuel cells that use hydrocarbon fuels directly.

They have under development fuel cell systems using impure hydrogen/air (the hydrogen being obtained by refining of natural gas, kerosene, or methanol); methanol wood alcohol/air fuels; and ammonia/air fuel cells. The only oxidizer being considered at this time is air.

Both the Carbox (R) (hydrocarbon-air) and Hydrox (R) (hydrogen-oxygen) fuel cells are developments of LML.

Leesona has licensing agreements with *United Aircraft Corp. (Pratt & Whitney Aircraft Div.)*. Under the agreements, United Aircraft is licensed to use LML patents in its own work with fuel cells. Both organizations are working simultaneously in this field, with United Aircraft's Activity being centered in application engineering and hardware design and development work. LML is concentrating on fundamental research to advance the state-of-the-art. Current areas of interest include basic studies of electrode-reaction mechanisms, solid state and catalysis, fundamental properties of electrolytes, electrode kinetics, surface chemistry and heterogeneous catalysis.

Electro-Optical Systems, Inc. is developing a simple, compact, sealed rechargeable hydrogen-oxygen fuel cell requiring no external controls. Energy to charge the cell would come from plugging it into regular house current. When used in space applications, it

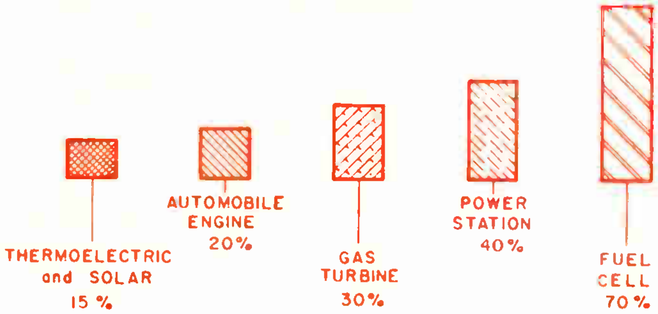


Fig. 6. In this comparison of the achievable efficiency of energy conversion systems, the fuel cell is considered a power plant. Its efficiency advantage over other power plants is clearly shown.

Fig. 5. General Electric fuel cell battery undergoes below-freezing test. The 30 watt fuel cell battery is being evaluated by Army Quartermaster Corps as a potential power source for arctic clothing.

Fuel Cells *(Continued)*

would be charged by the solar energy system. The cell will provide 15-75 w hrs./lb. In comparison, current nickel cadmium batteries yield less than 5 hrs./lb after thousands of cycles.

The M. W. Kellogg Co. is currently engaged in the development of a fuel cell pilot power plant for the U. S. Navy Bureau of Ships. It uses sodium amalgam and oxygen as the reactants.

The pilot power plant consists of five cells in series, each cell having approximately 10.4 sq ft of effective electrode area. Open circuit voltage of the plant is slightly over 10 volts, and the maximum power output is approximately 16 kw.

Ionics, Inc. have conducted studies on an alkaline cell containing two anion membranes with a strong potassium hydroxide solution between them. This cell is operable at 60°C. with reasonable discharge characteristics, at which temperature water vapor may be removed and condensed elsewhere.

Another cell which has been investigated is the Fuelox cell, which combines the characteristics of a good hydrogen electrode with the equally good discharge characteristics of the bromine-bromide reaction. The bromine solution in the regenerative Fuelox cell is in a closed system.

Two types of Fuelox cells have been investigated with regard to discharge characteristics. The first one contains a "thick" sulfonic ion exchange membrane of about 10 ohm/cm^2 resistance, and the second, a "thin" sulphonic membrane, of only 5.8 ohm/cm^2 resistance.

Fuel cell research at *Allis-Chalmers* dates back to 1953. The company has investigated both high temperature, high pressure systems and ion exchange membrane systems. They predict a low pressure, low temperature system, which can be used for mobile power applications.

The first Allis-Chalmers hydrogen-oxygen fuel cell was displayed in 1958. The power volume was 0.1 kw/cu ft and it produced 30 w.

In 1959 a fuel cell power plant was used to drive a farm tractor. One thousand and eight cells, in modules of nine parallel connected cells, produced 15 kw. The tractor, constructed for research purposes only, was operated over a period of six months. It was later donated to the Smithsonian Institution where it is now on display.

Allis-Chalmers research efforts since 1959 have been aimed at increasing the power to volume ratios and the power to weight ratios of the fuel cell. They have also conducted life tests and corrosion studies.

The company's best results has been achieved with hydrogen-oxygen, alcohol-oxygen, alcohol-hydrogen peroxide and ammonia-oxygen. The hydrogen-oxygen cell is by far the most advanced.

Allis-Chalmers is one of several companies sponsoring work at the Electrochemical Eng. Div. of the Battelle Memorial Institute.

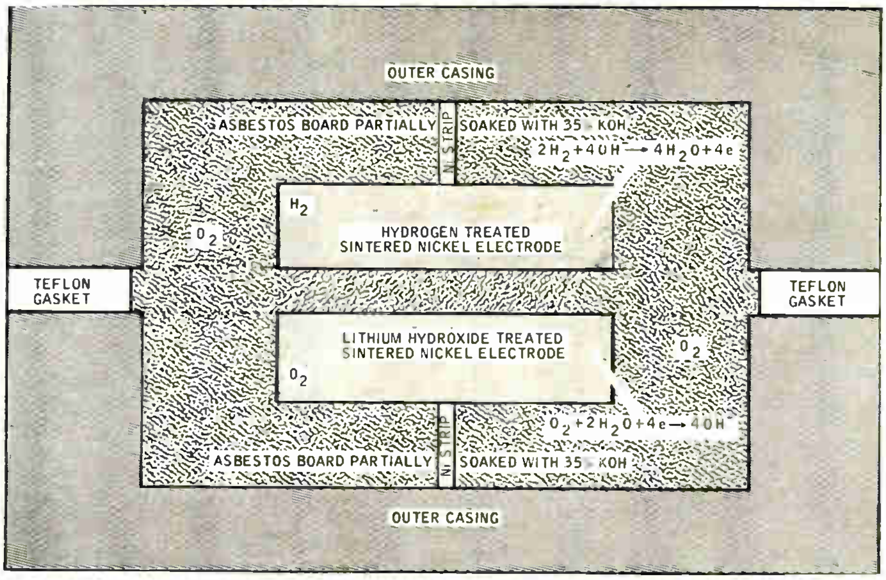
North American has announced that the Apollo will use fuel cell batteries. This fuel cell will be used to furnish both electric current and drinking water for the long journey to the moon and back. North American has picked two manufacturers to design competitive versions of an Apollo fuel cell. One is the *Pratt and Whitney division of the United Aircraft Corp.* The other is the *Tapco division of Thompson-Ramo-Wooldridge, Inc.* Both fuel cells are to be of the hydrogen-oxygen type.

Exide is conducting evaluating tests on hydrogen-oxygen type fuel cells. Work is being done on trying to find cheap sources of hydrogen. Their cells are close to feasible for highly specialized markets, such as military, and possibly industrial.

General Motors Corp., Allison Div. has under development a thermally regenerative liquid metal fuel cell. It will provide a means of converting heat energy directly into electrical energy to supply electrical power for instruments aboard satellites and space vehicles.

Esso Research and Engineering Co. is under contract to the U. S. Army Signal R&D Lab to do fuel cell research. It will investigate carbon-based liquid fuels that are water soluble. Examples of these are methanol, isopropanol, and ethylene glycol. These

Fig. 7. General Electric power supply has demonstrated its ability to power field radar equipment. Air breathing hydrogen-oxygen battery consists of 40 fuel cells in series (r). Chemical generator supplies hydrogen, and is easily replaced when charge is expended.



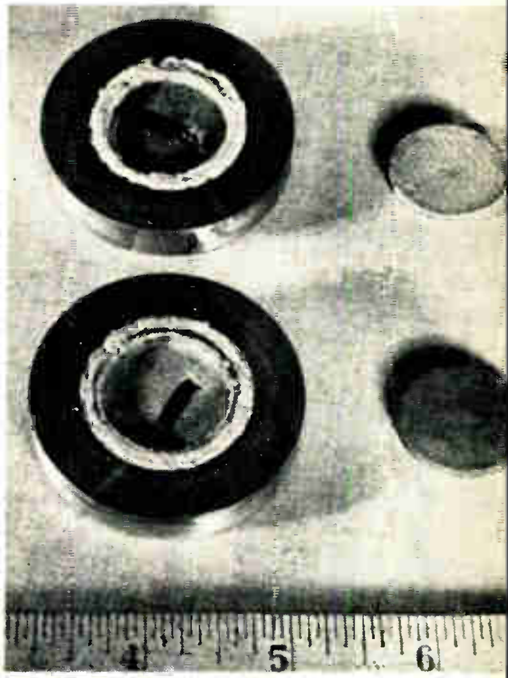


Fig. 8. Above illustration shows a cross section of a hydrogen-oxygen regenerative fuel cell made by Electro-Optical Systems, Inc. Disassembled fuel cell (right) shows outer casing, asbestos bed and electrode contact. Also shown are the nickel electrode.

fuels are relatively inexpensive, easily transported, and easily stored when compared to fuels used in other experimental cells.

Esso has more than five years' experience studying fuel cells, especially those using hydrocarbon fuels.

Consolidation Coal Co.'s main interest has been the type of cells that would be capable of using coal as fuel. In this type of cell, coal would be gasified by means of steam or carbon dioxide. This would produce a carbon monoxide rich gas, suitable for use in fuel cells.

Although not active experimentally in years, this company has done considerable work on high temperature fuel cells.

Surface Processes R&D Corp. has worked on low temperature fuel cells using ethane, propane and isobutane as fuels.

The fuel cell that *Monsanto Research Corp.* is considering uses hydrazine fuel in a strong NaOH electrolyte, with a nitric acid oxidant and platinized-platinum electrode.

Most of the activity of *Hoffman Electronics Corp.* was first related to sodium amalgam-bromine and sodium amalgam-chlorine fuel cells. Using high surface area carbon electrodes, with a proper pore structure may result in fuel cells that could maintain at least 2v. and possibly 2.5v. at current densities of 200 to 250 ma/cm^2.

Electrochemical couple of their Smatko cell is made of sodium as sodium amalgam for fuel (or any other alkali metal), and a halogen as the oxidizer. For convenience, bromine was selected as the oxidizer. It is highly soluble in sodium bromide solutions and easy to handle.

Armour Research Foundation has developed a fuel cell which can directly convert heat to electricity at efficiencies exceeding 50%. The Foundation principle consists of essentially three parts. First the heat converts the chemicals for the generation of electricity. In the second step, electrical power is taken off while the chemical is cooling. Then, in the third step, portions of the spent chemicals are regenerated by the heat source and are again available for the generation of electricity. Taking off electricity at one point and regenerating materials at another results in a constant conversion of the heat energy to electricity. The heat energy could come from the sun, or possibly the tremendous amounts of heat given off by nuclear reactors could be utilized.

The Foundation is active in fuel cell research on cells with ion-exchange membrane electrolytes. It has also aided the Institute of Gas Technology in their work on natural gas fuel cells.

The Institute of Gas Technology is active in research and development work on high-temperature methane fuel cells. Tests on molten carbonate and solid oxide cells are being conducted.

MSA Research Corp, inventors of the lithium-lithium fuel cell have constructed and operated both calcium-hydrogen and lithium-hydrogen cells. Current loads as high as 420 a/sq ft. on the hydrogen electrode at approximately ½ the open circuit voltage have been obtained.

Work at *Union Carbide* covers a wide range of topics in the fuel cell field. This includes temperatures from below zero to over 1000°C.; pressures from ambient to several hundred lbs/sq in.; neutral. acid and alkaline electrolytes (aqueous and fused salt); porous carbon and porous metal electrode

Fig. 9. Paths for conversion of chemical energy of combustible fuels into electrical energy. Note that fuels cells bypass the heat generation step.

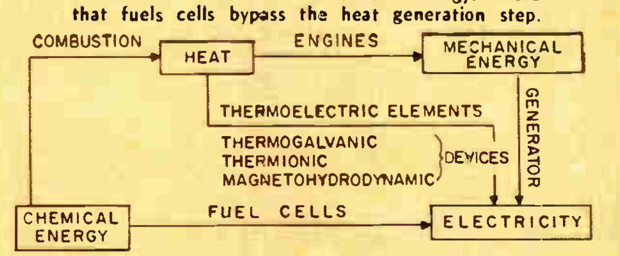


Fig. 10. One thousand and eight Allis-Chalmers fuel cells were used to drive this farm tractor in an experiment conducted in October of 1959.

Fuel Cells *(Continued)*

types; "redox" systems; and a broad group of fuels and oxidants.

Direct utilization of organic fuels in cells operating at low (less than 100°C.) temperature has been researched with many cells and batteries of this type having been tested.

The Union Carbide Fuel Cell (Hydrogen-Oxygen) is readily operated at temperatures of 70°F.-150°F. and at pressures ranging from atmospheric to a few atmospheres.

In 1957, a hydrogen-oxygen fuel cell battery was demonstrated to the U. S. Signal Corps for use on its portable "Silent Sentry" radar sets. Another demonstration of the fuel cell was made in 1958 at the World's Fair in Brussels, Belgium.

At present, Union Carbide makes batteries only on special orders, but models for the general market are anticipated for the near future.

General Electric's new Direct Energy Conversion Operation in Lynn, Mass., is currently studying ways of getting a fuel cell to operate directly on common fuels such as gasoline, propane or natural gas.

The company's Aircraft Accessory Turbine Dept. has built a portable 200 w air breathing power source that has demonstrated its ability to power portable radar and radio equipment. They have also produced a 30 w fuel cell power source that has been demonstrated successfully under below-freezing conditions as a potential power source for arctic clothing. They are investigating the application of fuel cells to remote operating devices such as sonobuoys and navigation buoys, as small power sources, for unattended emergency standby power applications, and for submarine propulsion.

The laboratory in Lynn is doing fundamental work in electrochemistry, and electrode systems. Other engineering studies cover wick systems for water transport and storage, heat transfer, compact lightweight construction, feasibility studies of new fuel cell types using liquid electrolytes and general cost reduction.

Efficient use of conventional hydrocarbons in low temperature fuel cells is the primary aim of hydrocarbon fuel cell research carried on at the research laboratory in Schenectady, N. Y.

MSVD at Valley Forge, Pa., is conducting a program leading to development of a 500 w cell for the U. S. Army Signal Corps.

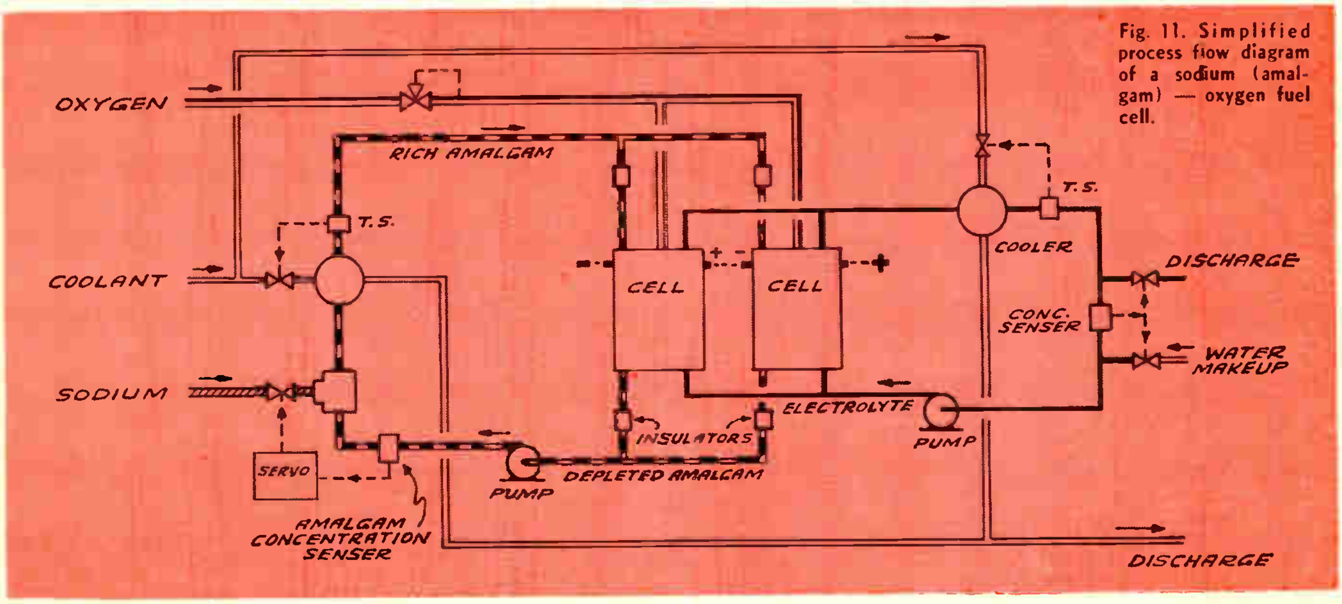


Fig. 11. Simplified process flow diagram of a sodium (amalgam) — oxygen fuel cell.

A small ion-membrane fuel cell battery mounted in a re-entry vehicle has been lofted 600 miles high and recovered after approximately 30 minutes. It performed successfully under conditions approaching those expected to be encountered in an orbital flight. The principle of the hydrogen-oxygen fuel cell with the ion-exchange membrane was conceived and improved by G.E. scientists.

General Electric, under contract with McDonnell Aircraft Corp. will develop a fuel cell battery to supply the primary for the two-man Gemini spacecraft. It will be the first time that conventional batteries or mechanical power units have been displaced by fuel cells as the primary electrical power source in space flight. This hydrogen-oxygen type fuel cell will deliver a peak load of almost 2 kw.

Potential Uses

Fuel cells will assume increasing influence and a multitude of new uses will undoubtedly be found for them as their development progresses.

A large potential market for fuel cell power supplies would be for one capable of supplying the necessary power and heat for the home. Initial cost of such a unit would have to be low. Long operating life and reliability would be other necessary features. It would also require a simple method of converting the direct current output of the cell to alternating current.

It is expected that fuel cells will someday be in competition with the internal combustion engine, either gasoline or diesel. It should also enter into competition with the power generating steam station or the diesel energy conversion system. Once again the emphasis would be on long life and reliability.

Fuel cells will no doubt find useful application for propulsion purposes. These cells may one day be used for power in switching engines, tractors, trucks, autos, in-plant vehicles, golf carts, etc.

The fuel cell has been suggested for a power source in remote installations or for emergency standby power. In fact, the fuel cell could be the answer any place where independence of power line connections is of prime importance. Boats and other mobile equipment could use fuel cells for power. A sodium-oxygen cell is under development as a power plant for submarine applications, and lead acid batteries may one day be replaced with zinc electrode-oxygen fuel cells.

Work now in progress indicates that the carbonaceous fuel cell can be used as a chemical reactor, in dehydrogenation, and reforming reactor oxidation reactions capable of producing chemicals and power.

The use of fuel cells for military and space applications, industrial plants, household appliances and electrochemical refining plants can be anticipated.

It would be safe to assume that the fuel cell will eventually become a major power source, replacing other systems in some applications. The many improvements and technological advances which have been made in the last few years offer proof of this. However, for the present, fuel cell applications will probably be restricted to those in which fuel efficiency, silence, freedom from fumes, and simplicity of design and operation are important requirements.

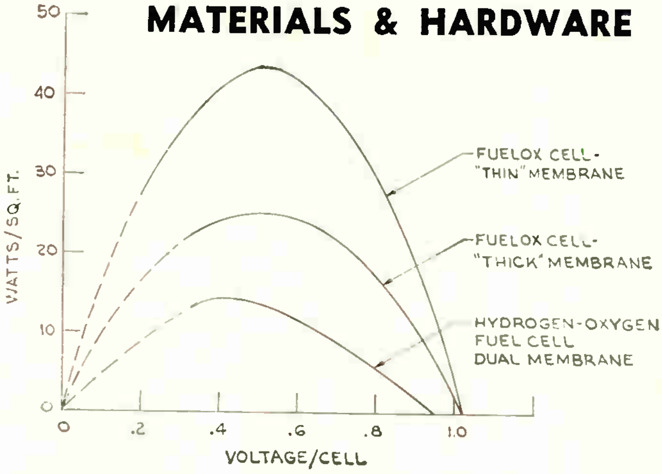


Fig. 12. Watts/sq.ft. of electrode area versus cell voltage of three full cell types are related in order to compare power density.

Bibliography

1. Blackmer, R. H., and Phillips, G. A., "Ion-Exchange Membrane Fuel Cell for Space Vehicle Electric Power," Prepared for presentation at SAE National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 9-13, 1961.

2. Bregman, J. I., and Dravnieks, Andrew, "Fuel Cells with Ion-Exchange Electrolytes" (Received from Armour Research Foundation of Illinois Institute of Technology, Chicago 16, Ill.).

3. Celent, C. M., "Electronic Industries Looks At . . . Unconventional Power Converters," *Electronic Industries*, Vol. 19, No. 9, pp. 101-116, Sept. 1960.

4. Ciarlariello, T. A., Shearer, R. E., and Werner, R. C., "Regenerative Type," Proceedings—Thirteenth Annual Power Sources Conference, Power Sources Division, U. S. Army Signal R&D Laboratory, Fort Monmouth, N. J., 1959.

5. Davison, E. L., and Webber, J. F., "New Auxiliary Power Units for Cryogenic-Fueled Space Vehicle," American Rocket Society Space Flight Report to the Nation, New York, N. Y., Oct. 9-15, 1961.

6. Fox, H. W., and Roberts, R., "Fuel Cells," *IRE Transactions on Military Electronics*, Vol. MIL-6, No. 1, pp. 46-57, Jan. 1962.

7. Frank, H. A., Ludwig, F. A., and McCelland, D. H., "Design Parameters for Regenerative Fuel Cells," presented at the 15th Annual Power Sources Conference, Atlantic City, N. J., May 9, 1961.

8. "Fuel Cell Status Report" (Received from Leesonia Moos Laboratories, Jamaica, L. I., N. Y.).

9. Juda, W., Tirrell, C. E., and Lurie, R. M., "Fuel Cells with Ion Exchange Membranes," Presented at the ARS Space Power Systems Conference, Santa Monica, Calif., Sept. 27-30, 1960.

10. Kirkland, T. G., and Platner, John L., "Allis-Chalmers Progress in Fuel Cells."

11. Niedrach, Dr. L. W., "The Ion Exchange Membrane Fuel Cell," for Thirteenth Annual Power Sources Conference, Atlantic City, N. J., April 29, 1959.

12. Phillips, George A., "Status of Development and Future Prospects for the Ion-Exchange Membrane Fuel Cell," Prepared for presentation at the Fall General Meeting of American Institute of Electrical Engineers, Detroit, Mich., Oct. 15-20, 1961.

13. Read, M. D., and Voltz, S. E., "Regenerative Hydrogen-Oxygen Fuel Cell," *IRE Transactions on Military Electronics*, Vol. MIL-6, No. 1, pp. 63-67, Jan. 1962.

14. Shultz, Jr., E. B., Marianowski, L. G., Linden, H. R., and Vorres, K. S., "Natural Gas Fuel Cells for Power Generation, *American Gas Journal*, May 1961.

15. Slaughter, John I., "Fuel Cell Power State of the Art—1961" (Received from Allis-Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis.).

16. Smatko, Joseph S., "The Sodium Amalgam-Halogen Fuel." (Received from Hoffman Electronics Corp., Los Angeles, Calif.)

17. Smatko, Joseph S., "The Smatko Fuel Cell and Other Secondary Fuel Cells, "For the IRE Winter Convention on Military Electronics, Los Angeles, Calif., Feb. 1, 2, 3, 1961.

18. "Some Plain Talk About Fuel Cells," Booklet published by General Electric Co.'s Aircraft Accessory Turbine Dept., Lynn, Mass.

19. "Union Carbide Fuel Cell," Booklet published by Union Carbide Consumer Products Co., New York, N. Y.

20. Young, G. J. (Ed.), "Fuel Cells," *Reinhold Publishing Corp.*, New York, N. Y., 1960.

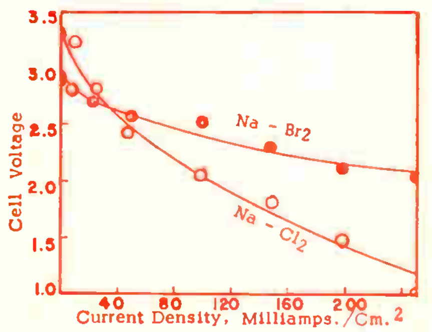
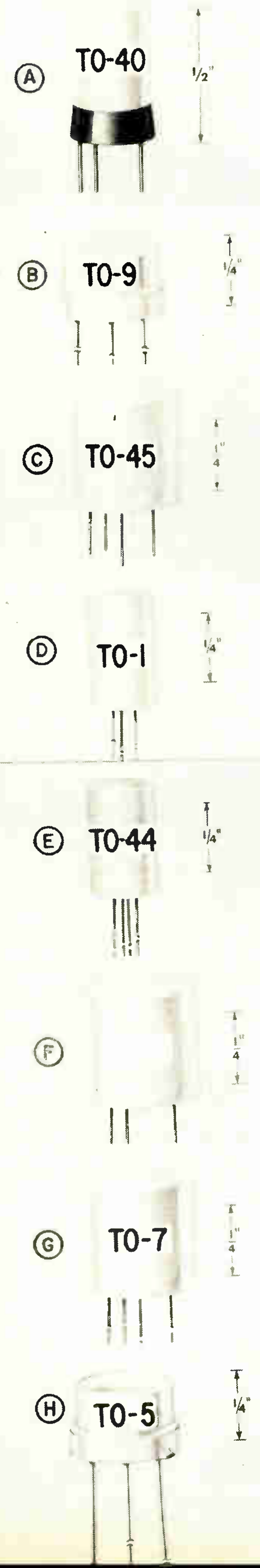


Fig. 13. Discharge curves for Sodium Amalgam - Chlorine and Sodium Amalgam - Bromine Fuel cells.



Transistor Mounting

Information about mounting, replacing, soldering, sockets, and heat sinks for the major types of transistors is given in an easy-to-follow tabular form.

To obtain optimum performance from a transistor, it is as important to use proper mounting, socketing and soldering procedures as it is to operate the unit within maximum electrical ratings.

This guide describes the important procedures that should be observed when mounting or replacing most commercially available transistors. In addition, it gives information on sockets, mounting hardware, and heat sinks intended for use with these transistors.

The table is a key to the paragraphs which apply to each type of transistor. The procedures, precautions, and the socketing and heat sink information are given in the numbered paragraphs. The guide is used by locating the photograph of the transistor of interest and then checking the pertinent column (mounting, replacement, soldering, sockets, heat sinks) to obtain the numbers of the paragraphs that apply. The JEDEC number is the transistor outline number assigned by the Joint Electron Devices Engineering Council.

Mounting

1. **Shield Lead:** Some high-frequency, drift-field transistors of the type shown are provided with a shield lead that is either internally or externally connected to the case. To minimize interlead capacitance and coupling to adjacent circuit components, the shield lead should be connected to the chassis ground.

2. **Heat Sink:** To ensure adequate transfer of heat from the transistor, the mounting flange should be securely fastened to a heat sink. It is recommended that Silicone lubricant be applied between the base of the transistor and the heat dissipator.

3. **Electrical Insulation Between Collector and Chassis:** In an n-p-n transistor application where the chassis is connected to the negative terminal of the battery, or in a p-n-p transistor application where the positive terminal of the battery is connected to the chassis, an electrical insulator is needed between the mounting flange and the chassis. Satisfactory insulators include an anodized aluminum washer that de-

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This guide includes components known to the author at this time. It is not intended to be limiting or restrictive. Suitable components may be available from manufacturers other than the examples listed here.

By JERRY EIMBINDER
Semiconductor & Materials Div.
Radio Corp. of America
Somerville, N. J.

and Application Guide

pends upon a thin oxide film coating for electrical insulation and various other washers of approximately 0.002 to 0.003 inch in thickness.

The aluminum washer should be about ⅛ in. thick and should be drilled or punched to provide clearance holes for the emitter and base pins, and for the mounting hardware. To prevent accidental short circuits, the washer should be carefully deburred before anodizing, and all burrs should be removed from the chassis before mounting.

a. Suitable mica insulators manufactured by the Reliance Mica Co., Inc., 341-351 39th St., Brooklyn 32, N. Y., are part no. 712 for TO-3 outline and 2N301-type transistors, and part no. 732 for transistors conforming to the TO-36 outline.

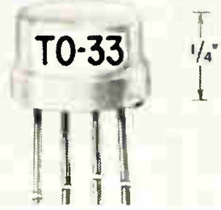
TRANSISTOR MOUNTING AND APPLICATION TABLE

Photo Identifications and JEDEC Types	Typical Transistor Type	For Description, See Indicated Paragraph				
		Mounting	Replacement	Soldering	Sockets	Heat Sinks
JEDEC TO-40 (Fig. A)	2N140		1, 4	6	4	8
JEDEC TO-9 (Fig. B)	2N580	3, 3b	1, 4	1 to 4	2	3
JEDEC TO-45 (Fig. C)	2N1180	1	1	6	3	4
JEDEC TO-1 (Fig. D)	2N220		1, 4	1 to 4		1
JEDEC TO-44 (Fig. E)	2N384	1	1, 4	1 to 4		1
(Fig. F)	2N270		1	1 to 4	3	4
JEDEC TO-7 (Fig. G)	2N370	1	1	1 to 4	3	4
JEDEC TO-5 (Fig. H)	2N585	3, 3b	1, 4	1 to 4	2	3
JEDEC TO-8 (Fig. I)	2N1485	4	1	6		5
JEDEC TO-3 (Fig. J)	2N1490	2, 3, 3a, 5	1, 3	5	1	2
(Fig. K)	2N301	2, 3, 3a, 5	1 to 4	5	1	2
JEDEC TO-33 (Fig. L)	2N1395	1, 3, 3b	1	1 to 4		3
JEDEC TO-18 (Fig. M)	2N706		1	1 to 4		6
JEDEC TO-11 (Fig. N)	2N1384	3, 3b	1, 4	1 to 4	2	3
JEDEC TO-36 (Fig. O)	2N1511	6	1 to 3	6		7
(Fig. P)	2N1768	7		6		

I


J


K


L


M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O


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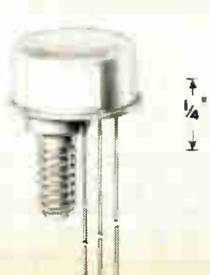


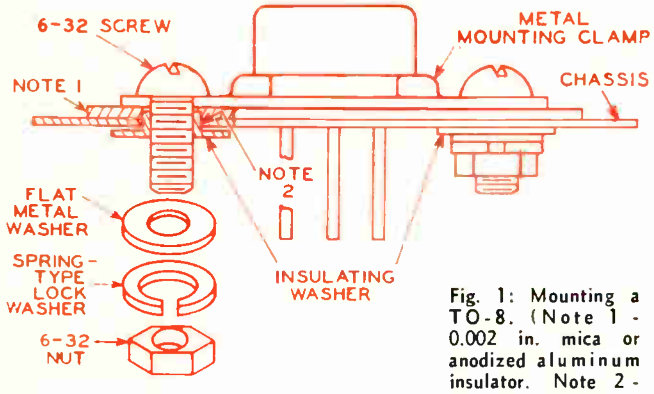


Fig. 1: Mounting a TO-8. (Note 1 - 0.002 in. mica or anodized aluminum insulator. Note 2 - Remove all burrs.)

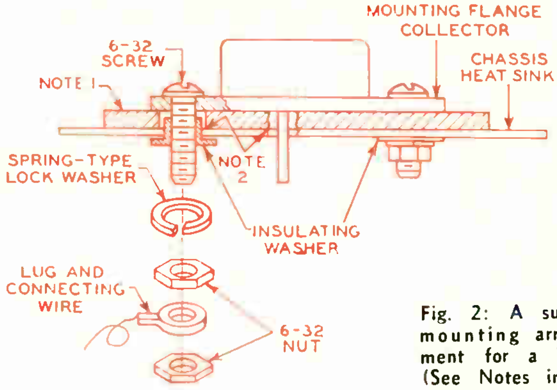


Fig. 2: A suitable mounting arrangement for a TO-3. (See Notes in Fig. 1).

Mounting Guide *(Continued)*

b. Suitable mylar*, silicon-fiber glass, and nylon insulating washers manufactured by the Reliance Mica Co., Inc., are part no. 1 and part no. 8 for 2N301-type transistors and transistors having the TO-3 outline; and part no. 3 and part no. 4 for transistors having TO-5, TO-9, TO-11, and TO-33 outlines.

4. **Suggested Mounting Arrangement for 2N1485 and Similar Transistors:** Fig. 1 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline No. TO-8. The mounting clamp is usually supplied by the transistor manufacturer.

5. **Suggested Mounting Arrangement for 2N1490 and Similar Transistors:** Fig. 2 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline TO-3. A mounting hardware kit is manufactured by Delco, part no. 7274775.

6. **Suggested Mounting Arrangements for 2N1511 and Similar Transistors:** Fig. 3 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline No. TO-36. A mounting hardware kit is manufactured by Delco, part no. 7274633.

7. **Suggested Mounting Arrangement for 2N1768 and Similar Transistors:** Fig. 4 illustrates a mounting arrangement suitable for outlines similar to that of the 2N1768.

* Dupont registered trademark.

Replacement

1. **Removal or Installation of Transistor:** The power should be turned off before inserting or removing a transistor. Failure to turn off the power may result in transient currents that will damage the transistor.

2. **Bias Adjustment:** After replacing audio-frequency power transistors, such as these used in the output stages of automobile radio receivers, the bias potentiometer should be readjusted for optimum performance.

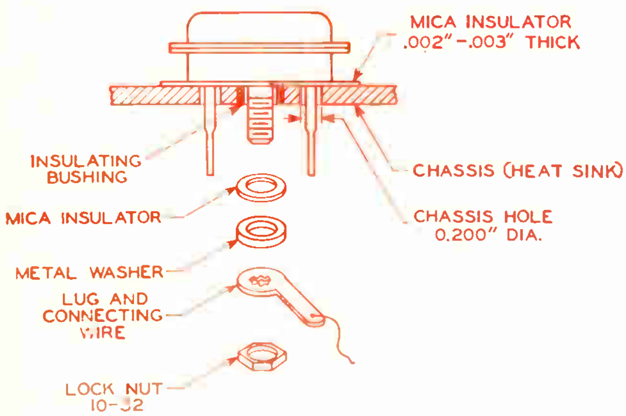
3. **Shock Hazard:** The metal shell of the transistor may operate at a voltage appreciably above or below ground potential. Reasonable care should be exercised when servicing.

4. **Lead or Pin Identification:** Several methods are used to identify the leads or pins of these transistors. Some manufacturers place a color mark near the collector or a colored band around the collector lead; others place an index tab adjacent to the emitter lead. When in doubt, consult the manufacturer's literature.

Soldering

1. **Lead Soldering:** Leads may be soldered close to the glass seal if care is taken to conduct excessive heat away. A pair of long-nose pliers used to hold the lead while soldering or unsoldering is effective in reducing the amount of heat carried to the seal.

Fig. 3: A suitable mounting arrangement for a TO-36 transistor.



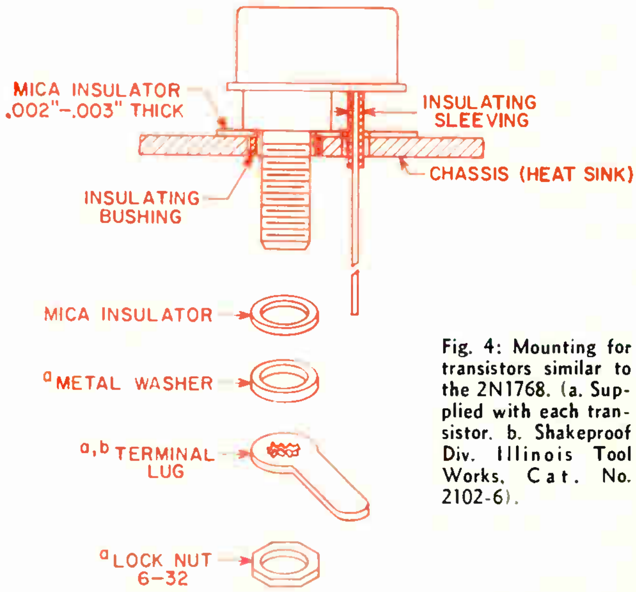


Fig. 4: Mounting for transistors similar to the 2N1768. (a. Supplied with each transistor. b. Shakeproof Div. Illinois Tool Works, Cat. No. 2102-6).

2. **Soldering Iron:** A low-wattage (25 or 30 watts) soldering iron, such as the pencil types intended for printed-circuit work or fine soldering, should be used. Higher-wattage irons (35 to 50 watts) should be used with caution.

3. **Dip Soldering:** These transistors may usually be dip soldered in the assembly of printed circuits provided that: (1) the temperature of the solder does not exceed that specified (255° C. for some types); (2) the immersion period does not exceed 10 seconds; and (3) the leads or pins are soldered at no closer than 1/32 in. from the transistor case.

4. **Short-Circuit Prevention:** When double-sided printed-circuit boards or printed circuit boards with eyelets are used, an insulating washer or similar standoff device, made of good dielectric material, may be used to keep the solder from shorting the leads to each other or to the board.

5. **Mounting Flange:** The mounting flange of a power transistor should not be soldered to a heat sink. The heat of the soldering operation could permanently damage the transistor.

6. **Pins:** Solder connections may be made directly to the pins of the transistors if care is taken to conduct the heat away from the pin seals. Failure to do so could result in cracking the glass seal.

Sockets

1. **Manufacturers of Power-Transistor Sockets with 2-hole Mounting Arrangement:** Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type numbers 14T24324, 54T24246. Loranger Mfg. Corp., Warren, Pa.: socket type number 2149.

2. **Manufacturers of Sockets for Transistors with JEDEC Outlines TO-5, TO-9, TO-11, and TO-33:** Elco Corp., M St., Philadelphia 24, Pa.: socket type numbers 3301, 3303, 3304, 3305, 3306, 3307, and 3308. Grayhill, Inc., 561 Millgrove Ave., LaGrange, Ill.: socket type number 22-11.

3. **Manufacturers of Sockets for Transistors with JEDEC outline TO-7 (when the transistor leads are suitably out) and TO-45:** Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type number 46A20967.

4. **Manufacturers of Sockets for Linotetrar 3-Pin Bases:** Elco Corp., M St., Philadelphia 24, Pa.: socket type numbers 799BC, 803BC, 3301, 3303, 3304, 3305, 3309, 3310, 3311, 3312, 3313. Eby Sales Co., 130 Lafayette St., New York 13, N. Y.: socket type number SM3. Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type numbers 46A20782, 46A20928, 46A22648, 46A22455, 46A24052, 46T20248, 46T22825.

Heat Sinks

When ordering heat sinks it may be necessary to specify finish (unfinished aluminum, black anodized aluminum, etc.) length, TO-outline, and hardware (if desired). The list below is representative. Equivalent types produced by other manufacturers are also available.

1. **Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-1 and TO-44:** Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif., part numbers 3AL-635, 3AL-669, 3AL-680.

2. **Manufacturers of Heat Sinks Intended for Use with 2-Pin Power Transistors (TO-3 Outline types and 2N301-case types):** Accel Electronic Products Co., Box 467, Monterey Park, Calif., part number SR-23. Astro Dynamics, Inc., Second Ave., Northwest Industrial Park, Burling, Mass., part numbers 2503, 2504, 2505, 2506, 2501-B. Augat Brothers Inc., 33 Perry Ave., Attleboro, Mass., part numbers 8038-1G1, 8038-1G2, 8038-1G3, 9004-1G1, 9006-1G1, 9006-1G2. Birtcher Corp., part numbers 3B-663, 3AL-672, 3B-693, 3AL-704, 4AL series. Delta Division, Wakefield Engineering, Inc., Wakefield, Mass., NC-401A, NC-403A, NC-421A, NC-423-A, FC-501. International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif., part numbers TO3P-174-100, TO3P-174-125, TO3P-174-150, TO3P-174-200, TO3P-174-250, TO3P-174-300, TO3P-174-350, TO3-250-050, TO3-250-100, TO3-250-150, TO3-250-200, TO3-250-250, TO3-250-300. UP-TO3. UP-TO3B. National Beryllia Corp., First & Haskell Ave., Haskell, N. J., part number BTO-3. Vermaline Products Co., Franklin Lakes, N. J., part numbers HS6030-3A3, HS6030-3F3, HS7030-3A3, HS7030-3F3, HS8030-3A3, HS8030-3F3, HS6071-3A3, HS6071-3F3, HS6029-3A3, HS6029-3F3.

3. **Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-5, TO-9, TO-11, and TO-33:** Astro Dynamics, Inc., part numbers 2701, 2702, 2703, and 2704-B. Birtcher Corp., part numbers 3AL-635, 3AL-669, 3AL-680, 3AL-681, 3AL-682, 3AL-683, 3AL-711, 3AL-716. International Electronic Research Corp., part numbers TXBP-032-029B, TXBP-032-037, TXBP-032-037B. National Beryllia Corp., part numbers BTO-5, BTO-9, BTO-11, BTO-33. Thermolloy Co., 2130 Irving Blvd., Box 4341, Dallas 8, Tex., part numbers 1101, 1101A, 2208, 2209.

4. **Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-7 and TO-45:** Birtcher Corp., part numbers 3AL-675, 3AL-681, 3AL-683.

5. **Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-8:** Birtcher Corporation, part number 3AL-705. International Electronic Research Corporation, TXB-050-037B, TXB-050-037B. National Beryllia Corporation, part number BTO-8.

6. **Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-18:** Birtcher Corp., part numbers 3AL-635, 3AL-680, 3AL-702, 3AL-715. International Electronic Research Corp., part numbers TXBP-018-028B, TXB-018-028B. National Beryllia Corp., part number BTO-18. Thermolloy Corp., part numbers 1106, 1107.

7. **Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-36:** Accel, part number SR-26. Astro Dynamics, Inc., part numbers 2501-B, 2503, 2504, 2505, 2506. Augat Brothers Inc., part numbers 9004-1G2, 9009-1G1. Birtcher Corp., part numbers 3B-645, 3B-684, 3B-688, 4AL series. Delta, part numbers NC-401B, NC-403B, NC-4C1B, NC-423B, FC-502. International Electronic Research Corp., UP-TO36, UP-TO-36B. National Beryllia Corp., part number BTO-36. National Beryllia Corp., part numbers HS6030-3B3, HS7030-3B3, HS8030-3B3, HS6071-3B3, HS6029-3B3.

8. **Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-40:** Birtcher Corp., part numbers 3AL-635, 3AL-680.

PRECIOUS METALS APPLICATIONS CHART

	Platinum (Pt) Mechanical Grade	Platinum (Pt) Thermopure	Palladium (Pd)	Iridium (Ir)	Rhodium (Rh)	Ruthenium (Ru)	Osmium (Os)	Gold (Au)	Silver (Ag)
Atomic weight	195.23		106.7	193.1	102.91	101.7	190.2	197.2	107.88
Specific gravity	21.45		12.02	22.5	12.44	12.2	22.5	19.32	10.49
Density, lb/cu. in. @ 68° F	.775		.434	.813	.449	.441	.813	.698	.379
Melting point, °F °C	3216 1769		2826 1552	4449 2454	3571 1966	4530±180 2500±100	4900±360 2700±200	1945.4 1063.0	1761.4 960.8
Thermal conductivity, Btu/ft²/in./°F/hr (32–212° F)	480		493	406	618	—	—	2031	2902
Coefficient of expansion, in./in./°F x 10^{-6} (32–212° F)	4.94		6.50	3.61	4.6	5.33	3.33	8.0	10.93
Specific heat, Btu/lb/°F @ 32° F @ 212° F	0.0315 0.0325		0.0584 —	0.0307 (68°F)	0.058 —	0.057 —	0.0309 0.0314	0.0312 (64°F)	0.0559 0.0568
Resistivity, ohms/cir mil ft @ 32° F @ 68° F @ 212° F	58.86 63.60 81.90		60.0 64.8 —	— — —	30.1 — —	47 84 —	54 57.1 —	13.1 14.1 —	9.56 8.84 —
Mean temperature coefficient of resistance per °C, 0–100° C (32–212° F)	—	.00392	.0037	.00392	.00457	—	.0042	.0034	.0041
Tensile strength, psi annealed 50% RA	20–23,000 35,000	17–19,000 34,000	28,000 47,000	21,000 —	80,000 360,000	— —	— —	19,000 32,000	18,000 50,000
Modulus of elasticity, psi annealed 50% RA	21.3 x 10^6 22.6 x 10^6		13.8 x 10^6 17.5 x 10^6	74.7 x 10^6 —	42.5 x 10^6 —	— —	— —	— —	— —
Vickers hardness (similar to Brinell—10 mm ball, 3000 kg load) cast annealed 50% RA	45 42 106		49 46 118	183 189 351	147 144 401	231 310 —	362 381 —	— 25 66	— 26 90

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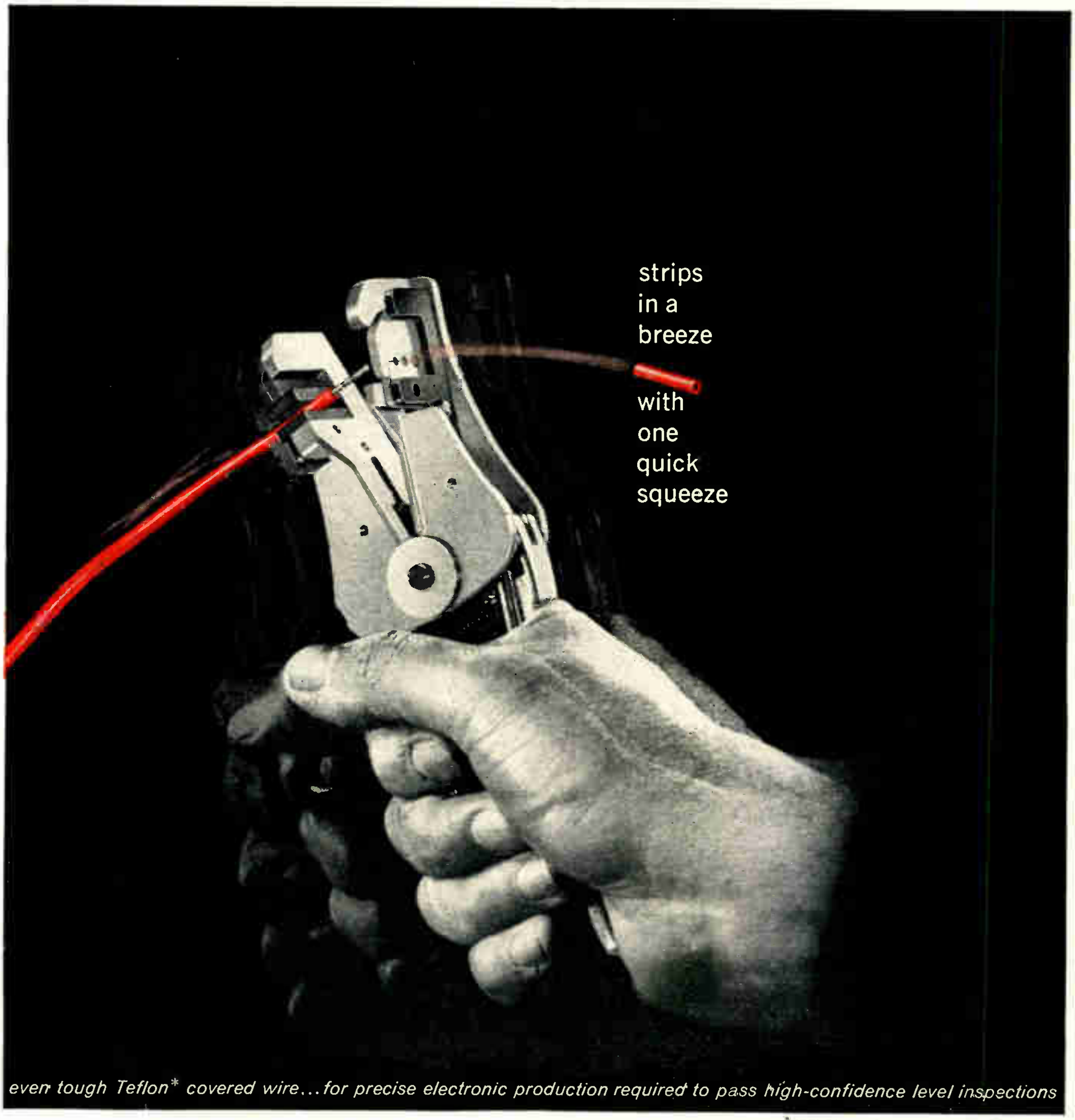
Rh Plating, Ir, Pd-Ag, Pt-Ru, Au, Pd-Ru, Au, Ag, Pd-Cu, Pt-Ir, Pt-Pd-Ru, Pt-Rh	Contacts Plated Contacts Strip	Relays, switches, telephone relays, telegraph transmitters, printed circuits, multi-position switches in automatic telephone and telegraph exchange equipment, alarm systems, radio frequency circuits, temperature controllers, spark plugs, Magnets, Sensitive Relays, Voice Relays, Heating pads, Railway Signals.
Pt-Rh, Pt	Wire, Sheet	Electronic equipment, brushes, sliprings.
Pt, Pt-Rh	Wire	Furnaces
Pt, Pt Alloys	Wire	Thermionic valves.
Pt, Pt-Ir	Contacts and Discs	Electromatic Road traffic control equipment.
Pd-Au, Au	Wire	Thermal Fuses.
Pt, Pd-Al	Wire, Gauze	Exothermic Fuses—Detonating devices.
Pt-Ir	Wire	Miniature moving coil relays.
Pt-Rh, Ru-Pt, Pt-Rh-Ru, Pt-Ir	Wire	Potentiometers.
Pt, Pt-Rh	Thermocouple Wire	Resistors.
Pt, Pt-Rh	Wire, Sheet	High Temperature Xray Diffraction.
Pt-Cobalt	All Forms	Permanent Magnets (Hearing Aids, Electric Watches).
Pt Alloys	Foil	Radio Tuners.
Pt Alloys	Wire, Tape	Cat Whiskers.
Pt, Pd, Pd-Au	Chemicals, Sponge, Powders	Fuel Cells.

* Material provided by J. Bishop & Co. Platinum Works, Malvern, Pa.



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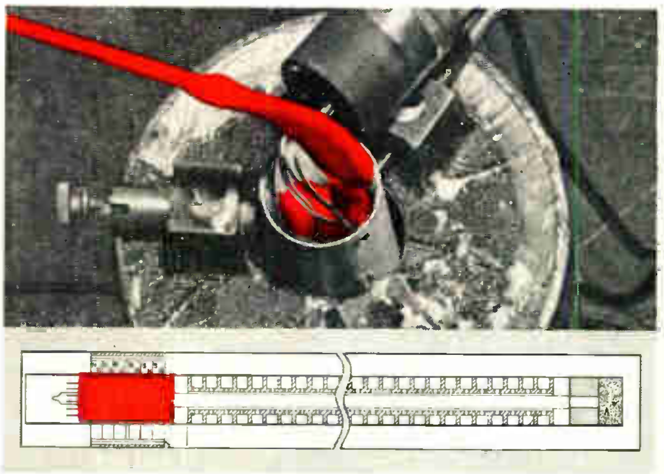

This traveling wave tube made by Huggins Laboratories, Inc., is a broad band receiving and transmitting tube used in communications, radar, missile checkout . . . other complex electronic gear. It provides: power amplification greater than 10,000 over a two-to-one frequency range; operating band widths to 7,000 megacycles. To assure this performance, precise positioning of the electron gun is vital and must be maintained under all operating conditions. Silastic® RTV, the Dow Corning liquid silicone rubber that cures at room temperature, is used to bond and cushion the gun in position within the capsule. Quick set-up time of Silastic RTV speeds production, while high dielectric strength helps assure performance.

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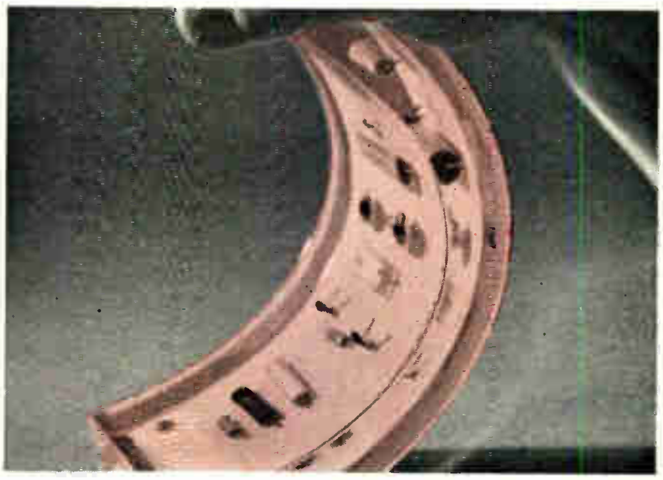

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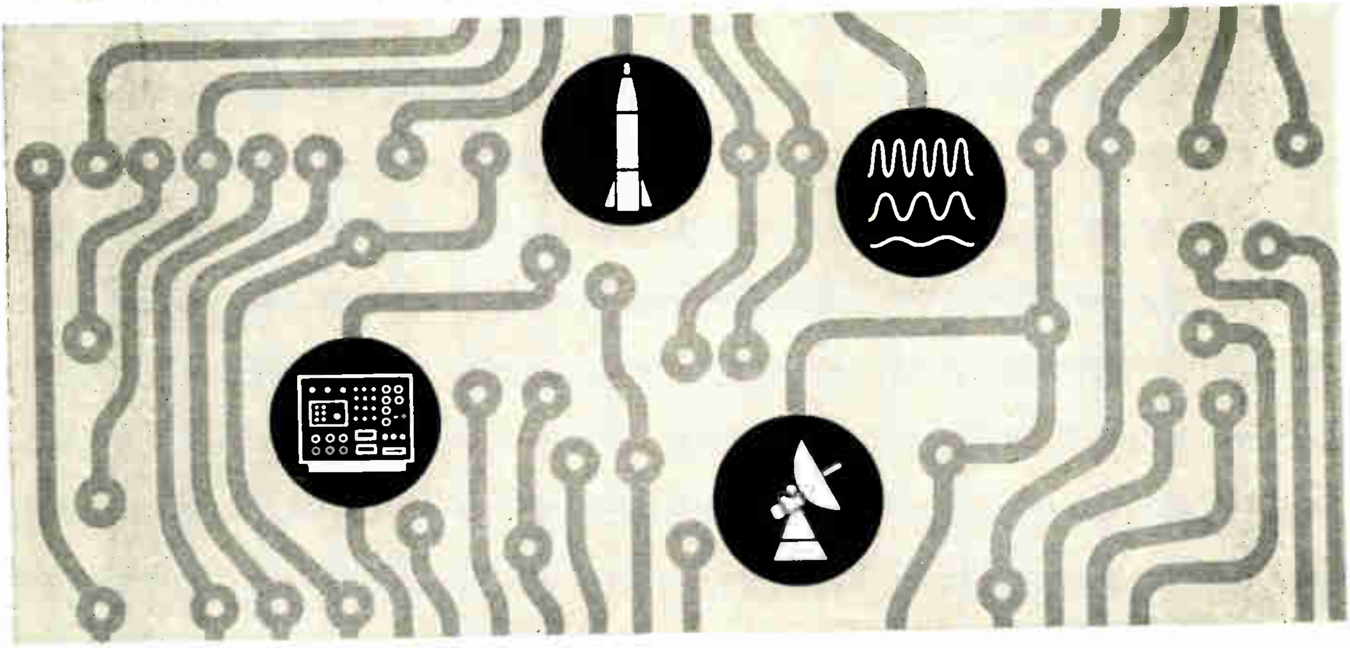

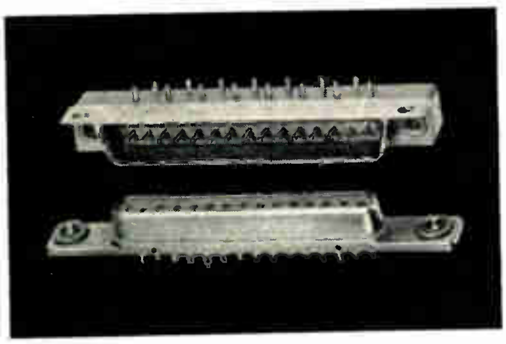

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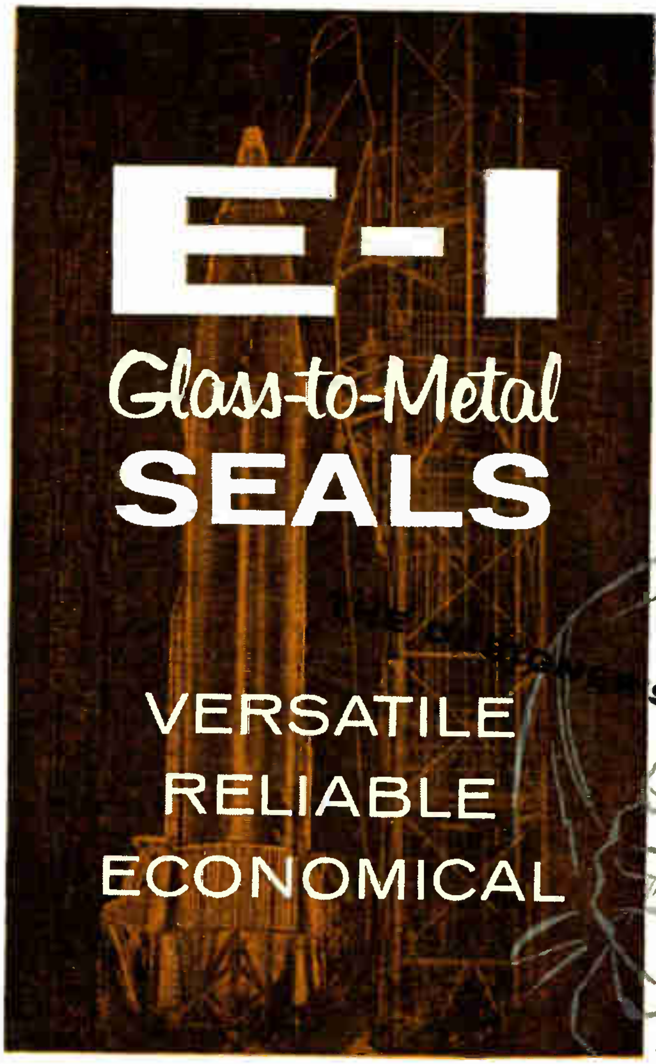

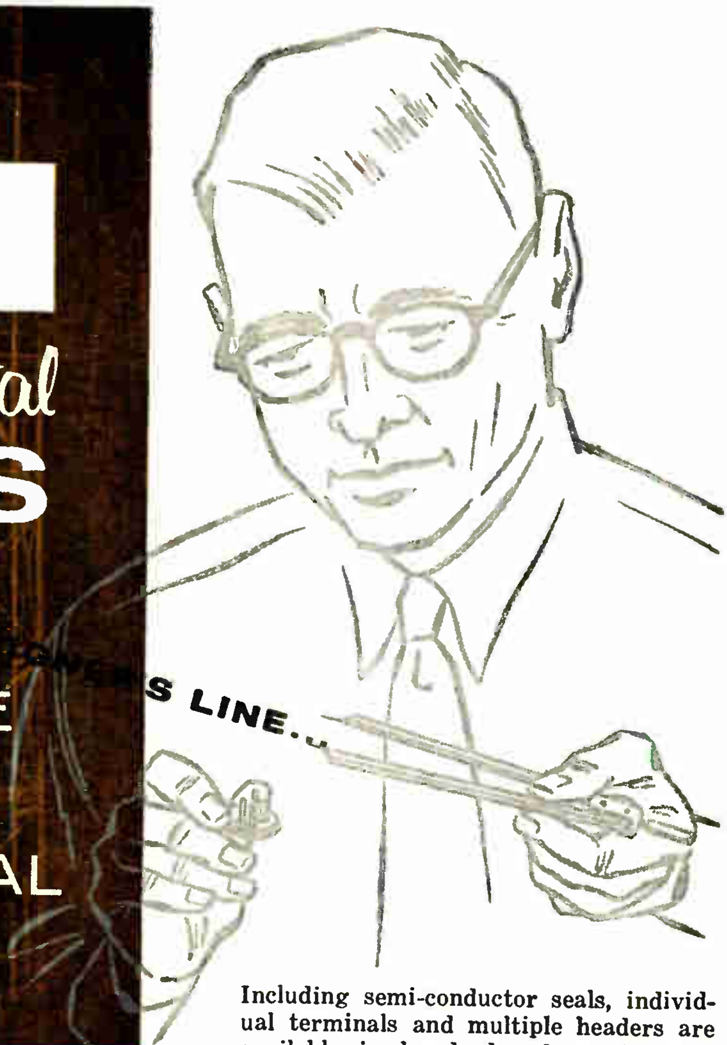

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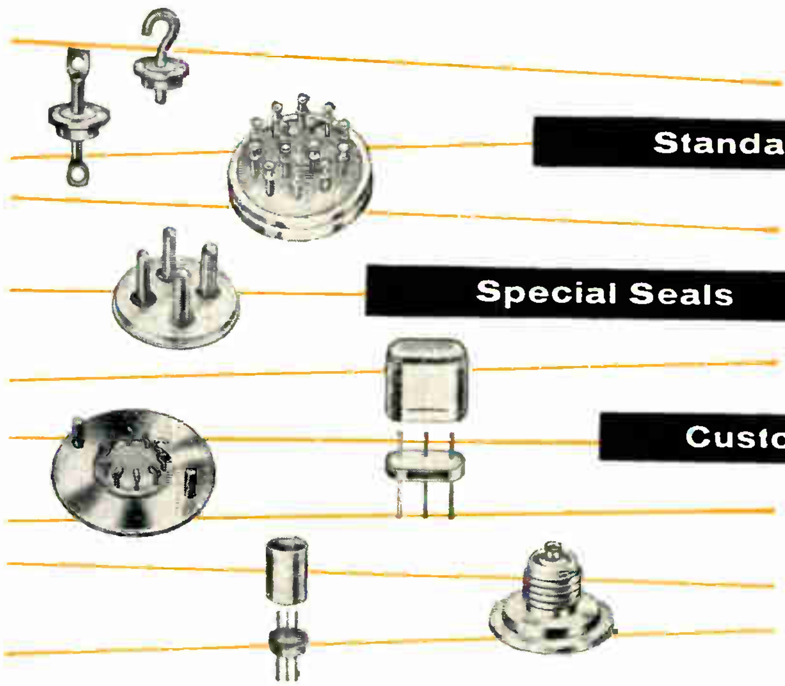

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Tech Data for Engineers

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Bobbin Cores, which have the retentive properties characterized by a rectangular hysteresis loop and are made of very tiny tapes reducing the time delay effects caused by eddy currents, designed for digital data processing systems are described in tech data available from G-L Electronics, 300 Harvard Ave., Westville, N. J. Included are dimensional drawings and size tables on ceramic and stainless steel types.

Circle 362 on Inquiry Card

Bearing Analysis

"Ball and Roller Bearing Analysis Through Electronics," 6-pages, describes a high speed measuring instrument for evaluating the internal working surfaces of 97% of all bearings. Bearing Inspection, Inc., 3311 E. Gage Ave., Huntington Park, Calif.

Circle 363 on Inquiry Card

Metals

Tech data, 8-pages, is available from Riverside-Alloy Metal Div., H. K. Porter Co., Inc., 19 Washington St., E. Orange, N. J., on electrical and electronic industry metals. Included are photographs and descriptions on nickel group, monel group, inconel group, nickel silvers, stainless steel, and nickel-clad copper wire metals.

Circle 364 on Inquiry Card

Ceramic Material

CarBerlox, a lossy dielectric ceramic material offers high ability to absorb and transmit heat, which gives high high-freq. energy absorption without thermal damage. This hard-fired ceramic is dimensionally stable to temps. approaching 3500°F and has high mechanical strength and thermal shock resistance. Included are characteristic curves. National Beryllia Corp., First and Haskell Aves., Haskell, N. J.

Circle 365 on Inquiry Card

Precious Metals

This 22-page, 2-color brochure describes the abilities and capabilities of Engelhard Industries, Inc., in the field of precious metals for use in such industries as the electrical, electronic, electroplating, delay line, semiconductor, nuclear, optics, missile, radar, radio, and aircraft. Information is also included on research in electrochemical techniques, ceramics, fuel cells, metal physics and metallurgy. Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J.

Circle 366 on Inquiry Card

Tech Data
for Engineers

Vinyl

Additional test data, processing information and suggested uses for hi-temp Geon vinyl are contained in a 12-page booklet entitled "Hi-Temp Geon" available from B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio. Hi-temp Geon vinyl can be extruded, molded, calendered, formed or stamped on conventional thermoplastic processing equipment.

Circle 396 on Inquiry Card

Resins

A 24-page technical manual-catalog giving complete electrical, physical and chemical properties of "Teflon" TFE and 100 FEP resins is available from Tri-Point Industries, Inc., 175 I.U. Willets Rd., Albertson, L. I., N. Y. Specs. for a wide variety of basic extruded and molded forms, including rod, tube, tape, film, sheet, plate and spaghetti in virgin resin, as well as special filled and reinforced resin compounds are included.

Circle 397 on Inquiry Card

Lithium Metal

Products list available from the Foote Mineral Co., Rt. 100, Exton, Pa., lists lithium chemicals, metal and minerals, electrolytic manganese, zirconium, welding grade products, and steel addition agents for use in the chemical, metallurgical, ceramic electronic, nuclear and astronautic industries.

Circle 398 on Inquiry Card

Glass-to-Metal Terminals

This 25-page multi-colored catalog describes specifications on glass-to-metal hermetic terminals. Divided into 5 sections, summary information is provided on hermetic terminals, for design engineers and purchasing agents. The 5 major sections detail single electrode terminals, multiple electrode terminals, solid glass headers, miniature relay headers, and diode and transistor headers. The Fusite Corp., 6000 Fernview Ave., Cincinnati 13, Ohio.

Circle 399 on Inquiry Card

Caulking Compounds

Tech. data is available on relatively low-cost, highly conductive putty-like caulking compounds designed for both the hermetical and electrical sealing of r-f enclosures. Two plastic types are offered. One is a non-setting paste and the other is solvent based and sets to a semi-rigid condition, giving moderate bonding. They are compatible with all types of metals and can be used over a temp. range of -85 to 100°C. Chomerics, Inc., 341 Vassar St., Cambridge 39, Mass.

Circle 400 on Inquiry Card

Circle 70 on Inquiry Card

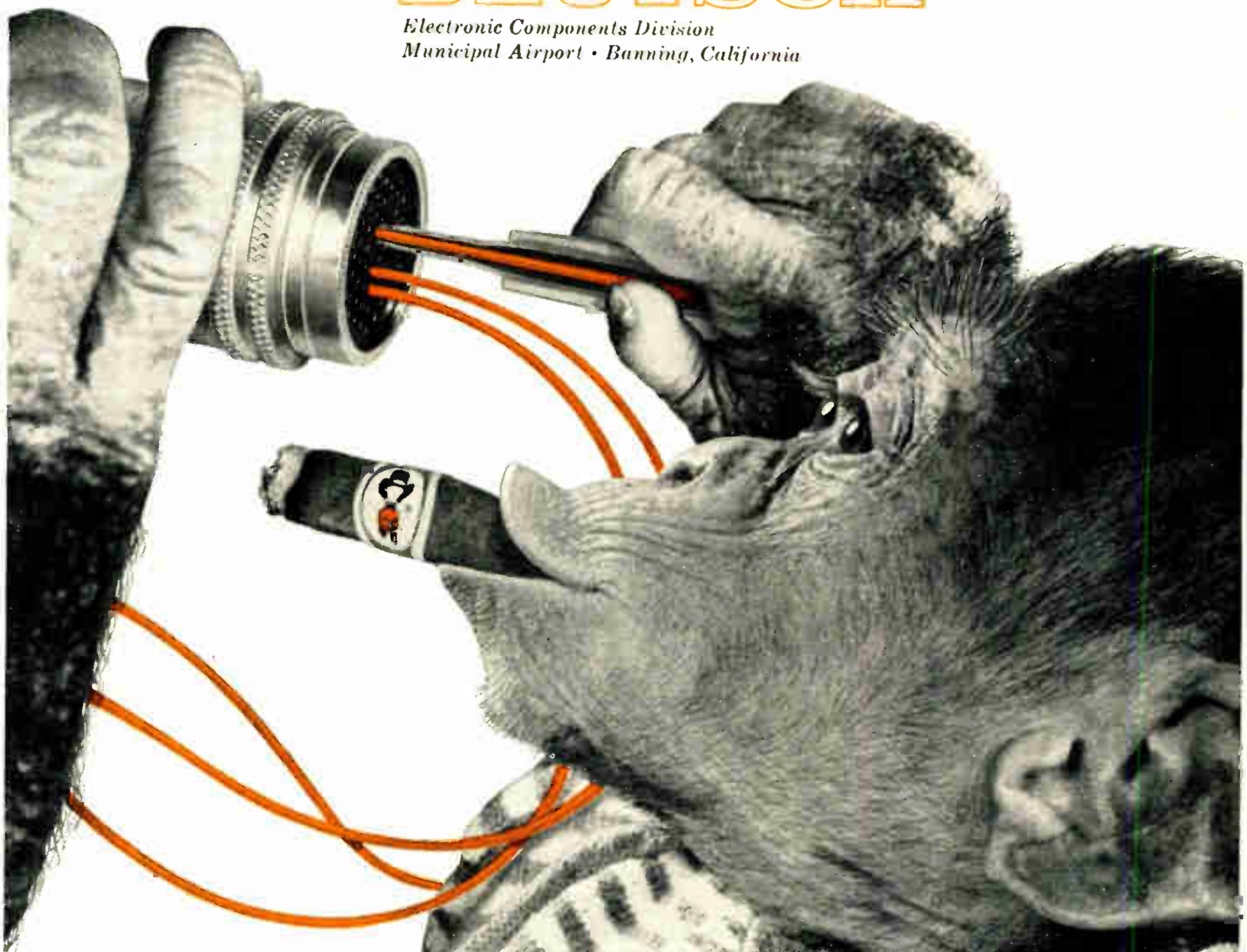

Shielded Power Supply Cables—Rubber
Duplex Connector Extension Cords
Cathode Ray Tube Lead
Miniaturized Cables
Grid Wires
Control Cables
Magnet Wire
Plastic Microphone Cables
Automation Cable
Shielded Interconnecting Cables
Low Impedance Lines
Unpaired Intercom Cables
Audio Cables
Individually Shielded Intercom Cables
Shielded Control Cables
Mr. Design Engineer...
BELDEN Has It
Every electronic and electrical wire you need—from the finest drawn magnet wire to the most complex multi-conductor cable.
There is a Belden wire or cable in every insulation and shielding to meet your design and application requirements. Here is just part of this complete line. Available from stock.
Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO
One Wire Source for Everything Electronic and Electrical
• electronic wire • magnet wire • lead wire • power supply cords
• cord sets • portable cordage
8-4-1
Coiled Test Prod Wire
RG/U Transmission Line Cables
RC/U Cables
3-Conductor Power Cords
Control Cables
Rubber Microphone Cables
Hook-Up Wires
Miniature Audio Cables
Duplex Primary Wires
Strain Gauge Cables
Call System Cables
Test Prod Wires
Broadcast Audio Cables
PA System Cables
2-Conductor Power Cords
TV Eye Camera Cable
Sound & Alarm System Cables
2 & 3 Conductor Extension Cords
Miniature Microphone Cables
Multiple Pair Cables
Mil-Spec Wires
Belden
WIRES · CABLES · CORDS
ELECTRONIC WIRES
Color, Studio, Closed Circuit Camera Cables
Industrial Intercom Wires
75-Ohm Video Cable
Lamp Cordage
Portable Cordage
Coiled Cords
Teflon* Wires
*DuPont trademark
Shielding & Bonding Cable
Special Sound Cables

Take the Monkey Business Out of Connector Assembly with the Rugged MDR

No need to monkey around with delicate inserts found in so many electrical connectors today now that the new Deutsch Rigid is available. This rugged design with its solid plastic insert makes multiple contact connector assembly easy as falling out of a tree. And look at all the features the MDR has inherited from its space age relatives: crimp-type contacts that snap in and stay in, a reliable Deutsch ball-lock coupling mechanism that just needs an easy push to connect and gentle pull to disconnect, plus interchangeability with other Deutsch connector series. But for complete facts on this little beauty, contact your local Deutschman today or write for Data File U-6.

DEUTSCH

Electronic Components Division
Municipal Airport • Banning, California



ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

Circle 109 on Inquiry Card

Long Nose Special Wire Cutter LC56
Wire Stripping Plier ST55
Diagonal Cutting Plier MS54
Long Nose Plier LN54
Long Nose Side Cutting Plier SN54
Duck Bill Plier DN54
Transverse End Cutting Plier EC54
Curved Long Nose Plier CN54
Designed to the requirements of industry
A variety of precision pliers built
to stand up under the continuous use
of production workers.
Little
DIAMOND ®
Electronic Pliers
Light weight ...shaped to fit the hand
Ask your favorite electronic distributor for Diamalloy Pliers.
DIAMOND TOOL and Horseshoe Co.
DULUTH, MINNESOTA • TORONTO, ONTARIO
EST. 1908

ON THE SHELF— ARNOLD CORES

IN WAREHOUSE STOCK FOR IMMEDIATE DELIVERY

Let us handle your inventory problems and save you time and money on your magnetic core requirements.

Extensive stocks of four types of Arnold cores in the most popular sizes have been set up in our Marengo, Illinois and Fullerton, Calif. plants. Subject of course to temporary exhaustion of stock by prior sales, these cores will be shipped *the same day* on orders received at the warehouse by 12:00 noon. When cores are out of stock at the nearest plant, we may be able to ship within 24 hours from the other.

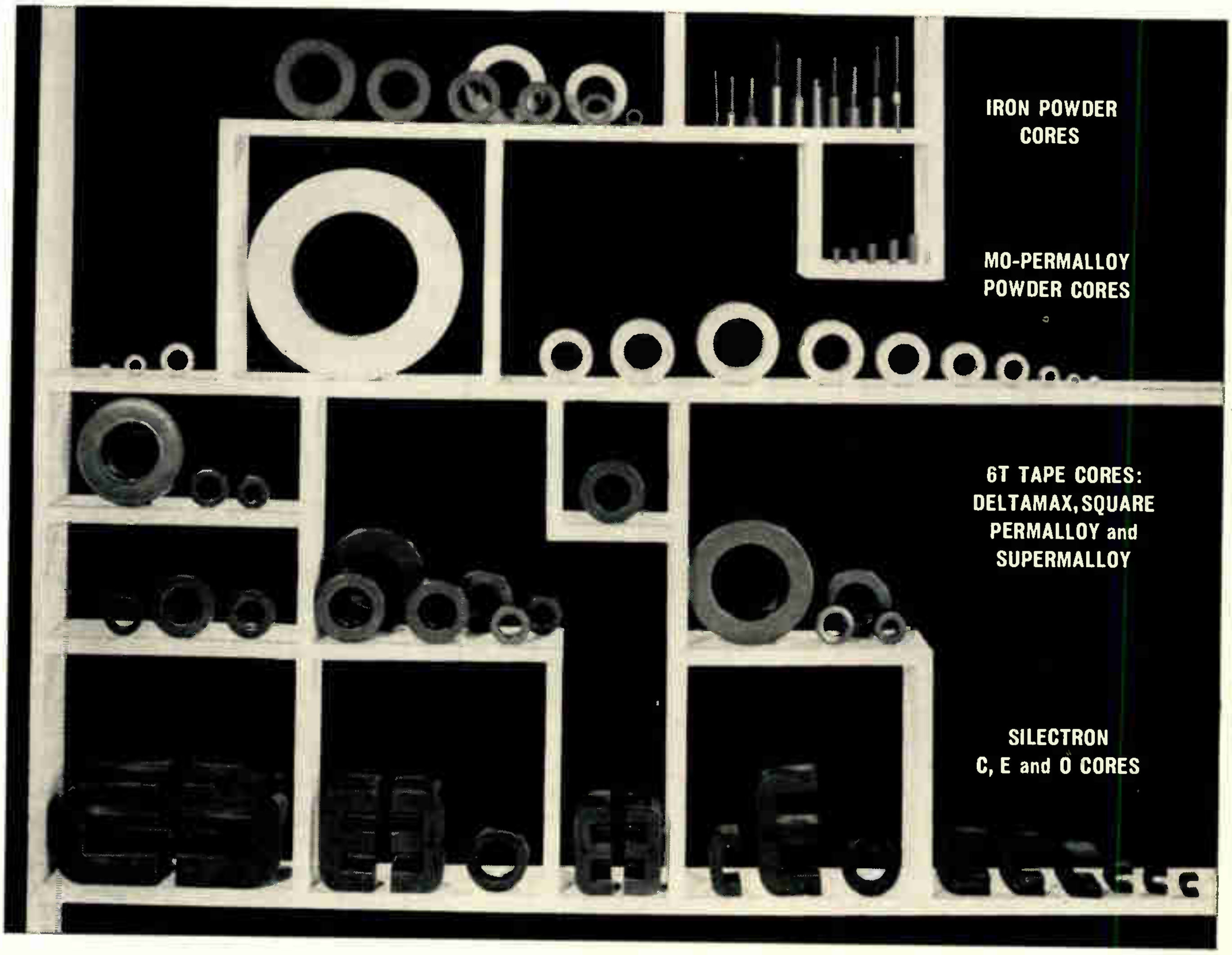
Arnold core products covered by this warehouse stock program include: 1) Silectron C, E and O cores in 2, 4 and 12-mil tape. 2) Type 6T aluminum-cased cores of Deltamax, Square Permalloy and Supermalloy, in 1, 2 and 4-mil tape. 3) Mo-Permalloy powder cores, both temperature-stabilized and unstabilized types, ranging down to 0.260″ diameter. 4) Iron powder toroids, threaded cores and insert cores.

All four products are available in a wide range of selection, for your convenience and economy in ordering either prototype design lots or regular production quantities. ● Stock lists, bulletins, etc. are available—write for information. *The Arnold Engineering Company, Marengo, Ill.* 2998A

ADDRESS DEPT. EI-6

ARNOLD
SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • *Find them FAST in the YELLOW PAGES*



Au/Ni = RELIABILITY

AMP PRODUCT PERFORMANCE PROVES IT!

Gold over nickel plating . . . the standard AMP choice for printed circuit connector contacts! Not optional . . . but standard! And with good reason.

No haphazard choice dictated the metallic fraction that makes plating an important feature of the AMPin-cert* Printed Circuit Connector line. The decision to make gold over nickel standard plating came only after exhaustive tests involving a whole wide range of metals in various thicknesses and combinations.

Plating thicknesses, porosity, contact forces—all these were thoroughly tested. Exposure to heat, cold, corrosion and humidity . . . series after series of tests ran the gamut of extreme environmental conditions for every plating metal considered. Results, tabulated over a period of years, pointed to one fact—gold over nickel was vastly superior in every way.

These AMPin-cert Printed Circuit Connectors can be loaded to accommodate only those circuits actually needed. There are no pre-loaded, unused contacts!

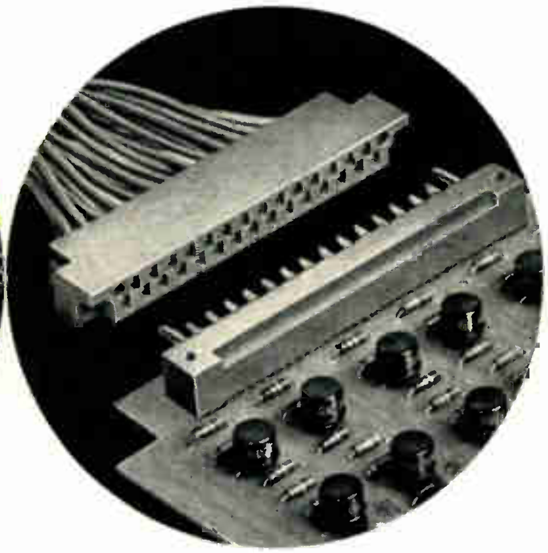
Crimp, snap-in type contacts are plated with .000030″ gold over .000030″ nickel (min.). There is no metal "creep". No debilitating oxide insulation buildup. Contact pressures are engineered to avoid excessive or quick plating wear. Consequently, AMPin-cert connectors last longer, give maximum performance and assured reliability.

Research findings on plating and facts on the AMP gold over nickel standard are available in reprints of papers published by AMP Research. Write for your copy today.

AMP
INCORPORATED
Harrisburg, Pennsylvania

AMP-LEAF* and AMP-BLADE* Connectors . . . are part of the AMPin-cert line which includes Pin and Socket, Printed Circuit, Coaxial, and General Duty types

AMP-LEAF



AMP-BLADE

AMP products and engineering assistance are available through subsidiary companies in:
Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

*Trademark of AMP Incorporated

Special Pliers for the Highly Specialized Electronics Field

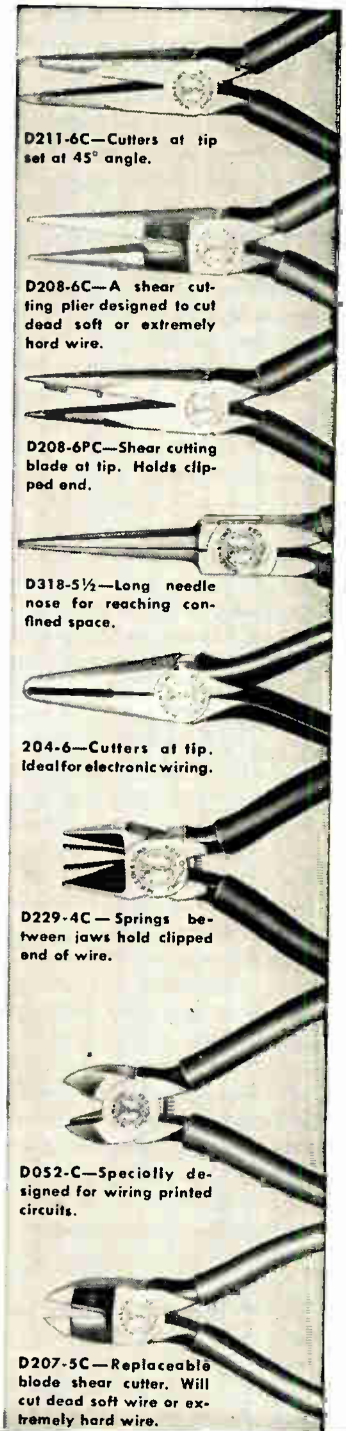
When the early transmission lines were strung in this country a century ago, it was Klein Pliers in the hands of linemen that helped do the job.

Klein has kept pace with the development of the electrical field, meeting each new challenge with tools specially designed to do the wiring job better . . . more economically.

Shown here are a few of the many highly specialized Klein Pliers carried in stock to meet the needs of electrical and electronics manufacturers.

You will find your assemblies go together more smoothly and wiring is done more rapidly when the right Klein Plier is used.

SEE YOUR DISTRIBUTOR



D211-6C—Cutters at tip set at 45° angle.

D208-6C—A shear cutting plier designed to cut dead soft or extremely hard wire.

D208-6PC—Shear cutting blade at tip. Holds clipped end.

D318-5½—Long needle nose for reaching confined space.

204-6—Cutters at tip. Ideal for electronic wiring.

D229-4C — Springs between jaws hold clipped end of wire.

D052-C—Specially designed for wiring printed circuits.

D207-5C—Replaceable blade shear cutter. Will cut dead soft wire or extremely hard wire.

Mathias KLEIN & Sons
Established 1857 — Chicago, Ill., U.S.A.
INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL.

Mathias Klein & Sons, Inc. 7200 McCormick Road, Chicago 45, Ill.
Please send me the Klein Plier Catalog and information.

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________________ State ________

Circle 75 on Inquiry Card

How many of these B&A Electronic Chemicals do you need?

Check your requirements against General Chemical's extensive line of B&A® "Electronic Grade" chemicals. Principal products are listed here—and there are many others too! You'll find that "B&A"—America's leading line of "Electronic Grade" chemicals—is your best single source for *all* your high purity chemical needs!

As America's foremost producer of laboratory and custom chemicals, General Chemical has the wide range of products, the versatile production facilities, and the specialized experience to meet virtually every electronic chemical need! Write today for our free information folder, "B&A Electronic Chemicals." Gives specifications plus other valuable information.

Allied Chemical

GENERAL CHEMICAL DIVISION

40 Rector Street, New York 6, N.Y.

Baker & Adamson® "Electronic Grade" Chemicals

PRODUCTION OF SEMICONDUCTORS:

For Etching:

- ☐ Acetic Acid—Reagent, A.C.S.
- ☐ Ammonium Bifluoride—Technical
- ☐ Ammonium Fluoride—Reagent
- ☐ Bromine—Reagent, A.C.S.
- ☐ Glycerin—Reagent, A.C.S.
- ☐ Hydrochloric Acid—Reagent, A.C.S.
- ☐ Hydrofluoric Acid—Electronic Grade
- ☐ Hydrogen Peroxide (Stab.)—Electronic Grade
- ☐ Nitric Acid—Reagent, A.C.S.
- ☐ Phosphoric Acid—Reagent, A.C.S.
- ☐ Potassium Hydroxide Pellets and Solution—Electronic Grade
- ☐ Sodium Carbonate—Electronic Grade
- ☐ Sodium Hypophosphite—Reagent
- ☐ Sodium Hydroxide Pellets and Solution—Electronic Grade
- ☐ Sulfuric Acid—Reagent, A.C.S.

As Solvents:

- ☐ Acetone—Electronic Grade
- ☐ Alcohol, Ethyl—Reagent
- ☐ Carbon Tetrachloride—Electronic Grade
- ☐ Ether—Electronic Grade
- ☐ Methyl Alcohol—Electronic Grade
- ☐ Propyl Alcohol Iso—Electronic Grade
- ☐ Trichloroethylene—Electronic Grade
- ☐ Trichloroethane—Reagent
- ☐ Xylene—Reagent, A.C.S.

For Plating:

- ☐ Fluoboric Acid—Purified
- ☐ Cadmium Fluoborates—Purified and High Purity
- ☐ Cupric Fluoborate—Purified
- ☐ Indium Fluoborate—Technical
- ☐ Lead Fluoborate—Technical
- ☐ Stannous Fluoborate—Purified
- ☐ Nickle Chloride—Reagent, A.C.S.
- ☐ Nickle Sulfate—Reagent, A.C.S.

Germanium Products:

- ☐ Germanium Dioxide—Electronic Grade
- ☐ Germanium Metal—Electronic Grades

For Post Treatment of Semiconductors:

- ☐ Hydrogen Peroxide—Electronic Grade

PRODUCTION OF TV TUBES:

- ☐ Barium Acetate—Electronic Grade
- ☐ Barium Nitrate—Electronic Grade
- ☐ Calcium Nitrate—Electronic Grade
- ☐ Strontium Nitrate—Reagent, A.C.S.
- ☐ Aluminum Nitrate—Electronic Grade

PRODUCTION OF CAPACITORS:

- ☐ Ammonium Hydroxide—Reagent, A.C.S.
- ☐ Boric Acid—Reagent, A.C.S.
- ☐ Manganous Nitrate—Reagent, A.C.S., Electronic Grade
- ☐ Oxalic Acid—Reagent, A.C.S.
- ☐ Sulfuric Acid—Reagent, A.C.S.

FOR PHOSPHOR PRODUCTION:

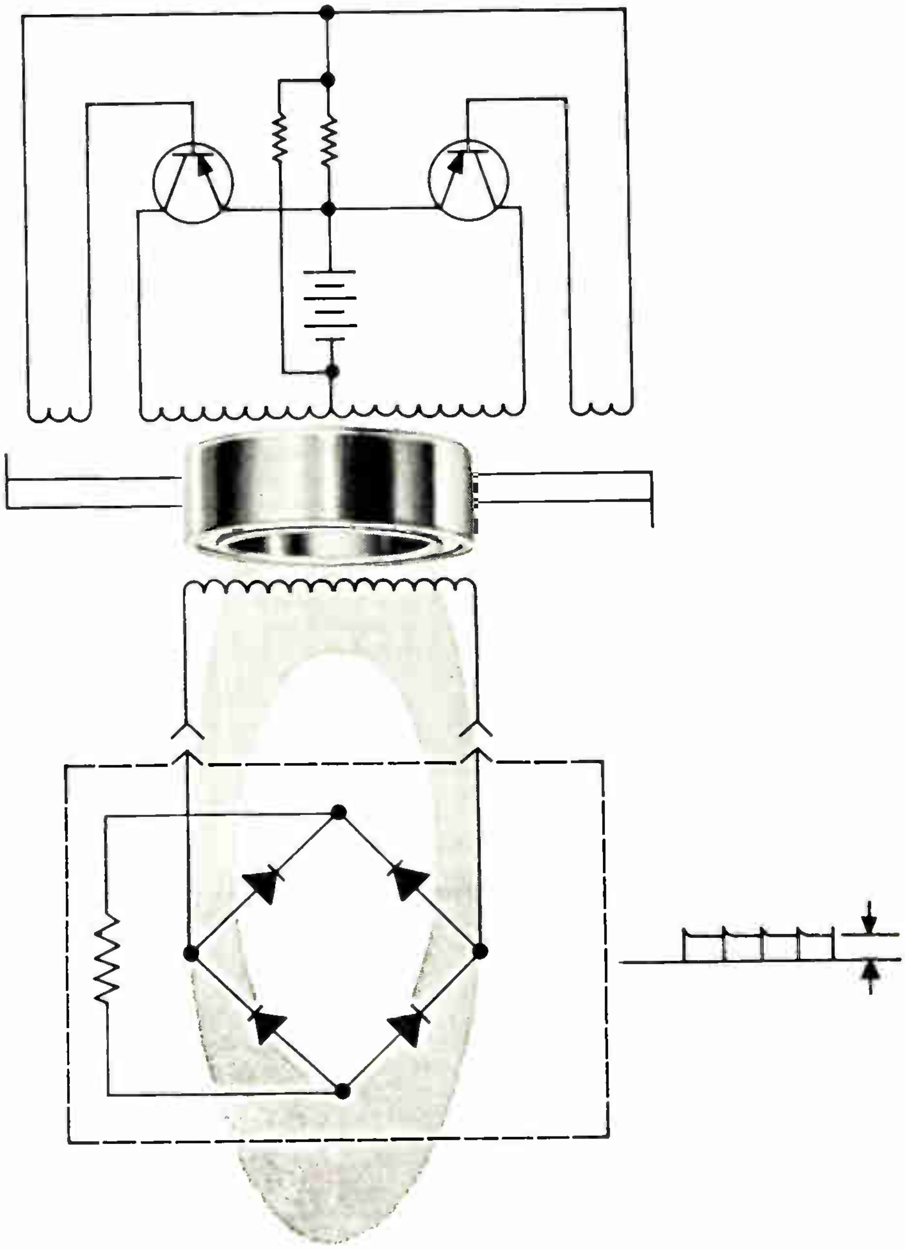
- ☐ Zinc Sulfide

FOR GASEOUS INSULATION:

- ☐ Sulfur Hexafluoride

Circle 76 on Inquiry Card

Circle 77 on Inquiry Card



How to design a static converter/inverter

Basically a magnetic coupled multivibrator, the square wave output of this static converter/inverter can be delivered as a-c directly to a load. Or, it can be rectified (full wave) to supply d-c voltages higher or lower than battery supply voltage. Ideal for highly portable equipment, the circuit has all the advantages of solid state devices. And, because transistors are the switches, replacing mechanical vibrators, potential maintenance problems are eliminated.

A Magnetics Inc. tape wound core is the *key* to perfect switching operation. The rapid change in core impedance in going from the unsaturated to saturated state forces the transistor switching. Thus, *a properly selected core* and the number of turns of wire on it become important, since this determines the operating frequency of the inverter.

Core material is important, too. For example, Magnetics Inc. Orthonol,® is ideal for most power applications where a given voltage and frequency are required. Where the design calls for a high voltage at low power levels, such as a d-c supply for photo tubes, Geiger tubes, or where high efficiencies are required under light loads, Magnetics Inc. Permalloy 80 should be selected.

Since power requirements, wire size, and frequency influence core size, Magnetics Inc. has a complete range of sizes and alloys available for complete design freedom.

To help you choose the core you need . . . and for more details on this circuit, write for bulletin "Designing d-c to d-c Converters" to Magnetics Inc., Butler, Pa.

MAGNETICS inc.®

Circle 78 on Inquiry Card

the magnificent trifle

news about solders, fluxes, preforms special alloys, lead and tin products

alpha®

alpha metals, inc. 56 Water Street, Jersey City, New Jersey • HEnderson 4-6778
Los Angeles, Calif. • Alphaloy Corp. (Div.) Chicago, Ill. • Alpha Metals, Inc. (U. K.) Ltd., London, Eng.

VACULOY® USERS REPORT 90% LESS REJECTS AND REWORK PLUS 10% SAVINGS ON SOLDER

In a recent value analysis study by a major electronic product manufacturer, Alpha Vaculoy bar solder reduced rejects by 90%, produced higher quality joints, and provided 10% more joints per pound with less maintenance or critical control. The direct dollar saving is estimated to be nine times the extra cost of Vaculoy . . . and this figure does not include the intangibles anticipated from reduced field failures or the added value of increased reliability.

Alpha Vaculoy bar solder conforms to federal specifications QQS-571 and applicable ASTM standards. It is substantially freer from oxide forming elements than other solders, because it is produced by a unique processing method which affects physical properties without disturbing metallurgical balance.

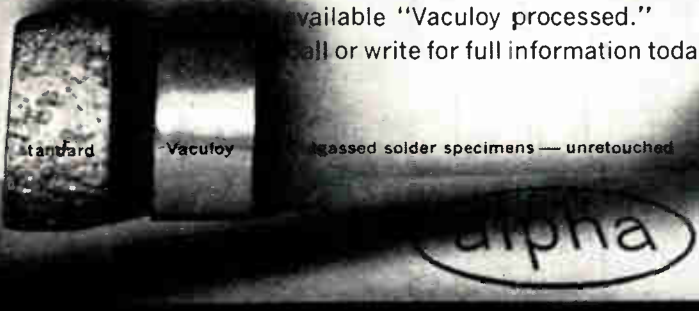
Other cases in point

A radio manufacturer had to pre-tin transistor leads prior to printed circuit assembly when using conventional 60/40 solder. A switch to Vaculoy 60/40 solder eliminated the need for pre-tinning.

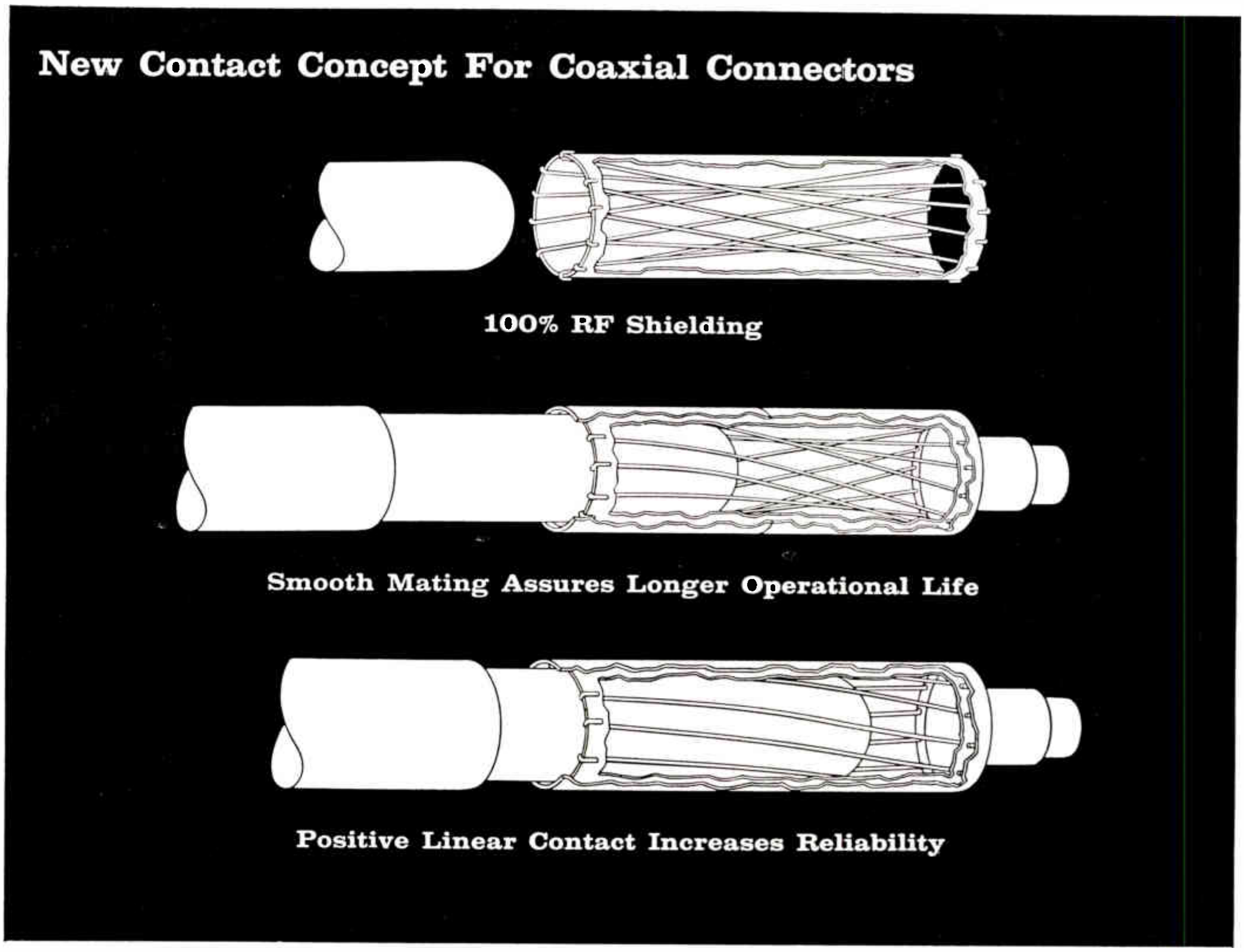
A large manufacturer of resistors and capacitors uses an automatic dip machine to pre-tin leads. Thermal precautions limit the depth of the immersion. Pre-tinning of leads without heat damage is mandatory. Hence, rejects were high. A switch to Vaculoy process solder in the same alloy gave more complete tinning in less time, cutting down rejects.

Laboratory and production runs prove Vaculoy solder offers superior quality, reduces rejects and cuts solder costs. All Alpha alloys are available "Vaculoy processed."

Call or write for full information today.

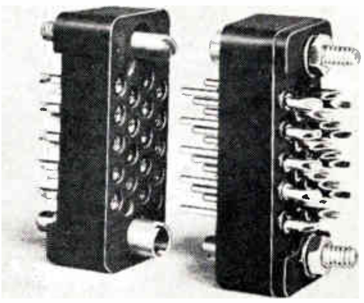


standard Vaculoy degassed solder specimens — unretouched



CURTAC®

Operational Reliability That Lasts . . . Even After 100,000 Insertion Cycles



Ideal for all coaxial applications, CURTAC Connector design can also be applied to a variety of multiple rack and panel arrangements.

CURTAC Connectors are completely new — in concept, design and construction — to give you reliable and consistent electrical and mechanical performance.

In life tests, CURTAC contacts functioned to specifications after 100,000 insertions. Elastic wrapping action of each contact wire, under tension, gives positive linear contact that withstands 50g shock, 20g vibration and temperatures ranging from 125°C to −65°C without physical damage or contact chatter. Multi-point contact provides normal operation after long static periods.

Contact design, plus wire wrapping action, assures 100% RF shielding — provides dependable contact pressure, low voltage drop and high current rating. Smooth mating of the CURTAC contact and solid pin make manual insertion of multiple coaxial contact arrangements easy and smooth. Meet or exceed all applicable Mil. Specs.

Electronic Fittings Corporation
Route No. 7 Danbury, Connecticut
A SUBSIDIARY OF
CURTISS-WRIGHT CORPORATION

Circle 81 on Inquiry Card

TIMES MAKES AND STOCKS MORE RG CABLES THAN ANYONE ELSE

in-stock cable shipped within 24 HOURS

Times can supply you with *any* RG coaxial cable you need—*when* you need it. This exclusive customer service is possible because Times produces and stocks the world's most complete line of polyethylene and teflon RG cables . . . including special and standard cables in an extensive variety of multiconductor configurations.

Times stocks more than 125 different types of RG cables in huge quantities, including the largest supply of Mil-Spec. approved RG cables. All Times cable in stock at the factory and at Times' nationwide distributors can be shipped within 24 hours. And Times' large production facilities and high volume business make its RG cable available at the most competitive prices.

In addition to being a major supplier of RG cable, Times also produces and stocks Teflon Hook-up Wire, Mil-Spec. 16878D.

Times publishes a *weekly* stock list indicating which cables are in stock and the amount available. For further information on this service and other Times' capabilities, write on your letterhead to Sales Manager, Dept. 600.

*A DuPont Trademark

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

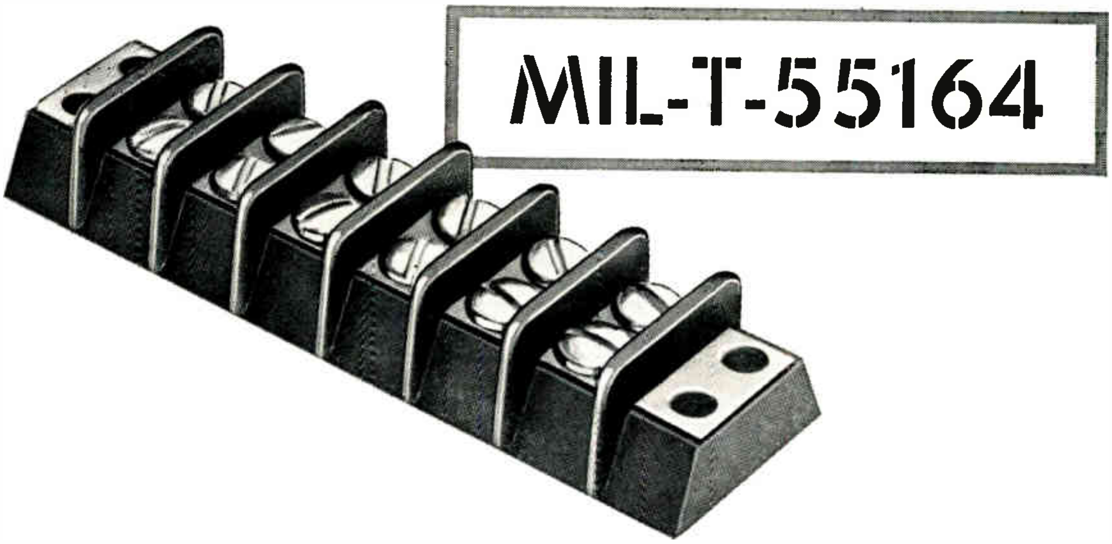
TIMES

TIMES WIRE AND CABLE
Division of The International Silver Company
Wallingford, Connecticut

TRANSMISSION SYSTEM DESIGN AND ENGINEERING • STANDARD & SPECIAL PURPOSE COAXIAL CABLE • MULTICONDUCTOR CABLE • COMPLETE CABLE ASSEMBLIES • TEFLON* HOOK-UP WIRE

IN ACCORDANCE WITH NEW

GOVERNMENT SPECIFICATION



GEN-PRO SOLID BLOCK TERMINAL BOARDS

Available for Immediate Delivery

New coordinated Government specification MIL-T-55164 requires that terminal boards with solid backs and molded-in inserts be used for all terminal board applications in equipment manufactured for the Department of Defense.

Gen-Pro Terminal Boards — manufactured by General Products Corporation — are in complete accordance with the requirements of new specification MIL-T-55164 and are available for immediate delivery.

SOLID BACKS save cost of insulating strips, resist moisture and breakage.

"MOLDED-IN" CONDUCTORS
assure greater capacity and permanent retention, reinforce mounting holes, eliminate separate saddle plates.

GEN-PRO solid block terminal boards are molded from Compound GDI-30F glass-filled diallyl phthalate flame resistant per MIL-M-19833 as required by this new coordinated government terminal board specification.

GEN-PRO®

Write today for illustrated brochure to Military Marketing Manager

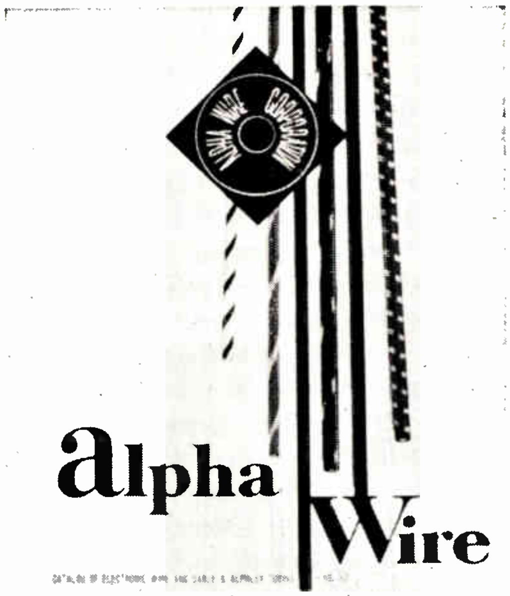
GENERAL PRODUCTS CORPORATION
UNION SPRINGS, NEW YORK TWX No. 169 Phone (Area code 315) TT 9-7367

OVER 25 YEARS OF QUALITY MOLDING

AUTHORITATIVE REFERENCE DATA:

HOW TO SPECIFY ELECTRONIC WIRE, CABLE & INSULATING MATERIALS...

FROM ALPHA... 40 YEARS OF APPLIED ENGINEERING KNOW-HOW!

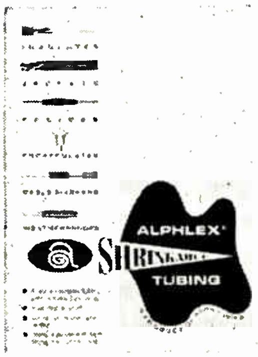


NEW ALPHA ELECTRONIC WIRE AND CABLE CATALOG:

Complete engineering information describing the entire Alpha & Alphlex lines of over 6,000 electronic wire, cable and tubing products. Included in this comprehensive book are Military Specification breakdowns, plus complete descriptions and applications of all wire, tubing and related products. The catalog highlights —

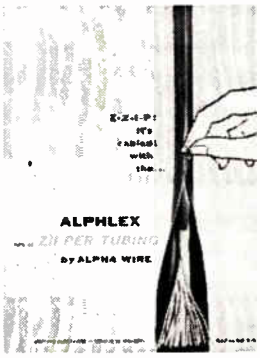
● Shrinkable Irradiated Polyolefin Tubing ● Teflon Tubing ● Teflon Cables ● Retractile Coil Cords and Extension Cord Sets ● Alpha-Tempil Temperature Indicators ● Alpha-Brady Wire Markers ● Lacing Cords and Tapes

A complete section describes Alpha's special facilities such as Striping, Cutting, Stripping, Tinning, Coloring of Cable Jackets and Short Run Cables.



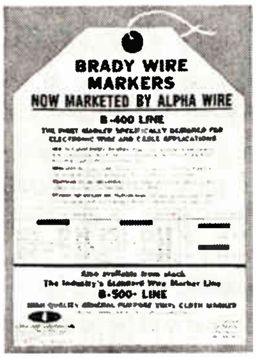
ALPHLEX SHRINKABLE TUBING

An irradiated polyolefin tubing featuring controlled shrinkage. Forms a tight mechanical bond seconds after heat is applied. Sizes, physical properties and a complete "How to Use" section are included.



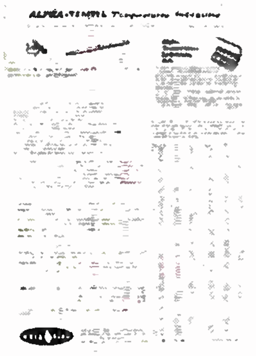
ALPHLEX ZIPPER TUBING

The most up-to-date and complete engineering brochure on the Alphlex line of Zipper Tubing. Featured is complete information on all 5 types of Zipper Tubing. Dimensions and physical properties are completely charted.



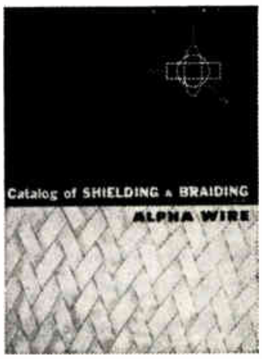
ALPHA-BRADY WIRE MARKERS

Featuring the new vinyl B-400 line of miniature markers. The first wire marker specifically designed for Electronic Wire and Cable. Full data on the B-500, standard line of wire markers is also listed. Includes complete application instructions and ordering information.



ALPHA-TEMPIL TEMPERATURE INDICATORS

For positive indication of critical temperatures. All electronic components can be temperature checked to $\pm 1\%$ accuracy without expensive and complex thermocouples. Available in liquid (Tempilaq) or solid (Tempilstik) form. Catalog contains typical applications, characteristics, listings of more than 100 available temperature ranges and information on new Alpha Temperature Indicating Kits.



SHIELDING AND BRAIDING

Applications, descriptions and all engineering data on Alpha Shielding and Braiding. Specifications on the 3 different types, Flat Braid, Oval Commercial Braid and Tubular Braid to military spec QQ-B 575 are provided. A special glossary is included.

Complete Data Sheets on New Alpha Products and Services.

- **Cable Coloring Process**
- **Packaged Shrinkable Tubing Assortments**
- **Comprehensive Price Sheet on Cut Tubing, marked and unmarked**

SEE OUR COMPLETE PRODUCT LISTING IN "RADIO MASTER" OR WRITE TODAY FOR YOUR COPY OF ANY OR ALL ALPHA WIRE CATALOGS.

ALPHA electronic WIRE

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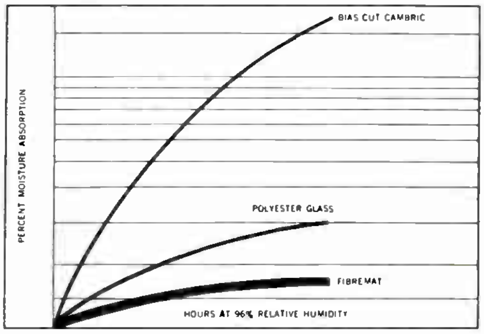
Pacific Division:
11844 Mississippi Ave., Los Angeles 25, Calif.

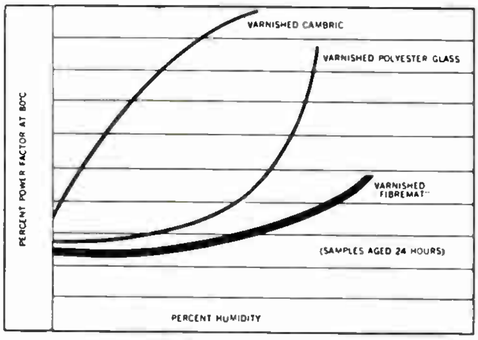
FOUR COMPARISON TESTS SHOW WHY YOU GET GREATER DEPENDABILITY WITH

NEW Fibremat® BRAND ELECTRICAL INSULATIONS

MOISTURE PICKUP ON UNCOATED FABRICS



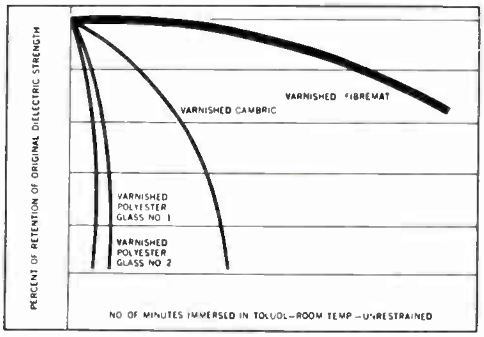
POWER FACTOR VS. HUMIDITY



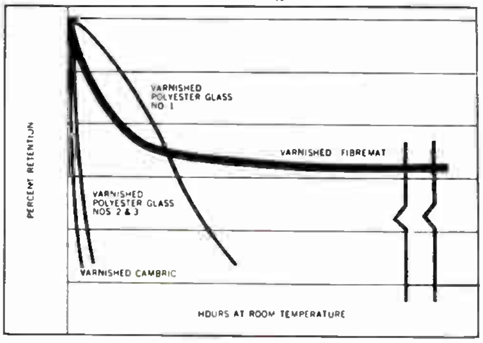
MOISTURE ABSORPTION – UNCOATED FABRICS – There's no pre-baking to drive out moisture when you use "Fibremat." The non-hygroscopic base fabric resists moisture. When exposed to 96 percent relative-humidity for 45 hours bias-cut cambric showed a moisture absorption of 25 percent, polyester-glass showed a moisture absorption of 2 percent, while "Fibremat" showed a moisture absorption of less than .7 of one percent. Proof of the superior moisture-resistance of "Fibremat" Insulation.

MOISTURE ABSORPTION – COATED INSULATIONS – In moist or humid environments "Fibremat" outperforms varnished cambric or polyester-glass materials. Continuous filaments in woven fabrics wick up moisture and offer a direct path for moisture to follow. The non-woven construction of "Fibremat" prevents wicking and moisture absorption. The power factor of varnished "Fibremat" remains relatively stable while the power factor of the other insulations zoom upward under increased humidity conditions.

SOLVENT RESISTANCE



RETAINED DIELECTRIC AT 12% ELONGATION



SOLVENT RESISTANCE – COATED INSULATIONS – "Fibremat" offers outstanding resistance to solvents used in dipping or impregnating operations. Conventional woven insulations leave relatively large unsupported areas of varnish film between the filaments. This unsupported film, when exposed to solvent, tends to swell and flake away from the base fabric and cause electrical failure. The uniform dispersion of fibers in "Fibremat" however, provides equal support for all areas of the varnish film and prevents this solvent-caused breakdown.

RETAINED DIELECTRIC AT 12% ELONGATION—COATED INSULATIONS—At 12% elongation varnished "Fibremat" retains a significantly greater percentage of its original electric strength than either varnished cambric or varnished polyester-glass materials. Woven insulation, when stretched, creates points of stress where filaments cross each other. Elongation produces a scissor-like action that weakens the structure, tends to tear the varnish film and rupture the insulation coating. Non-woven "Fibremat" has built-in stretch, doesn't "scissor", supports the entire film.

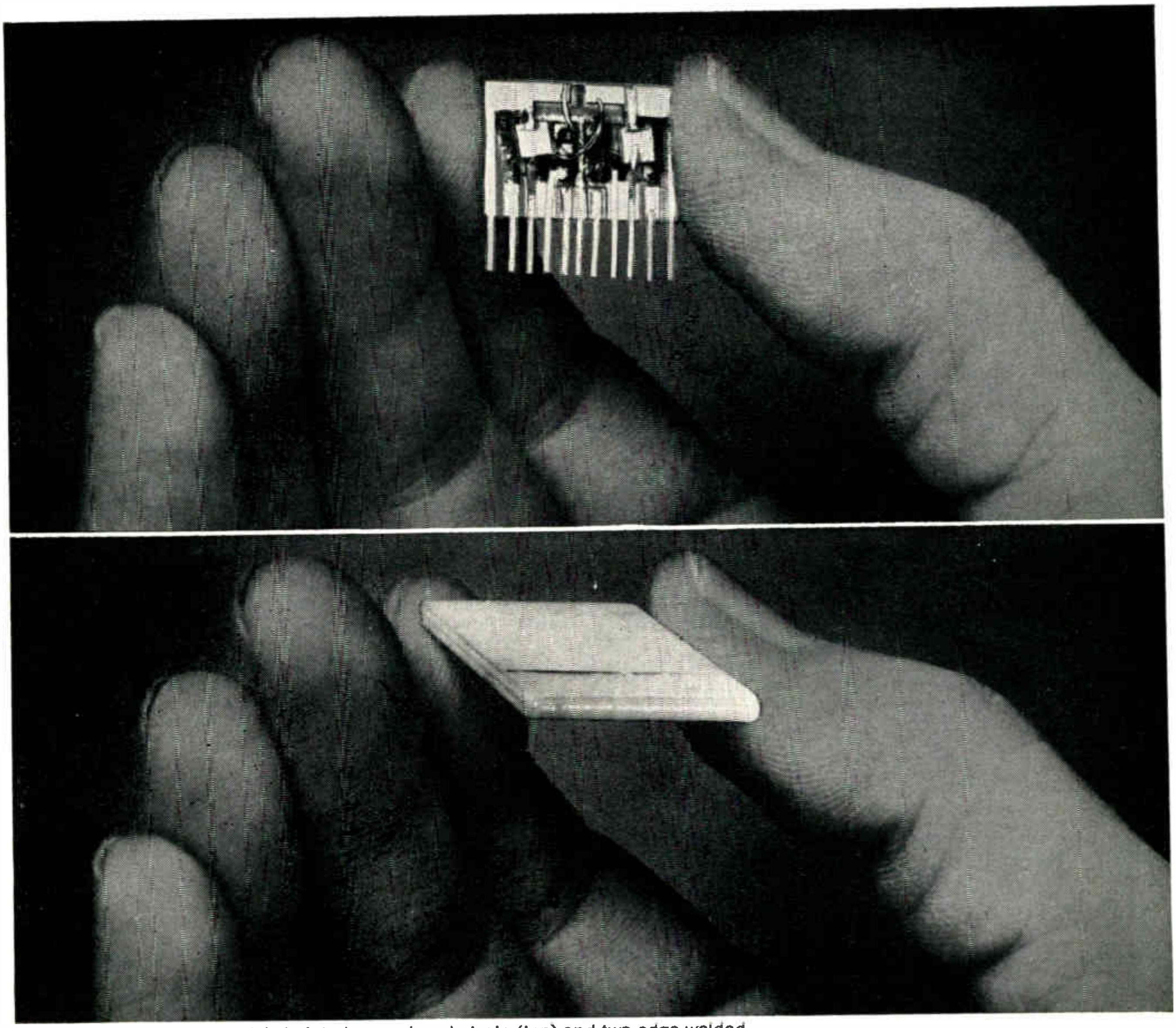
Irvington Division
3M MINNESOTA MINING & MANUFACTURING CO.

"FIBREMAT" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 1, MINN.

"Fibremat" is no ordinary insulation. It's formed from a non-woven web of polyester fibers without the use of adhesives or any other bonding agent. This unique non-woven construction gives "Fibremat" flexibility to conform snugly to irregular shapes without gapping or voiding. Helps it retain electric strength under elongation so fewer layers are needed to attain the same electrical performance achieved with many layers of ordinary insulating materials. Use "Fibremat" for wrapping form wound coils, layer and phase insulation, slot liners, and high voltage cable. For more information, write: 3M Company, Irvington Division, St. Paul 6, Minn., or phone and ask for "Fibremat" at your nearest branch office listed below.

ATLANTA, 451-1661; BOSTON, HI 9-0300; BUFFALO, TX 4-5214; CHICAGO, GL 8-2200; CINCINNATI, EL 1-2313; CLEVELAND, CL 2-4300; DALLAS, DA 7-7311; DETROIT, 875-7111; LOS ANGELES, RA 3-6641; PHILADELPHIA, PI 2-0200; NEW YORK, OX 5-5520; ST. LOUIS, WY 1-1320; ST. PAUL, PR 6-8511; SAN FRANCISCO, PL 6-0800; SEATTLE, MU 2-5550.

Circle 85 on Inquiry Card



Micro-electronic welds to nickel-plated ceramic substrate (top) and two edge-welded aluminum oxide ceramic wafers (bottom) show versatility of Hamilton-Zeiss Welders.

ELECTRON BEAM WELDING . . .
a new world of design at your fingertips

Hamilton-Zeiss Electron Beam Welders produce ultra-precise microminiature welds which set new standards of connection reliability. They also permit fabrication with difficult-to-join materials such as ceramics, refractories, and titanium. The Hamilton-Zeiss process allows designers of micro-electronic circuits and components to achieve optimum packaging density, reduced weight, and increased reliability.

The three exclusive Hamilton-Zeiss features which make these advantages possible are:

- Small beam diameter with high power density (37½ million watts per square inch).
- Optical viewing system which shows exact position of the beam on the workpiece at all times (40 mag.).
- Precise, repeatable control of beam energy, position, and penetration.

The process also permits component encapsulation and contamination-free joints of high structural integrity because the work is performed in a vacuum.

For full technical data on Hamilton-Zeiss Electron Beam Welder, write or wire: Electron Beam Systems, Hamilton Standard Division, United Aircraft Corporation, Windsor Locks, Connecticut.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

Circle 86 on Inquiry Card

Homemade

small precision parts . . .

are just like Torrington

precision parts . . .

except they cost more

If you make your own small precision metal parts—or buy them—send Torrington a print or sketch—and sample if available. We will send you a prompt quotation that may amaze you. You see, our plants produce small parts like these daily by the millions in the temper, hardness and microfinishes Torrington is famous for. More than 90 years of precision metalworking experience assures you of quality and economy. As we said, send us a print or sample. We'll make the part faster, better and for less. Whenever you need small precision parts in volume, write: Specialties Division.

PROGRESS THROUGH PRECISION **THE TORRINGTON COMPANY** TORRINGTON, CONNECTICUT

Serving industry throughout the world with metal specialties, all basic types of antifriction bearings, rotary swaging machines.

Circle 87 on Inquiry Card

Tech Data
for Engineers

Soldering Fixture

DIP-RAC is an adjustable universal printed circuit dip soldering fixture. It eliminates the necessity of building custom fixtures for different sizes and types of boards. Defiance Printed Circuit Corp., Malden, Mass.

Circle 367 on Inquiry Card

Soldering Irons

Tech data is available on 80 different models in 7 distinct types of soldering irons. Information is also included on a featherweight solder gun, and pencil irons. Hexacon Electric Co., Roselle Park, N. J.

Circle 368 on Inquiry Card

Thin Films

Optical Coating Laboratory, Inc., 2789 Giffen Ave., Santa Rosa, Calif. is offering a brochure on their capabilities and abilities in the field of thin films. Information is also included on an 8 micron long wavelength pass filter, a blue-red reflector, the "HEA" high efficiency anti-reflection coating; and a cold mirror.

Circle 369 on Inquiry Card

Laminates

Tech data is available on Genclad® F copper-clad Teflon®-Glass printed circuit laminates. Features include low dielectric loss under extreme temp. conditions, and low deformation under heat and pressure. General Plastics Corp., 55 La France Ave., Bloomfield, N. J.

Circle 370 on Inquiry Card

Component Clips

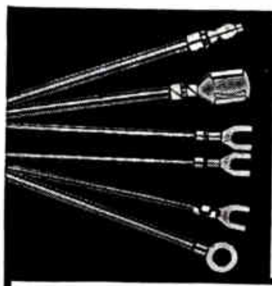
Transistor retainers of beryllium copper are fully described, including dimensional drawings and size tables, for a wide variety of transistors now on the market. Information is also included on capacitor retainers, and fuse clips. Braun Tool & Instrument Co., Inc., 140 Fifth Ave., Hawthorne, N. J. Two-colors, 11-pages Bulletin E-108.

Circle 371 on Inquiry Card

Technical Ceramics

This 4-page brochure on technical ceramics features a chart of some typical properties of special compositions which include a family of 5 grades of high purity aluminum oxides, steatite, zirconia, magnesia and cordierite. Technical Ceramics Div., Gladding, McBean & Co., 2901 Feliz Blvd., Los Angeles 39, Calif.

Circle 372 on Inquiry Card



DO YOU NEED

AUTOMATION

for

FINISHED WIRE LEADS

with

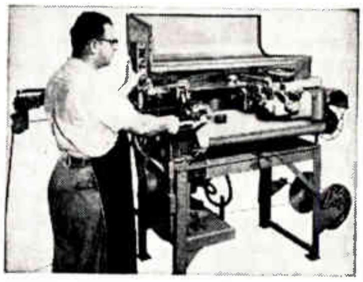
Terminals Attached?

NEW ARTOS TA-20-S
Performs 4 Operations Automatically!

1. Measures and cuts solid or stranded wire 2" to 250" in length.
2. Strips one or both ends of wire from 1/8" to 1".
3. Attaches any prefabricated terminal in strip form to one end of wire. (Model CS-9-AT attaches terminals to BOTH ENDS OF WIRE simultaneously.)
4. Marks finished wire leads with code numbers and letters (optional attachment).

UP TO 3,000
finished pieces per hour. Can be operated by unskilled labor. Easily set up and adjusted to different lengths of wire and stripping. ENGINEERING consultation without obligation. Machines for all types of wire lead finishing.

AGENTS THROUGHOUT THE WORLD



WRITE for FREE Bulletin No. 655 on Artos TA-20-S

ARTOS ENGINEERING CO.

2753 South 28th Street • Milwaukee 46, Wisconsin

Circle 89 on Inquiry Card

What could YOU do with this Sensitive Abrasive?

CRATEX® RUBBERIZED ABRASIVES

Without significantly changing dimensions of the workpiece, CRATEX® deburrs, smooths, cleans and polishes easy and hard-to-reach surfaces.

The unusual performance of Cratex results from its cushioned chemical rubber base. It is slightly compressible; shaped in a variety of forms, including Wheels, Points, Blocks, Sticks and Cones. First quality Silicon Carbide abrasive particles are evenly distributed throughout the base and each Cratex shape is available in 4 grit textures: (C) coarse; (M) medium; (F) fine; (XF) extra fine.

Typical Cratex applications include:

- precision finishing without loss of tolerances,
- cleaning out and finishing intricate designs,
- relieving stress concentration,
- radiusing,
- removing surface blemishes.

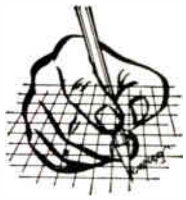
You can count on CRATEX® to do the same dependable job, time after time.

A comprehensive Cratex catalog and price list is available on request, without charge. Product and performance data provided may suggest how Cratex will benefit you in terms of time-saving cost reduction and quality improvement.

CRATEX® MANUFACTURING COMPANY, INC.
1600 ROLLINS ROAD BURLINGAME, CALIF.

Cratex is sold through leading industrial distributors.

Circle 90 on Inquiry Card



Time after time engineers specify Johnson connectors!

Whatever the choice . . . sub-miniature nylon connectors for printed circuit use—or Johnson's patented "Six-Way" Binding Post . . . time and time again design and development engineers specify Johnson connectors!

A complete line of nylon and standard connectors are readily available to meet most military and commercial applications—nylon types include: sub-miniatures for printed circuit applications; insulated solderless tip and banana plugs; tip and banana jacks; tip jack and sleeve assemblies; metal-clad and "rapid-mount" tip jacks; dual banana plugs and a unique, "6-way" binding post. Available in 13 colors for coded applications, nylon connectors are designed to operate throughout an extremely wide temperature range and under conditions of high relative humidity—voltage breakdowns available up to 11,000 volts on some types! For detailed information on the complete Johnson connector line and other Johnson electronic components—write today for our newest components catalog!

E. F. JOHNSON COMPANY
2020 TENTH AVENUE S.W. • WASECA, MINN.

NYLON AND STANDARD CONNECTORS

DETAILED COMPONENTS CATALOG AVAILABLE —Write today on company letterhead!

•CAPACITORS •TUBE SOCKETS •CONNECTORS •PILOT LIGHTS •INSULATORS •KNOBS AND DIALS •INDUCTORS •HARDWARE

Circle 91 on Inquiry Card

Tech Data

for Engineers

Epoxies

Tech data is available on CONAP 1610, which is a 2-component epoxy for potting and encapsulation. It features flexibility and maintains good electrical properties at temps. of 130° C and above. Other features include reasonable pot life, low viscosity and short cure for production efficiency. CONAP Inc., 184 E. Union St., Allegany, N. Y. Bulletin 1610.

Circle 373 on Inquiry Card

Heatsinks

Tech data is available on a line of heatsinks in all types and sizes. Vemaline Products Co., Franklin Lakes, N. J.

Circle 374 on Inquiry Card

Copper Alloy

This 4-page, 2-color, folder (D-29) lists the applications and physical properties of Amzirc—a heat-treatable, oxygen-free zirconium copper alloy. The alloy may be used for semiconductor bases, incandescent lamp filament supports, resistance welding electrodes and wheels, and commutators and slip rings. Chase Brass & Copper Co., Waterbury, Conn.

Circle 375 on Inquiry Card

Electronic Alloys

"Huntington Alloys for Electronic Uses" gives data on nickel and high-nickel alloys for electronic component parts. Chemical compositions, general characteristics, typical uses and availability of mill products are included. Huntington Alloy Products Div., The International Nickel Co., Inc., Huntington 17, W. Va.

Circle 376 on Inquiry Card

Glass-to-Metal Units

Information is available from Electron Technology, Inc., 626 Schuyler Ave., Kearny, N. J., on their abilities and capabilities for manufacturing stems and glass-to-metal assemblies, cathode-ray tubes, multiplier phototubes, ionization gauges, and special purpose tubes.

Circle 377 on Inquiry Card

Springs

Tech data is available on a line of beryllium copper compression springs, flat springs, strip springs, finger contact strips, and long contact strips. Instrument Specialties Co., Inc., Little Falls, N. J. This 19-page brochure also includes sections on properties, ductility, hardness, grain direction, tolerances, design recommendations, and endurance.

Circle 378 on Inquiry Card

HYSHRINK®

TUBING AND SLEEVING

Anaconda's Hyshrink tubing and sleeving gives you custom-fitting, insulating sheath on connectors, multi-pin connectors, cables, terminals, capacitors, pigtails and many other similar applications.

HERE'S HOW IT WORKS

1) Cut a section of Hyshrink tubing the length you want. Slip it on.

2) Apply 275°F heat for a few seconds.

3) Hyshrink shrinks to form a protective sheath the exact shape of the area covered.

RESULT

You get a custom-molded mechanical bond with these outstanding features.

- **CONTROLLED SHRINKAGE** Hyshrink is an irradiated polyolefin material. The molecular cross-links control the shrinking—giving you the dimensions you require.
- **EXCELLENT TEMPERATURE CHARACTERISTICS** —minus 67°F to 275°F. Tubing wil not run, flow, melt, harden, crack or blister.
- **HIGH DIELECTRIC AND MECHANICAL STRENGTH** Hyshrink is an excellent insulating material.
- **MOISTURE AND CHEMICAL RESISTANCE** Hyshrink protects against weathering. Is unaffected by most chemicals.

All of these features make Anaconda's Hyshrink the most versatile tubing and sleeving yet developed. For complete information, just write Anaconda Wire and Cable Co., 2201 Bay Road, Redwood City, California, Dept. JEB-2.

WRITE THE MAN FROM

ANACONDA

about HYSHRINK

Circle 93 on Inquiry Card

THE BIG PLUS BEHIND *GREMAR'S* NEW RIGID LINE CONNECTORS

Another new advance in Connectronics® combines excellent cable retention, high torque resistance, consistently low V S W R and 100% effective weatherproofing!

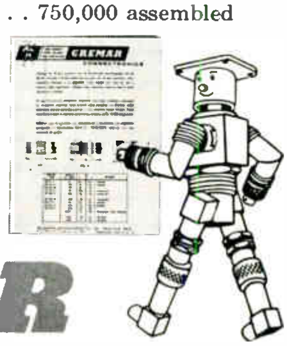
TRUST GREMAR to produce a brand new connector to solve problems long plaguing the rigid cable field! Here's a complete series for Foamflex, Styroflex, Styrofoam, Spirafil-T, Coaxitube and other rigid cable applications that deliver exceptional electrical and mechanical performance.

It wrenches up to a lock-grip that gives unequalled stability in service, despite the most severe torque, vibration, thermal cycling and environmental attack. It can be assembled and taken apart repeatedly without need to replace parts or redress cable sheath . . . does not require special tools or fixtures.

TRUST GREMAR to develop unique weatherproofing: successive coatings of copper, electroless nickel, silver and rhodium, plus silicone gasket sealing that defeats any climate.

TRUST GREMAR for any R F connector requirement. Standards can be shipped in hours from our stock of 3200 types . . . 750,000 assembled units . . . 8,000,000 parts! If custom adapting to your spec's is required, we'll handle it with speed and efficiency unmatched in the industry. If it's a new design, our Model Shop handles prototypes fast!

WRITE FOR TECHNICAL BULLETIN . . .



RELIABILITY THROUGH QUALITY CONTROL

GREMAR

MANUFACTURING COMPANY, INC. • WAKEFIELD, MASS. • TEL. 245-4580

Circle 94 on Inquiry Card

New Tech Data
for Engineers

Semiconductor Cans

Tech data is available on cans for relays, crystals, and semiconductors made of nickel-silver, brass, copper, mu-metal, cold roll steel, cupro-nickel and stainless steel. Hudson Tool & Die Co., Inc., 18-38 Malvern St., Newark 5, N. J.

Circle 379 on Inquiry Card

Filters

Tech data is available on filters, variable r-f attenuators, transformers, and wire wound resistors. Resistant ranges are from 0.1Ω to 5 megohms; wattage range from 0.1w to 2w and standard T.C. is ±5ppm above 100Ω. Ortho Industries Inc., 7 Paterson St., Paterson 1, N. J.

Circle 380 on Inquiry Card

Current Regulators

Tech data is available on a line of constant current sources and regulators which feature a high ac impedance in addition to high dc resistance. They are suited for use in testing diodes or saturation effects of chokes. Leighner Mfg. Co., 1510 N. Neil St., Champaign, Ill.

Circle 381 on Inquiry Card

Flat Flexible Cable

IRC Polystrip® is ultra-thin, flat, flexible cable containing multiple conductors protected between tough plastic sheets. The 7-page brochure includes photographs, ordering information, information on testing, inspection, quality control, an insulation parameter table, and characteristics curves and dimension tables. International Resistance Co., Plastic Products Div., 401 N. Broad St., Phila. 8, Pa.

Circle 401 on Inquiry Card

Wire Markers

Bulletin 729 describes self-sticking B-400 Wire Markers designed specifically for wires in electronic equipment, parts and assemblies. The markers are designed to withstand continuous heat up to 250°F without change, and are resistant to oil, solvents, fuels, dirt and abrasions. W. H. Brady Co., 726 W. Glendale Ave., Milwaukee 9, Wis.

Circle 402 on Inquiry Card

Ground Stud

Jan Engineering, 2018 Pico Blvd., Santa Monica, Calif., has tech. data available on their ground stud, P/N 5008. Designed for circuits requiring up to #14 AWG wire and for establishing a true reference for single point ground to eliminate the possibility of ground loops and noise pick-up. Information includes spec. sheets and outline drawings.

Circle 403 on Inquiry Card

Impulse Counters

SODECO Impulse Counters for totalizing, predetermining, printing and transmitting are described in tech data available from Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

Circle 382 on Inquiry Card

Transformers

Dura-Clad® Transformers feature hybrid balance and longitudinal balance as high as 60 db and reflected impedance held to ± 5% over the freq. range of 300CPS to 30MC. They are for data processing, automatic control, multiplex telephone and telemetry equipment. Aladdin Electronics, Dept. 2-M, Nashville 10, Tenn.

Circle 383 on Inquiry Card

Semiconductor Tips

"25 Tips on How to Buy Semiconductors" covers: rating suppliers; the use of distributors; the influence of pricing; reliability; use of standard specs.; use of drawings; buying in quantity; and other pertinent items. Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

Circle 384 on Inquiry Card

Multiplex Equipment

"CT-42 Solid State Tone Multiplex Equipment," 16-pages, gives detailed data on equipment applications, freq. allocations, component diagrams, transmitter and receiver options and complete system specs. The CT-42 can be used with existing microwave, carrier or wireline circuits to give AM or freq. shift data transmission, teletype, telemetering, remote control and signaling functions. RCA, Microwave Dept., Bldg. 15-4, Camden 2, N. J.

Circle 404 on Inquiry Card

Magnetic Materials

Lodex T.M. is a permanent magnet material based on highly elongated single domain particles. Four distinct magnetic grades are available for commercial use. Lodex 31, 32, 41, 42, are all iron-cobalt particles in a lead matrix. The four types differ in their manner of processing. Included are specs. and characteristic diagrams. General Electric Co., Magnetic Material Section, Edmore, Michigan.

Circle 405 on Inquiry Card

Tapping Screws

This tech. bulletin on Type "K" Kaptiv screws is available from Parker-Kalon, a div. of General American Transportation Corp., Clifton, N. J. The P-K Kaptiv taps and stakes itself in a single operation. Bulletin 1C/4.

Circle 406 on Inquiry Card

Now-Specify

VARFIL Sleeving and Tubing...

and get these **5 BIG** *Advantages*

- HIGHER DIELECTRIC RETENTION
- GREATER FLEXIBILITY
- MORE HEAT RESISTANCE
- AVAILABLE IN COILS
- CAN BE AFTER-TREATED

AVAILABLE IN FOLLOWING **NEMA** CLASSES
CLASS B-A-1
7000 VOLTS AVERAGE
CLASS B-B-1
4000 VOLTS AVERAGE
CLASS B-C-1
[illegible] VOLTS AVERAGE
CLASS B-C-2
1500 VOLTS AVERAGE

Even under the most severe operating conditions, Varfil Sleeving and Tubing retains its average dielectric strength. Twist it, tie it, bend it, wrap it, knot it. Remains just as pliable as when you started. Won't crack, peel or suffer dielectric loss. Heat Varfil 2000 hours at 110° C.—1,000 hours at 125° C. —and even for extensive periods at 150° C. It won't break down. Can be after-treated in baking and varnishing operations. Reacts better than other oleoresinous materials and synthetic coated tubings. Available in handy coils so you can cut the exact lengths you need . . . no waste. Standard colors. Wide range of sizes. Exceeds or meets all A.S.T.M. specifications.

Varflex CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

SEND TODAY FOR FREE SAMPLE FOLDER

VARFLEX Corporation, 308 N. Court St., Rome, N. Y.

Circle 96 on Inquiry Card

Weckesser

CABLE CLAMPS

Nylon for high temperature and other severe service conditions.

of economical Ethyl-Cellulose for maximum service at minimum cost.

A STYLE AND SIZE FOR EVERY CABLE FASTENING REQUIREMENT

Weckesser Cable Clamps offer superior insulating properties, high strength, light weight . . . with *no* rust or corrosion.

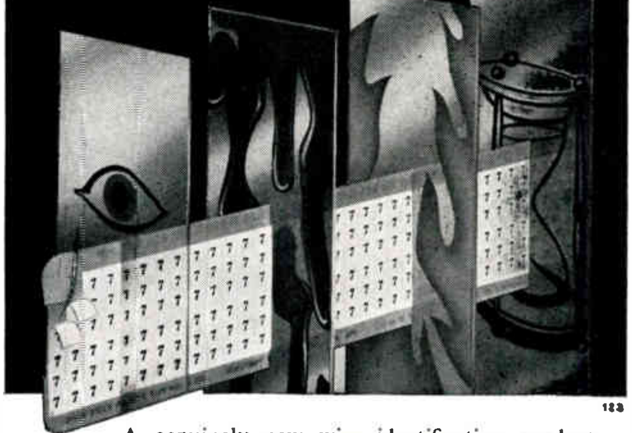
Non-circular shapes also available. Immediate delivery from on-hand stocks.

WRITE TODAY FOR FREE SAMPLES AND PRICE SHEET

Weckesser COMPANY, Inc.
5711 Northwest Highway • Chicago 46, Illinois

Circle 97 on Inquiry Card

NEW! for ELECTRONIC WIRES
BRADY B-400 wire markers



183

A genuinely new wire identification product. Made of self-sticking B-400 Reinforced Plastic. Combines superior legibility, oil resistance, heat resistance and permanence . . . PLUS adhesive compatibility with all types of wire, even Teflon — or wires coated with silicones, oil, or containing plasticizers. Dispenser Card Mounted for fast application. Over 1100 standard legends in stock in four sizes.

Write for sample and fact-filled bulletin.

W. H. BRADY CO., 750 W. Glendale Ave., Milwaukee 9, Wis.
EST. 1914

Manufacturers of Quality Pressure-Sensitive Industrial Tape Products, Self-Bonding Nameplates, Automatic Machines for Dispensing Labels, Nameplates, Masks and Tape.

Circle 99 on Inquiry Card

NEW Hi WIRE CONNECTORS

BAKELITE • SCREW-ON

WITH BUILT-IN "BAND-OF-STRENGTH"

- **APPROVED UP TO 1000V**
- A real he-man's connector for No's. 18 thru 10 wires. Improved design. Coarse knurling gives good grip.

3 SIZES: Hi-3, Hi-4, Hi-6

also Ceramic "screw-on" and Bakelite "set-screw" connectors

SMALL SIZE Hi-0 "LOK-ON"

For No's. 16 and 18 wires. Patented locking insert.

SEND FREE SAMPLES NEW WIRE CONNECTORS

NAME ____________
FIRM ____________
ADDRESS ____________
CITY ____________ STATE ______

Hi HOLUB INDUSTRIES, INC.
448 ELM ST. • SYCAMORE, ILLINOIS

Circle 100 on Inquiry Card

New Tech Data for Engineers

Consoles

"Consoles & Cabinets Human Engineered" contains photographs and descriptions on a line of radar, computer, test and control consoles. Information is also included on a line of rack cabinets. Falstrom Co., 186 Falstrom Court, Passaic, N. J.

Circle 385 on Inquiry Card

Temperature Testing

Tech data is available on Thermochrom Crayons and DetectoTemp Paints which are designed for measuring surface temperatures. When certain temperatures are reached, these indicating materials completely change color to a completely different color. Princeton Div., a div. of Curtiss-Wright Corp., Princeton, N. J.

Circle 386 on Inquiry Card

Delay Lines

Mechanical and electrical properties and features of fixed length and tapped microwave delay lines are described in a 6-page bulletin available from the MicroDelay Div., Franklin Technical Corp., Kulpsville, Pa. Attenuation, input VSWR vs. freq., and internal reflections are discussed and full tech. specs are given. Bulletin 201.

Circle 387 on Inquiry Card

Silicon Rectifiers

Bulletin No. 62-SA-3, 8 pages, describes single-phase bridge and center tap, and 3-phase half-wave, bridge, and full-wave center tap assemblies. Also included are applications, circuit design factors, and typical rectifier circuit drawings. Sarkes Tarzian, Inc., 415 N. College, Bloomington, Ind.

Circle 407 on Inquiry Card

Shock Mounting

Technical Specialties Co., Inc., 415 Concord Ave., New York 55, N. Y., is offering a catalog of technical data on many types of rubber parts available with pressure sensitive, high-tack adhesive backing. The materials are suited for waterproofing, insulating, shock mounting, weather-stripping, protecting and skid-proofing electronic and electrical components and assemblies.

Circle 408 on Inquiry Card

Turret Terminals

Components Catalog No. 61 describes and illustrates, with fully dimensioned drawings, over 500 stock turret terminals including single-end, double-end, tubular, slabbed, slotted, taper-pin, and insulated. Also included is data on swaging tools, terminal-boards, and other electronic hardware. This 48 page catalog is available from Precision Metal Products Co., 41 Elm St., Stoneham, Mass.

Circle 409 on Inquiry Card

Clean Rooms

Tech data is available on transparent atmosphere enclosures for operations requiring control of dust, fumes, moisture and inert gases in micro parts assembly, inspection, research and microscopic studies. Affiliated Manufacturers Inc., Box 105, Oldwick, N. J.

Circle 388 on Inquiry Card

Chromatography

This 4-page bulletin describes a full line of gas chromatography instrumentation available from F & M Scientific Corp., Rt. 41 and Starr Rd., Avondale, Pa. Data is included on a dual column temp. programmed gas, and automatic preparative gas chromatographs, and a power proportioning temp. programmer.

Circle 389 on Inquiry Card

Antenna Testing

Rohde & Schwarz, 111 Lexington Ave., Passaic, N. J., is offering tech data on their "Reflectromat" which is a unit for the automatic plotting of reflection coefficients over the freq. range of from 30 to 400MC. Features included are dynamic range of 60 (80) db and a reflection coefficient range of 0.1% to 100%. Also included are photographs, tests setup, and

Circle 390 on Inquiry Card

Fused Synthetic Silica

Thermal American Fused Quartz Co., Rt. 202 & Change Bridge Rd., Montville, N. J., is offering a 2-color, 4-page bulletin on Spectrosil, a synthetic fused silica. Chemical and physical properties are shown in detail. Applications and specifications are also included.

Circle 410 on Inquiry Card

Tubing

J. Bishop & Co., Platinum Works, Malvern, Pa., is offering Bulletin No. 13, 20 pages, which gives the sizes, specs, finished, tolerances, chemistry, and suitable uses for small diameter stainless steel, nickel alloy, and refractory tubing. The line includes tubing up to 1 in. O.D.

Circle 411 on Inquiry Card

Transfer Molding

A technical paper entitled, "Transfer Molding—Past, Present and Future" is available from Hull Corp., Hatboro, Pa.

Circle 412 on Inquiry Card

Pre-printed Symbols

A money and time saving item, STANPAT tri-acetate sheets are coated with a water-clear adhesive and are pre-printed with repetitive symbols. Tech data describes the line of stock symbols and the custom printed service offered. Custom symbols of any type and detail are possible. STANPAT Co., Whitestone 57, N. Y.

Circle 413 on Inquiry Card

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*U.S. Patent No. 2,612,459 and others

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Circle 80 on Inquiry Card

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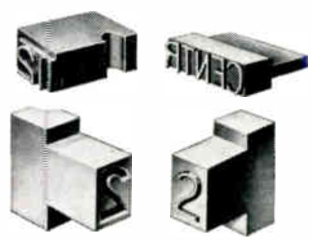

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Brooklyn 8, N. Y.

The FORCE OF NUMBERS

Circle 105 on Inquiry Card

New Tech Data
for Engineers

Light Detectors

Farrand Optical Co., Inc., Bronx Blvd. & E. 238th St., New York 70, N. Y., is offering a brochure describing ultra-violet, infra-red and visible light range-finders and detectors; navigation systems; servo-mechanisms; optical tooling, optical and electro-optical systems; electronic circuits, analog to digital converters and computers; and mechanical devices. In total, the brochure covers more than 100 subjects.

Circle 391 on Inquiry Card

Calibration Standard

Tech data is available on Model 1900 Semi-Automatic DC Instrument Calibration Standard which is a servo-type, wide-range, stable source of dc voltage and current for calibrating dc voltmeters and ammeters to within 0.05% of reading. Included are specs., features and photographs. Radio Frequency Laboratories, Inc., Boonton, N. J.

Circle 392 on Inquiry Card

Indicator Lamps

Signalite Inc., 1833 Heck Ave., Neptune, N. J., is offering tech. data on its complete line of Glow Lamps. Signalite Glow Lamps are used as indicators and as circuit components.

Circle 393 on Inquiry Card

Glass/Ceramic Reference

"How to Define Your Glass and Ceramic Requirements," 21 pages, is available from the Product Development Dept., Electrical Products Div., Corning Glass Works, Corning, N. Y. The reference material covers electrical, thermal, chemical, optical and mechanical properties of glassy materials. These include volume resistivity, dielectric constant, loss tangent, upper operating temps., thermal conductivity, ultraviolet and infrared transmittance, and photosensitivity. The illustrated booklet is available upon request under company letterhead.

Molding Compounds

A booklet describing, in detail, the physical chemical, and electrical properties of molding compounds based on diallyl phthalate, epoxy, and alkyd resins is available from Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 25, Calif. The 96-page booklet contains special sections dealing with important advantages of each type of compound and how to choose between them for a given use. Also included is a general reference data section with information ranging from temp. and time conversion tables to listed percentages of thread for various materials.

Circle 395 on Inquiry Card

Tech Data

for Engineers

Infrared Heating

Fostoria Corp., Dept. 109, 1200 N. Main St., Fostoria, Ohio, is offering tech data on radiant heat. Brochure describes Fostoria's equipment for use of electric infrared radiant heating processes and pictures some of the many and varied applications.

Circle 586 on Inquiry Card

Encapsulation

Encapsulation of resistors and capacitors in a heat shrinkable Thermofit sleeve is described in a new bulletin by Rayclad Tubes, Inc., Redwood City, Calif. The technique is suited for low cost automated production.

Circle 587 on Inquiry Card

Refractory Metals

Tech. data is available on high pressure cast refractory metals. Information is included on HPC Molybdenum, Tungsten and tungsten-molybdenum alloys for electronic applications. Oregon Metallurgical Corp., Albany, Ore.

Circle 588 on Inquiry Card

Ceramic-to-Metals Seals

A 32-page catalog covering over 40 standard types of high-alumina terminals, all of which remain high-vacuum-tight during continuous operation 350°C in air is available from Ceramseal, Inc., New Lebanon Center, N. Y.

Circle 589 on Inquiry Card

Fasteners

"What You Should Know About Stand-off Fasteners," is available from Western Sky Industries, 21301 Cloud Way, Hayward, Calif. Sections covered include, Advantages and Disadvantages of each Type, Causes of Failure of Stand-off Fasteners, How to Compare Cost of Fasteners, and How to Select Stand-off-Fasteners.

Circle 590 on Inquiry Card

RFI Shielding

A 4-page reprinted article, "Shielded Rooms for Electronic Equipment," describes the techniques and materials used to protect sensitive electronic equipment from RFI. Ace Engineering and Machine Co., Tomlinson Rd., Huntington Valley, Pa.

Circle 591 on Inquiry Card

Breadbording

Circuit Structures Lab., P. O. Box 36, Laguna Beach, Calif., will send data on their circuit builder which is designed for breadboarding and training; it eliminates soldering; gives quick circuit change; and is for vacuum tube or solid state circuits.

Circle 592 on Inquiry Card

ADS OF INTEREST IN OTHER SECTIONS . . .
dealing with "Materials & Hardware"

Alden Products Co. .... p. I-17
Centralab, The Electronics Div. of Globe-Union Inc. .... p. F32
Sealectro Corp. .... p. I-12

New Tech Data for Engineers

Molding Material

Commercial Resins Corp., 1250 W. 7th St., St. Paul 2, Minn., is offering tech. data on "Premix Molding." This is a relatively simple compression molding material prepared by the molder from a special polyester resin, chopped glass fiber and inexpensive fillers.

Circle 270 on Inquiry Card

Coaxial Connectors

A 10-page catalog completely describing a new line of subminiature coaxial connectors is available from The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. Information includes specs., performance characteristics and availability data on these all crimp terminated r-f connectors.

Circle 271 on Inquiry Card

Microwave Amplifier

Broadband Microwave Amplifier, Model MWA-1, accommodates any one of 4PPM focused traveling wave tubes, to provide a noise figure of 10db and a gain of 30db over the 1-2.6, 2.3-4.45, 4.3-7.35, and 7.05-10.75GC freq. bands. Applied Technology, Inc., 930 Industrial Ave., Palo Alto, Calif.

Circle 272 on Inquiry Card

Eyelets

Prepared especially for designers and manufacturers of printed circuitry and other electronic devices, this is 4-page, 3-color bulletin gives complete details on the line of electronic eyelets. Bulletin E-107, "United Electronic Eyelets" is available from Fastener Div., United Shoe Machinery Corp., Shelton, Conn.

Circle 273 on Inquiry Card

Induction Heating

"High Frequency Heating Review" available from Lepel High Frequency Laboratories, Inc., 55th St. & 37th Ave., Woodside 77, N. Y., features an article on "Induction Heating in Vacuum and Controlled Atmosphere" as well as shop hints, new equipment and typical induction heating applications.

Circle 274 on Inquiry Card

Alumina Ceramics

Bulletin 621 "AlsiMag® Alumina Ceramics" contains a property chart which includes information on 3 dense and 3 porous AlSiMag Alumina Ceramics. Also included are photographs on different shapes available and production information. American Lava Corp., Chattanooga 5, Tenn.

Circle 275 on Inquiry Card

Tantalum Pentachlorides

An 8-page, 2-color booklet on the properties, uses and handling of columbium and tantalum pentachlorides is available from Stauffer Chemical Co., 380 Madison Ave., New York, N. Y. It discusses the use of these materials to prepare pure columbium and tantalum metals, and vapor deposition coating of other materials with columbium and tantalum.

Circle 276 on Inquiry Card

Solder Catalog

This illustrated tech. catalog on solders, fluxes, preforms, special alloys, lead and tin products and ultra high purity metals for semiconductor devices is available from Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. Bulletin A-103 also contains characteristic charts on solder alloys and fluxes.

Circle 277 on Inquiry Card

Control Equipment

Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa., is offering a 6-page control equipment brochure illustrating and giving brief descriptions of high-performance feedback control hardware. Included in the brochure are operational amplifiers, freq. response test equipment, pressure transmitters and receivers, actuators, and programmers.

Circle 278 on Inquiry Card

Notching Units

Unipunch catalog FTB fully illustrates and describes the complete line of Unipunch Series FTB hole punching and notching units. The units provide unobstructed feeding of the work and hole locations over the entire area of large work pieces. Punch Products Corp., 370 Babcock St., Buffalo 6, N. Y.

Circle 279 on Inquiry Cord

Connectors

Tech. data is available on Micro-Miniature Connectors Series 220 and 221, which give positive low resistance contacts even after 1,000 cycles of insertion and withdrawal. Photographs, outline drawings, and specs. are included. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 280 on Inquiry Card

Heating & Cooling

Tech Data Bulletin 356 from Dean Products, Inc., 1042 Dean St., Brooklyn 38, N. Y., contains information on heating, cooling, heat transfer, an instantaneous LMTD chart, how to figure heating load, how to select heating surface and pressure drop short cuts, and uses of their Panelcoil®.

Circle 281 on Inquiry Card

Connectors

The Ucinite Co., a div. of United-Carr Fastener Corp., Newtonville 60, Mass., is offering a 4-page, 2-color illustrated bulletin #7010, describing its line of TELERITE communications products. The line consists of a series of Mil-spec and commercial telephone jacks and plugs, miniature and subminiature jacks and plugs, a number of hybrid and standard jack-and-switch, and jack-and-plug assemblies.

Circle 282 on Inquiry Card

Chromium Oxide

Tech. data is available on single crystals of chromium oxide which are available in limited quantities. The chromium oxide single crystals are both undoped and doped with 1, 3, 6, and 10% additions of Al_2O_3, most of which is retained in the as-grown crystal. Crystal Products Dept., Linde Co., 4120 Kennedy Ave., E. Chicago, Ind.

Circle 283 on Inquiry Card

Recording Device

Series 3440 Dataplotter is described in a 12-page illustrated brochure available from Electronic Associates, Inc., Long Branch, N. J. The 3440 Dataplotter is a 30 x 30 in. X-Y recording device for automatically plotting digital information from magnetic tape, punched tape, punched cards or manual keyboard. Bulletin DP 6188-1.

Circle 284 on Inquiry Card

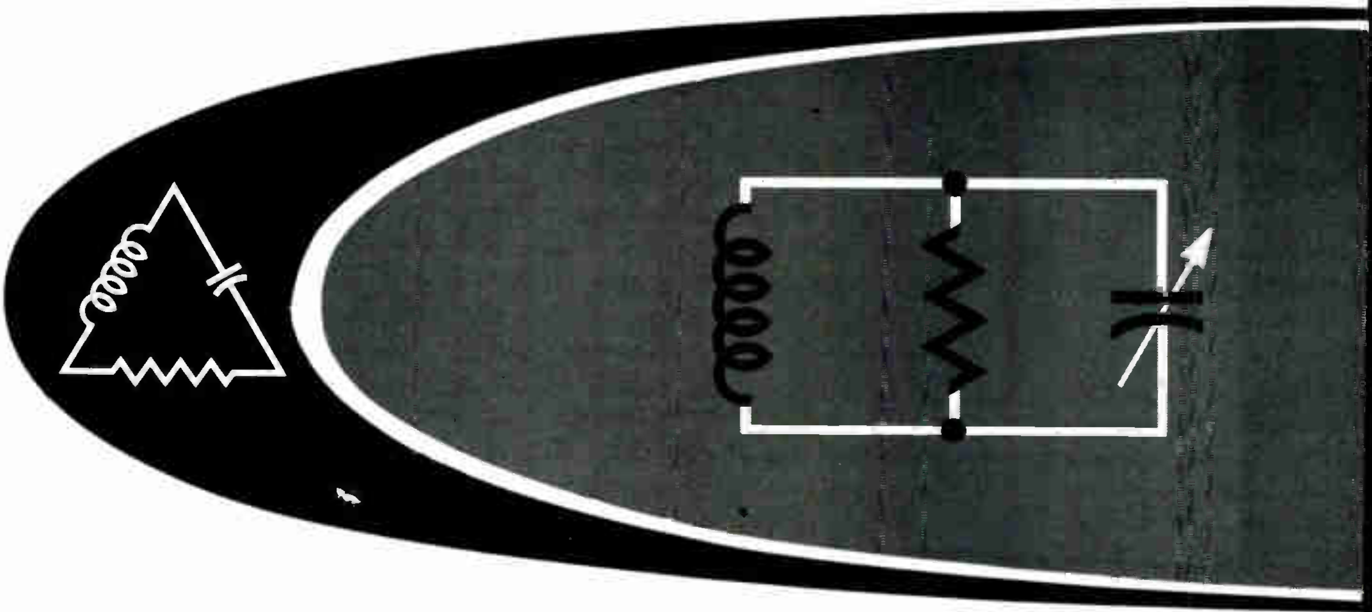
Microwave Components

Diamond Antenna & Microwave Corp., 35 River St., Winchester, Mass., is offering a catalog covering their line of antenna systems, rotary joints, microwave components, microwave test equipment, and microwave accessories. Specs, descriptions and photographs plus outline drawings are included. Also included is a section of custom components.

Circle 285 on Inquiry Card

Section E

Electronic Components



Ordering Mil Spec Components

There is no mystery to properly ordering components. However, there are some points that you should know to facilitate your buying.

ORDERING components and materials for military use requires a knowledge of the military specifications involved. Generally, a component cannot be ordered by the Mil Spec number alone. Each specification has it own set of code designations that should be used to order a specific value or size of component. See Example 1.

Often a capacitor is purchased from a local parts supplier by an electronic serviceman. A serviceman usually tells the parts supplier he wants a "5%, 100

Example No. 1:

MIL-C-5B
CAPACITORS, MICA, FIXED

CM20	C	011	J	N	3
1	2	3	4	5	6

1. Mil type, style and case size.
2. Characteristic

Symbol	Temp. Coefficient Parts/Million/°C	Cap. Drift
B	not specified	not specified
C	−200 to +200	±0.5%
D	−100 to +100	±0.3%
E	−20 to +100	±(0.1% 0.1pf)
F	0 to +70	±(0.05% ±0.1pf)

3. Capacitance. First two digits are first two figures of capacitance value in pf and third digit is the number of zeros which follow.
4. Capacitance Tolerance
   G = ±2%
   J = ±5%
   K = ±10%
5. Temperature Range

Symbol	Oper. Temp. Range
M	−55 to +70°C
N	−55 to +85°C
O	−55 to +125°C
P	−55 to +150°C

6. Vibration

Grade	Condition
1	10 to 55 cps
3	10 to 2,000 cps

Example No. 2:

MIL-C-10950B

CB11	N	D	011	M
1	2	3	4	5

1. Mil type, specifies shape and case size.
2. Terminal Assembly

Designation	Terminal
L	single L-rod
N	eyelet
P	single L
Q	single U
R	double L
S	double U
T	offset
V	rod

3. Characteristic

Symbol	Temp. Coefficient Parts/Million/°C	Cap. Drift
B	not specified	not specified
D	−100 to +100	0.3% or 0.3pf (whichever is greater)
E	−20 to +100	±0.1% +0.1pf

4. Capacitance. First two digits are first two figures of capacitance value in pf, and third digit is the number of zeros which follow.
5. Capacitance Tolerance
   G = 2%
   J = 5%
   K = 10%
   M = 20%

micromike mica at 600 volts." Under the Mil Specs you do the same thing, but with a set of code numbers as illustrated in Example 1 or 2. Also, your order is more specific than the serviceman's order. By the use of letters and numbers you specify the type, size and shape of the item, ratings, temperature characteristics, tolerances, voltage ratings, electronic values, etc.

Note from Example 1, that the letters and numbers designate exactly what is ordered. These designations do not always mean the same thing for all specifications. The letter N in Example 1 does not have the same meaning as the N in Example 2, even though both specifications are for capacitors.

To properly order a component the purchaser, as well as the supplier, must have access to the necessary Mil Specs. These should be kept readily available for quick reference, and where necessary, the specifier of parts should be very familiar with the applicable Mil Specs. If in doubt as to where to purchase parts, a Qualified Products List (QPL) can be consulted. Such lists are available from the military department contracting officer or from the Departments of the Army, Navy, or the Air Force, depending on which service issued the contract. Before ordering parts, in addition to the above, the following should be known:

a. Determine if government inspection is required. Inspection can be conducted at the supplier's plant or at the customer's plant, or the parts can come from bonded stock. The point of inspection should be given.

b. If the contract requires Government Source Inspection (GSI) at the supplier's plant or from bonded stock, the purchase order must specify in writing that GSI is necessary and give the government contract number and priority rating. A copy of this should also go to the government inspector concerned.

c. A Certificate of Compliance can be supplied (when required) to a Mil Spec or commercial specification. The Certificate is usually signed by two or more witnesses and may be notarized.

d. Be sure that the supplier is on the Qualified Product Lists for the required part when ordering Mil Spec components that require GSI.

e. Watch for changes in Mil Spec and QPL suppliers. These change periodically.

Below and on the following pages we have selected the more common specifications that are available from the Armed Services Electro-Standards Agency (ASESA). Copies of these specifications and others can be obtained from ASESA.

MILITARY SPECIFICATIONS

The following are some of the more common Mil Specs available from the Armed Services Electro-Standards Agency (ASESA). These were Abstracted from ASESA List 100-56. A complete List 100-56, as well as the specifications listed here may be obtained from ASESA, Fort Monmouth, N. J. The specifications listed here are common to the three military departments.

Adapter, Coaxial, to Waveguide	MIL-A-22641
Adapters, Connector, Coaxial, Radio Frequency, Between Series, General Specification For	MIL-A-27434
Attenuators, Fixed (Coaxial-Line and Waveguide)	MIL-A-3933
Batteries, Dry	MIL-B-18C
Batteries, Dry	MIL-B-13136A
Cable Assemblies and Cord Assemblies, Electrical (For use in Electronic, Communication, and Associated Electrical Equipment)	MIL-C-3885A
Cables, Radio-Frequency; Coaxial, Dual Coaxial, Twin Conductor, and Twin Lead	MIL-C-17C
Cable and Wire, Electrical (Power and Control); Flexible and Extra Flexible, 300 and 600 volts	MIL-C-3432B
Capacitors, Variable, Air-Dielectric, (Trimmer)	MIL-C-92A
Capacitors, By-Pass, Radio-Interference Reduction, Paper Dielectric, AC & DC, (Hermetically Sealed in Metallic Cases)	MIL-C-12889A
Capacitors, Feed Through, Radio-Interference Reduction, Paper Dielectric. A.C. and D.C. (Hermetically Sealed)	MIL-C-11693B
Capacitors, Fixed, Ceramic-Dielectric (General Purpose)	MIL-C-11015B
Capacitors, Fixed, Ceramic-Dielectric (Temperature Compensating)	MIL-C-20D
Capacitors, Fixed, Electrolytic (A.C., Dry-Electrolytic, Nonpolarized)	MIL-C-3871
Capacitors, Fixed, Electrolytic (DC, Aluminum, Dry Electrolytic, Polarized)	MIL-C-62B
Capacitors, Fixed, Electrolytic (Tantalum)	MIL-C-3965B
Capacitors, Fixed, Solid Electrolyte, Tantalum	MIL-C-26655A
Capacitors, Fixed Glass-Dielectric	MIL-C-11272B
Capacitor, Fixed Mica-Dielectric	MIL-C-5B
Capacitors, Fixed, Mica-Dielectric, Button Styles	MIL-C-10950B
Capacitors, Fixed, Paper-Dielectric, Direct-Current (Hermetically Sealed in Metallic Cases)	MIL-C-25C
Capacitors, Fixed, Paper-Dielectric (Non-metallic Cases)	MIL-C-91A
Capacitors, Fixed, Paper (Or Paper-Plastic) Dielectric, Direct-Current, High Reliability, Hermetically Sealed in Metallic Cases	MIL-C-14157B
Capacitors, Variable, Ceramic Dielectric	MIL-C-81A
Capacitors, Variable (Piston Type, Tubular Trimmer)	MIL-C-14409A
Coils, Radio Frequency; and Transformers, Intermediate and Radio Frequency	MIL-C-15305B
Connectors, Coaxial, Radio Frequency, Series BNC, and Associated Fittings	MIL-C-3608A
Connectors Coaxial RF Series C and Associated Fittings	MIL-C-3989A
Connectors, Electrical, (Power, Bladed Type)	MIL-C-3767A
Connectors, "HN", for Radio Frequency Cables	MIL-C-3643A
Connectors, Coaxial, Radiofrequency, Series LC	MIL-C-3650A
Connectors, "N" for Radio Frequency Cable	MIL-C-71A
Connectors, Pulse, for Radio Frequency Cables	MIL-C-3607A
Connectors, Twin, for Radio Frequency Cables	MIL-C-3655A
Connectors, Plug and Receptacle, Electrical (Molded Body); and Accessories	MIL-C-8384B
Connectors, Plug and Receptacle (Electrical Waterproof); and Accessories	MIL-C-12520B
Couplers, Directional (Coaxial and Waveguide)	MIL-C-15370A
Dynamotors	MIL-D-24B
Electron Tubes and Crystal Rectifiers	MIL-E-1D
Filters, Radio Interference	MIL-F-15733D
Filters: High Pass, Low Pass, Band Pass, Band Suppression and Dual Functioning	MIL-F-18327A
Flanges, Waveguide, General Purpose	MIL-F-3922A
Fuseholders, Block & Plug Type, and Associated Electrical Clips	MIL-F-21346
Insulators, Glass-Bonded-Mica, Radio	JAN-I-7
Insulators, Glass, Radio	JAN-I-9
Insulating and Jacketing Compounds, Electrical (For Cable, Cord, and Wire)	MIL-I-3930A
Insulating Materials, Electrical Ceramic, Class L	MIL-I-10A
Insulator, Pin (Lime-Glass)	MIL-I-3676A
Insulators, Porcelain, Radio	JAN-I-21
Insulators, Steatite, Radio	JAN-I-8
Knobs, Control (For use with Electronic, Communications, and Allied Equipment)	MIL-K-3926

(Continued on page E-7)

By **WILLIAM W. HAPP**

Microsystems Electronics Dept.
Lockheed Missiles & Space Co.
Sunnyvale, Calif.

For Microsystem Designers . . .

Stray Capacitance in Thin Films

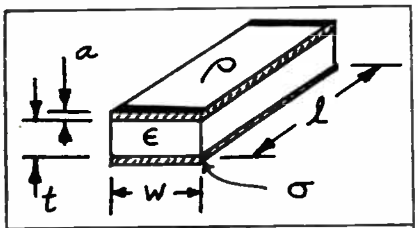
The interelectrode capacitance becomes critical as dimensions decrease and as substrates of high dielectric constant are developed. Here are some useful design charts and engineering approximations for evaluating its effect.

WHEN making thin film functional assemblies, high dielectrics are used to realize a large capacitance per unit area.[1-6] Fig. 1 shows a resistive film of thickness a and resistivity ρ deposited on a substratum of dielectric constant ε and thickness t; the resistance R and capacitance C can then be computed in terms of length l and width w of the film, if a perfect conductor σ is assumed for the opposite capacitor plate.

It is convenient to replace ε by $\varepsilon_0 K$, and to express the capacitance per unit length as

$$C' = C/l = 0.225\ K\,W/t\ .\ .\ .\ \text{picofarad/inch}$$

All formulas for interelectrode capacitance are based on this basic relationship.



RESISTANCE	$R = \frac{\rho}{a}\,\frac{\ell}{W}$
CAPACITANCE	$C = \frac{\epsilon}{t}\,\ell W$
TIME CONSTANT	$RC = \frac{\rho\epsilon}{at}\,\ell^2$
IMPEDANCE LEVEL	$\frac{R}{C} = \frac{\rho}{\epsilon}\,W^{-2}$

Fig. 1 (left): The circuit parameters for thin film capacitance.

Range of Dielectric Materials

In selecting dielectric substratum, these factors must be considered:

Dielectric Constant. The range of K is shown in Fig. 2 for several materials.

Dielectric Breakdown. Corresponding values are shown on Fig. 2.

Bulk Leakage Current. Associated with a high dielectric constant is often a relatively low resistivity, Fig. 3.

Fig. 2 (right): The dielectric materials for thin film circuits.

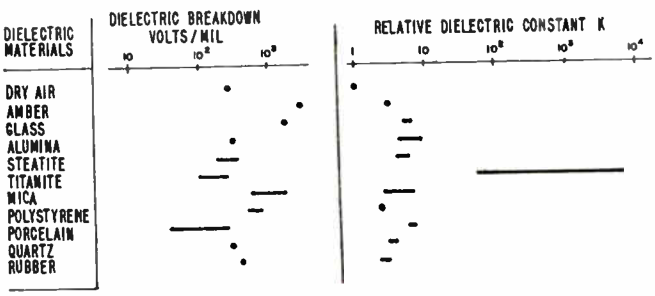


TABLE 1. CALCULATED VALUES OF CIRCUIT PARAMETERS

Component	ρ/a		t	l	w	R = ρ l/(aw)	C = .225 lw ε/t	RC
	ohms per square		inches	inches	inches	K ohm	pf	μ sec
RC_1	200	1800	0.020	0.74	0.49	3.0	7400	22
RC_2	200	1800	0.020	0.38	0.13	5.9	1000	5.9
RC_3	200	1800	0.020	0.51	0.10	10.0	1600	16

Component	ρ/a	l	w	R = ρ l/(aw)
	ohms per square	inches	inches	K ohm
R_4	725	0.10	0.13	0.56
R_5	725	0.28	0.11	1.9

TABLE 2 CALCULATED VALUES OF CAPACITANCE

Capacitance	Picofarad
C'_1	11
C'_2	11
C'_3	2
C'_4	15
C'_5	15
C'_6	2.5
C'_7	2.5

Temperature Characteristics. The refractory oxides, Fig. 3, are examples of substrate with high melting points and often particularly desirable temperature characteristics.

Other factors include: compatibility of expansion coefficient of substratum and of deposited film, mechanical stability, chemical stability, surface characteristics, producibility, and reproducibility, to name only a few. With these and other factors in mind, there appears to be a clear trend toward high K substrates.

The capacitance range in microsystem structures is shown in Fig. 4; here, the shaded regions C and D reflect the range of dielectric constants. The shaded regions A and B reflect area limits due to wafer size and resolution of the deposition process. Given the range in area and dielectric constant, Fig. 4, the product C^* of capacitance and substratum thickness, in picofarad-inches, is useful in assessing when the effect of stray capacitance must be considered. The enclosed region, Fig. 4, gives a range of values readily realizable with present technologies, the shaded region hints at possibilities.

Stray capacitance found in many uses is in the range of 1 to 10 pf; and, the dielectric substratum thickness is usually in the range of 0.010 to 0.100 in. Much of the available region, Fig. 4, becomes subject to limitations imposed by stray capacitances. With the increasing use of high K materials and smaller dimensions, the limitations become significant.

Useful Approximations

In Fig. 5, the interelectrode capacitance between two strips of width w, separated by a distance d is to be calculated. The substratum is of thickness t and dielectric constant K. It is advantageous to compare the resultant capacitance per unit length C' to that of an equivalent capacitance of a parallel plate capacitor, Fig. 5,

$$C' = 0.225\ K\ t_o/d_o$$

Two useful approximations are obtained by assuming $d = d_o$

$$\text{if } d >> t \quad \text{then } t_o = t$$
$$\text{if } d << t \quad \text{then } t_o = w$$

In the first case, the effective size of the plates are determined by the thickness of the substratum. They are independent of the electrode width. In the second case, the electrode width is alone the relevant factor in determining the effective capacitance.

When these asymptotic approximations are plotted a design graph, Fig. 6, results. This graph is fairly accurate provided d exceeds w; but, as w increases, an increasing error in C' results. This error can be assessed from the following:

The chart reads high in C' if $d << t$, since the effective separation d_o will exceed d.

The chart reads low in C' if $d >> t$, since the effect of large electrodes can no longer be neglected.

The order of magnitude of the resultant error can often be estimated, thereby extending the validity of Fig. 6 to values of w comparable to d.

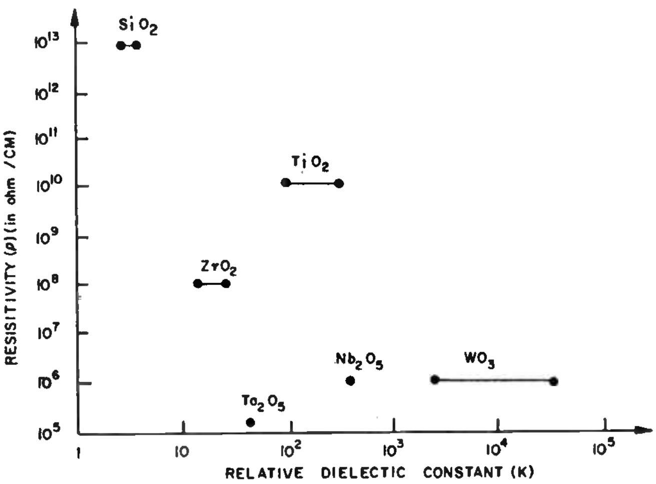
Intermediate values can be obtained by a more sophisticated analytical approach.

Exact Solution

By conformal transformations, an exact relationship between t_o d_o in terms of w, t, and d can be calculated.[7, 8] The Schwarz-Christoffel transform yields a solution in terms of elliptic integrals.[9, 10] Numerical values of these integrals F are available from standard reference tables.

$$d_o' = 2F(\cos\theta, \pi/2) \qquad \text{with } d_o' = \pi\, d_o/(4t)$$
$$t_o' = F(\sin\theta, \pi/2) \qquad \text{with } t_o' = \pi\, t_o/(4t)$$

Fig. 3: The characteristics for some refractory oxide materials.



ELECTRONIC COMPONENTS

Thin Films *(Continued)*

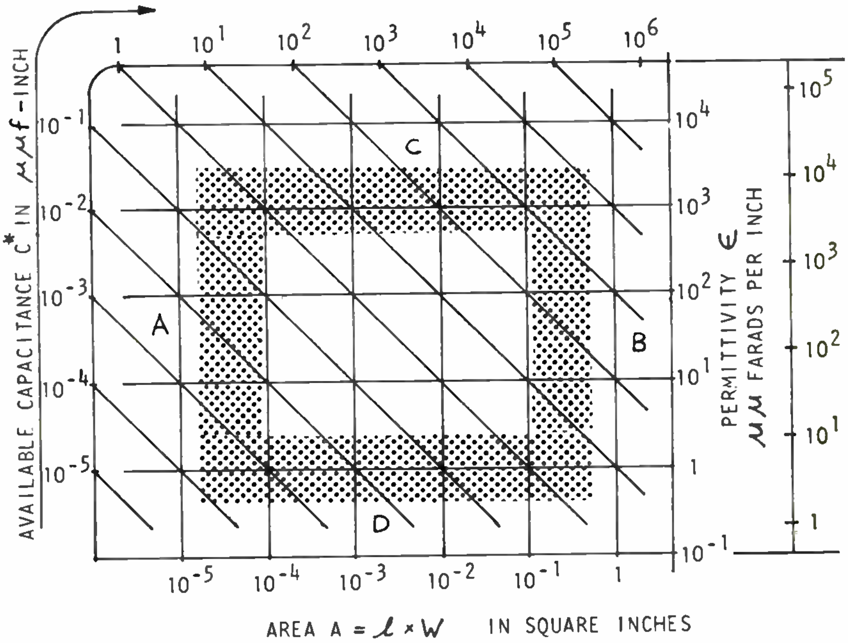
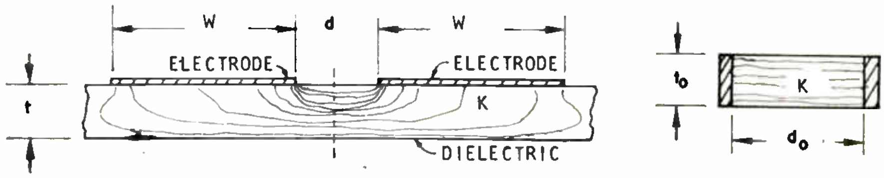


Fig. 4: Limit of film-type capacitance due to stray capacitance, area, high & low K, with specified dielectric thickness.

Fig. 5: Useful diagrams in the approximation of the interelectrode capacitance.



and

$\cos\theta = \tanh d'/\tanh(2w' + d')$ with $w' = \pi w/(4t)$ and $d' = \pi d/(4t)$

These exact formulas serve to verify the above approximations and permit computation of values of C' in the range where t is comparable to d. Comparison of computed and experimental values show excellent agreement,[8] thus establishing the useful design chart, Fig. 7.

Amplifier Design Considerations

Harmful effects on circuit performance may result from undesirable stray capacitances when the size of stray capacitance between various conductive layers is no longer negligible compared with circuit components. It is, therefore, necessary to estimate these stray capacitances and to include their effects in the circuit design.

Fig. 8 shows the schematic diagram of an i-f 455 KC amplifier. The corresponding resistive and conductive patterns, front and back, for a wafer approximately 1.25 x 0.75 in. are shown in Fig. 9. The appropriate values of circuit parameters are presented in Table 1. Interelectrode capacitances were calculated from the above design charts and are summarized in Table 2. The stray capacitances shown in the layout correspond to the circuit diagram. The dielectric substratum was $BiTaO_2$ with a dielectric constant of approximately 1700.

Recommendations

In the design, example stray capacitances were sufficiently significant to require consideration in evalu-

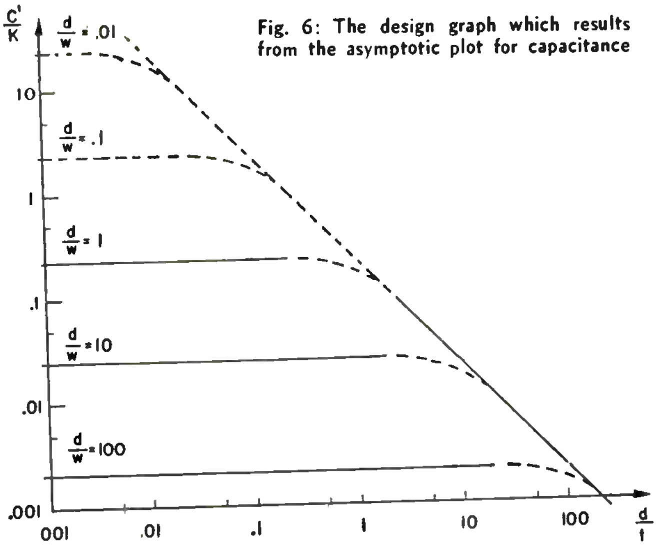
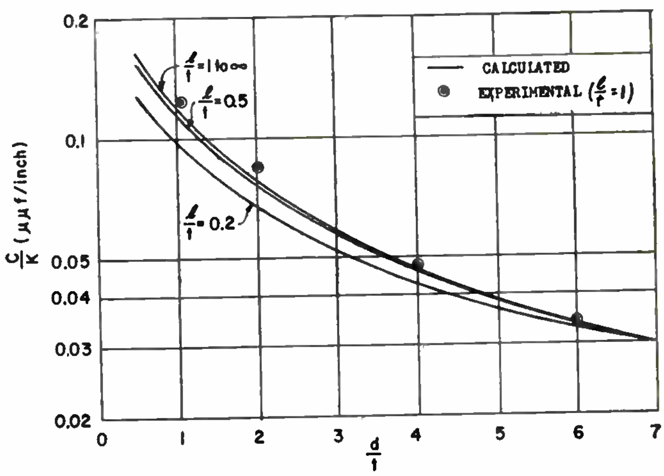


Fig. 6: The design graph which results from the asymptotic plot for capacitance

Fig. 7: Experimental values for interelectrode capacitance.



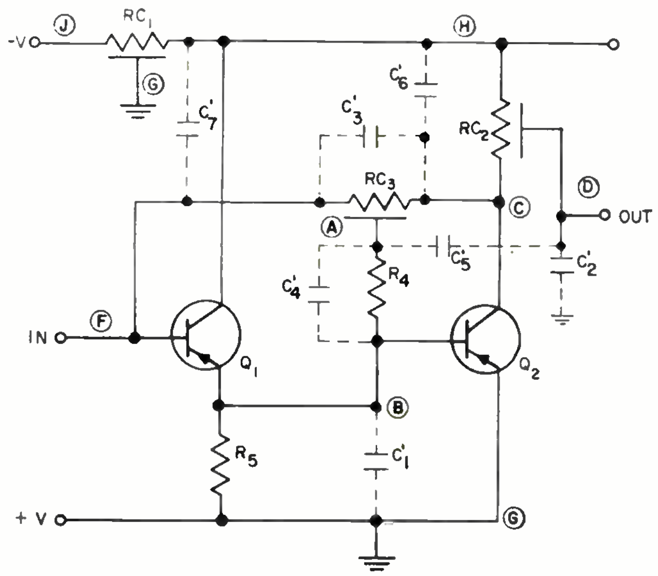


Fig. 8: Schematic for an intermediate frequency, 455 KC. amplifier.

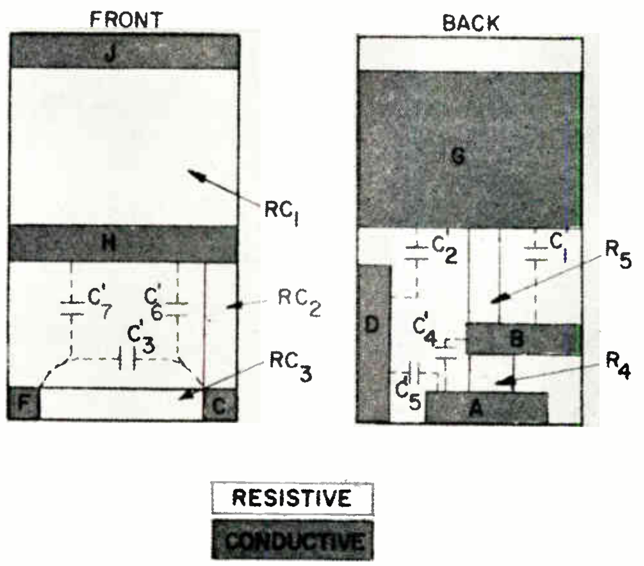


Fig. 9. Resistive and conductive patterns for amplifier of Fig. 8.

ating and interpreting amplifier performance, but presented no design limitation. However, if the dimensions of the wafer are to be reduced by a factor of 5 or more, or if the electrodes are spaced more closely, stray capacitance may present a serious constraint, particularly for high frequency characteristics.

References

1. Happ, W. W. and Castro, P. S., "Distributed Parameter Circuit Design Techniques," *NEC Proceedings*, Vol. 17, pp. 44-70, 1961.

2. Happ, W. W. and Fuller, W. D., "Design Procedures for Film-Type Distributed Parameter Circuits," *NEC Proceedings*, Vol. 17, pp. 597-610, 1961.

3. Fuller, W. D., "Titanium Thin Film Circuits," *NEC Proceedings*, Vol. 17, pp. 32-43, 1961.

4. Fuller, W. D. and Castro, P. S., "A Microsystem Bandpass Amplifier," *NEC Proceedings*, Vol. 16, pp. 139-151, 1960.

5. Happ, W. W. and Riddle, G. C., "Limitations of Film-Type Circuits Consisting of Resistive and Capacitive Layers," *Proc. National IRE Conference*. New York.

6. Happ, W. W. and Castro, P. S., "Distributed Parameter Circuits and Microsystems Electronics," *NEC Proceedings*, Vol. 16, pp. 448-460, 1960.

7. Wolf, P. N., Westinghouse Research Labs., Pittsburg, Private Communication, Oct. 1960.

8. Kaiser, H. R. and Castro, P. S., "Capacitance between thin film conductors deposited on high-dielectric-constant substrate," Lockheed Tech. Rept. 6-59-61-2, June, 1961.

9. Korn, G. A. and Korn, T. M., *Mathematical Handbook for Scientists and Engineers*. Sect. 7.9-4, McGraw-Hill, 1961.

10. Jahnke, E. and Emde, F., *Tables of Functions with Formulae and Curves*. Dover, New York, 1945.

Mil Spec Components

(*Continued from page E-3*)

Lampholders; Lights, Indicator; Indicator-Light Housings; and Lenses, Indicator Light, General Specification for TD-LC20 (Holders and Housings) LC11BD (Lenses)	MIL-L-3661A
Plastic-Material, Molding; Rigid Thermoplastic, Aniline Formaldehyde; for use in Electronic, Communication, and Allied Electrical Equipment	MIL-P-3408
Plastic-Material, Molding; Rigid Thermoplastic, Polydichlorostyrene; for use in Electronic, Communication, and Allied Electrical Equipment	MIL-P-3409
Plastic Material, Molding; Rigid Thermoplastic, Polyvinyl Chloride and Copolymers Thereof, for use in Electronic, Communications, and Allied Equipment	MIL-P-3410
Plastic-Material, Molding; Rigid Thermoplastic, Vinylidene Chloride; for use in Electronic, Communications, and Allied Electrical Equipment	MIL-P-3411
Plastic-Sheet, and Plastic Rod, Thermosetting, Cast	MIL-P-77C
Plastic-Sheet, Acrylic Base, Antielectrostatic, Transparent (For Indicating Instrument Windows)	MIL-P-80B
Plastic Sheet, Filled Phenolic, Uncured	MIL-P-13436A
Plastic Sheet, FEP-Fluorocarbon (Unfilled), Copper Clad (For Printed Wiring)	MIL-P-27538
Plastic Sheet, Laminated, Copper-Clad Paper Base Phenolic	MIL-P-13949B
Rectifiers, Metallic, Selenium	MIL-R-11050A
Relays, (Electrical, Excluding Thermal), for Electronic and Communication Type Equipment	MIL-R-5757D
Resistors, Adjustable, Wirewound, Power	MIL-R-19365C
Resistors, Fixed Meter Multiplier, External (High Voltage, Ferrule Terminal Type)	MIL-R-29A
Resistors, Fixed, Composition (Insulated)	MIL-R-11D
Resistors, Fixed (Composition Film, Very High Frequency)	MIL-R-10683A
Resistors, Fixed Film (High Stability)	MIL-R-10509D
Resistors, Fixed, Film (Power Type)	MIL-R-11804D
Resistors, Fixed, High-Megohm (Hermetically Sealed	MIL-R-14293A
Resistors, Fixed, Wirewound (Accurate)	MIL-R-93C
Resistors, Fixed, Wire-Wound (Low-Power) TD: RU4A100K	JAN-R-184
Resistors, Fixed, Wirewound (Power Type)	MIL-R-26C
Resistors, Fixed, Wirewound, (Power Type, Chassis Mounted)	MIL-R-18546C
Resistors, Variable, Composition	MIL-R-94B
Resistors, Variable, Wirewound, (Low Operating Temperature)	MIL-R-19A
Resistors, Variable (Wirewound, Power Type)	MIL-R-22A
Resistors, Variable, Wirewound, Precision	MIL-R-12934B
Semiconductor Devices	MIL-S-19500B
Sockets, Electron Tube; and Accessories	JAN-S-28A
Sockets, for Plug-in Electronic Components; and Accessories	MIL-S-12883A
Switches (Coaxial) Radio Frequency Transmission Line	MIL-S-3928A
Switches, Rotary (Circuit Selector, Low Current Capacity)	MIL-S-3786A
Switches, Sensitive	JAN-S-63
Switches, Toggle	MIL-S-3950A
Transformers and Inductors (Audio, Power, and Pulse)	MIL-T-27A
Vibrators, Interrupter and Self-Rectifying	MIL-V-95A
Waveguide Assemblies, Flexible	MIL-W-287B
Waveguide Assemblies, Rigid	MIL-W-3970
Waveguide, Rigid, Circular	MIL-W-23066
Waveguides, Rigid, Rectangular	MIL-W-85C
Wire and Cable, Hook-Up, Electrical, Insulated	MIL-W-76B
Wire, Magnet, Electrical	MIL-W-583B

By **HAROLD D. ERVIN**

Electrical Engineer
Space Technology Laboratories, Inc.
8433 Fallbrook Avenue
Canoga Park, Calif.

Here's a quick refresher on the parameters of magnetomotive force. It should be useful in designing magnetic components.

Reviewing Magnetic Law

In designing magnetic components, we must define and understand the magnetic law relating to the parameters of magnetomotive force. This law is a counterpart to Ohm's law for electromotive forces. If $E = IR$ in Ohm's law, then $F = \phi R$ in the magnetic law,

where,

E = electromotive force (emf) is analogous to magnetomotive force (mmf), F

I = electrical current is analogous to magnetic flux, ϕ

R = electrical resistance is analogous to magnetic reluctance, R

The two laws are related since an emf is required to establish the mmf necessary to produce core flux.

Several systems are in use for defining the magnetic parameters; however, the following definitions will be limited to the more frequently used cgs (centimeter-gram-second) units. These units, which are also referred to as the irrational cgs electromagnetic units, are compared in Table 2 with similar units used in other systems.

Magnetomotive force: Abbreviated "mmf" this quantity relates magnetic potential to the product of ampere turns. It is force which produces lines of flux in a magnetic material. The unit of force is the gilbert, and one gilbert = $.4\pi NI$, where NI is one ampere turn.

$$F = .4\pi NI = R\phi = BAR = Hl,\ I = \frac{F}{.4\pi N},\ N = \frac{F}{.4\pi I}$$

Magnetic flux: This is equal to the total number of magnetic lines of force. Its dimensions are measured by lines or maxwells; one line = one maxwell. Flux in a magnetic circuit is proportional to ampere turns and inversely proportional to the reluctance of the magnetic path.

$$\phi = \frac{F}{R} = BA = \mu HA$$

Flux density: This quantity is measured in gauss and refers to the total amount of flux distributed over a given core area. One gauss = one maxwell/cm^2.

$$B = \frac{\phi}{A} = \frac{Hl}{AR} = \mu H$$

This simple diagram is used to define and understand the magnetic law relating to the parameters of magnetomotive force.

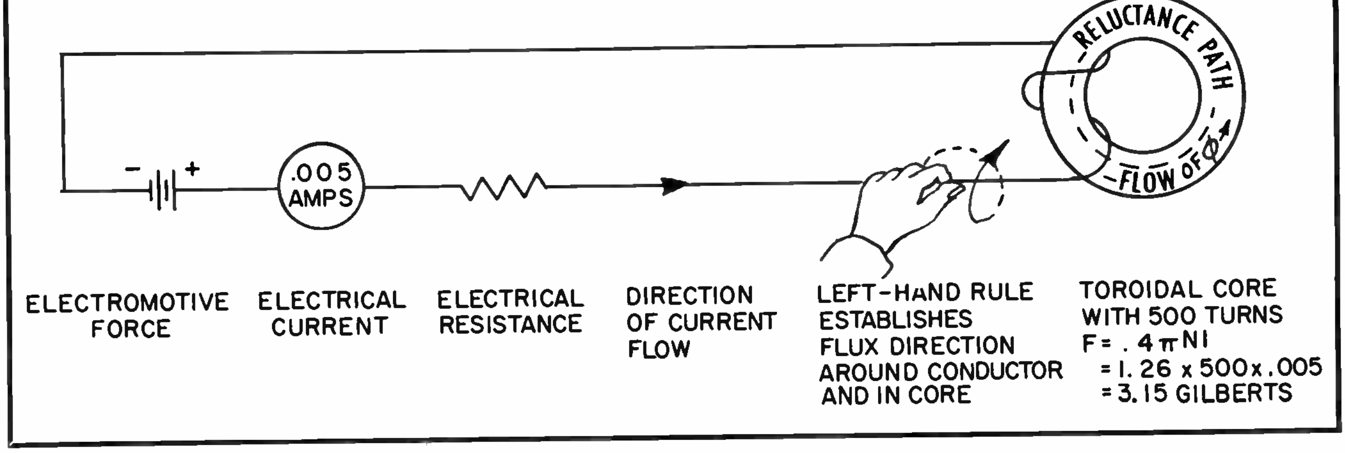


TABLE 2

Conversion of Magnetic Units

Units of	To Convert	Into	Multiply By	Conversely Multiply By
ϕ	Maxwells	Lines	1	1
ϕ	Maxwells	Webers	10^{-8}	10^{8}
ϕ	Webers	Volt-Seconds	1	1
B	Maxwells/CM.^{2}	Gauss	1	1
B	Lines/Inch^2	Gauss	.1550	6.452
B	Webers/Meter^2	Gauss	10^4	10^{-4}
H	Gilberts/CM.	Oersteds	1	1
H	Ampere-Turns/Inch	Oersteds	.495	2.02
H	Ampere-Turns/Meter	Oersteds	.01257	79.58
H	Ampere-Turns/CM.	Oersteds	1.257	.7958
H	Ampere-Turns/CM.	Ampere-Turns/Inch	2.540	.3937
F	Ampere-Turns	Gilberts	1.257	.7958
μ	Henrys/Meter	Gauss/Oersted	7.958×10^5	1.257×10^{-6}
R	Ampere-Turn/Weber	Gilberts/Maxwell	1.257×10^{-8}	7.958×10^7
P	Webers/Ampere-Turn	Maxwells/Gilbert	7.958×10^7	1.257×10^{-8}

Magnetizing force: This parameter is often referred to as field strength and magnetic intensity. With units of oersteds, it is a measure of the magnetic potential drop per unit core length. When a mmf of one gilbert is distributed across 1 cm. of core length, the magnetic drop is one oersted.

$$H = \frac{F}{l} = \frac{.4\pi NI}{l} = \frac{B}{\mu} = \frac{BAR}{l} = \frac{\phi}{\mu A}$$

TABLE 1

Symbol	Dimensions	Definition	Useful Formulas
N	Turns	Turns through core	$N = \frac{Hl}{.4\pi I}$
I	Amperes	Average current	$I = \frac{Hl}{.4\pi N}$
NI	Ampere-Turns	Current times turns	$NI = \frac{Hl}{.4\pi}$
A	Square Centimeters	Effective core cross section area	$A = \frac{\phi}{B} = \frac{Hl}{BR} = \frac{\phi}{\mu H}$
B	Gauss	Flux density	$B = \frac{\phi}{A}$
H	Oersteds	Magnetizing force	$H = \frac{.4\pi NI}{l}$
l	Centimeters	Means magnetic path length	$l = \frac{.4\pi NI}{H} = \frac{BAR}{H}$
μ	None	Permeability	$\mu = \frac{B}{H} = \frac{1}{V}$
ϕ	Lines or Maxwells	Total flux	$\phi = BA$
F	Gilberts	Magneto-motive force	$F = .4\pi NI$
R	None	Reluctance	$R = \frac{l}{\mu A} = \frac{\ }{P}$
P	None	Permeance	$P = \frac{\mu A}{l} = \frac{1}{R}$
V	None	Reluctivity	$V = \frac{1}{\mu}$

Permeability: Measures ease with which flux can pass through a magnetic material with reference to air. If the number of lines of flux in an air core coil were increased by 5000 when inserting a magnetic material into it, the permeability of the material would be 5000. One oersted of magnetizing force will produce one gauss of flux density when the permeability is one.

$$\mu = \frac{B}{H} = \frac{l}{RA} = \frac{\phi}{HA} = \frac{\text{gauss}}{\text{oersteds}}$$

Reluctance: This magnetic resistance quantity is a measure of the oppostion offered to lines of flux in the magnetic path of a core. Its value is dependent upon the physical dimensions and permeability of the core. The electrical counterpart of reluctance is resistance; however, reluctance has an additional characteristic in that it changes with permeability. Since permeability changes with flux density in most magnetic materials (certain powder cores bring exceptions), the reluctance becomes inversely proportional to permeability.

$$R = \frac{l}{\mu A} = \frac{l}{\left(\frac{B}{H}\right)A} = \frac{Hl}{BA} = \frac{F}{\phi} = \frac{F}{BA} = \frac{1}{P} = \frac{\text{gilberts}}{\text{maxwells}}$$

Permeance: The permeance of a magnetic material defines its ability to pass flux. Since permeance is the reciprocal of reluctance, any of the reluctance formulas may be used to find permeance by interchanging the denominator with the numerator.

Reluctivity: This unit is the reciprocal of permeability. Any of the permeability formulas with the denominator and numerator inverted may be used to find reluctivity.

* * *

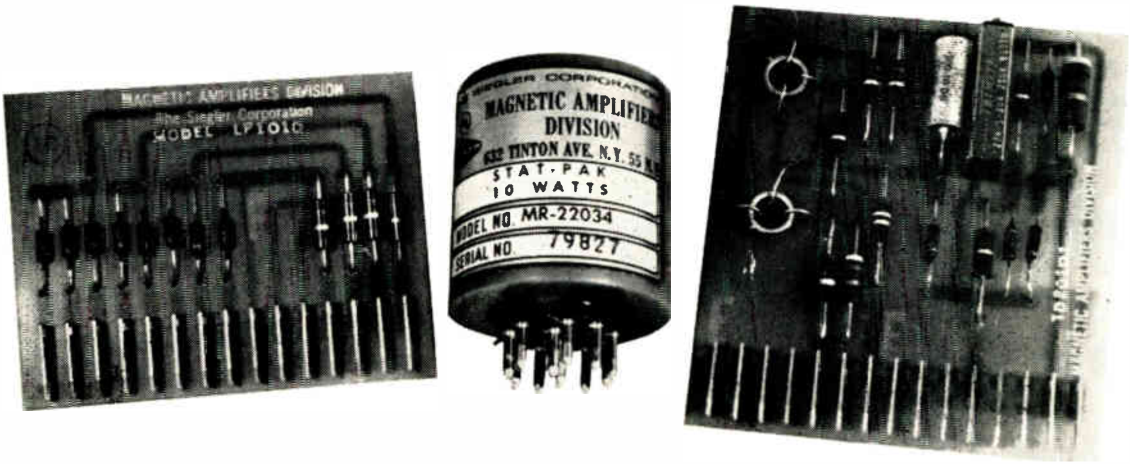


Fig. 1: Compact magnetic amplifier plug-in modules provide highly reliable building blocks for complex control or logic systems. Each module is comprised of toroidally wound magnetic cores and silicon rectifiers.

Courtesy of The Siegler Corp., Magnetic Amplifiers Div.

A New Look at

THE magnetic amplifier uses an input signal to control the flux density in a special ferromagnetic core. Controlling this flux density controls the impedance of a reactor in series with the load and thus controls the power delivered to the load. The devices are amplifiers because a relatively small input signal can control a large output.

The saturable reactor was the first—and is still the simplest—form of the magnetic amplifier. The modern magnetic amplifier is built around the saturable reactor; rectifiers and other electronic components are added to produce outputs entirely different from the saturable reactor.

Interest in these devices waned a few years ago as other amplifying techniques appeared. For example, magnetic amplifiers were used in the early days of radio, but these amplifiers do not reproduce the input signal waveshape, and vacuum-tube amplifiers early preempted this field. But, recent developments in the field of high permeability magnetics have produced new core materials, and new rectifiers have been developed which have ideal characteristics for this application.

As an example of the tremendous improvements being made, one company (Acromag, Inc.) reports—since 1952—an 80% reduction in size, a 75% reduction in space, a six-fold improvement in stability plus added improvement in packaging and reliability in their control system amplifiers.

The widespread use of magnetic amplifiers really began during the 1950's. An engineering highlight of this decade was the increased use of automatic control loops both in military and in industrial systems. These were complex new systems which demanded components with exacting standards of reliability and exceptional resistance to extremes of environments. The newly developed magnetic amplifier circuits proved remarkably well suited to these new systems. They were rugged and reliable; they could be miniaturized; and they were capable of high performance under adverse conditions.

There is renewed interest in these devices, because

Fig. 2: The basic saturable reactor. The control coil determines when during the positive half-cycle of line voltage the core will become saturated. At saturation, the impedance of the coil in series with the load drops abruptly.

From "Magnetic Amplifier Engineering," G. M. Attura, McGraw-Hill Book Company Inc., 1959, pp 48.

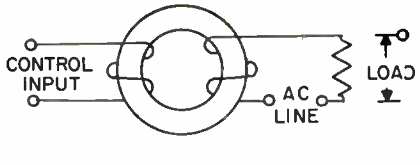
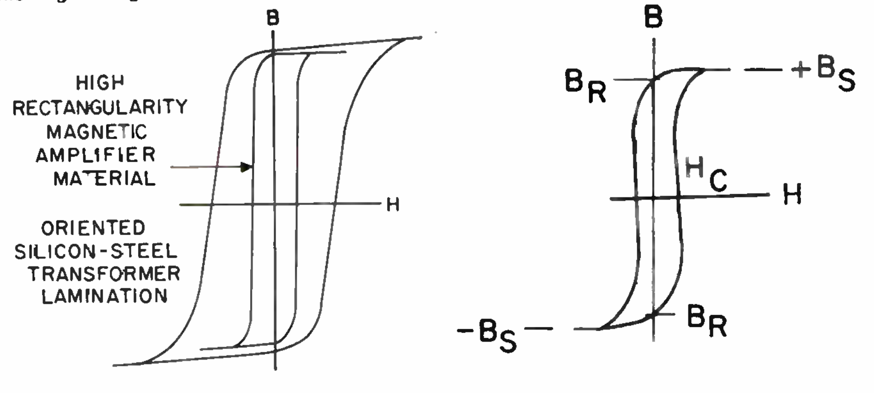


Fig. 3a: Flux-current loops for transformer grade and magnetic amplifier core materials. Fig. 3b: Bs is the saturation density; Br measures the residual magnetization in the material; Hc is the magnetizing force needed to bring the flux density from Br to O.



Engineers are taking a new look at a relatively old device—the magnetic amplifier.
New core materials and new rectifiers have been developed which are ideal for magnetic amplifier applications.
Standard "lines" have been developed and new manufacturing techniques have reduced prices.
A wide variety of magnetic amplifiers is available.

Magnetic Amplifiers

they can be used in combination with vacuum-tube and transistor amplifiers; each amplifying technique serving its own unique application. Combinations of different types of amplifiers, using the best features of each amplifier, are rather common. The magnetic amplifier is often used as the output stage in these "hybrid" circuits, because it can easily handle large blocks of power; vacuum-tube and/or transistor circuits are often used to drive the output stage.

Fig. 10 shows a high precision power supply system built by Airpax Electronics, Inc., Fort Lauderdale, Fla., for RCA's new 601 computer. The power supply uses transistor-driven magnetic amplifiers to regulate six critical voltage levels for the computer. Regulation is to within ¾ of 1% of rated output even under severe variations of line voltage (plus or minus 15%) and output loads (80 amps as a step function with a rise time of 50 microseconds).

The power supply system is in two racks and weighs 2,500 lbs. It can handle a total load of 13 kw with precise regulation of each power level. The magnetic amplifiers in the power section are in bridge-type circuits operating from 208 v, three phase. The ripple frequency in the power supply output is 360 CPS filtered by a conventional LC filter.

Modern magnetic amplifiers have many advantages. They can be operated directly from line voltage; no warm-up time is needed (no-tubes); they use long-life components; many signals can easily be mixed; complete isolation between control and load is possible; and the units can be hermetically sealed. They provide dependable service under severe operating conditions of shock, vibration, moisture, and overload.

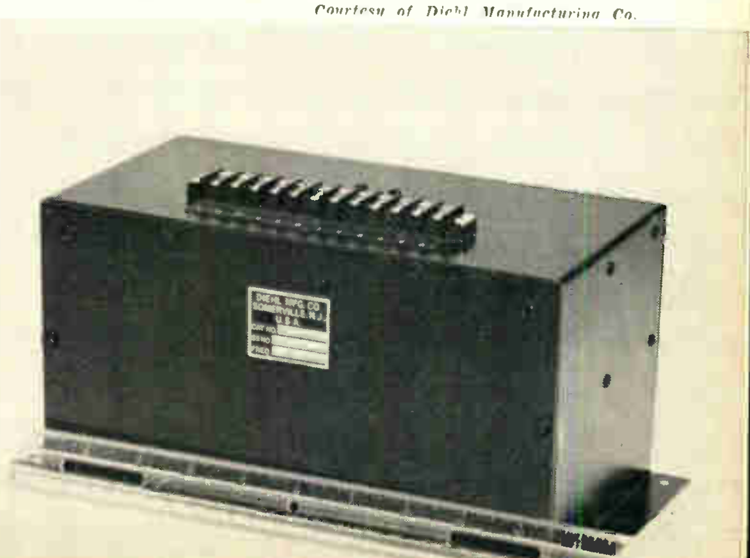
One feature—becoming more important every day—is their resistance to nuclear radiation. The Marquardt Corp., Van Nuys, Calif., recently successfully tested a 4800 cycle magnetic amplifier (developed for Project Pluto) to 10^{16} NVT fast neutrons at Convair's Ft. Worth reactor. This particular amplifier has an operating temp. range from 0 to 200°F. It is part of a line being developed by the company for high-gain thermocouple error amplifiers, integrators, logarithmic amplifiers, servo-valve drive amplifiers, and operational type amplifiers. The line will be used in airborne control systems for space power generators and nuclear propulsion systems.

Magnetic amplifiers can be used for fast-response switching and for all principal logic functions such as "and," "or," "not," memory, and time delay. Fig. 1 illustrates one unit in a line of plug-in modules built by the Magnetic Amplifiers Div., The Siegler Corp., 632 Tinton Ave., New York 55, N. Y., as reliable building blocks for complex control or logic systems.

(Continued on following page)

Fig. 4: Solid-state servo amplifier, XA-500, eliminates the need for constantly energizing a reference phase. Using the high-gain ac input (input impedance of 20K) full torque is obtained at the motor shaft with a signal input of 20 mv. Using the high-gain dc input (input impedance of 45K), full torque is obtained at the motor shaft with an input of approximately 120 mv.

Courtesy of Diehl Manufacturing Co.



Magnetic Amplifiers *(Continued)*

The Saturable Reactor

The saturable reactor is the "heart" of all magnetic amplifiers, and by itself is still widely used as a power amplifier and controller. This section describes rather simply how these devices work. Fig. 2 illustrates the principle of operation.

Two coils are wound upon a single core made of a special ferro-magnetic material. One winding is energized by the ac line and is in series with the load. The second coil is fed from a dc signal source; this is the control coil. The key to the circuit action is in the magnetic properties of the core.

The core differs from standard transformer core materials by having a B-H characteristic which is extremely rectangular. (The B-H characteristic is a plot of flux density "B" versus magnetizing force "H".) Fig. 3a illustrates the difference between the characteristics of transformer core materials and magnetic amplifier core materials.

In the linear inductor, a rather simple mathematical relationship describes "B" and "H" ($B/H = \mu$).[1] No such relationship obtains with modern magnetic amplifier core materials—the relationship must be obtained experimentally. Several points on the curve in Fig. 3B are of interest; B_s is the maximum flux density or saturation density. B_r is the retentivity or the level the flux will decay to from B_s when the magnetizing force "H" is reduced to zero. H_c is the magnetizing force needed to reduce the flux density to zero from B_r.

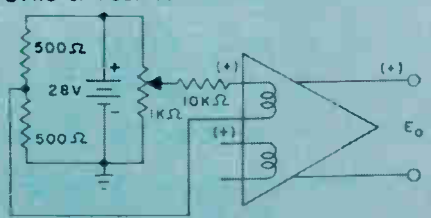
The ratio of B_r to B_s is the "Rectangularity." For magnetic amplifiers, this value should be as close to unity as possible. The materials should also have a low value of H_c.

The saturable reactor is designed so that as long as the current in the control winding is zero, the flux density in the core produced by the line volt-second, remains less than the saturated value. When the flux density is less than saturation, the load coil is a high impedance in the ac line. However, with control current flowing, during the positive half-cycle of line voltage, the magnetizing forces of both line and control combine to drive the core to saturation. When the core saturates, the reactor is a low impedance in the

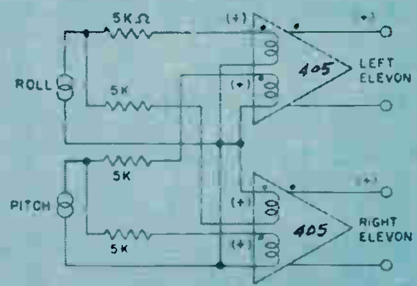
[1] μ = permeability.

Fig. 5: Typical applications of the modern magnetic amplifier. Schematic courtesy of Acromag, Inc.

GYRO or POSITION PICKOFF



Magnetic amplifier used to solve isolation problems frequently encountered with gyros or other position feedback transducers using dc potentiometer pickoffs. Circuit eliminates extra power supply and inconvenient grounding arrangement.

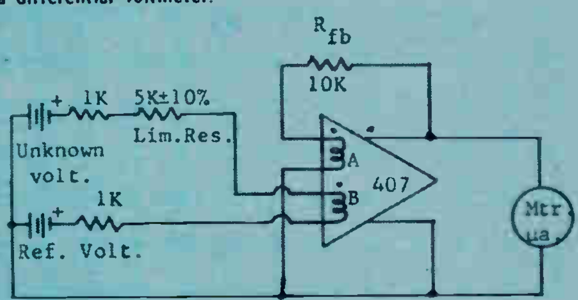


"ELEVON" CONTROL SYSTEM

Signal mixing technique used in guided missiles. System combines "roll" and "pitch" information in the missile's automatic pilot computer.

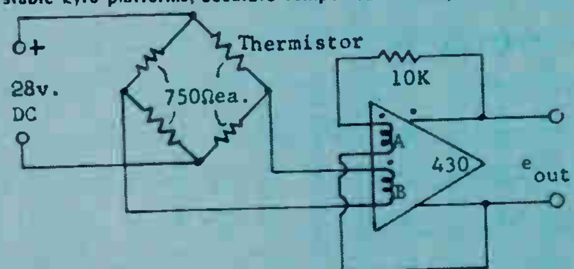
ACCURATE VOLTAGE COMPARATOR

For measuring the voltage difference between a standard voltage and an unknown voltage. The isolated input winding permits its use as a differential voltmeter.



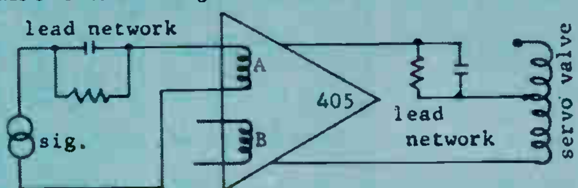
THERMISTOR AMPLIFIER

Magnetic amplifiers make excellent dc preamplifiers for thermist signals. This circuit is a typical temperature regulating applicatio for stable gyro platforms, accurate temperature baths, and similar uses.



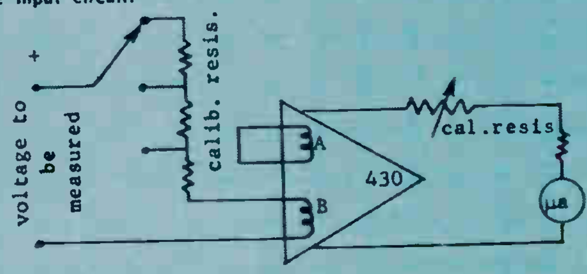
ELECTRO-HYDRAULIC VALVE DRIVE

This application requires a stable and linear dc to dc amplifier for proper operation. Fast time response is needed for good phase margins. This circuit has been tested with several commercially available valves and has given excellent results.



DC VOLTMETER CIRCUIT

A computing magnetic amplifier makes a good voltmeter circuit. Th extra control winding can be used to offset the zero for zero cente scale operation, and a simple DPDT toggle switch can be used to reverse the meter signal to measure negative voltages without opening the input circuit.



circuit, and power is delivered to the load.

By controlling the dc in the control coil, we can control the firing point of the reactor. The firing point is the point on the positive half-cycle at which the reactor saturates. This controls the length of time that power is delivered to the load. Low dc inputs to the control coil mean later firing and less load power; high dc inputs mean earlier firing and more power output.

During the negative half-cycle of line voltage, the flux moves away from saturation. But, power is reflected into the load from the control winding by transformer action, and the output of the saturable reactor is ac with no dc component.

The familiar equal-ampere-turns law ($IN_{control} = IN_{load}$) governs in the saturable reactor. This means that for more output power, more input power must be supplied.

Other Saturable Reactor Configurations

To minimize the coupling effects of the two windings, a high impedance can be inserted in the control circuit, or two reactors can be connected so that the load coils are in series aiding and the control windings in series opposition. Another variation has the control windings in series opposition and the load windings in parallel.

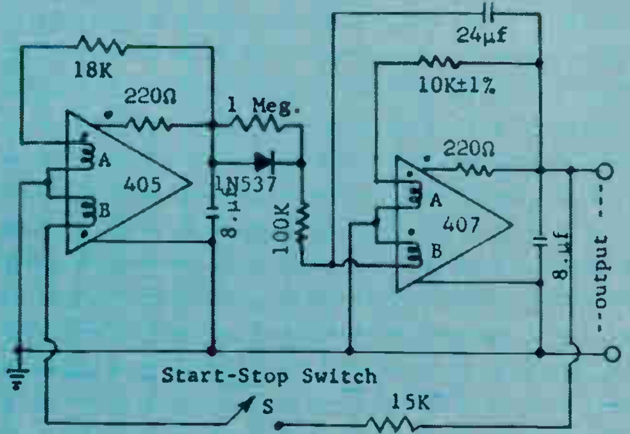
The outputs of both of these circuits are ac. With load rectifiers, the output is single polarity dc.

The major advantages of the saturable reactor amplifier are simplicity and reliability. The only active element is the coil, and if conservative ratings are used, the life of a saturable reactor is practically unlimited. The gain is not exceptional because of the equal-ampere-turns law, but this relationship is used to good advantage where a dc-dc transformation is needed.

The saturable reactor is still very much used for lighting control, electric furnace control, temperature sensing, two-phase servomotor drives, and other applications where rather large blocks of power must be controlled. The saturable reactor is also used to measure current safely at a high potential above ground.

Fig. 4 is a solid state servo amplifier recently introduced by the Diehl Manufacturing Co.'s Small Motors Division, Somerville, New Jersey. This amplifier will drive both phases of 115/115 volt, 60 cycle, servo motors with outputs from 25 to 100 watts. The unit uses silicon controlled rectifiers in conjunction with saturable reactors. Four inputs, two ac and two dc, are provided; they may be used in any combination.

(Continued on following page)

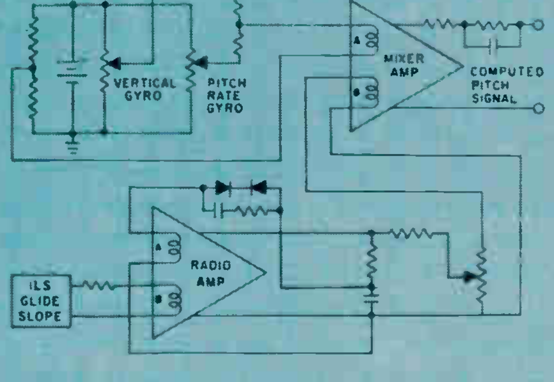


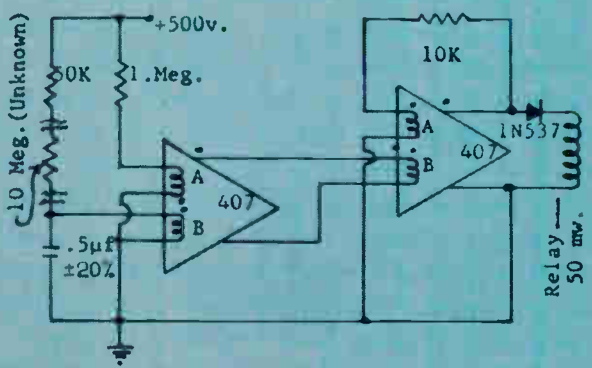
MAGNETIC SWEEP GENERATOR

This sweep generator is used to test precision magnetic amplifiers.

AUTOMATIC PILOT PITCH CONTROLLER

The computer combines signals from the Instrument Landing System, Radio Receiver, the Gyro Vertical, and the Pitch Rate Gyro. The complete computer weighs less than 1.3 lbs., operates on approximately 4 watts of 115 v, 400 CPS power, and can be packaged in a module 3.5 x 1.75 x 4 in. Compare this to a conventional vacuum tube chopper stabilized type amplifier.





INSULATION RESISTANCE TESTER

This circuit was designed to check a wiring harness for electrical leakage. The magnetic amplifier is used as an accurate current comparator and accepts the harness if the resistance exceeds 10 megohms. The circuit resolves to an accuracy of better than ½ of 1%. Accuracy is not affected by minor changes in the 500 supply.

VELOCITY SERVO CIRCUIT

This arrangement gives good results in stabilizing the speed of helicopter rotors and in stabilizing the speed of precision film drives in aerial cameras. Positive feedback can be applied to increase the low frequency gain and enhance the accuracy of the system. These systems have produced speed accuracies of 0.1% under favorable circumstances.

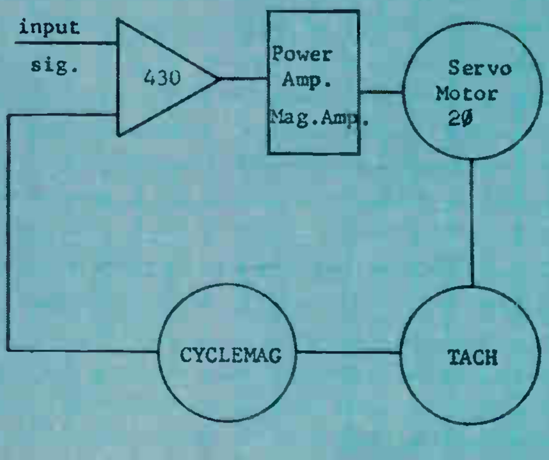


Fig. 6: This magnetic amplifier reactor assembly has no moving parts —no tubes. For motor speed control of 200 hp motors, it is rated at 173 kva, 240 v, 60 CPS.

Courtesy of Magnetics, Inc.

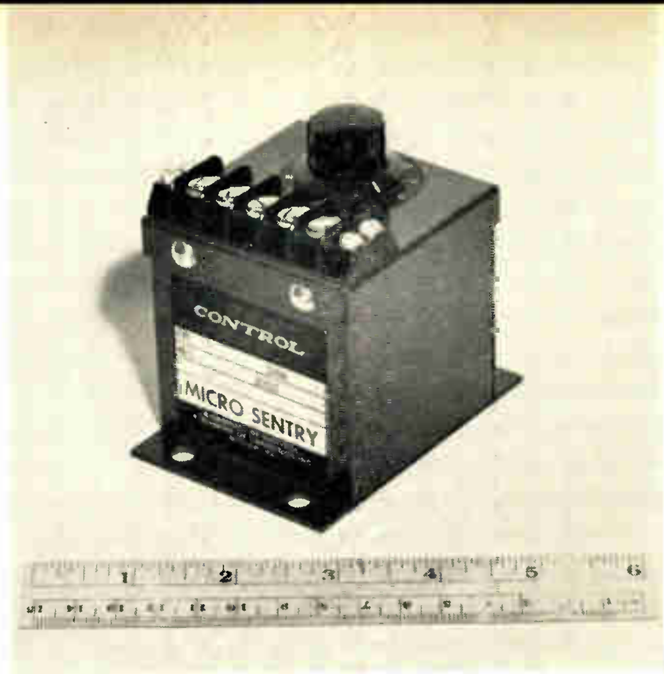


Fig. 7: This amplifier (the "Micro Sentry") will switch five watts on input of only 2.5×10^{-9} watts, or 0.5 mv at 5 μa. Input is adjustable.

Courtesy of Magnetics, Inc.

Magnetic Amplifiers *(Continued)*

The Reactor-Rectifier Combination

Adding a rectifier to the load circuit of the saturable reactor completely changes its output characteristics.

When the line voltage is in the negative half-cycle, the rectifier in the load circuit effectively opens the circuit. The reactor is isolated from the line voltage allowing the control circuit to be fully effective in controlling the flux level in the core.

During the control half of the line cycle, the control windings move the flux away from the saturated value "B_s" to a point on the B-H curve called "B_o". B_o is called the initial flux density. The value of B_o determines the point during the positive half-cycle at which the reactor fires. If B_o is very near the value of B_s, the reactor will fire early in the positive half-cycle, and nearly maximum power will be delivered to the load. If the control moves the flux to a value of B_o considerably below the B_s value, the reactor will fire later in the half-cycle and less power will be delivered to the load. The further away B_o is from the saturated value, the longer it will take the line volt-seconds to saturate the core.

Ideally, with no control current, the core will remain at B_s and the reactor will fire at the beginning of the positive half-cycle and deliver maximum power. But, if the B-H loop is not perfectly rectangular, the flux density will move away from saturation to B_r (see Fig. 3B) even with no control current. This means that on each cycle, the line volt-seconds must supply enough additional flux to drive the core from B_r to B_s and the reactor can never fire at the beginning of the positive swing. To compensate for this condition, a bias winding may be added. The bias current provides enough flux to maintain the flux density at B_s with no control current flowing.

The important feature of the reactor-rectifier combination is that the load action and the control action take place separately. The gain is much improved over the saturable reactor amplifier and so is the response. The output of the amplifier is limited only by heating, and the input is determined by the characteristics of the core.

As many as 20 different signals can be combined in the control circuits of magnetic amplifiers. These signals can be combined electrically using a summing point, or they can be combined using ampere-turn mixing within the amplifier's core.

This combination of saturable reactor and rectifier is the basic modern magnetic amplifier circuit. The output of the single section just described is half-wave rectified and the power output is determined by the length of time the core is saturated during the positive half-cycle of the line.

Combinations of these basic amplifiers may be used in conjunction with other electronic components to produce almost any output from the most basic to the most sophisticated imaginable.

Full-Wave DC Output

Two of the half-wave reactor-rectifier units described above can be combined for a full-wave rectified output. The load circuit is arranged so that current flows in the same direction regardless of which reactor is firing. One of the sections fires on the positive swing of the line, and the other section fires on the negative swing of the line. The units are designed so that each

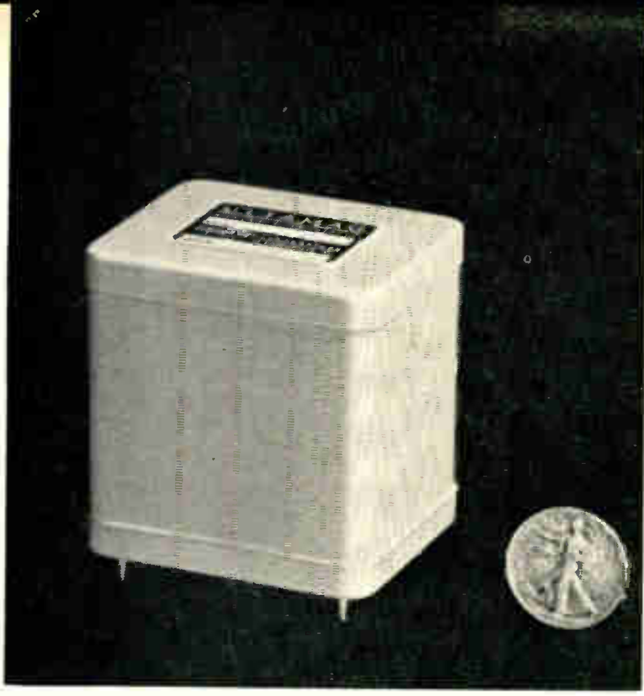


Fig. 8: "Ten Line" series provide 43 db gain at control levels less than 5 microwatts. Powered from 115 v, the units deliver 7.5 v across 1K with zero errors below 1% for input signals in the microamp region. Overloads of 1,000% can be withstood and the unit can be operated into a dead short without damage.

Courtesy of Military and Computer Electronics Corp.

Fig. 9. "One Hundred" line provide up to 43 db polarity reversible gain with zero stability better than 1%. Overload capacity is 1,000% and the units are highly resistant to radiation. Operating Temperatures are from −10 to 180°F. Units measure 4.31 in. High x 2.53 in. dia.

Courtesy of Military and Computer Electronics Corp.

reactor fires at the same point in their respective half-cycles.

For the same power output as the half-wave circuit, this configuration has lower dissipation and lower load heating. Efficiency is high, and the circuit can handle large blocks of power.

Full-Wave AC Output

The basic reactor-rectifier units can also be combined to give a full-wave ac output with little or no dc component such as is obtained from the series connected saturable reactor.

Two half-wave sections are combined in a circuit. Each unit acts as a controlled rectifier feeding power to the load on alternate half cycles. The first rectifier fires on the positive half-cycle of line voltage and contributes a positive segment to the load. The second unit fires on the negative half-cycle of line voltage and contributes a negative segment to the load.

When reactor-rectifier units are combined there may be interactions between the units which affect their performance. For example, when one section fires, its ac impedance drops and it could effectively short out the other section. This affects the control circuit action of the second section. It also means that changes in control are reflected back and forth between the two units.

Reversible Circuits

Magnetic amplifiers are quite often used to drive reversible loads which means, of course, that the magnetic amplifier must have a reversible output.

Several unidirectional magnetic amplifiers can be arranged in a circuit so that as the output of one increases the output of the other decreases. The net output and direction depends on the difference between the two. The output can be fed to two separate control circuits or be compared differentially in a single circuit.

One undesirable feature of reversible output circuits is that considerable power is dissipated at low outputs. This is because two currents or voltages are being compared—the power must be dissipated either in the amplifier itself or in the load.

Some Problems

The magnetic amplifier, like any other device, has both advantages and disadvantages.

One disadvantage of these devices is that they do not reproduce the waveshape of the input. Because of this feature, these devices are not widely used in communications work.

The output of the magnetic amplifier is neither a clean sinusoid nor pure dc, and the effect of the distorted waveshape on the load should be carefully analyzed.

Matching the load to the magnetic amplifier can also be a problem, because the output impedance of the magnetic amplifier is generally high, and for maximum power transfer, the load impedance must be high.

Since magnetic amplifiers are used in automatic control systems, their transient response and time delays are important. Although the response depends a lot on the circuit used, the minimum delay is between one-half and one and one-half cycles of the line frequency since control and load action occur in alternate half-cycles. When two or more units are connected in a circuit, the firing of one can effect the firing of the others. A change in control can be reflected back and forth between the several units increasing the time constant. Large impedances can be inserted in the circuits to counteract this effect, but this impairs the circuit efficiency.

(*Continued on following page*)

Magnetic Amplifiers *(Concluded)*

In designing a magnetic amplifier drive, not only must the effect of the output wave shape on the load be considered, but also the induced electrical effects of the load on the magnetic circuit.

Some Applications

There are so many possible applications for these versatile devices that it would be impractical to list each of them. We suggest that the design engineer, interested in the possibilities of these devices, contact the manufacturers listed at the end of this article or listed in the Directory section of ELECTRONIC INDUSTRIES' June issue.

A few typical circuits are shown in Fig. 5. These circuits (from Engineering Bulletin 403-A, published by Acromag. Inc., 15360 Telegraph Road, Detroit, Mich.) illustrate the wide range of applications possible.

Fig. 6 shows a magnetic amplifier reactor assembly rated at 173 kva, 240 v supply, 60 CPS, designed for speed control of 200 hp motors. This unit is made by Magnetics, Inc., Butler, Penna. Magnetics, Inc., uses a sensitive, high-gain magnetic amplifier to trigger a silicon-controlled rectifier in their "Micro Sentry" (see Fig. 7). The device is designed to replace sensitive meter relays in such applications as reverse current protection, over-temperature control, and overspeed control.

The Micro Sentry will operate on a signal as low as 0.5 mv at 5 μa. The output of 5 w is enough to drive static power amplifiers or pick up auxiliary relays. Two types of units are available: one operates from 15 v at 60 CPS: the other operates from 120 v at 60 CPS. Rated load of either unit is 30 ohms or greater, and maximum input is 15 ma. By using the magnetic core, the input and outputs are completely isolated—another attractive feature of magnetic amplifiers.

One of the main reasons for the renewed interest in magnetic amplifiers is that standardized "lines" are now being offered by companies in this field. Just a few years ago, most magnetic amplifiers were strictly "custom-made" for each application. With standard units available (the building block concept) design engineers now have excellent flexibility and adaptability in selecting the magnetic amplifier that is perfect for their job.

For example, General Electric Company's Specialty Transformer Dept. in Ft. Wayne Ind. makes a line of magnetic amplifiers (called Amplistats) for amplifying signals from relatively low impedance sources (up to several thousand ohms). The line includes ac and dc output units, static control power amplistats, and general purpose units. Input signals may come from thermocouples, strain gauges, thermistors, photocells, phototube amplifiers, and transistor amplifiers. Typical controlled devices include relays, solenoids, motor armatures and fields, lamps and heating elements. (For more information on this line, write for the Company's publication, GEA-6930.)

Fig. 8 and 9 illustrate two lines of magnetic amplifiers available from Military and Computer Electronics Corp., 900 N. E. 13th St., Ft. Lauderdale, Fla. Fig. 8 illustrates the "Ten Line" used for instrumentation and Control, servo systems, operational amplifiers, and other dc to dc amplification. Fig. 9 illustrates the "One Hundred Line" for instrumentation, control, servo system drive, and control, differentiating, mixing, integration, summing, all types of dc to dc amplification, null detection, meter drive, and preamplification.

Another company offering a line of magnetic amplifiers and saturable reactors is the Freed Transformer

Fig. 10a. Power supply for RCA's new 601 computer fits into two 46 x 20 x 76 in. racks. Three voltage levels are controlled to within ¾ of 1% of rated value; three others to within 1 and ½%. All voltages can be brought up in precise ratios from zero to full power in 15 seconds without using auxiliary equipment.

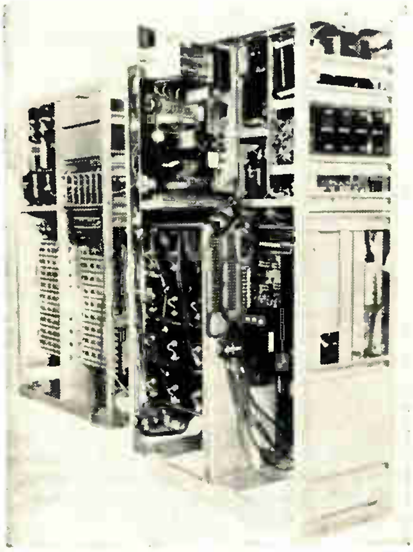
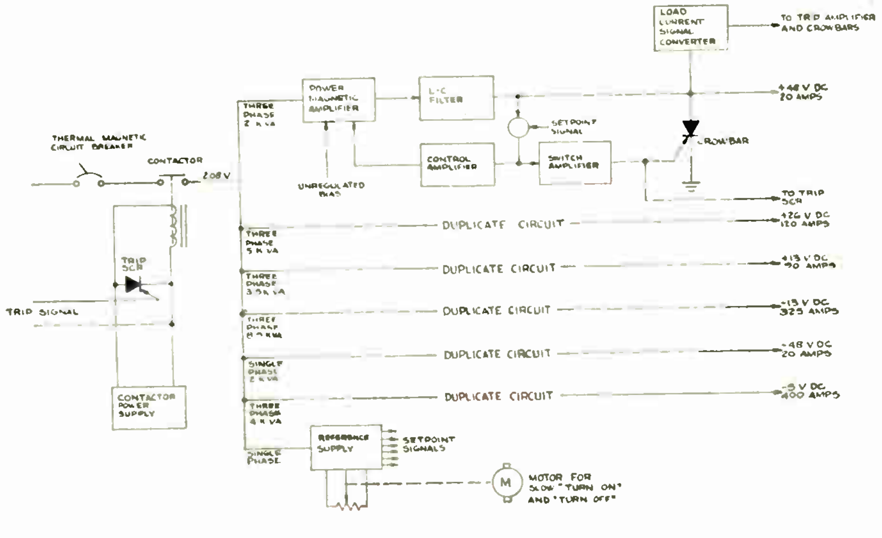


Fig. 10b. Simplified block diagram of the power supply. The transistor driven magnetic amplifiers are used to regulate voltage levels. *Courtesy Airpax Electronics*



Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y. (Write for catalog no. 5930.) The line includes units ranging from saturable transformers to half-wave type, fast response servo amplifiers. The units are designed for continuous operation in an ambient temperature range of −55 to 75°C. If high impedance inputs are required, the company offers a line of vacuum tube and transistor preamplifiers.

Fig. 11 shows just one of the magnetic amplifiers made by the Kearfott Div., General Precision, Inc. It is used in many applications requiring dc control. For example, it is used for temperature control of critical components, in conjunction with heaters and a temperature sensitive element.

Fig. 11: This magnetic amplifier, the A5150, provides extremely high power gain. It is a single-ended, single stage circuit, with self-contained fixed bias. Input control current is from −0.4 to +0.8 ma dc; output ranges from 0.5 to 85 v rms.

Courtesy of Kearfott Div., General Precision, Inc.

Acknowledgments

Information for this article was solicited from many individuals and companies in the magnetic amplifier field.

Mr. Christopher M. Celent, Radio Corp. of America, Camden. N. J. has been particularly helpful in assembling this article.

We also thank the companies listed below for their cooperation (and those whose information arrived to late to be used.) We suggest if you are interested in finding out more about these devices—that you write to these companies.

The following books are excellent engineering texts on magnetic amplifiers.

a. "Magnetic Amplifier Engineering," George M. Attura, McGraw-Hill Book Co., Inc.

b. "Magnetic Amplifier Analysis," David L. LaFuze, John Wiley & Sons, Inc.

The following company bulletins, design data sheets, catalogs, etc. were also used:

1. Design Manual, Bulletin 403-A, Acromag, Inc., 15360 Telegraph Rd., Detroit, Mich.
2. "How to Reduce Magnetic Circuit Size and Response Time," Magnetics, Inc., Butler, Penna.
3. Amplistats and Amplistat Reactors for Industrial Applications, Bulletin GEA-6930, General Electric Co., Specialty Transformer Dept., Fort Wayne, Ind.
4. "Magnetic Amplifier Circuit Applications," Blaz Mazzeo, Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Florida.

Magnetic Amplifier Manufacturers

1. General Precision, Inc., Kearfott Div., 1150 McBride Ave., Little Falls, N. J. (Catalog data sheets).
2. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.
3. General Electric Co., Specialty Transformer Dept., Fort Wayne, Ind.
4. Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y. (Catalog No. 5930.)
5. Industrial Control Co., Central Ave. at Pinelawn Farmingdale, L. I., N. Y. (Catalog.)
6. Magnetico, Inc., 6 Richter Court, East Northport, L. I., N. Y.
7. Varo, Inc., Magnetics Div., 2201 Walnut St., Garland, Texas. (Catalog Sheets.)
8. The Marquardt Corp., Van Nuys, Calif.
9. Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Fla.
10. Magnetics, Inc., Butler, Penna.
11. Cedar Engineering Div., Control Data Corp., 5806 West 36th St., Minneapolis 16, Minn.

MAGNETIC AMPLIFIER DEFINITIONS*

(Courtesy of General Electric Co.)

BIAS WINDINGS—The bias windings of a saturable reactor are those control windings by means of which the operating condition is translated by an arbitrary amount.

CONTROL WINDINGS — The control windings of a saturable reactor are those windings by means of which control magnetomotive forces are applied to the core.

FEEDBACK—Feedback (in a magnetic amplifier) is a circuit connection by means of which an additional magnetomotive force, which is a function of the output quantity, is used to influence the operating condition.

MAGNETIC AMPLIFIER — A magnetic amplifier is a device using saturable reactors either alone or in combination with other circuit elements to secure amplification or control.

OUTPUT WINDINGS—The output windings of a saturable reactor are those windings other than feedback associated with the load and through which power is delivered to the load.

SATURABLE REACTOR—A saturable reactor is an electromagnetic device, employing one or more nonlinear magnetic cores, which is used in a.c. circuits to secure amplification or control, commonly by means of a d.c. signal which influences the nonlinearity.

SELF-SATURATION—Self-saturation in a magnetic amplifier refers to the connection of half-wave rectifying circuit elements in series with the output windings of the saturable reactors.

SIGNAL WINDINGS—The signal (input) windings of a saturable reactor are those control windings to which the independent variables (signals) are applied.

CONTROL AMPERE-TURNS — Control ampere-turns expresses the magnitude and polarity of the control magnetomotive force required for operation of a magnetic amplifier at a specified output.

CONTROL CHARACTERISTIC—The control characteristic of a magnetic amplifier is a curve of the output quantity versus control quantity under specified conditions, both expressed in suitable units.

FIRING—Firing in a magnetic amplifier is the transition from the unsaturated to the saturated state of the saturable reactor during the conducting or gating alternation. Firing is also used as an adjective modifying phase or time to designate when firing (n) occurs.

RECTIFIER, COMPLEMENTARY — Complementary rectifiers are those half-wave rectifying circuit elements in the output circuit of a magnetic amplifier which are not self-saturating rectifiers.

RECTIFIER, SELF-SATURATING—Self-saturating rectifiers are those half-wave rectifying circuit elements connected in series with output windings of a saturable reactor in the self-saturating magnetic amplifier circuit.

RESPONSE TIME—The respone time of a magnetic amplifier is that period of time required for a given change of the output quantity following a step change of the input quantity. This change of the output quantity shall be 63% of the total change unless otherwise specified. The "Response Time" specified shall be the maximum which exists for any condition within the rating (e.g. such effects as growth or decay, time phase of signal application, temperature).

ENVIRONMENTAL SENSITIVITY—Environmental sensitivity in a magnetic amplifier is the change in the control characteristic due to specified changes in environmental conditions. These include changes in ambient temperature, supply voltage, supply frequency, and other specified changes.

* Proposed Standard Terms and Definitions for Magnetic Amplifiers—AIEE Definitions Sub-committee of the AIEE Magnetic Amplifier Committee.

An application chart for both
—the practical engineer, and
—the marketing analyst.

Resistor Application Guide

THE material presented in chart form on the following page is designed to serve two purposes—engineering and marketing.

Engineering

The engineering purpose of this chart is to show where the engineering emphasis should be placed. It is apparent that where reliability is not a major problem, e. g., the consumer market, the inexpensive carbon composition resistor, a worthy component of long standing, has been sufficiently developed. But, the military market is a different story. Here, a relatively new, and expensive type, the metal film, has the bulk of the market. Emphasis must be placed on improving an already reliable device and reducing the cost.

Marketing

This ties in very closely with the engineering considerations. However, a manufacturer must decide on what types he is able to produce—engineering-wise and manufacturing cost-wise—and then attack the markets he is able to satisfy. The breakdown within each market should make his job a little easier.

RESISTOR APPLICATION CHART

RESISTOR TYPE

Market	Application	Carbon Composition	Deposited Carbon	Metal Film	Glaze/ Cermet	Power Wirewound	Precision Wirewound
Consumer	Television	XXXX				XXXX	
	Home Radio	XXXX	X			XXX	
	Portable Radio	XXXX				XX	
	Auto Radio	XXXX				XXXX	
	Hearing Aids & Misc.	XXX	XX	X	XX		
Estimated Percentage of Market		90	4	< 1	< 1	> 3	< 1
Estimated Percentage of Unit Usage		30	35	>19	50	15	< 1
Industrial	Computer	XXX	XXX	XX	XXX	XXX	XXXX
	Communication	XXX	XXX	XX	XXXX	XXXX	XXX
	Power Supply & Instrumentation	XXX	XX	XXX	XXXX	XXXX	XXXX
	Automotive & Misc.	XXXX	XXX	XX	XXX	XXXX	X
Estimated Percentage of Market		50	20	5	5	5	15
Estimated Percentage of Unit Usage		50	5	< 1	20	55	>49
Military	Ground-Based Computer	XX	XXXX	XXX	XXX	XX	XX
	Ground-Based Communication	XX	XXXX	XXX	XXX	XXX	XXX
	Manned Aircraft	X	XXX	XXXX	XX	XXX	XX
	Missile & Space		XXX	XXXX	XX	X	X
	Power Supply & Instrumentation	X	XXXX	XXX	XXX	XXX	XXX
Estimated Percentage of Market		30	20	15	10	10	15
Estimated Percentage of Unit Usage		20	60	80	30	30	50

1. The extent of use in each end equipment is indicated by the number of X's. Thus, XXXX for metal film resistors in the Military Missile and Space category indicates that more metal film resistors are used in those applications than any other kind of resistor.

2. The Estimated Percentage of Market indicates that portion of the total of a specific market, e.g., Consumer, Industrial, or Military, which is held by a specific type of resistor, e.g., Carbon, Metal Film, etc.

3. The Estimated Percentage of Unit Usage indicates that portion of the total produced of a specific type of resistor, e.g., Carbon, Metal Film, Precision Wirewound, which is used in a specific market, e.g., Consumer, Military, etc.

—Courtesy of International Resistance Co.

With so many types of capacitors available, capacitor selection is not always easy. The factors to be considered include size, shape, voltage, capacitance, cost, stability, and environmental capabilities.

Selecting the Right Capacitor

FROM the capacitor selection chart and graphs on the following pages, it will be seen that many types of capacitors are available. This large selection is both a blessing and a problem. The large number of types gives the designer a wide latitude, but also makes it difficult to select the most suitable one quickly. Generally, no one type meets a designer's requirements 100%.

To select the best type of capacitor for a given application, the designer must predetermine what type of configuration is needed for packaging, how much space is available, the circuit requirements, and the environment in which the equipment will operate. These facts, plus a few others, are necessary for an intelligent selection. Over-specification should be avoided, as well as under-specification, because the tighter the capacitor requirements, the higher the cost.

Capacitor manufacturers say that money can be saved and capacitor selection aided by calling them in during the design stages. They ask that they at least be consulted about a selection before the capacitor is ordered, if only to check the designer's selection.

Understanding the Chart

Now, let's take a look at the Capacitor Selection Chart for fixed capacitors. The first thing that will be noticed is the color coding on the chart. The coding indicates the outstanding, normal, and limiting characteristics of each capacitor. The color coding will help you spot the needed desirable features of a capacitor for your application, as well as the limiting factors. Across the top of the chart are listed the various types of dielectrics used in capacitors. The characteristic of each capacitor is listed down the columns under each dielectric type. The legend for the characteristics is shown at the top of the chart.

Applicable Military Specification numbers are listed across the bottom of the chart. The latest revision designations (usually a letter following the number) have been deliberately left off because of the changes that are constantly taking place.

Reading across the chart for the Temperature characteristics, you will find notes saying "See graph . . .". These graphs are on the page following the chart. Graph 1 is a plot of paper capacitors with various impregnants and Graph 2 shows capacitors using other dielectrics or combinations with paper. Reference point is 25°C. A close examination of Graph 1 will show that the most stable paper capacitor is #8, with #9 second. The first thought would probably be that you would always use a paper capacitor impregnated with #8s impregnant. However, before you jump to this conclusion, remember your design requirements and cost—perhaps #1 or #5 will meet your temperature needs. They may be much cheaper to buy if they will do the job within the operating and environmental temperature limits of your equipment at the required voltage and capacity. Graph 2 should be used with the same selection thoughts in mind as those just mentioned for paper.

Another point that must be kept in mind is the capacitance and voltage requirements. The best dielectric material temperature-wise may not be available in either the voltage or capacitance rating required. This is also true for other characteristics such as stability or physical size.

Chart A, General Basic use of Various Dielectrics Over the Frequency Spectrum, will be useful as an aid in selecting a capacitor type where ac operation or ac characteristics are important considerations. From this Chart the optimum frequency ranges for each dielectric can be seen.

The charts and other information on the following pages were supplied by Cornell-Dubilier Electronics, Division of Federal Pacific Electric Company, Newark, N. J.

CAPACITOR SELECTION

Values and ranges shown herein are generally typical or average for fixed capacitors. However, actual

CAPACITOR CHARACTERISTICS		ELECTROLYTIC Aluminum	TANTALUM Wet Anode & Foil	TANTALUM Dry Anode	PAPER	MYLAR*	PAPER-MYLAR (Comb.)	POLYSTYRENE MYLAR (Comb.)	METALLIZED PAPER
CAP.	CAPACITANCE Range – Mfd.	.5–150,000	.2–1250	.25–330	.001–200	.01–20	.01–30	.001–1	.01–20
	TOLERANCE Standard %	+50, +100, +150 –10	+10, +20, +75 –10	±20	±20	±20	±20	±10	±20
	TOLERANCE Minimum %	±25	±15	±5	±2	±1	±2	±1	±5
VOLTS	DC OPERATING	2.4–500	3–150	6–35	50–200,000	50–1000	100–15,000	50–1000	50–600
	AC 60 CPS. OPERATING	40–320 Intermittent Duty	Limited	Limited	50–75,000	Seldom used	Seldom used	Seldom used	25–250
D. F.	DISSIPATION FACTOR % at 60 CPS.	6–35, depending on voltage	(120 cps.) 18%, foil, varies with C and V	At 120 cps. 10% max.	.2–.5	.3	.3	.1	.4–.6
	% at 1000 CPS.	–	–	–	.2–.5	.5	.5	.2	.6–.8
	% at 1MC Low Capacitance Values	–	–	–	Higher; varies with type	Relatively High	Relatively High	.75	Relatively High
I. R.	INSULATION RESISTANCE Megohm/Mfd. at 25°C	Leakage current (ma.) .006 x √CV	Leakage at 25°C .02 μa/mfd./volt	Leakage at 25°C .02 μa/mfd./volt	300–20,000	50,000	20,000	>50,000	600–1200
	INSULATION RESISTANCE at 85°C compared to 25°C	Leakage current 4 x 25°C value	Leakage current 4 x 25°C value	Leakage current 10 x 25°C value	$\frac{1}{100}$	$\frac{1}{25}$	$\frac{1}{40}$	$\frac{1}{20}$	$\frac{1}{60}$
TEMP.	OPERATING RANGE °C	–40 +85	–55 +125	–55 +125	See graph 1	–55 +150	–55 +125	–55 +125	–55 +125
	Coefficient TC in % or PPM	Cap. drops from 30–60% at –40°C	Cap. drops from 12–50% at –55°C	Cap. drops 12% max. at –55°C	See graph 1	See graph 2	See graph 2	See graph 2	See graph 2
STABILITY	CAPACITANCE CHANGE with Temp. Aging	Relatively Large	Large ±25	Medium ±10	Medium	Medium	Medium	Medium	Medium
D. A.	% Dielectric Absorption at 25°C	–	–	–	.6–3, depending on impreg.	.5	.9	.3–.5	–
SIZE	Varies as	CV approx.	CV approx.	CV approx.	CV^2	CV^2	CV^2	CV^2	CV^2
	For Equivalent CV Rating	Very small	Very small	Very small	Medium Small	Small	Medium Small	Large	Small
	Per KVA 60 CPS.	Small for intermittent duty	Small for intermittent duty	Small for intermittent duty	Small	Seldom used	Seldom used	Seldom used	Not used
	Per KVA 1MC	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
COST	Relative Cost for Equiv. CV Rating	Very low	Moderate	Moderate	Low	Moderately High	Moderately High	Moderately High	Moderately High
	Relative Cost per KVA 60 CPS.	Low for intermittent duty	Not used	Not used	Low	Seldom used	Seldom used	Seldom used	Not used
	Relative Cost per KVA 1MC	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
MIL. SPECS.	MIL-C-	62	3965	26655	25	19978	14157	None	11693
	MIL-C-	3871			91	27287	19978		18312
	MIL-C-				11693				
	MIL-C-				12889				

*Du Pont Trademark.

OUTSTANDING CHARACTERISTIC

NORMAL CHARACTERISTIC

LIMITING CHARACTERISTIC

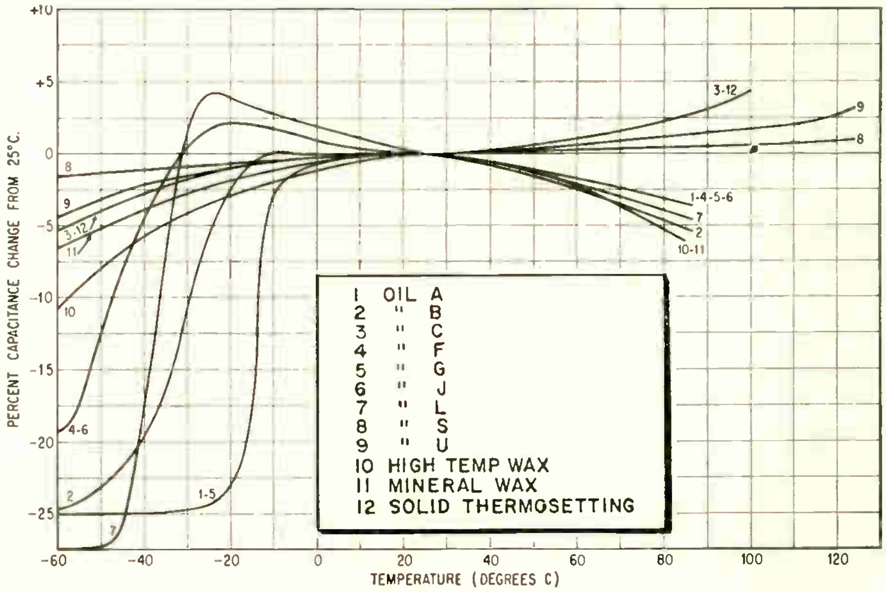
CHART

limits in practice, may be considerably more (or less) depending on the specific application or requirements.

METALLIZED MYLAR	METALLIZED PAPER-MYLAR (Comb.)	Low-Voltage CERAMIC	General-Purpose CERAMIC	Temperature Compensated CERAMIC	POLYSTYRENE	TEFLON	MICA RECEIVING	MICA TRANSMITTING	RECONSTITUTED MICA
.01–20	.01–12	.005–2.2	.000001–.02	.000001–.0025	.01–10	.01–4	.000001–.05	.00001–1.0	.01–4
±20	±20	±20 to GMV	±5 to GMV	±5 to ±20	±10	±10	±10	±5	±20
±2	±5	±20	±5	±.25 mmf.	±1	±2	±1	±1	±5
50–600	200–600	3–50	500–5000	500–5000	100–2000	50–1000	50–2500	200–50,000	200–15,000
25–250	Seldom used	Not used	Seldom used	Seldom used	50–350	Seldom used	Seldom used	R-F voltage varies with current & freq.	100–7500
.2–.3	.4–.6	–	–	–	<.1	<.1	Seldom used	Seldom used	Seldom used
.4–.5	.6–.8	2.5–10	2–2.5	–	.02–.05	.02–.05	<.1	.04–.07	.5
Relatively High	Relatively High	–	–	.05–.2	.05–.1	.04–.07	<.1	.03–.06	.7–.9
5000–50,000	2000	Variable with Voltage	>30,000 meg./unit	>50,000 meg./unit	>100,000	>100,000	20,000–50,000 meg./unit	15,000 meg./unit	10,000
$\frac{1}{40}$	$\frac{1}{12}$	$\frac{1}{20}$	$\frac{1}{60}$	$\frac{1}{50}$	$\frac{1}{15}$	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{1}{7}$	$\frac{1}{8}$
−55 +125	−55 +125	−55 +85	−55 +125	−55 +125	−55 +85	−55 +250	−55 +150	−55 +70	−55 +200 −55 +315
See graph 2	See graph 2	Variable	Variable	NPO–N4700 PPM/°C	See graph 2	See graph 2	0 to +70 Normal PPM controllable	−20 to +100 PPM controllable	+500 PPM −350 PPM
Medium	Medium	Medium	Small to Medium	Small	Small	Medium	Very Small; Excellent	Very Small; Excellent	Good
–	–	–	–	–	.02–.05	.02–.05	.3–	.3–	–
CV^2	CV^2	CV^2 & K	CV^2 & K	CV^2 & K	CV^2	CV^2	CV^2	CV^2	CV^2
Small	Small	Very small	Small	Small	Medium Large	Large	Large	Large	Large
Not used	Not used	Not used	Not used	Not used	Medium Large	Seldom used	Seldom used	Seldom used	Seldom used
Not used	Not used	Not used	Not used	Not used	Small	Small	Small	Small	Not used
Moderately High	Moderately High	Low	Low	Low	Moderately High	Very high	High	High	High
Not used	Not used	Not used	Not used	Not used	Moderately High	Seldom used	Seldom used	Seldom used	High
Not used	Not used	Not used	Not used	Not used	Low	Low	Low	Low	Medium
26487 (Proposed)	26487 (Proposed)	None	11015	20	19978	19978	5	5	None
	18312								

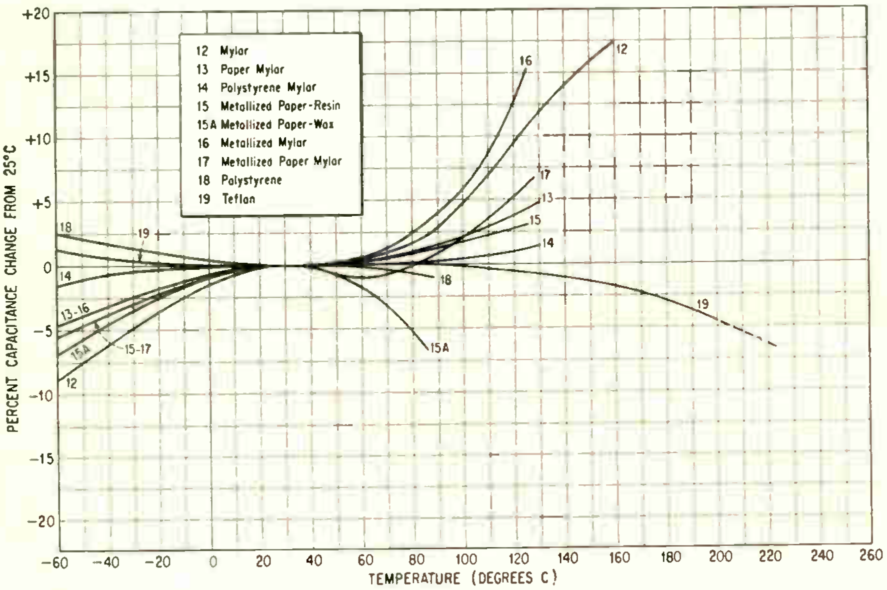
Capacitor Chart

(Continued)



GRAPH 1

Capacitance-Temperature Characteristics of Paper Capacitors with Various Impregnants

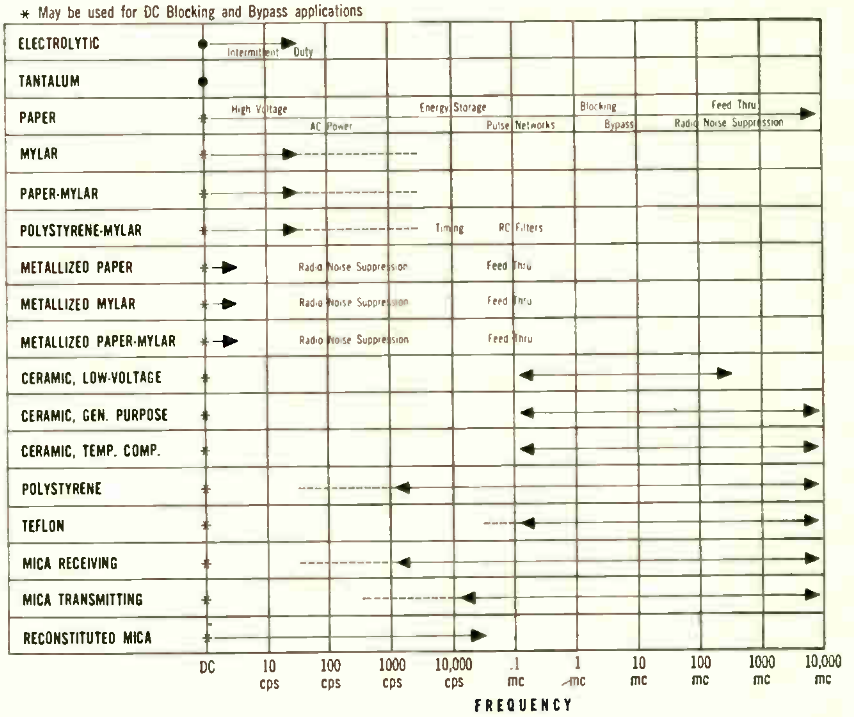


GRAPH 2

Capacitance-Temperature Characteristics using Various Plastic Films and Combinations of Dielectrics

CHART A

General Basic Use of Various Dielectrics over the Frequency Spectrum



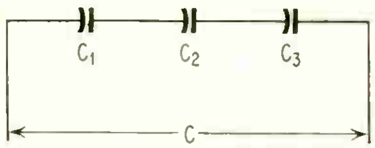
Useful Capacitor Equations

Capacitance C in Microfarads (mfd.)

$Q = CV10^6$ Coulombs.

$$\text{Energy} = \frac{QV}{2} = \frac{C(KV)^2}{2} \text{ Wattseconds or Joules}$$

$$C = \frac{0.225 \times \text{Area sq. in.} \times \text{Dielectric Con.}}{\text{Dielectric Thickness in Mils} \times 10^3}$$



$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

(Continued on page E34)

NEW..Space-Saving Replacement for MIL-C-25C

Good-All

TYPE 682 CAPACITORS

Superior Performance in a SMALLER Package

Ideally Suited For Transistor Circuitry

Proven Reliability — Excellent Stability

WRITE FOR TECHNICAL LITERATURE

SPECIFICATIONS

TEMPERATURE RANGE.........Full rated to 85° C; to —125° C with 50% derating.

ENVIRONMENTAL PROPERTIES..Exceeds all requirements of MIL-C-25C

CASE STYLES..........Available in all tubular MIL-C-25C versions

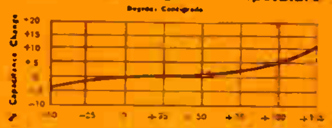
Type 682 Extended foil; 1 lead grounded
Type 683 Extended foil; both leads insulated
Type 684 Tab Construction; 1 lead grounded
Type 685 Tab Const., both leads insulated

CAPACITANCE TOLERANCES....Available in ±20% ±10%. ±5% and ±1%

FOR HIGH RELIABILITY REQUIREMENTS
These designs are capable of being produced, on a special project basis, to high reliability specifications comparable to MIL-C-14157 and MIL-C-26244 (USAF)

Comparative Dimensions

CAP. MFDS.	682 100 VOLTS D		L	CP08 100 VOLTS D		L
.001	.173	x	23/32	.175	x	3/4
.0022	.173	x	23/32	.175	x	3/4
.0047	.173	x	23/32	.175	x	3/4
.01	.173	x	23/32	.235	x	3/4
.022	.233	x	23/32	.312	x	7/8
.047	.313	x	23/32	.312	x	7/8
.1	.313	x	27/32	.400	x	7/8
.22	.400	x	1 1/16	.400	x	1 3/8
.47	.500	x	1 3/16	.562	x	1 3/8
1.00	.560	x	1 11/32	.670	x	1 5/8



Now Available at Authorized Industrial Distributors

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GOOD-ALL ELECTRIC MFG. CO.

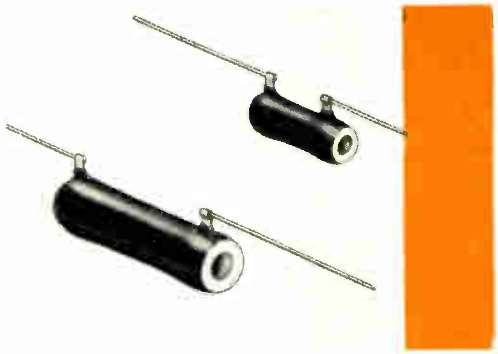
OGALLALA, NEBRASKA / A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

Circle 113 on Inquiry Card

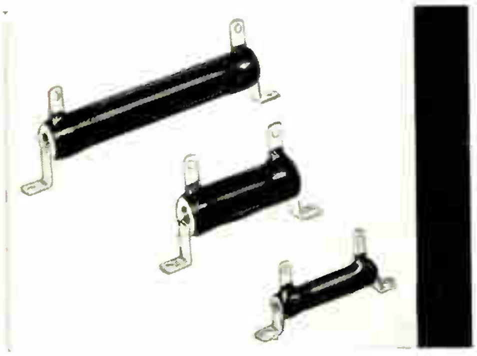
22 WAYS TO GET OHMS AT OHMITE

■ Like the proverbial iceberg, what shows here is only the smaller part of Ohmite's variety in MIL and commercial resistors. However, the 22 families illustrated do give some idea of scope, and incidentally, are a partial survey on the state of the art. As far as we know, Ohmite resistors form the largest selection available anywhere today—innumerable "specials", and thousands of standard units available from factory stock or distributors everywhere. This selection, combined with top engineering service, can provide unexcelled solutions to your procurement problems.

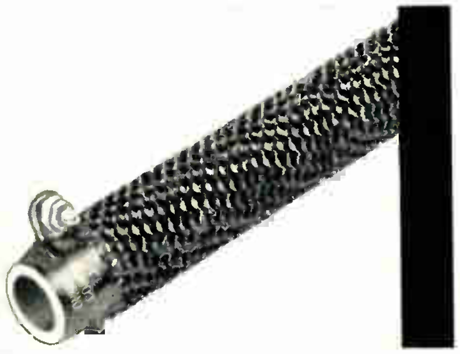
Write on Letterhead for Catalog and Engineering Manual 58



BROWN DEVIL®: Vitreous Enameled; Wire-Wound; 5, 10, 20 Watts

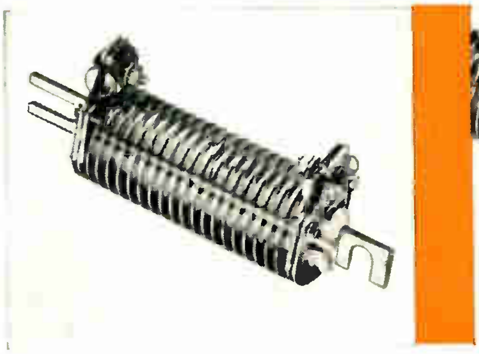


PRECISION, POWER: Wire-Wound; Vitreous Enameled; In Most Styles



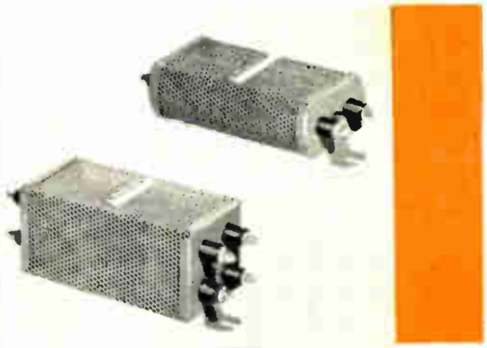
HIGH CURRENT: Corrib®; Low Resistance; Up to 1500 Watts

ADJUSTABLE HIGH CURRENT: Corrib®; Low Resistance



HIGH CURRENT: Powr-Rib®; Low Resistance; Up to 100 Amps

ADJUSTABLE HIGH CURRENT: Powr-Rib®; Low Resistance



IN CAGES: Terminal Type, Line Voltage Reducer Type, and Others

NON-INDUCTIVE: Vitreous Enameled; Wire-Wound; 10, 50, 100, 160 Watts

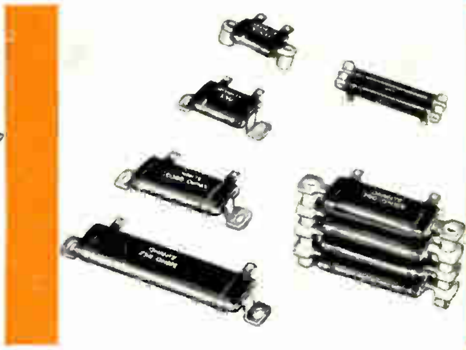
FERRULE MOUNTING: Four Styles; Up to 200 Watts

EDISON SCREW BASE: Up to 215 Watts

WORLD'S LARGEST SELECTION

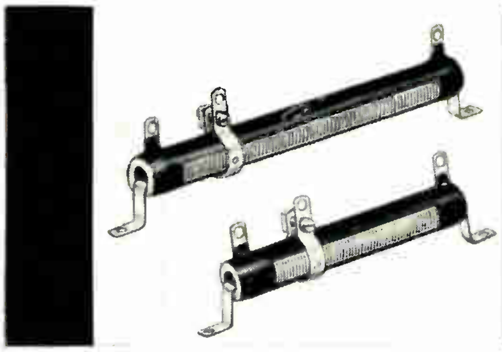
RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS • TANTALUM CAPACITORS

LUG TYPE: Vitreous Enameled; Wire-Wound; 10, 25, 50, 100, 160, 200 Watts

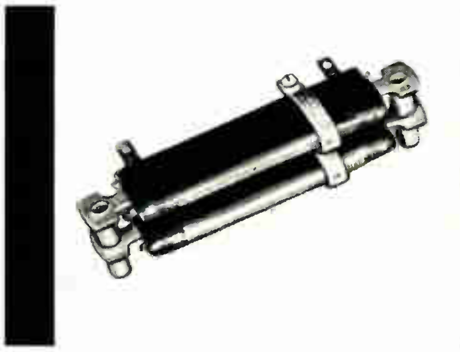


THIN TYPE: Vitreous Enameled; Wire-Wound; 10, 20, 30, 40, 55 Watts

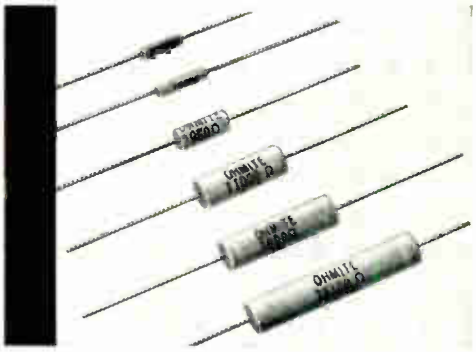
AXIAL LEAD: Vitreous Enameled; Wire-Wound; 1, 3, 5, 10 Watts



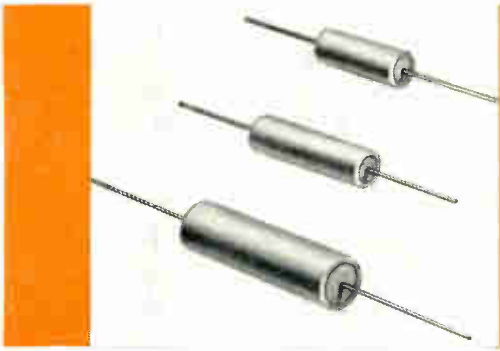
ADJUSTABLE: Dividohm®; Vitreous Enameled; Wire-Wound; 10, 25, 50, 75, 100, 160, 200 Watts



ADJUSTABLE THIN TYPE: Vitreous Enameled; Wire-Wound; 10, 20, 30, 40, 55 Watts



INSULATED: Wire-Wound; Molded; Precision Power; 1, 3, 5, 7, 10 Watts

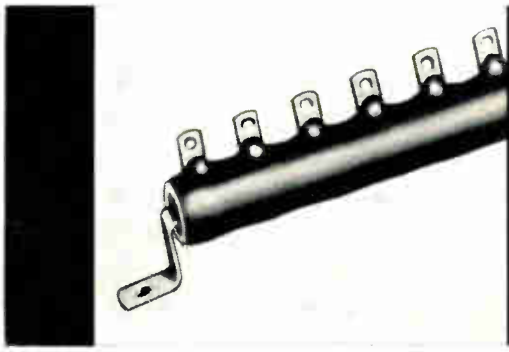


INSULATED: Tubeohm® Style; Wire-Wound in Sealed Ceramic Tube; 5, 10, 25 Watts

MIL-R-26C (FIXED): All Sizes; Tubular, Flat*, Axial Lead*, Insulated*, Ceramic Jacketed*

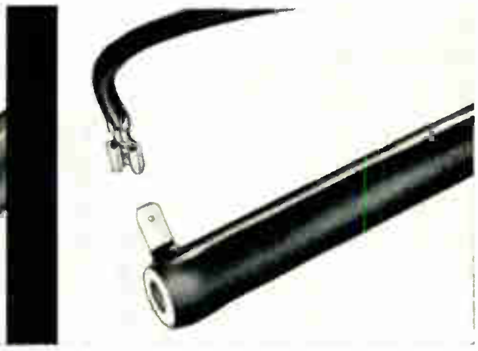
*Not illustrated

MIL-R-19365C (ADJUSTABLE): Wire-Wound; Vitreous Enameled; All Eight MIL Sizes



TAPPED: Available in Any Terminal Style or Combination

NON-TURN: Notched or Fluted Cores Prevent Turning on Brackets; Fixed, Adjustable, Tapped



PUSH-ON CONNECTOR TERMINALS: For Lug Type Resistors Up to 10 Amps Current Rating

OF RESISTORS

TAP SWITCHES • RELAYS • R. F. CHOKES • GERMANIUM DIODES

OHMITE

OHMITE

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

DALE Deposited Carbon Resistors

(Available with weldable leads)

Designed for inherent stability, long load life and excellent protection against environmental factors in a wide range of applications. Made of pure crystalline carbon film bonded to selected ceramic cores. Excellent high frequency characteristics.

Type DC

Miniature size, protection against moisture at low cost. Resistance range from 1 ohm to 200 megohms; tolerance 1%. Seven wattages—1/10, 1/8, 1/4, 1/2, 1, 2 5; ten sizes.

Type DC

Ask for Catalog A

Types MC - DCF - DCH

(Insulated—Meet functional requirements of MIL-R-10509D)

TYPE MC is completely insulated and protected from environmental and mechanical damage by molded housing; resistance range from 1 ohm to 50 megohms. Avaliable in five wattages—1/8, 1/4, 1/2, 1, 2; five sizes in standard tolerance of 1%.

TYPE DCF has a new coating material which provides a completely insulated resistor, yet maintains miniature size. Resistance range from 1 ohm to 50 megohms; six wattages—1/10, 1/8, 1/4, 1/2, 1, 2; nine sizes in standard tolerance of 1%.

TYPE DCH hermetically sealed in non-hygroscopic ceramic envelope. Resistance range from 1 ohm to 50 megohms; seven wattages—1/10, 1/8, 1/4, 1/2, 1, 2, 5; ten sizes in standard tolerance of 1%.

Type MC

Type DCF

Type DCH

Ask for Catalog A

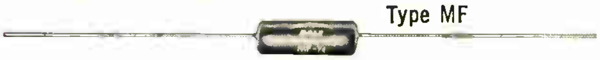
DALE Metal Film Resistors

(Available with weldable leads)

Type MF

Inherently good R.F. characteristics and low noise levels. Completely insulated and protected against moisture and other severe environmental factors. Resistance range from 100 ohms to 4 megohms, depending on size; tolerance 1%. Five wattages—1/8, 1/4, 1/2, 1, 2; five sizes. Temperature coefficient ±50 and ±100 P.P.M.

Type MF



Ask for Catalog A

DALE

Trimmer Potentiometers

WIRE WOUND

Series 1200 - 900 - 600 - 1500 - 5000

Produced under stringently controlled "white room" conditions to assure highest quality and reliability. Welded construction throughout; sealed to protect against moisture and potting compounds.

SERIES 1200—Humidity proof; three terminal configurations for standard or printed circuit mounting; 10 to 50K ohms; 5% tolerance; 1 watt.

SERIES 900—Humidity proof, three terminal configurations for standard or printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt.

SERIES 600—Humidity proof; eight terminal configurations for standard, panel or printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt.

SERIES 1500—Humidity proof; nine terminal configurations for standard, panel or printed circuit mounting; 10 to 50K ohms; 5% tolerance, 1 watt.

SERIES 5000—Humidity proof; space saving, square configuration; 100 to 50K ohms; 5% tolerance; 1 watt.


Ask for Catalog B

Series 100 - 200 - 300 - 1100

Designed to give excellent performance for normal circuit problems where economy is of prime importance, yet dependable performance is a necessity.

SERIES 100—Five terminal configurations; 10 to 50K ohms; 5% tolerance; 0.8 watt.

SERIES 200—Five terminal configurations; 10 to 50K ohms; 10% tolerance; 0.5 watt.

SERIES 300—Two terminal configurations; 100 to 20K ohms; 15% tolerance; 0.25 watt.

SERIES 1100—High temperature; three terminal configurations for standard or printed circuit mounting; 10 to 50K ohms; 10% tolerance; 1 watt.

Ask for Catalog B

Special Problems?

When your requirements are for special resistance components and networks, please send us an outline of your problems.

Our standard line can be modified and special resistors can be produced to meet the toughest requirements.

Other products made by Dale are lightning arrestors; surge arrestors, RF and IF transformers; custom coils, chokes, torroidal inductors, ferrite antennas; precision potentiometers and tube shields.

DALE ELECTRONICS, INC.

DALE

1304 28th Ave., Columbus, Nebraska

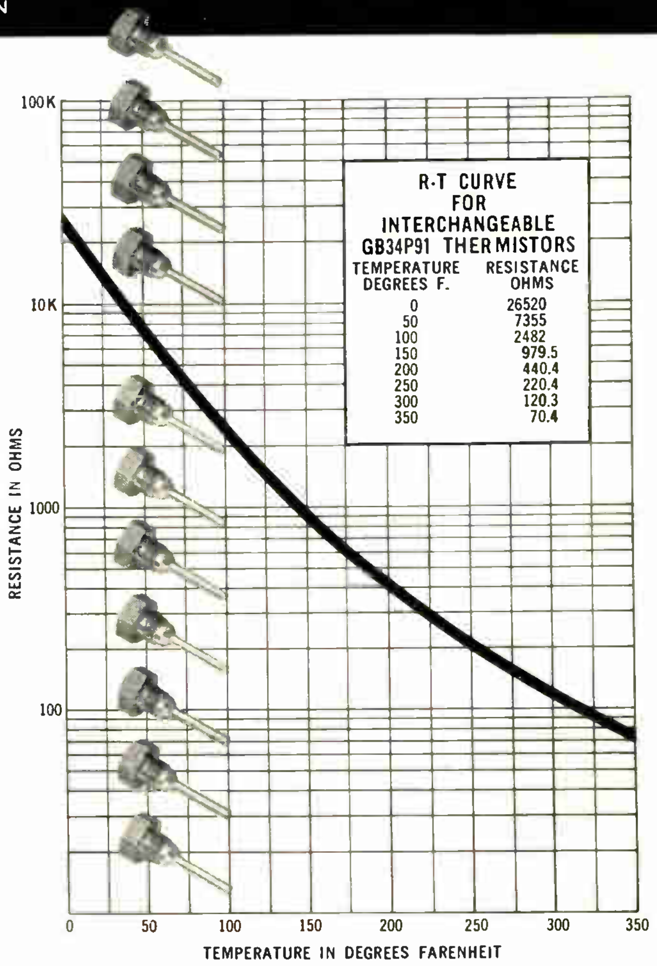
A subsidiary of The Lionel Corp.

Circle 115 on Inquiry Card

BREAKTHROUGH! IN THERMISTOR DESIGN

Fenwal Electronics' new "identical" thermistors permit complete interchangeability! What do you need from a thermistor in the way of performance? Reliability? Extreme stability? High shock resistance? Long life? Fenwal Electronics can supply it. But Fenwal Electronics' thermistors provide an additional important characteristic all their own: **they can be supplied with identical resistance temperature curves.**

That means that now, for the first time, you can have complete interchangeability. It means you can rely absolutely on consistently accurate resistance changes versus temperature of Fenwal Electronics' thermistors. It means also you can now achieve accurate, multi-point temperature indication or control through a single system without having to calibrate out each individual sensor.



FROM FENWAL ELECTRONICS . . . THE MOST COMPLETE LINE OF PRECISION THERMISTORS

GLASS PROBES & BEADS

— 0.006" to 0.100" diameter. Resistance values: 500 ohms to 100 megohms

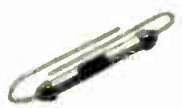
DISCS . . .

— 0.1" to 1" diameter. Resistance values: 5 ohms to 1,000 ohms

WASHERS . . .

— .75" diameter. Resistance values: 5 ohms to 3000 ohms

RODS . . .



— 0.053" to 0.173" diameter varying lengths. Resistance values: 500 ohms to 500,000 ohms

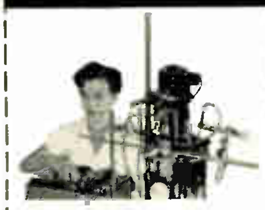
PROBE Assemblies . . .

— Built to your specific requirements,* enclosed and mounted in individual housings or "packages" and ready to install

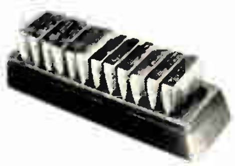
E-I Matched pairs

— Thermistor beads matched to voltage current characteristics and mounted on special hermetically sealed stems, designed for use in thermal conductivity gas analysis instruments.

FROM FENWAL ELECTRONICS . . . MORE HELP ON THERMISTOR PROBLEMS



• Complete thermistor engineering service backed by 20 years field experience



• Thermistor Experimental Kit — to help you expedite operations at the bread board stage. Just $19.95 at electronics jobbers

• New Thermistor "Computer" — 5" X 8" "computer" reduces lengthy computations to single "slide rule" setting. Yours for the asking

• New Thermistor Catalog EMC-3

• New Probe and Housing Brochure — Gives selection of probe designs

For complete information, or the name of the Fenwal Representative in your area, write:

Fenwal Electronics

33 MELLEN STREET, FRAMINGHAM, MASSACHUSETTS

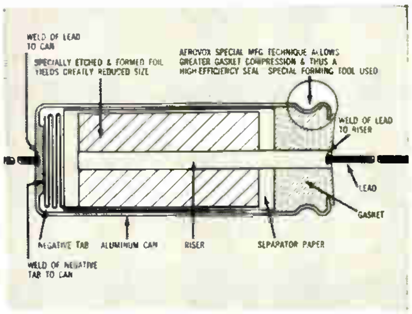
*Probes can be supplied individually calibrated at all desired temperatures. When interchangeability is required, they can be supplied with identical resistance-temperature characteristics.

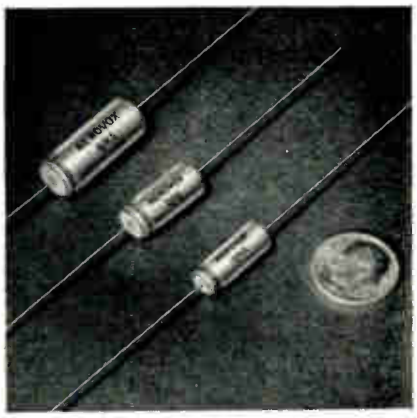
PRODUCT NEWS FROM AEROVOX

New Long-Life 85°C Electrolytic Capacitors in Ultra-Miniature Sizes a Product of New Design and Manufacturing Techniques

Aluminum-cased units permit circuit applications previously impossible

A new series of ultra-miniature tubular electrolytic capacitors is now available from Aerovox. A product of the continuing Aerovox program of advanced research and development, the greatly reduced sizes of these high-quality units have been made possible by the use of a revolutionary etching and formation process. All critical terminations are welded, thus eliminating the danger of open circuits with the passage of time in service. A unique, high-efficiency seal has been produced by specially designed forming tools which were developed by Aerovox after months of intensive engineering effort to improve on conventional sealing methods.

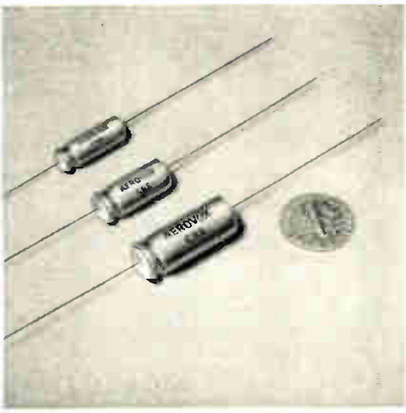




High-Reliability Type QRE

Due to a totally new design concept, Aerovox has achieved a new industry high for capacitors of this type. Type QRE capacitors offer a useful life expectancy of more than 10 years when operated within ratings.

The combination of long life, ultra-miniature size, and outstanding temperature characteristics now makes available an aluminum electrolytic capacitor which can be used in many circuit applications heretofore not considered possible with capacitors of this type. Design engineers in the computer and communications fields in particular can benefit from the extraordinary advantages offered by Type QRE. These units are manufactured in specially constructed super-clean "White Room" production areas where only the most experienced operators are employed. An exhaustive 100% testing program assures you high-reliability performance.



Commercial Type CRE

Type CRE ultra-miniature units are ideally suited for use in bypass, filter, and coupling applications in low voltage, compact, miniaturized equipments. This is especially true where assembly space is at a premium, such as personal radios, hearing aids, microphones, and wire receivers.

Availability

Aerovox Type QRE and CRE Ultra-Miniature 85°C Aluminum Cased Electrolytic Tubular Capacitors are available in prototype quantities for immediate delivery from the factory. See your Aerovox Representative for delivery information on production quantities.

TYPE QRE SPECIFICATIONS

Operating Temperature: −40°C to +85°C
Capacitance Tolerance: standard capacitance is −10% to +100% of rated capacitance.

DC Leakage Current:

Volts DC	Current – Microamperes
3 to 6	1.0
10 to 15	2.5
25 to 50	5.0
100 to 150	15.0

Surge Voltage:

Rated DC Working Voltage	Surge Voltage (Max.)
3	5
5	8
6	10
10	14
12	15
15	20
25	45
50	70
100	125
150	175

TYPE CRE SPECIFICATIONS

Operating Temperature: −30°C to +85°C
Capacitance Tolerance: standard capacitance is −10% to +100% of rated capacitance.

DC Leakage Current:

Volts DC	Current–Microamperes
3 to 6	1.0
10 to 15	2.5
25 to 50	5.0
100 to 150	15.0

Surge Voltage:

Rated DC Working Voltage	Surge Voltage (Max.)
3	4
6	8
12	15
15	18
25	40
50	65
100	125
150	175

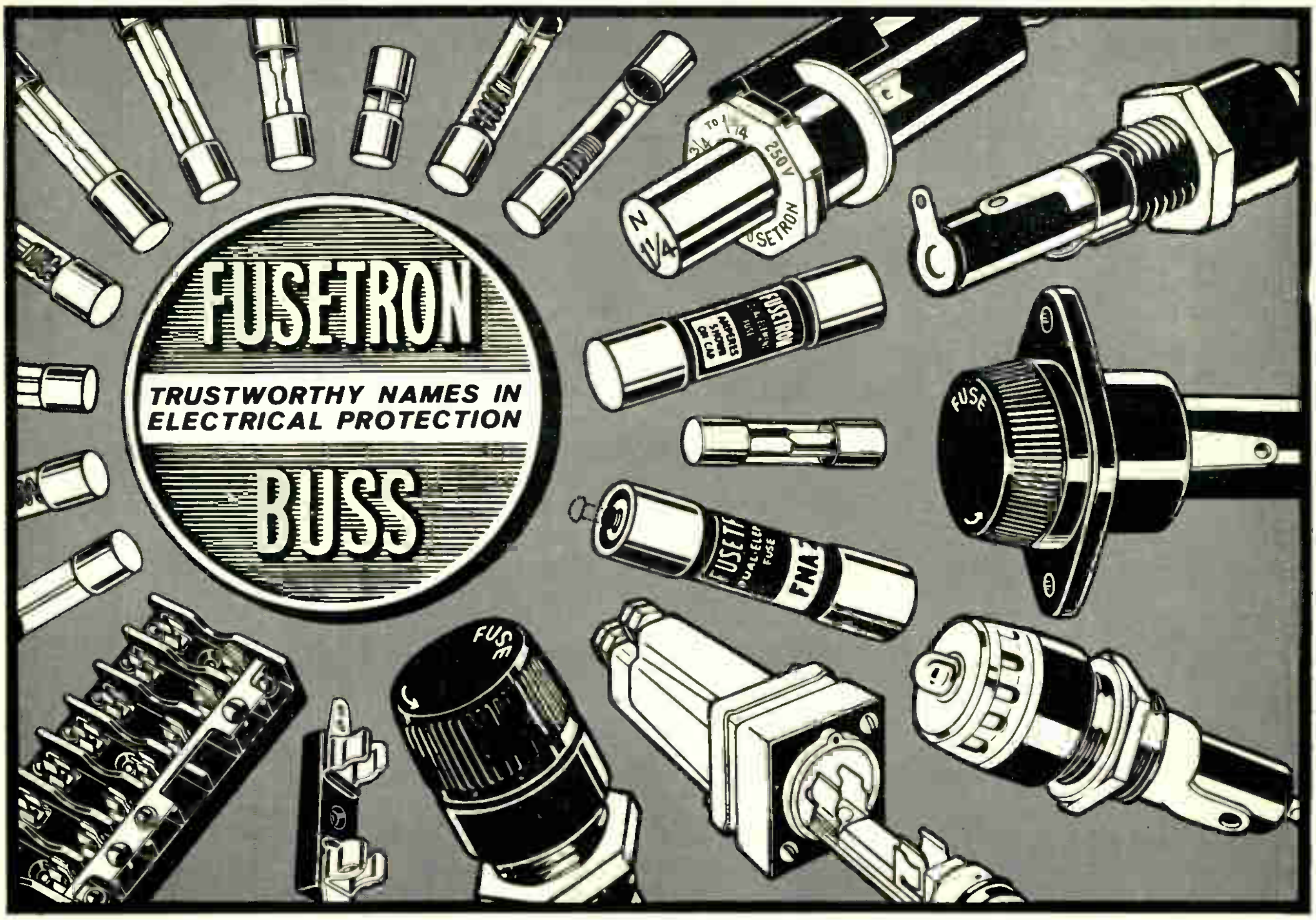
Complete Technical Data

Call your nearest Aerovox Field Representative or write today for a free copy of Bulletin 201B7 (Type QRE) and 201B6 (Type CRE).

AEROVOX

AEROVOX CORPORATION
NEW BEDFORD DIVISION   NEW BEDFORD, MASS.

Technical Leadership – Manufacturing Excellence



Save Time and Trouble by standardizing on BUSS Fuses—You'll find the right fuse every time... in the Complete BUSS Line!

By using BUSS as your source for fuses, you can quickly find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting", and signal or visual indicating types . . . in sizes from 1/500 amp. up—plus a companion line of fuse clips, blocks and holders.

BUSS Trademark Is Your Assurance Of Fuses Of Unquestioned High Quality

For almost half a century, millions upon millions of BUSS fuses have operated properly under all service conditions.

To make sure this high standard of dependability is maintained . . . BUSS fuses are tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

Should You Have A Special Problem In Electrical Protection . . . BUSS fuse engineers are at your service and in many cases can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be serviced easily.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders, write for BUSS bulletin SFB.

BUSS: The complete line of fuses and fuse mountings of unquestioned high quality.

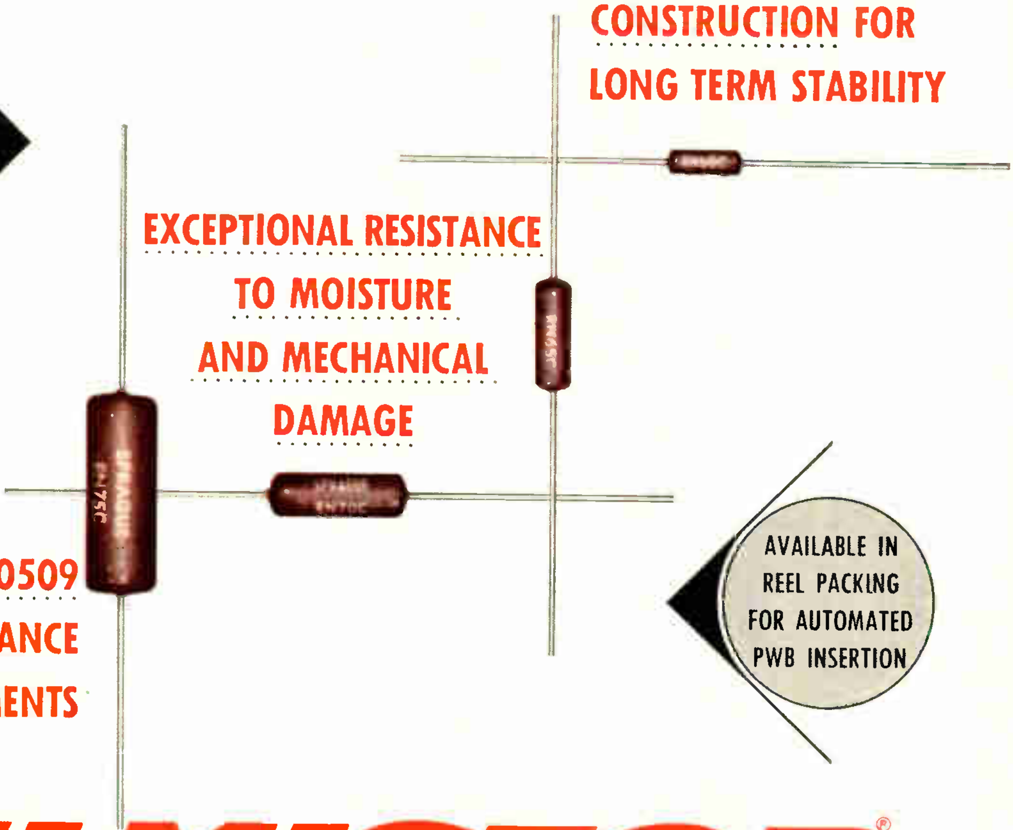
FUSETRON BUSS · McGRAW EDISON

BUSSMANN MFG. DIVISION
McGraw-Edison Co.
St. Louis 7, Mo.

NOW AVAILABLE WITH WELDABLE LEADS

RUGGED END-CAP CONSTRUCTION FOR LONG TERM STABILITY

EXCEPTIONAL RESISTANCE TO MOISTURE AND MECHANICAL DAMAGE



SURPASS MIL-R-10509 PERFORMANCE REQUIREMENTS

AVAILABLE IN REEL PACKING FOR AUTOMATED PWB INSERTION

FILMISTOR® METAL FILM RESISTORS

OFFER 5 DISTINCT TEMPERATURE COEFFICIENTS TO MEET ALL CIRCUIT REQUIREMENTS

Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity.

Close tracking of resistance values of 2 or more resistors over a wide temperature range is another key performance characteristic of molded-case Filmistor Metal Film Resistors. This is especially important where they are used to make highly accurate ratio dividers.

Filmistor Metal Film Resistors, in ⅛, ¼, ½ and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509D, Characteristics C and E. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 233 Marshall Street, North Adams, Mass.

For application engineering assistance write:
Resistor Division, Sprague Electric Co., Nashua, New Hampshire.

SPRAGUE COMPONENTS

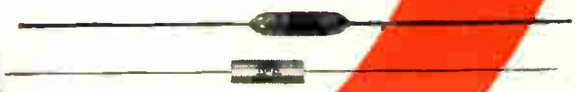
RESISTORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
MAGNETIC COMPONENTS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
TRANSISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY

Circle 120 on Inquiry Card

In PRECISION FILM RESISTORS **if it's news, expect it first from IRC**

T-0



Now... Evaporated Metal Film Reliability

for as little as 9 cents

Re-evaluate your deposited carbon resistor requirements. You can now upgrade your circuitry with the premium performance of evaporated metal film resistors . . . at deposited carbon prices.

IRC-T-0 (tee-zero) evaporated metal film resistors are available molded or with exclusive moisture-resistant M-Coat.* They meet or exceed all MIL-R-10509 performance requirements except temperature coefficient for C and E characteristic.

Using T-0 resistors, you benefit by a design tolerance 5 times tighter than that of deposited carbon (MIL-R-10509 Characteristic B) resistors, and 20 times tighter than that of carbon composition (MIL-R-11) resistors.

Premium quality Metal Film Resistors are no longer too costly for your higher performance demands. Write for new T-0 Bulletin B-22. International Resistance Co., 401 N. Broad Street, Philadelphia 8, Pa.

*IRC Trademark

CAPSULE SPECIFICATIONS

Hardcoat Metal Film			Molded Metal Film		
MIL	IRC	125°C	MIL	IRC	125°C
RN55	CEA	⅛ W.	RN60	MEA	⅛ W.
RN60	CEB	¼ W.	RN65	MEB	¼ W.
RN20	CEC	½ W.	RN70	MEC	½ W.

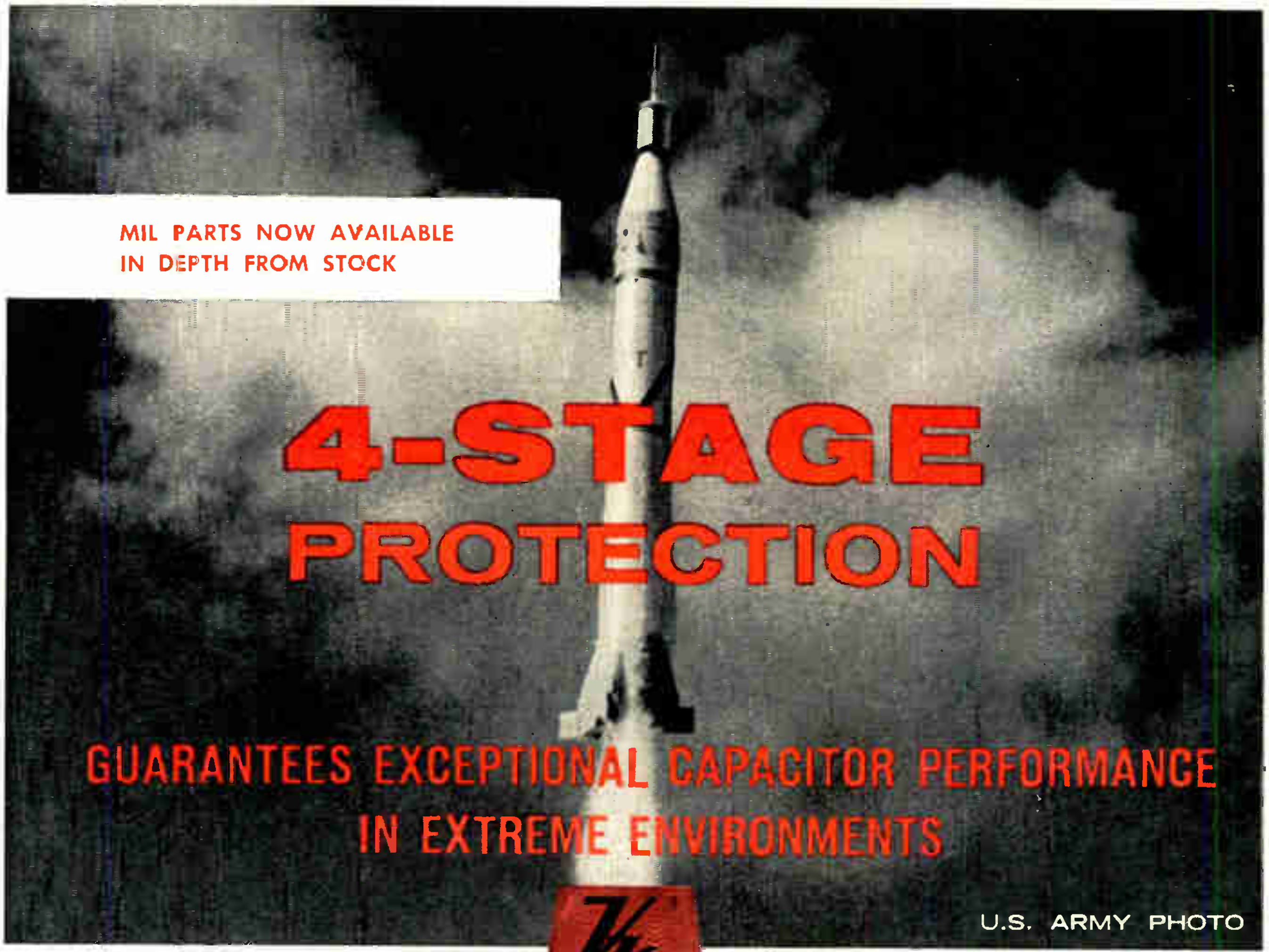
MIL-R-10509: exceed all requirements characteristic B and D; G without hermetic sealing; C except for ±50 PPM T.C.; E except for ±25 PPM T.C.

RESISTANCE: 30 ohms to 1.5 megohms.

TOLERANCE: ±0.5% and ±1%.

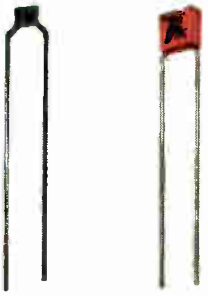
IRC *pacemaker in film resistors*

MIL PARTS NOW AVAILABLE IN DEPTH FROM STOCK



Vk® Micro-miniature CERAMIC CAPACITORS

Meets MIL-C-11015C/18A/19A



- 10–10,000 mmf
- –55°C to 150°C
- 200 vdc rating
- Small case size:
  .2 x .2 x .1 through 1000 mmf
  .3 x .3 x .1 through 10,000 mmf
- Also available uncased for complete assembly encapsulation.

........Rugged pre-molded flame-resistant outer case assures standard wall thickness, guaranteeing environmental immunity and absolute product uniformity. Square modular shape affords highest capacity per usable volume.

........Epoxy potting solidly anchors, hermetically seals capacitor within case; increases mechanical strength and eliminates humidity leaks around leads.

........Resilient, moisture-proof plastic sheathing protects unit during assembly and absorbs thermal shock at extremes of temperature cycling.

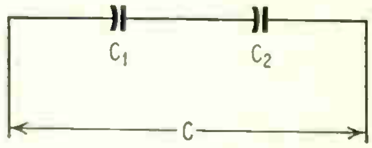
........Uniformly exact dielectric margins around electrodes eliminate short circuiting and breakdown across edges under surge voltages through 400% of rating. Single standard 0.2" lead dimension for all values simplifies circuit design.

Vitramon®
INCORPORATED
Box 544, Bridgeport 1, Conn.

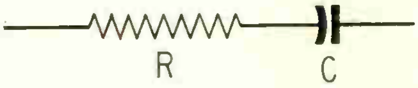
Circle 122 on Inquiry Card

Useful Capacitor Equations

(Continued from page E16)



$$C = \frac{C_1 C_2}{C_1 + C_2} \qquad C_1 = \frac{CC_2}{C_2 - C}$$



R = Equivalent Series Resistance

X = Reactance $= \dfrac{10^6}{2\pi f C}$ Ohms

When the Dissipation Factor (D) of a capacitor is less than 0.1 or 10% it is practically equal to the Power Factor Loss.

$D = \dfrac{R}{X}$ with both D and R at same frequency f

$D = R2\pi f C 10^{-6}$ with constant D, R varies as $\dfrac{1}{f}$

D at 1000 cps $= 0.00628RC \quad Q = \dfrac{1}{D}$

For a Damped Circuit: CR^2 is greater than $4L$ (L in Microhenries)

For a Critically Damped Circuit: $CR^2 = 4L$

For an Oscillatory Circuit: CR^2 is less than $4L$

For Resonant Frequency in KC:

$$f_{KC} = \sqrt{\frac{25330}{LC}}$$

L in Microhenries, C in Microfarads

$$\text{Reactance } X = \frac{10^6}{2\pi f C} \text{ Ohms}$$

1 Mfd. at 60 cps = 2654 ohms
1 Mfd. at 400 cps = 398 ohms
1 Mfd. at 1000 cps = 159 ohms
.001 Mfd. at 1 MC. = 159 ohms

$$EI_{RMS} = \frac{C\,(KV_{RMS})^2}{0.16} = VA \text{ Wattless Power}$$

Watt Loss = VA × Dissipation Factor

$$\%\ \text{Duty} = \frac{\text{Time On} \times 100}{\text{Time On} + \text{Time Off}}$$

Tech Data
for Engineers

Over-Voltage Protection

Input/Output protectors, ENI Models 500 and 510 isolate electronic equipment input connections from voltage transients and other over-voltage conditions. For solid-state, circuitry these protectors clamp to a zero voltage level in less than 1 μsec. any high-rise transients. Electro-Neutronics, Inc., 1401 Middle Harbor Rd., Oakland 20, Calif.

Circle 586 on Inquiry Card

Porcelain Capacitors

A brochure of 33 pages describes complete testing procedure and statistical analysis for porcelain capacitors. Specification is based on recommendations of the Ad HOC committee (Darnell) for Parts Specification Management for Reliability. High Reliability Specification S1002B. Vitramon, Inc., P.O. Box 544, Bridgeport, Conn.

Circle 587 on Inquiry Card

RIF Filters

Over 300 Genistron filters listed with important technical data are designed and manufactured according to Mil-F-15733D. The catalog, 56 pages, includes useful applications information on the Mil-F-15733D series including rectangular styles F1-51, 53, 56, 57, and cylindrical styles FL-22 and 24, covering a current range of 1 to 50a., both ac and dc. The Radio Interference Filter catalog is available for Genistron, Inc., 6320 W. Arizona Circle, Los Angeles 45, Calif. Photographs, dimension charts and characteristic charts are included.

Circle 588 on Inquiry Card

Tantalum Capacitors

"Parameters of Tantalum Capacitors" with physical, electrical, and chemical properties described, is available from Tansitor Electronics, Inc., Bennington, Vt. This 50-page booklet contains photographs, outline drawings, characteristics, charts, a partial list of type TS Solid Tantalum Capacitors. Information on: sintered anode type tantalum capacitors; ac and ripple considerations for polar vs non-polar; and case sizes is included.

Circle 589 on Inquiry Card

Battery Systems

A 20-page data book containing engineering design information on compact high-energy battery systems is available from Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y. The "Design Engineer's Energy Data Book," discusses the relationships of design parameters for integrated energy systems to the automatically-activated primary, manually-activated primary, and rechargeable battery systems. Characteristics of the silver-zinc and silver-cadmium battery systems are used. A glossary of battery terms is also included.

Circle 590 on Inquiry Card

Tech Data

for Engineers

R-F Amplifiers

This amplifier is designed for rugged military use, outdoors, under severe environments. It is watertight, pressurized, and has self-contained power supplies. Operating temps: −54° to +71° C. Gain is 26db, ± 2db. Freq. range is 145 to 245MC. HRB-Singer, Inc., Science Park, P. O. Box 60, State College, Pa.

Circle 591 on Inquiry Card

Catalog and Handbook

A new dc power supply handbook and catalog is now available to engineers in dc power design or procurement. This 24-page manual includes a step-by-step procedure, designed for engineers who wish to calculate packaging dimensions for multiple dc outputs. The catalog details over 200 power supplies. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Circle 592 on Inquiry Card

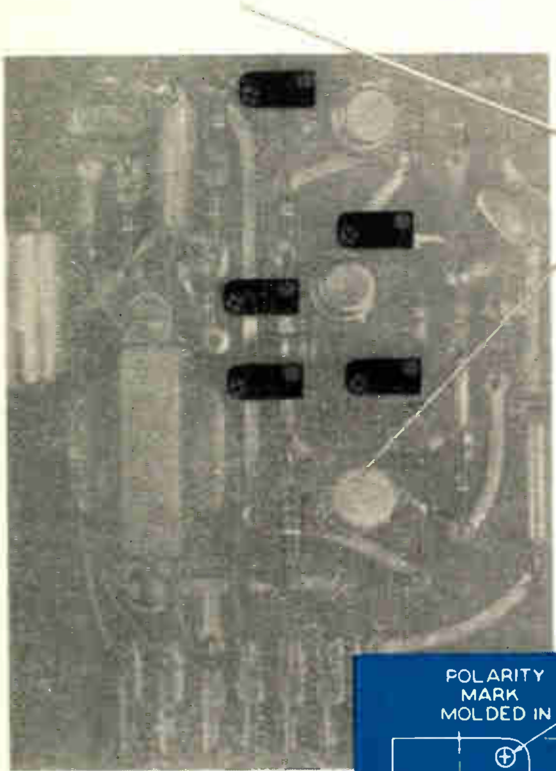
Electrolytic Capacitors

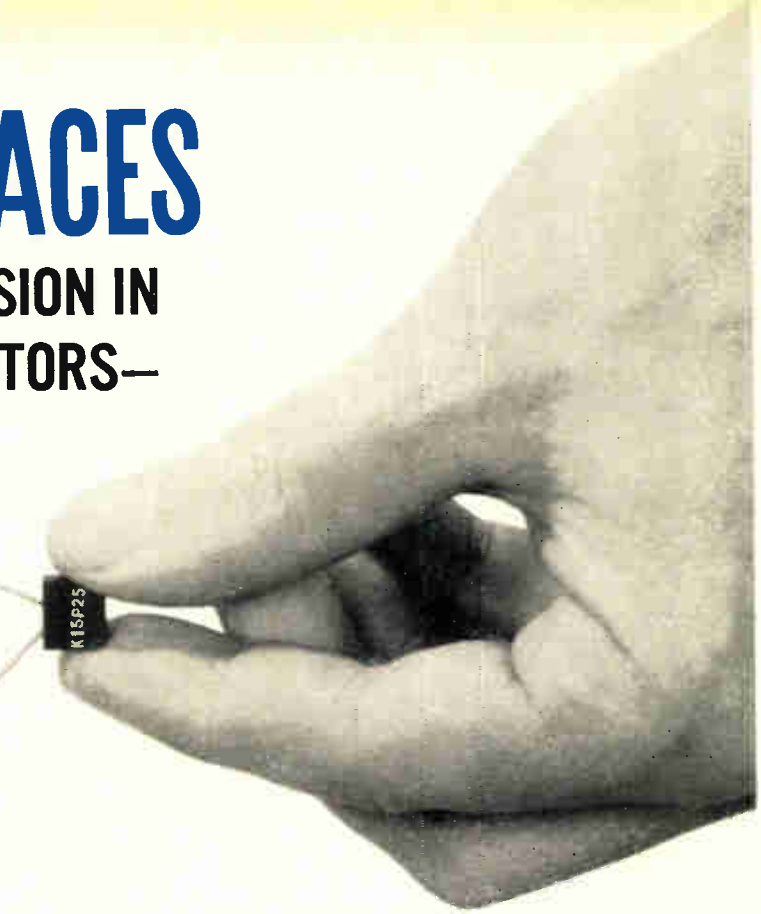
Miniature electrolytic capacitors for low voltage dc transistor use are described in a 6-page, 2-color fold-out available from International Electronic Industries, Inc., Box 9036, Nashville, Tenn. Features of these miniature units are ultra-small case sizes; high capacities with max. economy; and wide range of voltages and capacities.

Circle 593 on Inquiry Card

CRAMPED SPACES

NOW HAVE A NEW DIMENSION IN SOLID TANTALUM CAPACITORS—

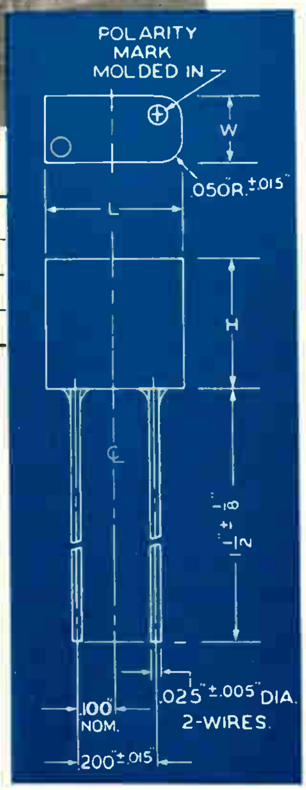




Actual size

CASE SIZE	H.	L.	W.
X	.225	.290	.170
Y	.325	.360	.170
Z	.375	.600	.195

Catalog Tolerance = ±.015"



"KEMET"

P-SERIES

Provides Maximum Capacitance Per Unit of Chassis Area!

Reduce, minimize . . . pack more efficiency into smaller space. "Kemet" meets the need with its new P-Series polar solid tantalum capacitors!

Manufactured in a flat, rectangular shape, this high-density package consists of a tantalum anode encapsulated in a tough plastic case with an epoxy end seal. The parallel leads of solder-coated copper-clad iron are uniformly spaced 2/10" to conform with present printed circuit grid designs.

Capacitance values range from 1.5 to 220 microfarads, in ±20% and ±10% tolerances, and in working voltages of 6, 10, 15, 25, and 35. They are designed to operate continuously at 85° C without voltage derating. P-Series also available in 50 and 75-volt ratings on special request.

For full information on these new additions to Kemet's widely-specified J- and N-Series—the only full line ranging up to 75 volts—write to "The Specialist in Solid Tantalum Capacitors." Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

OTHER "KEMET" PRODUCTS For ELECTRONICS:

Solid Tantalum Capacitors—special H-Series available in 9 metal case sizes. Miniature hermetically sealed J-Series meets or exceeds MIL-C-26655A. N-Series for non-polar applications.

Barium Getters—a shape and a size for every type of electron tube.

Semiconductor Silicon—consistently uniform and pure to assure reproducible quality.

Silicon Monoxide—for a wide range of evaporation films in mechanical, chemical, optical, and electrical uses.

Write for technical data

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CALL YOUR

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REPRESENTATIVE

for all your needs in

SOLID TANTALUM CAPACITORS

NEW ENGLAND AND EAST COAST

*Electrical Manufacturers Services, P. O. Box 489, Hempstead, N. Y. IVanhoe 5-4321; TWX: Hempstead 5777; Waltham 54, Mass., 680 Main St., TWinbrook 3-0100; New Haven 10, Conn., 265 Church St., UNiversity 5-9104; Syracuse 6, N. Y., 3001 James St., HOward 3-4866; Derby, N. Y., Old Lakeshore Rd., NA 7-2121; Poughkeepsie, N. Y., P. O. Box 843, 7 New Market St.; Mountainside, N. J., 1476 Force Dr., PLainfield 6-1018; Camden, N. J., 26 Haddon Ave., WOodlawn 4-8014. In Boston, Buffalo, Rochester, and Utica, ask long distance for ENterprise 4057; in Baltimore, ENterprise 9-4057; in Philadelphia, ENterprise 6057—all calls toll-free.

TENN., GA., FLA., S. C., MISS., ALA.

Roy Attaway Co., 2315 Bob Wallace Ave., S.W., Huntsville, Ala. Tel. 534-2811; TWX: HTVL ALA 8583; Orlando, Fla., 711 Magnolia Ave., GA 4-9983; TWX: OR FLA 7205

IND. (Except Lake County), MICH. (Lower Peninsula)

Warner, Kesler & Associates, P. O. Box 338, South Whitley, Ind. Tel. 723-5353

OHIO, Western PENN.

R. G. Sidnell & Co., 15120 Edgewater Dr., Cleveland 7, Ohio. ACademy 1-1313; Monroeville, Pa., 409 Hazelnut Dr.

MINN.

Stan Clothier Co., Inc., 12 West 58th St., Minneapolis 19, Minn. TAylor 5-1234; TWX: MP 970

NEB., KAN., MO., Southern ILL. (Including Quincy)

Harris-Hanson Co., 2814 So. Brentwood Blvd., St. Louis 17, Mo. MIssion 7-4350; TWX: WEB 237; Kansas City 32, Mo., 7916 Paseo St., HIghland 4-9494; TWX: KC 448

WIS. Northern ILL., IOWA, IND. (Lake County)

*D. Dolin Sales Co., (Nedco Electronics, Inc.) 3550 W. Peterson Ave., Chicago 45, Ill. JUniper 8-3738; TWX: CG 3373; Milwaukee 12, Wis., 811 East Vienna Ave., WOodruff 2-4270

TEX., OKLA., ARK., LA.

Ammon and Champion Co., 2714 Bomar St., Dallas, Tex. FLeetwood 7-3939; TWX: DL 210

COL., UTAH, NEW MEXICO, Southern IDAHO

Barnhill Associates, 1170 So. Sheridan, Denver, Col., WEst 5-4646; TWX: DN 1022; Albuquerque, N. M., 319A Wyoming N.E., 2657766; Centerville, Utah, 300 S. Main, AXtel 5-6521; TWX: SU 236

CAL., ARIZ., NEV.

*G. S. Marshall Co., 2065 Huntington Drive, San Marino, Cal. MUrray 1-3292, SYcamore 5-4304; TWX: Pasa Cal 7797; Redwood City, Cal., 801 Woodside Rd., EMerson 6-8214; Scottsdale, Ariz., 30 Pima Plaza, 9464276; San Diego, Cal., 4410 Kearny Mesa Rd., BR 8-6350

WASH., ORE.

Samuel N. Stroum Co., Inc., 621 So. Michigan St., Seattle 8, Wash. PArkway 3-7310; TWX: SE 403

*Kemet Solid Tantalum Capacitors available for prompt delivery from complete stocks maintained at these locations.

If there is no representative in your area, please get in touch with us direct: P.O. Box 6087, Cleveland 1, Ohio, ACademy 6-3330; TWX CV 911

KEMET COMPANY

DIVISION OF UNION CARBIDE CORPORATION

UNION CARBIDE

New Tech Data

for Engineers

Ceramic Capacitors

Tech data is available on subminiature ceramic capacitors which include thinline temperature-compensating, general purpose, UHF standoff, UHF ribbon, lead, and transistor-circuit types. Mucon Corp., 9 St. Francis St., Newark 5, N. J.

Circle 414 on Inquiry Card

Oscillators

"How to Specify Low Frequency Oscillators," 4-pages, 2-color, gives a complete breakdown and analysis of the important parameters in the specifying of low freq. oscillators. Accutronics, Inc., 12 So. Island, Batavia, Ill.

Circle 415 on Inquiry Card

Trimmer Capacitors

JFD Electronics Corp., 6101 16th Ave., Bklyn. 4, N. Y., has a 32-page catalog, C-62, covering its complete line of variable trimmer piston capacitors. The booklet covers complete electrical and physical data of JFD standard, split bushing, miniature, MAX-C, sealcap, split stator and differential trimmers in panel mount and printed circuit types.

Circle 416 on Inquiry Card

Potentiometers

Bourns, Inc., Trimpot Div., 1200 Columbia Ave., Riverside, Calif., is offering tech. data on their line of Trimpot® potentiometers. Included are dimensional drawings, specs., and photographs.

Circle 417 on Inquiry Card

Wideband Transformers

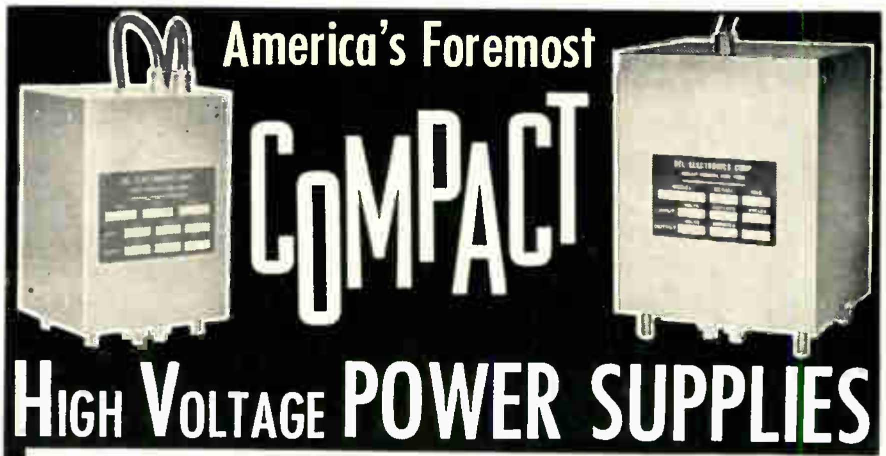
Type 0502 Wideband Transformer provides isolated coupling between 50Ω to 200Ω unbalanced over a freq. range of 200KC to 100MC. The insertion loss is less than 1db. Three case styles are offered. North Hills Electronics, Inc., Alexander Place, Glen Cove, L. I., N. Y.

Circle 418 on Inquiry Card

Magnetic Amplifiers

Tech data is available from MACE Corp., 900 N.E. 13th St., Ft. Lauderdale, Fla. on Ultamag® harmonic type solid state magnetic amplifiers. Information covers three 60CPS units: signal level; high stability; and high sensitivity units. The units can withstand 1000% overload and can be operated into dead short without damage.

Circle 419 on Inquiry Card



Unregulated — Series "S"
Output: 2.5 KV-2 MA up to 40 KV-2 MA
Input: 115 V, AC — 60/400 cycles
From Stock

Regulated — Series "TRHV"
Output: 1 KV-5 MA up to 20 KV-1 MA
Input: 115 V, AC — 60/400 cycles
From Stock

Both Del models represent the ultimate in quality. Their design and manufacture incorporate only the finest materials and workmanship to assure reliable and dependable service.

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Applications

- Missile Ground Support Equipment
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- Nuclear Applications
- CRT Applications
- Electrostatic Precipitation Equipment

DEL ELECTRONICS CORPORATION

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Circle 130 on Inquiry Card

Tech Data

for Engineers

Power Supplies

Complete data and selection guide for a line of modular power supplies designed specifically for microwave tubes is available from Micro-Power, Inc., 20-31 Steinway St., Long Island City 5, N. Y. This data is presented in an 8-page catalog covering such microwave tubes as BWOs, voltage tunable magnetrons, klystrons, and TWT amplifiers. Specs., features, and applications are included.

Circle 420 on Inquiry Card

Resistors

Rheostats of 25-1000w and fixed, adjustable, and wire-wound resistors are described in tech data available from Harwick, Hindle, Inc., Newark, N. J. Included are photographs and specifications. Information also covers ferrule terminal types, 10 and 20w fixed, and axial lead type resistors.

Circle 421 on Inquiry Card

SCR Controller

The SILICOTRIG is a variable phase controller which provides the gating signal necessary to fully use the capabilities of silicon controlled rectifiers. Tech data includes photographs, specifications and a number of schematics for high efficiency control systems. Bergen Laboratories Inc., 60 Spruce St., Paterson 1, N. J.

Circle 422 on Inquiry Card

DC Power Supplies

Electro Products Laboratories, Inc., Power Supply Div., 4500 N. Ravenswood Ave., Chicago 30, Ill., is offering Bulletin PS-562 covering their line of 18 low voltage, regulated, semi-regulated, and conventional dc power supplies. Information includes handy selection chart, characteristics and performance data.

Circle 423 on Inquiry Card

Variable Transformers

Product Guide, 12 pages, covers ratings and other essential tech. data on Powerstat Variable Transformers, Stabiline Automatic Voltage Regulators, Slo-Syn Synchronous Motors and Translators, Supercon Electrical Connectors, and Varicell Adjustable AC/DC Power Supplies. The Superior Electric Co., Dept. PG. Bristol, Conn.

Circle 424 on Inquiry Card

Resistors

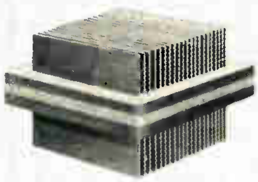
This 28-page, 3-color, brochure available from General Resistance, Inc., 430 Southern Blvd., New York 55, N. Y., catalogs the company's complete line of resistors, networks, cans and shells, and instruments. Resistor section describes design performance, the specs. and Mil equivalents, and gives performance curves. The instrument section offers complete specs. on the company's line of Wheatstone bridges, transfer standards, decade voltage dividers and resistance boxes, and binary coded resistance modules.

Circle 425 on Inquiry Card

MODULAR THERMO-ELECTRIC COOLING SYSTEMS

Ready for immediate installation in your assembly

"Peltron" Model TU-6F



"Peltron" Model TU-1

"Peltron" Model TU-6

"Peltron" Model TU-10

Applications :

- **Ice Making**
- **Water Cooling**
- **Electronic Component and System Cooling**
- **Standard Refrigeration**
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FOR INDUSTRIAL AND CONSUMER REFRIGERATING APPLICATIONS

"Peltron" thermoelectric cooling units, designed for low to medium capacity refrigeration applications, are available as standard, off-the-shelf models for direct application to users' equipment assemblies.

Ohio Semiconductors' new series of high-reliability coolers can be supplied as *modular* units for various cooling loads in industrial, commercial, and consumer refrigeration applications. Other accessory equipment is available depending on the users' needs. Your cooling problems are invited.

DIVISION OF TECUMSEH PRODUCTS CO.

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Columbus 12, Ohio

Pioneer in the design, development and production of compound semiconductors, and components and sub-systems, for electronic, thermoelectric and infrared applications.

Tech Data

for Engineers

DC Power Supplies

This 12-page, 2-color brochure contains information on dc power supplies and is available from Sola Electric Co., 1717 Busse Rd., Elk Grove Village, Ill. Information on a full line of regulated dc supplies includes the following basic categories: CVDC, CVDR, and CVQ (brute force, medium and fine). Included are schematic diagrams, and a convenient glossary of power supply terms. Brochure GDC-100.

Circle 426 on Inquiry Card

Filters

Erie Resistor Corp., Erie Electronics Div., 644 W. 12th St., Erie, Pa., is offering tech bulletin 512 covering 6 styles of high frequency low pass filters with minimum attenuation of 45 to 50 db. Capacitance of 1000 pf to 5000 pf and working voltage of 200 to 500 vdc.

Circle 427 on Inquiry Card

Power Supplies

Pacific Electric Motor Co., 1009 66th Ave., Oakland 21, Calif., has tech. data available on their "Q" line transistorized solid state power supplies. Specs. include current regulawarm-up; and for low impedance type magnet load, approx. 0.5 to 10Ω. Units range from 5 to 500kw.

Circle 428 on Inquiry Card

Trimmer Resistors

Bulletin 42-1216 is available from Centralab, The Electronics Div. of Globe - Union Inc., 900 East Keefe Ave., Milwaukee 1, Wis., containing detailed electrical and physical specs. on their line of PEC® miniature and microminiature trimmer resistors.

Circle 429 on Inquiry Card

Trimming Potentiometers

Handy "Standard Selection Chart" simplifies specifying of more than 2000 standard models of Squaretrim® precision, subminiature, trimming potentiometers. They are used for adjustment of computer, control, telemetering, missile, and other military and industrial electronic circuits. Included are actual curves showing power rating for 21 different series of Squaretrim potentiometers. Daystrom, Inc., Potentiometer Div., Archbald, Pa.

Circle 430 on Inquiry Card

Ceramic Capacitors

A 40-page, 2-color, catalog is available from the Hi-Q Div., Aerovox Corp., Myrtle Beach, S. C., on their complete line of Ceramic Capacitors. The catalog contains detailed electrical and physical specs. on disc, plate, tubular, ceramic trimmers and eyelet feed-thru, feed-thru, stand-off, high-voltage, ring and square can capacitors, and R/C network plate assemblies. Included are dimensional drawings, specs., tables, and operating curves.

Circle 431 on Inquiry Card

Design for Reliability and Superior Performance

with these Allen-Bradley quality electronic components

■ Mr. Design Engineer! When deciding upon components for your circuits, please remember that you can always be sure of obtaining *maximum reliability* with Allen-Bradley electronic components—and quality of production is consistent from one order to the next—and from one year to the next.

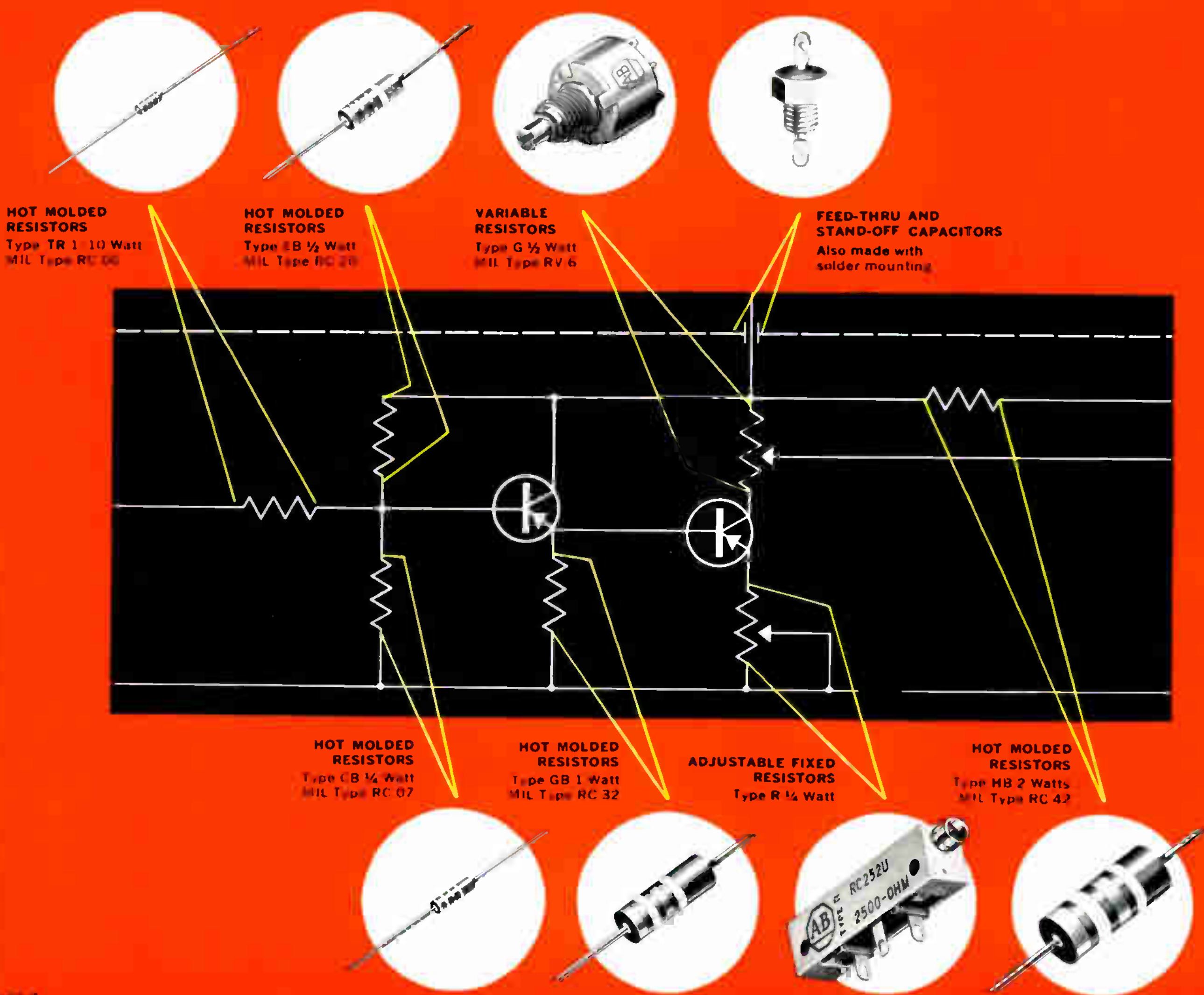
For example, Allen-Bradley fixed resistors—made by A-B's exclusive hot molding process—are famous for their conservative ratings, stable characteristics, and *complete freedom from catastrophic failures.*

Then there are the miniature Type G potentiometers. They feature a solid, hot molded resistance element that gives exceptionally long life and quiet operation which even improves with use. Control is always smooth—there are never any abrupt resistance changes during adjustment.

This same hot molding process is also used in making A-B's Type R adjustable fixed resistors, which provides "stepless" adjustment of resistance. In addition, the moving element is self-locking, resulting in absolutely stable settings.

Another "exclusive" is A-B's ceramic feed-thru and stand-off capacitors for use at VHF and UHF frequencies. With their *unique* discoidal design, all parallel resonance effects are eliminated at frequencies of 1000 mcps and less.

For details on the complete line of A-B *quality* electronic components, please send for Publication 6024.



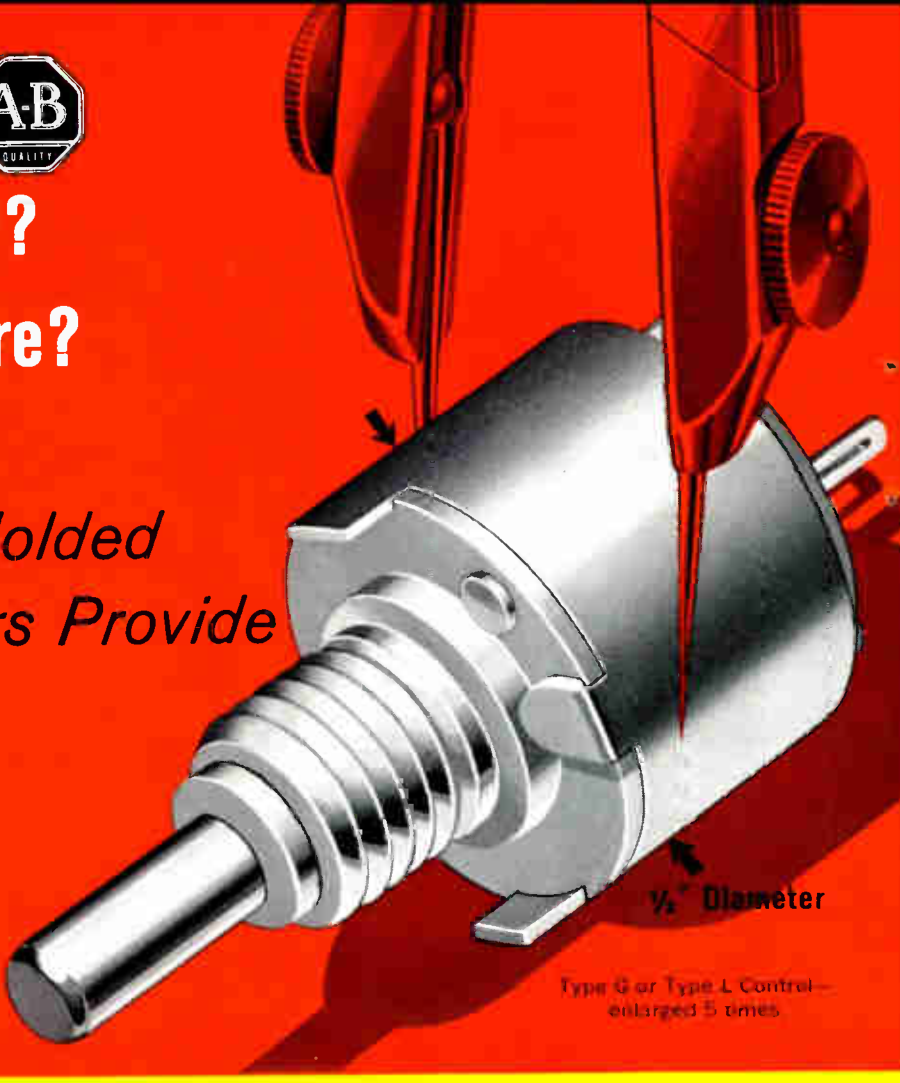
ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Space Restricted?
Application Severe?

Allen-Bradley Miniature Hot Molded Variable Resistors Provide Smooth Control Which Improves With Use!



Type G or Type L Control—enlarged 5 times


With locking bushing


With watertight panel seal


With encapsulation


With line switch


For board mounting

The same reliability and superior performance of Allen-Bradley's famous hot molded construction is found in this "space-saving" size. The solid resistance element, collector track, terminals and insulating material are all hot molded—by A-B's *exclusive* process—into a single solid structure. Molded contact brushes eliminate sliding metal contacts. This assures exceptionally low "noise" initially, and this quality feature improves with use. Incidentally, the operational life exceeds 50,000 cycles with less than 10% resistance change.

These miniature controls are available as:

Type G—For use over ambient temperature range from —55°C to +120°C. Rated 0.5 watt at +70°C.

Type L—For use over ambient temperature range from —55°C to +150°C. Rated 0.8 watt at +70°C.

Both furnished in maximum resistances from 100 ohms to 5 megohms. For full details on these *quality* controls, please write for Technical Bulletin B5201.

ADDITIONAL A-B HOT MOLDED CONTROLS

The Type F controls are especially designed for printed board mounting. Terminals fit 0.1 inch spacing. Type F temperature range —55°C to +120°C, rated 0.25 watt at +70°C. Type O temperature range —55°C to +150°C, rated 0.4 watt at +70°C.

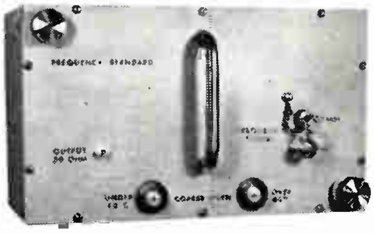
Type R adjustable fixed resistors allow stepless adjustment. Moving element is self-locking for absolutely stable settings. Watertight case permits encapsulation. For continuous use from —55°C to +125°C, rated 0.25 watt at +70°C.

Allen-Bradley Co., 222 West Greenfield Ave., Milwaukee 4 Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario 5-62-E

ALLEN-BRADLEY | ***QUALITY ELECTRONIC COMPONENTS***

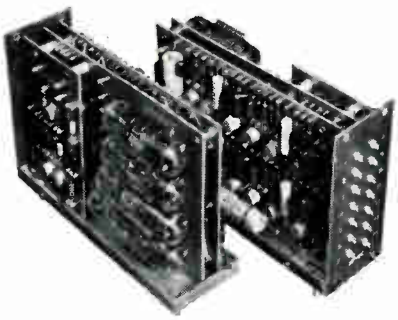
REEVES-HOFFMAN

FREQUENCY SOURCES AND STANDARDS, CRYSTALS, OVENS, FILTERS



FREQUENCY STANDARDS

Highly reliable, ultra-stable standards with a basic frequency of 5 mc are available with circuitry for division to 100 kc and 1 mc and doubling up to 10 mc. Stability is up to 1 part in 10^9 per day. Precision standards use crystals of our own manufacture and are packaged to your specifications.



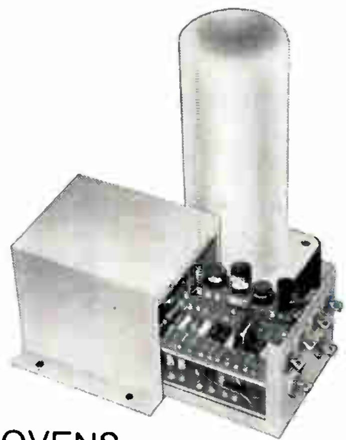
PACKAGED OSCILLATORS

TRANSISTORIZED AND HARD TUBE TYPES of Reeves-Hoffman packaged oscillators are available in a frequency range from 100 cps to 100 mc. Stability is up to 1 part in 10^9. Packaged to your specifications.

CRYSTALS

STANDARD TYPES of Reeves-Hoffman crystals, for all commercial and military applications, are available in a frequency range from 1 kc to 100 mc. Hermetically sealed in metal holders.

PRECISION TYPES of Reeves-Hoffman crystals, for use in high precision oscillators and secondary frequency standards, are available in a frequency range from 1 kc to 5 mc. Hermetically sealed in glass holders with standard radio tube bases.



OVENS

OVENS for precise temperature control are available in three types:

PROPORTIONAL CONTROLLED, for precise frequency standards, hold within 1/100th of 1° C at any fixed ambient.

THERMOSTATICALLY CONTROLLED, for high reliability requirements, hold within 1/10 of 1° C at any fixed ambient.

SNAP-ACTION CONTROLLED, for rugged military requirements, hold within 1° C at any fixed ambient.

FILTERS CRYSTAL FILTERS are available in a frequency range from audio to 30 mc.

Compact, rugged and highly reliable Reeves-Hoffman components are available in standard types or will be designed and manufactured to your specifications. Most units can be designed to withstand up to 10 g at 5 to 2000 cps. Write for complete details.

REEVES-HOFFMAN

DIVISION OF DYNAMICS CORPORATION OF AMERICA • CARLISLE, PENNSYLVANIA

JFD ELECTRONICS CORPORATION

Components Division • 6101 16th Avenue, Brooklyn, New York • Phone DEwey 1-1000 • TWX-NY25040

model	type mount	capacitance range pf measured per JFD-5177 min	max	DC working volts	dielectric strength measured at max. rated cap	insulation resistance 500 VDC	Q factor measured at 1 mc. per JFD 5178	temp. coeff. of capacitance PPM/°C +25 to +125°C for glass, −55° to +125°C for quartz	material (dielectric-piston)	length from panel	page no.
SEALCAP MINIATURE PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ											
SC131*, 141 & 151	Prt. Ct.	0.8	4.5	750	1500 VDC	2×10^{4} Meg.	500	±50	Glass - Invar	[illegible]	16
SC133*, 143 & 153	Prt. Ct.	0.8	8.5	1250	2500 VDC	10×10^{4} Meg.	500	±50	Glass - Invar	[illegible]	16
SC134*	Prt. Ct.	0.7	12.0	1250	2500 VDC	10×10^{4} Meg.	500	±75	Glass - Invar	[illegible]	
SC144 & 154	Prt. Ct.	0.8	12.0	1250	2500 VDC	10×10^{4} Meg.	500	±75	Glass - Invar	[illegible]	16
SC136*, 146 & 156	Prt. Ct.	0.8	18.0	1250	2500 VDC	10×10^{4} Meg.	500	±100	Glass - Invar	[illegible]	16
SC139*	Prt. Ct.	1.0	30.0	1250	2500 VDC	10×10^{4} Meg.	500	±100	Glass - Invar	[illegible]	16
SC149 & 159	Prt. Ct.	0.8	30.0	1250	2500 VDC	10×10^{4} Meg.	500	±100	Glass - Invar	[illegible]	16
QS171*, 181 & 191	Prt. Ct.	0.6	1.8	750	1500 VDC	2×10^{4} Meg.	1500	+25 ±25	Quartz - Invar	[illegible]	17
QS173*, 183 & 193	Prt. Ct.	0.6	5.5	1250	2500 VDC	10×10^{4} Meg.	1500	+25 ±25	Quartz - Invar	[illegible]	17
QS176*, 186 & 196	Prt. Ct.	0.6	9.5	1250	2500 VDC	10×10^{4} Meg.	1500	+25 ±25	Quartz - Invar	[illegible]	17
QS179*, 189 & 199	Prt. Ct.	0.8	16.0	1250	2500 VDC	10×10^{4} Meg.	1500	+25 ±25	Quartz - Invar	[illegible]	17
STANDARD SPLIT-STATOR PANEL MOUNT, GLASS AND QUARTZ											
VC16G	Panel	(A) 0.5 (B) 0.8	5.0 2.5	500	1000 VDC	10^{4} Meg.	700	±50	Glass - Invar	[illegible]	22
VC17G	Panel	(A) 0.6 (B) 1.1	8.5 4.5	500	1000 VDC	10^{4} Meg.	700	±50	Glass - Invar	[illegible]	22
VC18G	Panel	(A) 0.7 (B) 1.8	14.0 7.5	500	1000 VDC	10^{4} Meg.	700	±50	Glass - Invar	[illegible]	22
VC80A	Panel	(A) 0.4 (B) 0.5	1.5 0.8	750	1500 VDC	10^{4} Meg.	1000	+25 ±25	Quartz - Invar	[illegible]	22
VC81A	Panel	(A) 0.55 (B) 0.75	2.8 1.3	750	1500 VDC	10^{4} Meg.	1000	+25 ±25	Quartz - Invar	[illegible]	22
VC82A	Panel	(A) 0.65 (B) 0.95	5.0 2.5	750	1500 VDC	10^{4} Meg.	1000	+25 ±25	Quartz - Invar	1	22
VC83A	Panel	(A) 5.3 (B) 3.5	10.5 5.5	750	1500 VDC	10^{4} Meg.	1000	+25 ±25	Quartz - Invar	[illegible]	22
MINIATURE SPLIT-STATOR SERIES											
SP86G*, 206G & 216G	Prt. Ct.	(A) 0.8 (B) 0.8	4.2 2.0	750	1500 VDC	10^{5} Meg.	500	±50	Glass - Invar	[illegible]	23
SP87G*, 207G & 217G	Prt. Ct.	(A) 0.8 (B) 1.5	9.0 4.5	750	1500 VDC	10^{5} Meg.	500	±100	Glass - Invar	1†	23
SP88G*, 208G & 218G	Prt. Ct.	(A) 1.0 (B) 2.0	14.0 7.0	750	1500 VDC	10^{5} Meg.	500	±100	Glass - Invar	[illegible]	23
MINIATURE SPLIT-STATOR SEALCAP SERIES											
SPS226G*, 236G & 246G	Prt. Ct.	(A) 0.8 (B) 0.8	4.2 2.0	750	1500 VDC	10^{5} Meg.	500	±50	Glass - Invar	[illegible]	24
SPS227G*, 237G & 247G	Prt. Ct.	(A) 0.8 (B) 1.5	9.0 4.5	750	1500 VDC	10^{5} Meg.	500	±100	Glass - Invar	[illegible]	24
SPS228G*, 238G & 248G	Prt. Ct.	(A) 1.0 (B) 2.0	14.0 7.0	750	1500 VDC	10^{5} Meg.	500	±100	Glass - Invar	[illegible]	24
DIFFERENTIAL SERIES, STANDARD PANEL MOUNT, MINIATURE TYPES FOR PANEL MOUNT*, AND PRINTED CIRCUIT TYPES**											
DC401**, 411*, 421 & 431	Prt. Ct.	(1) 0.7 (2) 2.0	3.0 3.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	20
DC403**, 413*, 423 & 433	Prt. Ct.	(1) 0.8 (2) 2.5	8.0 8.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	20
DC404**, 414*, 424 & 434	Prt. Ct.	(1) 0.8 (2) 3.0	12.0 12.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	20
DC406**, 416*, 426 & 436	Prt. Ct.	(1) 0.9 (2) 3.5	16.0 16.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	20
DC409**, 419*, 429 & 439	Prt. Ct.	(1) 1.5 (2) 5.0	28.0 28.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	20
MINIATURE DIFERENTIAL SEALCAP SERIES											
DS441*, 451 & 461	Prt. Ct.	(1) 0.7 (2) 2.0	3.0 3.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	21
DS443*, 453 & 463	Prt. Ct.	(1) 0.8 (2) 2.5	8.0 8.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	21
DS444*, 454 & 464	Prt. Ct.	(1) 0.8 (2) 3.0	12.0 12.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	21
DS446*, 456 & 466	Prt. Ct.	(1) 0.9 (2) 3.5	16.0 16.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	21
DS449*, 459 & 469	Prt. Ct.	(1) 1.5 (2) 5.0	28.0 28.0	500	1000 VDC	10^{4} Meg.	500	±100	Glass - Invar	[illegible]	21
MAX-C SEALCAP SERIES											
MC601*, 611 & 621	Prt. Ct.	1.0	14.0	1000	2000 VDC	10^{4} Meg.	500	±50	Glass - Nickel Alloy Steel	[illegible]	18
MC603*, 613 & 623	Prt. Ct.	1.0	28.0	1000	2000 VDC	10^{4} Meg.	500	±50	Glass - Nickel Alloy Steel	[illegible]	18
MC604*, 614 & 624	Prt. Ct.	1.0	42.0	1000	2000 VDC	10^{4} Meg.	500	±50	Glass - Nickel Alloy Steel	[illegible]	18
MC606*, 616 & 626	Prt. Ct.	1.0	60.0	1000	2000 VDC	10^{4} Meg.	500	±50	Glass - Nickel Alloy Steel	[illegible]	18
MC609*, 619 & 629	Prt. Ct.	1.0	90.0	1000	2000 VDC	10^{4} Meg.	500	±50	Glass - Nickel Alloy Steel	1 1/4†	18
PC SERIES PANEL MOUNTS											
PC35H030	PANEL	0.5	3	500	These units meet the requirements of MIL-C-14409A					[illegible]	25
PC35H080	PANEL	1	8	500						[illegible]	25
PC35H160	PANEL	1	16	500						[illegible]	25
PC35H300	PANEL	1	30	500						[illegible]	25

LC TUNERS*	self-resonating frequency (MC)		nominal induct (microhenries)		nominal capacitance pf		Q factor	operating temperature °C	material	length (front of panel)
LC303*, 313, 323 & 333**	400 MIN	725 MAX	.0248 MIN	.0277 MAX	.54 MIN	6.56 MAX	170-200	−55 to +125	Glass - Invar	[illegible]
LC304*, 314, 324 & 334**	275 MIN	550 MAX	.0367 MIN	.0396 MAX	.85 MIN	11.66 MAX	150-175	−55 to +125	Glass - Invar	[illegible]
LC306*, 316, 326 & 336**	200 MIN	500 MAX	.0507 MIN	.0544 MAX	.86 MIN	20.19 MAX	135-170	−55 to +125	Glass - Invar	[illegible]
LC309*, 319, 329 & 339**	125 MIN	375 MAX	.0748 MIN	.0798 MAX	.88 MIN	24.49 MAX	145-155	−55 to +125	Glass - Invar	[illegible]

FOR JFD LC TUNERS. WITH SEALCAP CONSTRUCTION(LCS343, LCS353, AND LCS363 SERIES) SEE CATALOG T172

**Standard panel mount *miniature panel mount †Length Applicable for Panel Mount Types Only.

FIXED METALIZED INDUCTORS FOR PANEL MOUNT, (LF1P SERIES), OR PRINTED CIRCUIT MOUNT, (LF2W SERIES), ARE AVAILABLE "OFF THE SHELF" IN 23 VALUES ON A 15/32 INCH GLASS DIAMETER. THEY RANGE FROM .05 uh TO 2.00 uh. FIXED METALIZED INDUCTORS FOR PANEL MOUNT (LF3P SERIES), OR PRINTED CIRCUIT MOUNT (LF4W SERIES), ARE ALSO AVAILABLE "OFF THE SHELF" IN 22 VALUES ON A 19/64 INCH GLASS DIAMETER. THESE RANGE FROM .05 uh to 1.00 uh. THESE FOUR SERIES ARE DESCRIBED IN JFD CATALOG T172

TANK CIRCUITS, (SERIES LC371) AVAILABLE IN FIVE MODELS COVERING FIVE OVERLAPPING RANGES BETWEEN 170 Mc AND 1000 Mc ARE ALSO DESCRIBED IN JFD CATALOG T172

MORE ENGINEERS SPECIFY JFD

VARIABLE TRIMMER PISTON CAPACITORS LC TUNERS AND METALIZED INDUCTORS

For complete data on LC Tuners and Metalized Inductors, refer to Catalog No. T172.
For complete data on Delay Lines, refer to Catalog No. D82.
For custom modifications please contact the JFD sales engineering office or JFD Sales Representative nearest you as listed on page 32

model	type mount	capacitance range pf measured per JFD #5177 min.	max.	D.C. working volts	dielectric strength measured at max. rated cap.	insulation resistance 500 V D C.	Q factor measured at 1 mc. per JFD #5178	temp. coeff. of capacitance P P M /°C +25° to +125°C for glass —55° to +125°C for quartz	material (dielectric-piston)	length (front of panel)	page no.
STANDARD PANEL MOUNT, GLASS AND QUARTZ											
VC1G	Panel	0.7	9.0	1250	2500 VDC	10^4 Meg. Min.	500	—60 to +10	Glass - Invar	21/32	7
VC4G	Panel	0.8	18.0	750	1500 VDC	10^4 Meg. Min.	500	+350 to +450	Glass - Brass	1	7
VC5G	Panel	0.8	18.0	750	1500 VDC	10^4 Meg. Min.	500	—20 to +40	Glass - Invar	1	7
VC11G	Panel	0.6	14.0	750	1500 VDC	10^4 Meg. Min.	500	—30 to +40	Glass - Invar	1	7
VC11GRA	Panel	0.6	14.0	750	1500 VDC	10^4 Meg. Min.	500	—40 to +50	Glass - Invar	1	7
VC11GRB	Panel	0.6	14.0	750	1500 VDC	10^4 Meg. Min.	500	+350 to +450	Glass - Brass	1	7
VC11GRC	Panel	0.8	18.0	750	1500 VDC	10^4 Meg. Min.	500	+20 to +100	Glass - Invar	1	7
VC30G	Panel	0.8	30.0	750	1500 VDC	10^4 Meg. Min.	500	—10 to +50	Glass - Invar	1 15/32	7
VC2	Panel	0.7	4.5	750	1500 VDC	10^4 Meg. Min.	LARGELY	+25 ±25	Quartz - Invar	7/16	7
VC5	Panel	0.6	6.0	750	1500 VDC	10^4 Meg. Min.	IN	+25 ±25	Quartz - Invar	5/8	7
VC11	Panel	0.8	10.0	750	1500 VDC	10^4 Meg. Min.	EXCESS	+25 ±25	Quartz - Invar	1	7
VC12	Panel	9.0	21.0	750	1500 VDC	10^4 Meg. Min.	OF	+25 ±25	Quartz - Invar	1 11/32	7
VC99	Panel	0.8	10.0	2500	5000 VDC	10^4 Meg. Min.	2000	+25 ±25	Quartz - Invar	1 7/32	25
SPLIT BUSHING SERIES PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ											
VC3G	Panel	0.7	9.0	1250	2500 VDC	10^4 Meg. Min.	650	+300 to +500	Glass - Brass	21/32	8
VC3GI	Panel	0.7	9.0	1250	2500 VDC	10^4 Meg. Min.	650	+0 to —150	Glass - Invar	21/32	8
VC8GA	Panel	0.7	17.0	750	1500 VDC	10^4 Meg. Min.	750	+400 to +600	Glass - Brass	1 1/32	8
VC8GI	Panel	0.8	17.0	750	1500 VDC	10^4 Meg. Min.	600	—100 to +100	Glass - Invar	1 1/32	8
VC7G	Panel	2.0	30.0	750	1500 VDC	10^4 Meg. Min.	600	—100 to +100	Glass - Invar	1 5/8	8
VC801GW	Prt. Ct.	0.8	4.5	750	1500 VDC	10^4 Meg.	500	±50	Glass - Invar	15/32	9
VC803GWA	Prt. Ct.	0.8	8.5	750	1500 VDC	10^4 Meg.	500	±50	Glass - Invar	19/32	9
VC804GWA	Prt. Ct.	0.8	12.0	750	1500 VDC	10^4 Meg.	500	±75	Glass - Invar	51/64	9
VC806GWA	Prt. Ct.	0.8	18.0	750	1500 VDC	10^4 Meg.	500	±100	Glass - Invar	1 5/32	9
VC809GWA	Prt. Ct.	0.8	30.0	750	1500 VDC	10^4 Meg.	500	±100	Glass - Invar	1 41/64	9
VC811QWA	Prt. Ct.	0.6	1.8	750	1500 VDC	10^4 Meg.	2000	+25 ±25	Quartz - Invar	13/32	9
VC813QWA	Prt. Ct.	0.6	5.0	750	1500 VDC	10^4 Meg.	2000	+25 ±25	Quartz - Invar	19/32	9
VC816QWA	Prt. Ct.	0.6	9.5	750	1500 VDC	10^4 Meg.	2000	+25 ±25	Quartz - Invar	1 3/64	9
VC819QWA	Prt. Ct.	0.6	16.0	750	1500 VDC	10^4 Meg.	2000	+25 ±25	Quartz - Invar	1 41/64	9
DIRECT TRAVERSE, LOW COST, HIGH QUALITY, PANEL MOUNT, PRINTED CIRCUIT, GLASS AND CERAMIC, FOR COMMERCIAL APPLICATIONS											
VC13GB	Panel	0.8	13.0	2500	5000 VDC	10^4 Meg. Min.	500	+225 to +375	Glass - Ph. Bronze	1 3/16	10
VC50CB	Panel	5.0	50.0	1250	2500 VDC	10^5 Meg. Min.	450	+250 to +450	Ceram - Ph. Bronze	1	10
VC51CB	Prt. Ct.	5.0	50.0	1250	2500 VDC	10^5 Meg. Min.	450	+250 to +450	Ceram - Ph. Bronze	1 13/64	10
VC52	Panel	1.0	12.0	750	1500 VDC	10^4 Meg. Min.	500	+225 to +375	Glass - Ph. Bronze	1	10
VC53	Prt. Ct.	1.0	12.0	750	1500 VDC	10^4 Meg. Min.	500	+225 to +375	Glass - Ph. Bronze	1 11/64	10
SPLIT BUSHING, PANEL MOUNT, PRINTED CIRCUIT, GLASS SUBMINIATURE SERIES											
VC76	Panel	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	19/32	11
VC77	Panel	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	19/32	11
VC78	Panel	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	19/32	11
VC79	Prt. Ct.	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	49/64	11
PIN TRIM, PANEL MOUNT, PRINTED CIRCUIT, GLASS, "WORLD'S SMALLET PISTON CAPACITOR"											
PT901	Panel	0.5	2.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	3/8	12
PT902	Panel	0.5	3.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	1/2	12
PT903	Panel	0.5	5.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	3/4	12
PT904	Panel	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	1	12
PT911	Prt. Ct.	0.5	2.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	9/16	12
PT912	Prt. Ct.	0.5	3.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	43/64	12
PT913	Prt. Ct.	0.5	5.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	59/64	12
PT914	Prt. Ct.	0.5	7.0	500	1000 VDC	10^4 Meg. Min.	500	—	Glass-Nickel Alloy Steel	1 11/64	12
SLIDING PISTON, SPLIT BUSHING, PANEL MOUNT, GLASS											
VC481	Panel	0.8	4.5	750	1500	10^4 Meg. Min.	500	±50	Glass - Invar	3/16	13
VC483	Panel	0.8	8.5	750	1500	10^4 Meg. Min.	500	±50	Glass - Invar	9/16	13
VC484	Panel	0.8	12.0	750	1500	10^4 Meg. Min.	500	±50	Glass - Invar	49/64	13
VC486	Panel	0.8	18.0	750	1500	10^4 Meg. Min.	500	±50	Glass - Invar	1	13
VC489	Panel	0.8	30.0	750	1500	10^4 Meg. Min.	500	±50	Glass - Invar	1 5/8	13
MINIATURE PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ (* Panel Mount)											
VC20G * VC9G, VC9GW	Prt. Ct.	0.8	8.5	750	1500 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	9/16	14
VC21G* VC10G, VC10GW	Prt. Ct.	0.8	4.5	750	1500 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	5/16	14
VC22G *	Panel	0.7	12.0	750	1500 VDC	10^4 Meg. Min.	500	±75	Glass - Invar	41/64	14
VC23G* VC32G, VC32GW	Prt. Ct.	0.8	18.0	750	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1	14
VC24G *	Panel	1.0	30.0	750	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 5/8	14
VC31G, VC31GW	Prt. Ct.	0.8	12.0	750	1500 VDC	10^4 Meg. Min.	500	±75	Glass - Invar	23/32	14
VC42G & VC42GW	Prt. Ct.	1.0	21.0	750	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 5/32	14
VC43G, VC43GW	Prt. Ct.	0.8	30.0	750	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 5/8	14
MQ101*, 111 & 121	Prt. Ct.	0.6	1.8	750	1500 VDC	10^4 Meg. Min.	1500	+25 ±25	Quartz - Invar	5/16	15
MQ103*, 113 & 123	Prt. Ct.	0.6	5.5	750	1500 VDC	10^4 Meg. Min.	1500	+25 ±25	Quartz - Invar	9/16	15
MQ106*, 116 & 126	Prt. Ct.	0.6	9.5	750	1500 VDC	10^4 Meg. Min.	1500	+25 ±25	Quartz - Invar	1	15
MQ109*, 119 & 129	Prt. Ct.	0.8	16.0	750	1500 VDC	10^4 Meg. Min.	1500	+25 ±25	Quartz - Invar	1 5/8	15

JFD Capacitors meet or exceed applicable requirements of MIL-C-14409A.

Circle 137 on Inquiry Card

New Tech Data for Engineers

Inductors

Vari-L Co., Inc., P. O. Box 1433, Stamford, Conn., has available Catalog 61 on their electrically-variable inductors. Information includes function of the variable inductor, principles of operation, special types, applications, explanation of tabular data, characteristic curves and dimensional drawings.

Circle 445 on Inquiry Card

General Purpose Relays

Branson Corp., 41 S. Jefferson Rd., Whippany, N. J., has tech. data available on their transistor sized general purpose relay Type JR. Specs., characteristics, capabilities and dimensional diagrams are included. The unit is 0.04 cu. in. and weighs 5 grams.

Circle 446 on Inquiry Card

Voltage Regulator

Regohm® voltage regulators featuring an accuracy of regulation within 2% for the combined effects of line, load, freq., and power factor variations are described in Condensed Catalog 5.17-1 available from Dept. VA, Electric Regulator Corp., Norwalk, Conn. The Regohm also features insensitivity to freq.: 54-66CPS model holds output to ½% and the 45-1000CPS model holds output to better than 2%.

Circle 447 on Inquiry Card

Toroidal Core Design

Connolly & Co., P.O. Box 295, Menlo Park, Calif., has available "Genalex Toroidal Core Design Handbook," containing basic design information tips and formulas. Included are temp. curves, analysis of core loss, dc resistance, eddy current loss resistance, hysteresis loss resistance and self-capacitance.

Circle 448 on Inquiry Card

Resistors

New power metal film resistors which feature inherent stability and the ability to withstand severe environmental conditions are described in bulletin P-9 available from International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. The 3 and 4w. units were developed for most low power resistor needs and are available at wire wound prices.

Circle 449 on Inquiry Card

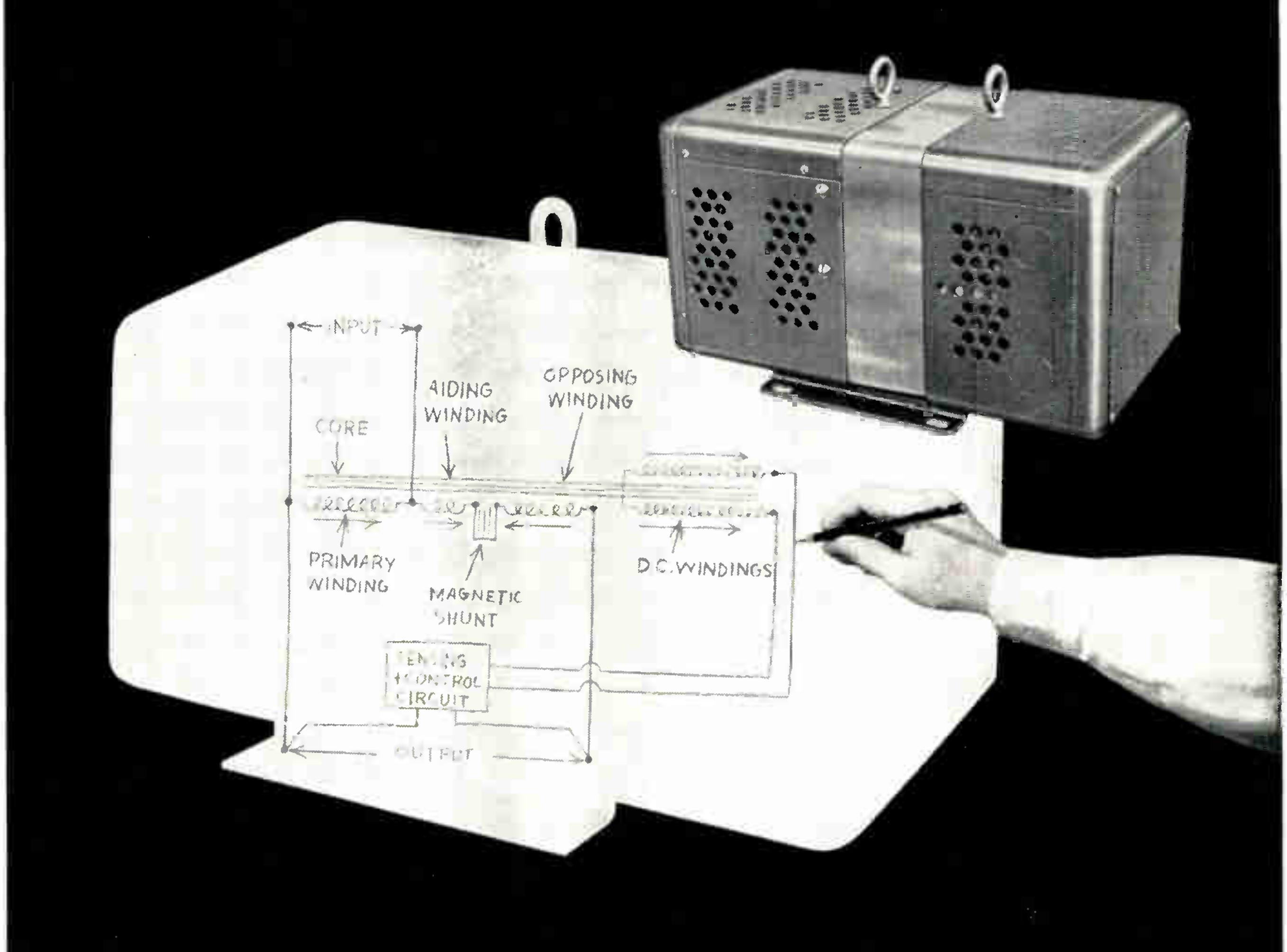
Resistors

The Daven Co., Livingston, N. J., has available a 17-page tech. brochure covering their precision wire wound resistors. Some of the resistors covered are encapsulated, sub-miniature axial lead types, lug types, high freg., card-type, complex networks, and information on their reliability resistor program.

Circle 450 on Inquiry Card

← Circle 214 on Inquiry Card

A new concept in line voltage regulation in the KVA range...



The SOLATRON Line Voltage Regulator

Sola now has developed a new uncomplicated breed of line voltage regulators. *Up to 10 times faster than mechanical regulators*, the new SOLATRON Line Voltage Regulator features no moving parts, lower operating cost per KVA, and is maintenance free!

Designed to cover the 3-100 KVA range, the SOLATRON Line Voltage Regulator offers corrective action the instant output departs from nominal . . . long before voltage even approaches boundaries of the regulation envelope! Output holds *stable* in the face of leading and lagging power factors. Efficiency — 95% at full load.

For more information on the new SOLATRON Line Voltage Regulator, send requests, on company letterhead, direct to our factory address.

• **EXCELLENT REGULATION** — ±1% from nominal, for any combination of line, load, and frequency change within specified parameters.

• **FAST RESPONSE** — practically instantaneous; even under extreme conditions, return to nominal will never exceed 10 cycles.

• **ULTRA-COMPACT** — Over-all dimensions for the 5 KVA measure approximately 8¼ x 8¼ x 16¼".

• **COMPLETE FLEXIBILITY** — designed for horizontal or vertical mounting; standard NEMA markings and color coding.

SOLA

Division of
Basic Products Corporation

BP
C

SOLA ELECTRIC CO.
1717 Busse Road
Elk Grove Village, Ill.
HEmpstead 9-2800
IN CANADA,
Sola-Basic Products Ltd.,
377 Evans Avenue,
Toronto 18, Ontario

Vacuum Tube Circuits for the Electronic Experimenter

By Julian M. Sienkiewicz. Published 1961 by Ziff-Davis Publishing Co., One Park Ave., New York 16, N. Y. 192 pages. Price $4.95.

The experimenter can find in this book all the basic diagrams, schematics, and other vital information on vacuum tubes and their circuits to use in building a piece of electronic equipment.

Beginning with the Edison effect, the author leads the experimenter right up to the multi-element vacuum tubes used in everyday circuits. Vacuum-tube circuit design is described in clear, concise terms. Plate resistance, transconductance, gain load lines, characteristic curves, and the like are clarified as useful tools for experimenters.

Computer Programming Handbook: guide for beginners

By Robert Nathan & Elizabeth Hanes. Published 1961 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 214 pages. Price $7.65.

Written especially for the beginner, this handbook provides a sound, practical approach to initial background knowledge in the field of computers. Specific machine operations of the major computers on the market are explained in clear, simple language.

The IBM 650 and 704, the Burroughs 220 and the Univac 1103A Scientific were selected as representative of the two major types of computers-binary and decimal. Fundamental principles of programming are related to each machine and the reader becomes familiar with the actual console, buttons, and commands of each type of computer. Only the most important features are stressed since anyone interested in more advanced programming and the use of computers may refer to the manuals issued by the individual companies.

Understanding Financial Statements and Corporate Annual Reports

By L. O. Foster. Published 1961 by Chilton Co., Book Div., Publishers, 56th & Chestnut Sts., Phila. 39, Pa. 135 pages. Price $3.95.

Major investors and stockholders, both private and institutional, base their decisions to buy, sell or hold securities primarily on careful analyses of companies' financial statements. The small investor, on the other hand, has traditionally been guided by tips, hunches, brokers advice, and advertisements. Today, however, he is coming to realize that he cannot invest wisely without reading and understanding corporate financial statements. This is particularly true of members of the thousands of investment clubs functioning throughout the country. This book enables anyone, without previous training and with minimum effort, to interpret and understand the meaning of a financial report.

Books

Modulation and Coding in Information Systems

By Gordon M. Russell. Published 1962 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 260 pages. Price $10.00.

Emphasis is placed on a logical development of the principles and general methods which apply to information processes of all kinds. The graduate engineer, seeking additional knowledge or in need of a refresher course in the electronic systems area, will find this text particularly appropriate for independent study.

1962 International Solid-State Circuits Conference Digest of Technical Papers

Published 1962 by Lewis Winner, 152 W. 42nd St., New York 36, N. Y. 112 pages. Priced at $5.00 each, copies may be obtained from H. G. Sparks, The Moore School of Electrical Engineering, Univ. of Penna., 200 S. 33rd St., Phila. 4, Pa.

Forty-six papers were presented at the conference on subjects which included logic, microwave parametric circuits, new devices and device characterization, memory, high-speed switching, low-noise amplification, tunnel-diode applications, digital transmission, functional components, and design applications.

Fundamentals of Rockets, Missiles, and Spacecraft

By Marvin Hobbs. Published 1962 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 272 pages. Price $8.95.

Book covers the theory and application of the basic elements of rockets, missiles and propulsion systems for space vehicles as well as both manned and unmanned spacecraft. Fundamentals of solid and liquid propellants, rocket engine components, basic rocket and missile elements, aerodynamic shapes of vehicles and nose cones, guidance and telemetry are covered prior to the treatment of missile and space rocket classes and types.

Statistical Analysis and Optimization of Systems

By E. L. Peterson. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 190 pages. Price $9.75.

Book deals with a subject of paramount importance in the development of automatic control systems—the theory and methods underlying the analysis, synthesis, and optimization of systems in which statistical uncertainty is involved in the process dynamics. It clearly formulates the problems which the subject involves, and shows the great progress that has been made toward their solution through recent theoretical advances and the growth of computer technology.

Thermal Conduction in Semiconductors

By J. R. Drabble & H. J. Goldsmid. Published 1961 by Pergamon Press ltd., Headington Hill Hall, Oxford, England. 235 pages. Price $10.00.

Recent developments in the field of thermoelectric devices have indicated a great need for a more fundamental understanding of thermal conduction processes in semiconductors, since these processes have a profound influence on all efficiency considerations. Because some of the materials concerned are available in highly pure and well ordered form, they are specially suitable for investigations of this kind. Present volume covers theoretical as well as practical aspects of these problems, including the techniques of measurement.

Satellite Tracking

By Stanley Macko. Published 1962 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 178 pages. Price $5.50.

Book explains how and why satellites are launched, why they behave as they do, and how the orbital elements of any terrestrial satellite can be derived with a minimum of data. The information and calculations presented in this book may, for the most part, also be applied to the field of guided missiles, and thus will also provide the reader with an understanding of missile trajectories.

Coding Theorems of Information Theory

By J. Wolfowitz. Published 1962 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 125 pages. Price $9.35.

This monograph describes and proves most of the known existence theorems of information theory. It begins from first principles and requires no prior knowledge of information theory.

Among channels discussed are: the discrete memoryless channel, compound channels, channels with stochastically determined states, channels with memory, semicontinuous and continuous channels.

Static Fields in Electricity and Magnetism

By D. H. Trevena. Published 1961 by Butterworth Inc., 7235 Wisconsin Ave., Washington 14, D. C. 255 pages. Price $6.50.

Book is concerned with the three main topics of electrostatics, magnetism and the magnetic fields of steady electric currents. Use of such concepts as the magnetic pole and the magnetic shell have been included. Problematic question of units, including M.K.S. units, is fully discussed and worked examples have been included throughout.

New Tech Data for Engineers

Capacitors

A precision calibrated standard capacitor, hermetically sealed, compact size, with a tolerance ±0.05%, is described in tech data available from Balco Capacitors, div. of Balco Research Laboratories, Inc., 49-53 Edison Place, Newark 2, N. J. The capacitor is for such uses as tuned circuits, filter networks, timing devices and computer applications.

Circle 613 on Inquiry Card

Terminals/Connectors

This 68-page catalog gives detailed information on a line of terminals and connectors including male and female quick-connect terminals in single and multiple styles; printed-circuit edge terminals; ring, space, taper, solder, and screw terminals; and a wide selection of adaptors to accommodate different terminal styles and circuits. Information is also included on terminal boards and on various automatic devices for attaching terminals. Ark-Les Switch Corp., 51 Water St., Watertown 72, Mass.

Circle 614 on Inquiry Card

Tube Catalog

This 33-page, condensed tube catalog is available from Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. Tubes covered include: cold cathode trigger; entertainment and audio; ignitrons; klystrons; magnetrons; power; photomultiplier; thyratrons; TWTS; microwave triodes and UHF special purpose types. Write for the catalog under company letterhead.

Circle 615 on Inquiry Card

R-F Connectors

Tech. data, brochure SL-121, on the BRM and BRMM series of r-f connectors is available from the Scintilla Div. of the Bendix Corp., Sidney, N. Y. The max. VSWR of both connectors is 1.1:1 over the freq. range of 1 to 10GC. The BRM is 1/28 and the BRMM is 1/48 the size of the standard N type connectors.

Circle 616 on Inquiry Card

Standoff Terminals

This 20-page illustrated catalog lists 350 molded, insulated standoff terminals and is available from Electronic Molding Corp., 40 Church St., Pawtucket 10, R. I. Information on insulating materials, coding colors, selection of terminal and mounting platings, and specs. are included.

Circle 617 on Inquiry Card

Microcircuits

Varo Inc., 2201 Walnut St., Garland, Tex., is offering a catalog on its microcircuitry devices, now available as standard circuits. Featured in the catalog is data on digital, computer, control and audio freq. circuits. Photographs, complete specs. and prices are included.

Circle 618 on Inquiry Card

High Voltage Components

Components For Research, Inc., 979 Commercial St., Palo Alto, Calif., has a brochure available on High Voltage Epoxy Resin Insulators, Feed-through Bushings, Very-High-Voltage Coax Terminations, and Hermetic-Seal Feed-through Bushings. Photographs, specs and line drawings are included.

Circle 619 on Inquiry Card

Bearings

Both flanged and sleeve bearings listed in bore ranges from 0.0469 to 0.3127 are contained in a catalog available from Northfield Precision Instrument Corp., Island Park, L. I., N. Y. Bores, outside dia. and concentricities are maintained to tolerance of 0.0002 in. The information covers Northfield's complete line of miniature precision sintered bronze Microspin bearings. Catalog No. 461.

Circle 620 on Inquiry Card

Printed Circuits

"Military Specifications on Printed Circuits" contains information on the early efforts by the Armed Forces to establish standards and specs. on printed circuit design and manufacture. Also included are the current group of specifications covering: terms and definitions (Mil-STD-429A), base materials (Mil-P-13949B), design standards (Mil-STD-275A), and manufacture and quality control (Mil-P-55110). This 12-page booklet is available from Arthur Ansley Mfg. Co., New Hope, Pa.

Circle 621 on Inquiry Card

AC/DC Power Supplies

A line of over 375 models of ac and dc power supplies is described in short form catalog No. 1200 available from Behlman-Invar Electronics Corp., 1723 Cloverfield Blvd., Santa Monica, Calif. Information is included on a series of 54 modular supplies for data processing and ground support applications.

Circle 622 on Inquiry Card

Capillary Tubes

A 4-page tech. bulletin on tungsten carbide semiconductor lead bonding capillary tubes is available from Tempress Research Co., Inc., 566 San Xavier Ave., Sunnyvale, Calif. In addition, a section is devoted to a discussion of the thermal compression "nail head" lead bonding process used in the manufacture of semiconductors.

Circle 623 on Inquiry Card

Piezo Ceramics

Tech data on piezoelectric transducer elements, high alumina ceramics, 9-96-99% alumina vessels, metalized ceramics, and high alumina custom shapes, is available from Electro-Ceramics, Inc., 2645 So. 2nd West, Salt Lake City 15, Utah. Information includes: properties; photographs; uses; design suggestions and a list of terms and definitions.

Circle 624 on Inquiry Card

PC Connectors

This 36-page, 3-color catalog contains complete information on printed circuit connectors. Information includes outline drawings, electrical and mechanical specs., illustrations and uses. The product line covers microminiature, miniature and standard size PC board receptacles for accommodating 1/32, 3/64, 1/16, 3/32, and ⅛ in. boards. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 625 on Inquiry Card

Control Knobs

Tech. data including a complete control knob guide is available from National Radio Co., Components Div., Dept. P, Melrose 76, Mass. Data Sheet CO-9 gives full specifications, photos and diagrams on a complete line of knobs.

Circle 626 on Inquiry Card

Zone Melting

Zone melting apparatus for precise control in solid state purification in zone refining, zone melting and crystal pulling is described in a Technical Review Vol. 2, No. 4 available from Research Specialties Co., 200 So Garrard Blvd., Richmond, Calif.

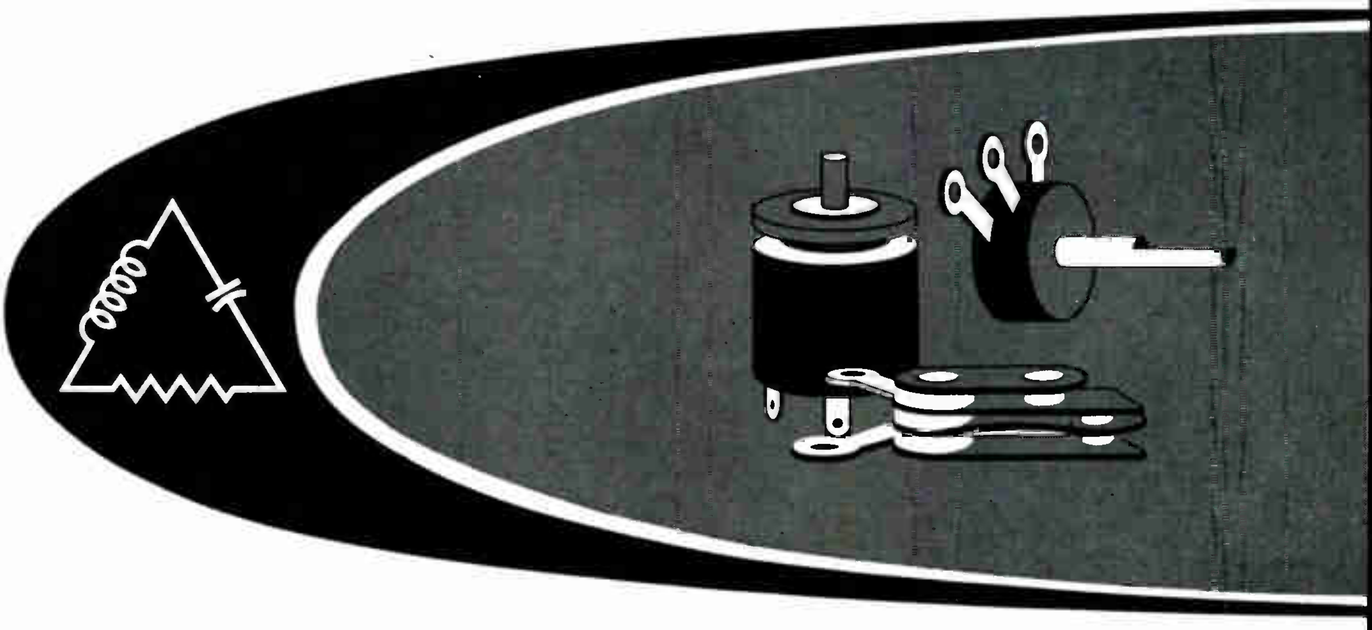
Circle 627 on Inquiry Card

ADS OF INTEREST IN OTHER SECTIONS . . . dealing with "Electronic Components"

Tung-Sol Electric Co. . . . . p. C62, C63

Section F

Electromechanical Components



Specifying the Fractional

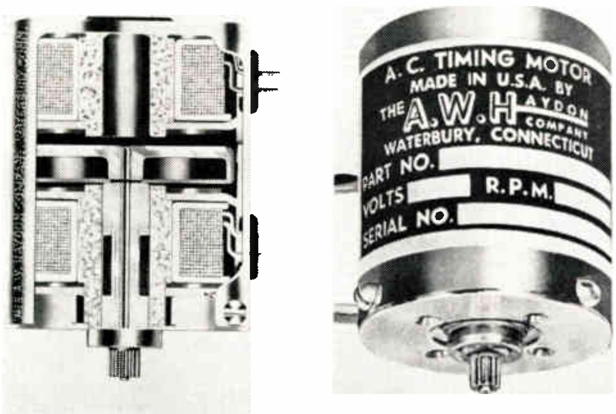


Fig. 1: Subminiature 400 CPS motor, the 25100 series, features almost instantaneous starting and stopping. Operating voltage is 115 v; current 20 ma. Power input is 3w max.; torque rating is 0.01 oz-in at 3000 RPM starting and running. Applications are in control systems in aircraft and guided missiles, in repeat cycle timers, time delay relays, and elapsed time indicators.

Courtesy of A. W. Haydon Co.

Fig. 2: Precision hysteresis synchronous motor. Motor-induced flutter will not exceed 0.1 rms at 1200 rpm or 0.15 rms at 360 rpm. They will withstand temperature ambients from −32 to 135 C. Applications include tape transports, turntable drives, missile instrumentation, and computer drum drives.

Courtesy of Hysyn Electromotive, Telecomputing Corp.

ELECTRONIC engineers find many uses for small fractional-horsepower motors, ranging from fan drives for cooling electronic equipment to automatic control systems where the speed or angular position of a shaft must be accurately controlled.

The design engineer looking for a small motor can rely on the many reputable U. S. motor manufacturers[1] to supply him with a motor which will precisely fit his needs. Most manufacturers have a wide variety of models to choose from and can meet virtually any special combination of electrical and mechanical specifications.

Electric motor theory can be rather complicated, and the design of these motors should be left to those engineers who are experts in this field. But, the engineer who uses these motors should know the differences between the several types of motors and their advantages and limitations.

1. See the list of manufacturers at the end of this article or consult the "Directory" section of this issue of ELECTRONIC INDUSTRIES.

Types of Motors

The principle working parts of electric motors are the armature and field windings. Current—either ac or dc—is fed to, or induced into, both of these windings. These current carrying windings are in a rotating magnetic field, and since a mechanical force is exerted on a current carrying conductor in such a field, torque is produced.

There are three major classes of motors: synchronous and induction motors (both ac), and dc motors.

A synchronous motor is a motor whose speed is directly related to the powerline frequency and the number of field poles. For example, from a 60 CPS line, a two-pole motor will run at 3600 RPM, a four pole motor at 1800 RPM, and a six-pole motor at 1200 RPM.

If the line frequency is 400 CPS, the speeds for the above number of poles are 24,000, 12,000, and 8,000 RPM.

In the induction motor, ac is fed directly to the

The design engineer has a wide variety of motors to choose from.
But one motor is best for his job.
The user should be ready to answer questions
on all details of how the motor will be used.
Lack of detailed information may result in his getting a too-expensive motor
or one that will fail under abnormal operating conditions.

Horsepower Motor

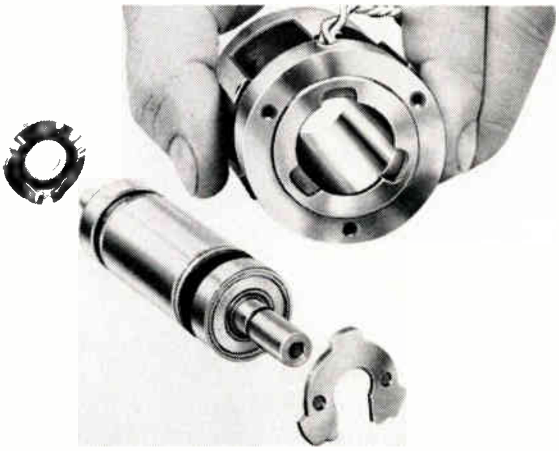


Fig. 3: Hysteresis synchronous motor provides high efficiency, noiseless operation. It operates at 14,400 rpm from a transistorized power supply, 30 v, 240 cps, 2-phase.

Courtesy of EMC Components Inc.

Fig. 4: Gear motor uses a unique rectangular field stack coupled with toroidal field windings. The 1 and ¼ lb unit delivers 1/10 hp continuous duty ¼ hp intermittent duty. Unit illustrated incorporates a 3:1 gear reduction and delivers approx. 22 in-oz torque at 3 and ½ a,27 vdc.

Courtesy of The Bendix Corp., Bendix-Pacific Div.

stationary (stator) windings and induced into the rotating (rotor) windings.

The third type of motor is the dc motor. Here dc is supplied to both windings. Lets take a quick look at each of these three classes of motor.

Induction Motors

In the induction motor, the power source is connected only to the stator windings. The current in the rotor is induced (transformer action). When a polyphase voltage is applied to the stator, a rotating magnetic field is produced, a voltage is induced in the rotor, and current flows in the rotor conductors. This condition: a current in a conductor in a rotating magnetic field, produce a force tending to move the conductor at right angles to the field and the current. These motors operate at a speed less than synchronous speed. The fraction by which the speed differs from synchronous speed is called the slip.

The rotor of this type of motor may have windings on it similar to the stator windings. This is called a wound-rotor. The rotor windings can either be closed on themselves or connected through slip rings and brushes to external resistances. These resistances may be varied to adjust the motor speed-torque-current characteristics.

A second type of rotor construction is the squirrel-cage rotor. This type of rotor has slots punched on its laminations. Bare copper bars are secured in the slots and connected at the ends with copper rings. The bars are often slightly skewed to reduce hum. The extreme simplicity and economy of this construction has made it the most common type of rotor.

Most small induction motors are powered from a single-phase source. A single-phase motor does not develop a rotating magnetic field, so it has no starting torque, but once started, it will continue to run. The method used for starting is another way to classify these motors.

Common types of small, single-phase induction motors—based on their method of starting—are: the

Motors *(Continued)*

split-phase; capacitor-start; permanent-split-capacitor; two-valve-capacitor; and the shaded-pole motor. Fig. 5 shows the schematics for these motors.

The Split-Phase Motor

This is a single phase induction motor with two windings on the stator connected in parallel. One winding, the auxiliary winding, is displaced nearly 90 electrical degrees from the other. (a 90° difference is ideal but not easily obtained or necessary) The auxiliary winding has a higher resistance-to-reactance-ratio than the main winding. This is obtained by using fewer turns of smaller size wire. Splitting the field windings in this manner produces the phase difference noted above and results in a rotating magnetic field. With the rotating magnetic field, all conditions necessary to produce a starting torque are present.

The auxiliary winding is used only to start the motor. When the motor approaches synchronous speed, the auxiliary winding is not needed as the motor will develop good running torque. An automatic centrifugal switch is built into the motor to disconnect the auxiliary winding from the circuit when a high enough speed has been reached.

Both standard and special purpose types of split-phase motors are built. The standard type is used for applications requiring frequent starts and long operating periods. Special purpose types are designed for high starting torques. Standard types have lower operating costs but higher initial costs. They are quieter operating than the special purpose types.

The split-phase motor is generally built for non-reversing service because the auxiliary winding must be connected to give direction to the rotor. This means that the motor would have to decelerate until the centrifugal switch closed. They can easily be built to reverse from the stop position, and special switching arrangements have been designed to allow connecting the auxiliary winding while the motor is running at full speed and thus permit reversing.

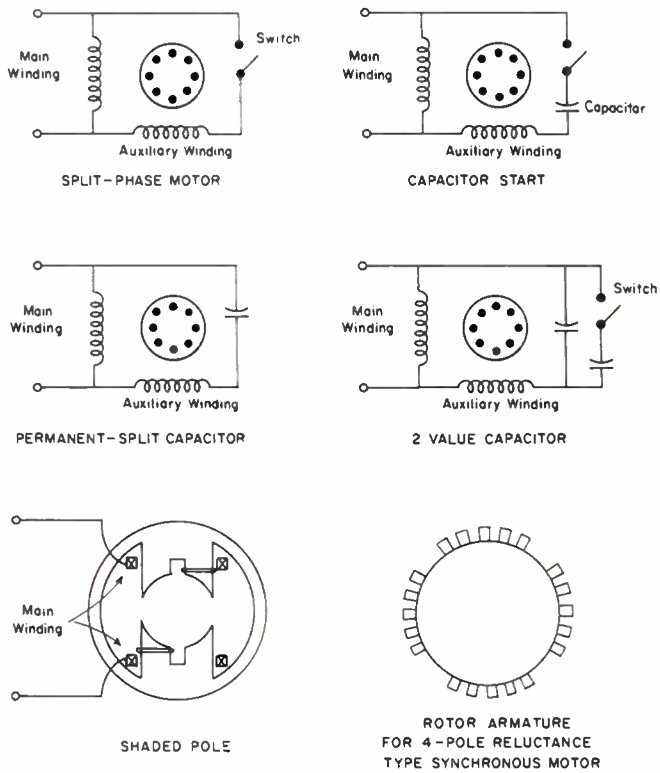


Fig. 5: Starting methods for single-phase fractional hp motors.

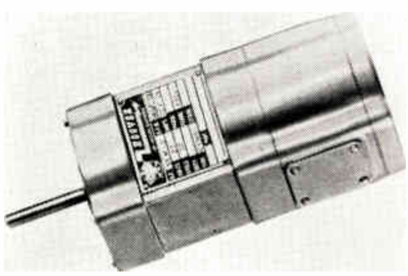


Fig. 6: Lightweight dc motor features 0.33 hp at 8400 rpm and 0.50 hp at 7700 rpm. It is a totally enclosed explosion-proof motor designed to Mil-M-8609 and Mil-E-5272A.

Courtesy of Hoover Electric Co.

Fig. 7: Universal motor, Model SMZ, develops ¼ hp, 27.5 v, 11a, 4500 rpm at 30 oz-in. Starting torque is 36 oz-in. It is 4 and ⅛ in. in dia. and about 4 and ¾ in. long.

Courtesy of Small Motors, Inc.

Figure 2 illustrates a split-phase motor built by the A. W. Haydon Co., Waterbury, Conn.

The Capacitor-Start Motor

The principle used to start this motor is the same as for the Split-Phase types, but the electrical displacement of the two stator windings is obtained by connecting a capacitor in the auxiliary winding. The phase difference using a capacitor can be made to approach 90° which makes the motor, essentially, two-phase.

Once the motor has been started, the capacitor is disconnected. A relatively inexpensive capacitor may be used, but precautions should be taken to insure that they are properly applied.

The running characteristics of capacitor-start motors are similar to those of the split-phase types but the starting torque is much higher than the starting torque of split-phase motors; the same restrictions apply as to reversing.

These motors are used where economy is wanted in a quiet operating motor with high starting and pull-in torque and low starting current.

The Permanent-Split-Capacitor Motor

Capacitor-start motors (See Fig. 11) can be simplified—and are less expensive—if the switches for disconnecting the capacitor at running speeds are eliminated. Leaving in the capacitor also improves the efficiency of the machine and makes it smoother and quieter running.

A more expensive capacitor must be used, however. The capacitor used is designed for good operation at normal running loads, and starting torque is reduced. The best features of both are combined in a motor which uses two capacitors, one for starting (which is then disconnected) and one for running speeds.

This motor is fairly quiet and it can be reversed while running provided it is connected to a low inertia load.

If two capacitors are used, the reversing and starting characteristics are similar to the capacitor-start motor, and the running characteristics are similar to the two-phase motor.

The Shaded-Pole Motor

This type of motor generally has salient poles[2]. One section of each pole is wound with a short-circuited turn called a shading coil. This winding is displaced magnetically from the main coil since the flux caused by the induced current in the shaded portion lags the flux generated by the main coils. The result is a rotating magnetic field—an imperfect rotating field but one sufficient to produce a starting torque. With the motor running, induced currents in the rotor maintain the field and running torque.

This type of motor is rather simple and is inexpensive to build but its efficiency is very low. They are generally not reversible and starting torque is low.

Synchronous Motors

These motors operate at a speed proportional to the frequency of the applied voltage. They are generally less efficient than induction-type motors. The two types of synchronous motor most often used in fractional-horsepower applications are the "reluctance" type and the hysteresis-type motor. (See Fig. 5).

The Reluctance Motor

Most fractional-horsepower induction motors can be made into synchronous reluctance motors. The motors are modified so that the reluctance of the magnetic circuit depends on the angular position of the rotor with respect to the stator coil axis. The rotor is built so that there are alternate high and low reluctance areas around the periphery of the motor. This, in effect, creates salient poles on the rotor. One way to do this is to remove some of the teeth and bars from a squirrel-cage rotor (leaving in the other bars and the end rings). Another way is to mill shallow grooves in the rotor.

The minimum value of reluctance is called the "direct-axis reluctance." The maximum value is called the "quadrature-axis reluctance." The applied excitation being ac, the flux in the air gap is alternating and the rotor will try to align itself in a position of minimum reluctance with respect to the flux wave.

The torque is developed only at synchronous speed, so the reluctance motors are not self-starting. This type of motor, however, is usually designed to start as an induction motor; when synchronous speed is

[2] In a salient pole machine, the poles are concentrated into confined arcs, and the windings are wrapped around these poles instead of being distributed in a series of slots around the machine.

Fig. 8: Breakdown torque for small single phase induction motors. NEMA standards.

Small power single phase induction motors shall be rated primarily on the basis of breakdown torque. The value of breakdown torque for the purpose of defining horsepower rating shall fall within the indicated range.

synchronous speed approx. full load, rpm	3600 3450	3000 2850	1800 1725	1500 1425	1200 1140	1000 950	900 850
brake hp rating	breakdown torque in ounce feet						
1/20	2.0–3.7	2.4–4.4	4.0–7.1	4.8–8.5	6.0–10.4	7.2–12.4	8.0–13.5
1/12	3.7–6.0	4.4–7.2	7.1–11.5	8.5–13.8	10.4–16.5	12.4–19.8	13.5–21.5
1/8	6.0–8.7	7.2–10.5	11.5–16.5	13.8–19.8	16.5–24.1	19.8–28.9	21.8–31.5
1/6	8.7–11.5	10.5–13.8	16.5–21.5	19.8–25.8	24.1–31.5	28.9–37.8	31.5–40.5
1/4	11.5–16.5	13.8–19.8	21.5–31.5	25.8–37.8	31.5–44.0	37.8–53.0	40.5–58.0
1/3	16.5–21.5	19.8–25.8	31.5–40.5	37.8–48.5	44.0–58.0	53.0–69.5	58.0–77.0
1/2	21.5–31.5	25.8–37.8	40.5–58.0	48.5–69.5	58.0–82.5	69.5–99.0	....
3/4	31.5–44.0	37.8–53.0	58.0–82.5	69.5–99.0	....	....	....
1	44.0–58.0	53.0–69.5	....	....	....	....	....

note: Breakdown torque range includes the higher figure, down to, but not including, the lower figure.

Courtesy of Westinghouse Electric Co.

Fig. 9: Effect of Variations in Voltage and Frequency: ac induction motors. NEMA standards.

This table shows the effect of variations of voltage and frequency when induction motors are operated under conditions different from their rated nameplate characteristics. Caution: These values are approximate and are not to be considered as guarantees.

	condition	speed synchronous	full load	percent slip	torque* starting & maximum running	current starting	current full load	full load efficiency	full load power service	temp. rise	momentary overload capacity	magnetic noise
voltage	110%	no change	slight increase	decrease 17%	increase 21%	increase 10%	decrease	slight increase	slight decrease	slight decrease	increase 21%	slight increase
voltage	90%	no change	slight decrease	increase 21%	decrease 19%	decrease 10%	increase	slight decrease	slight increase	slight increase	decrease 19%	slight decrease
frequency	105%	increase 5%	increase 5%	little change	slight decrease	slight decrease	slight increase	slight increase	slight increase	slight decrease	slight decrease	slight decrease
frequency	95%	decrease 5%	decrease 5%	little change	appreciable increase	slight increase	slight increase	slight increase	slight decrease	slight increase	slight increase	slight increase

*The starting and maximum running torque will vary as the square of the voltage. The speed will vary directly with the frequency.

Courtesy of Westinghouse Electric Co.

reached, the rotor poles will line up with the field and the motor will continue to run. Very small motors of this type can be started by spinning the shaft; at synchronous speed, the motor will "pull into step" and continue to run. The motor can stall if an excessive overload is applied which drops the speed much below synchronous speed.

Efficiency is low compared to similar type induction motors and they may tend to vibrate.

The Hysteresis Motor

The simplest type of hysteresis motor has a smooth cylindrical rotor made of a hard magnetic material. There are no windings on the rotor; poles are created by the hysteresis effect. The windings of the stator are distributed-type windings and are designed to produce a sinusoidal rotating flux field. Any of the previously discussed methods of obtaining a rotating flux field can be used.

The hysteresis effect in the rotor causes its magnetization to lag the inducing magnetomotive force wave. A relatively large hysteresis loss occurs with a corresponding torque to supply the loss.

One advantage of the hysteresis motor is that it develops consistant torque from starting to synchronous speed and can synchronize any load which it can accelerate. It is a quiet and smoothly operating motor but it is not very efficient and can handle only relatively light loads.

The motor can be designed for reversing service. It can reverse either from the stopped position or while rotating. The motors are quieter and smoother operating than the reluctance synchronous motors just described.

DC Motors

There are three general types of dc motors; the series-wound motor; the shunt-wound motor; and the compound-wound motor.

Advantages of dc motors include the wide range of load-voltage and load-speed characteristics which may be obtained and the ease with which dc motor speeds may be controlled. Quite often, ac is converted to dc so that a controllable dc motor may be used.

Fig. 11: Permanent-Split capacitor motor.

Courtesy of Bodine Electric Co.

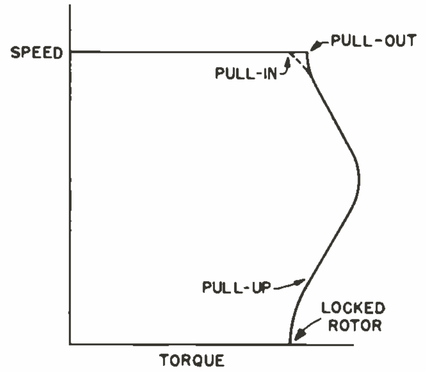


Fig. 10: Speed-torque curve of a synchronous induction motor.

Courtesy of Bodine Electric Co.

The Shunt-Wound Motor

In the shunt-wound motor, the rotating windings (usually the armature) and the stationary windings (usually the field) are connected in parallel.

These motors have fairly constant speeds which vary only slightly with a change in load (a small decrease in speed), and starting torque is moderate to high. The motors may be reversed either when rotating or when stopped by changing the input connections.

The speed of the motor can easily be controlled over a wide range. Either series or shunt resistors can be inserted in the armature circuit for speed control or a combination of series and shunt resistors may be used. Speed can also be controlled by inserting resistance in the field circuit but there is a limit to the speed variation because the armature current may become excessive.

The Series-Wound Motor

The field windings and the armature windings in this type of motor are connected in series. The starting torque is very high, starting current is medium, and there is a very large variation of speed with load (the lighter the load, the higher the speed).

The simplest way to control the speed is to insert a variable resistance in series with one of the leads. The no-load or light load speeds can be excessive and provisions should be made to control the motor under these conditions—a common practice is to use this type of motor in applications where the load is permanently connected to the motor.

Series wound motors can be built for reversing service, but the resulting motor is not as efficient as one built for rotation in one direction only.

Series motors can operate on ac or dc provided both stator and rotor cores are laminated but the speed and torque are greater when operated on dc. These "universal" motors are used where a light weight motor operating at very high speeds is wanted. The speed when used for ac service tends to be lower because of reactance-voltage drops in the field and the armature, but the difference can be minimized with compensating windings.

These motors are normally used for intermittent service applications because of the wear on the brushes and bearings at high speeds. They also tend to be rather noisy.

The Compound-Wound Motor

One of the windings in the compound-wound motor (usually the stator—or field winding) is in two sections. One of these section is connected in series with the armature and the other is connected in parallel with the armature.

The variation in speed with load depends on the relative strengths of the series and shunt fields. For example, if only a light shunt field is used, the motor characteristics are similar to a series-wound motor except that the shunt winding will limit the no-load speed to a controllable value.

These motors may be reversed by reversing the current through the armature. The reversing characteristics are better than those of a shunt wound motor.

Other Motors

In addition to the motors described in the preceding sections, wide use is made of special motors for special functions. Two of these are the "Servo Motor" and the "Torque Motor."

The Servo motor is a complete subject in itself, and space does not permit a detailed analysis of this motor. Basically, servo motors are characterized by their low rotor inertia, high speed response, and by having speeds proportional to the applied voltage.

Servo motors are usually two-phase induction motors. One phase is always energized, and when motion is required, a voltage is applied to the other phase (the control phase).

Torque motors (See Fig. 13) are used to supply torque either when stalled or turning at very low speeds. They are usually designed so that they may be stalled continuously. They can be designed for single-phase, poly-phase, or dc operation.

Standards

The horsepower rating alone of a fractional horsepower motor will generally not completely describe its capabilities. Other indications of a motor's performance are: breakdown torque; locked-rotor torque; starting current; and service factor. The user should consult the appropriate NEMA (National Electrical Manufacturer's Association) standard to determine the range of values for standard motors.

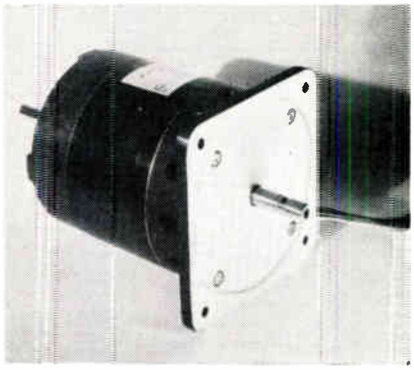


Fig. 13: Torque motor, model FBT-4520T, is used in reel take-ups in data recording equipment.

Courtesy of IMC Magnetics Corp.

Breakdown torque is the maximum torque a motor will develop without an abrupt decrease in speed. For different types of motors, NEMA divides breakdown torque into bands for the various horsepower ratings. Fig. 8 shows the adopted standards.

Locked-rotor torque (also called starting torque) is the torque developed by a motor at standstill. (See Fig. 10)

Service factor is a measure of the overload capabilities of the motor. The horsepower rating, multiplied by the service factor, determines the maximum continuous safe load of a motor. A factor which must be considered when operating a motor at overload conditions is the insulation life since the insulation is being subjected to higher operating temperatures.

Fig. 9, from Westinghouse Electric Co.'s, Brochure No. 2800, shows the effect on induction motors of variation in voltage and frequency from rated nameplate characteristics. (*Continued on following page*)

Fig. 12: Characteristic chart of fractional horsepower motors.

Courtesy of Bodine Electric Co.

CHARACTERISTIC CHART OF FRACTIONAL HORSEPOWER MOTORS

		Split Phase	Shunt or Compound	Series	Polyphase	Synchronous Split Phase	Synchronous Polyphase	Synchronous Capacitor	Shaded Pole	Series Governor	Capacitor	Capacitor Start
CURRENT SUPPLY	A.C.	X			X	X	X	X	X		X	X
	D.C.		X									
	A.C. or D.C.			X						X		
DUTY	Continuous	X	X		X	X	X	X	X		X	X
	Intermittent			X						X		
Unidirectional				X					X	X		
Reversible At Rest Only		X				X						X
Reversible At Rest or During Rotation			X		X		X	X			X	
SPEED	Constant Fixed	X			X	X	X	X	X		X	X
	Constant Adjust.		X							X		
	Variable			X								
STARTING TORQUE	Low							X	X		X	
	Normal	X	X			X						
	High			X	X		X			X		X
STARTING CURRENT	Low							X	X		X	X
	Normal	X	X		X	X	X					
	High			X						X		

Motor Enclosures

The environment in which the motor will operate will determine which type of enclosure is needed.

If the motor is to be operated in a fairly clean and dry atmosphere free from explosive particles or gases, an *open-type* motor will generally be sufficient. This type of motor can be *self-ventilated* by building a fan on the rotor shaft. Another type of open motor is the *drip-proof* motor. This motor is built so that moisture or dirt striking the motor at an angle not greater than 15° from the vertical will not enter the motor.

If the motor is operating in an atmosphere where dust or other foreign particles can enter the motor, a *totally-enclosed* motor should be used. In this type of motor, no air is exchanged between the inside and the outside of the case, but it is not so completely sealed as to call it airtight.

Splash-proof motors are built to prevent liquids or solid particles striking the motor at an angle not greater than 100° from the vertical from entering the motor.

If the motor is to be used where explosive gases are present, an *explosion-proof* machine (See Fig. 14) must be used. These motors are designed to prevent sparks, flashes, explosions, etc. within the motor from igniting the external gasses. The motor is also designed to withstand an explosion of the gas or dust inside of the motor.

If the motors are to be operated in hazardous locations, the National Electric Code Classification (Article 500, sections 5002 and 5006) requires special motor construction and Underwriters Laboratories approval. Explosive atmospheres are defined as follows:

Class 1, group A—Atmospheres containing acetylene

Class 1, group B—Atmospheres containing hydrogen or gases or vapors of equivalent hazard such as manufactured gas.

Class 1, group C—Atmospheres containing ethyl-ether vapor.

Class 1, group D—Atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors and natural gases.

Class 2, group E—Atmospheres containing metal dust such as magnesium, aluminum, etc.

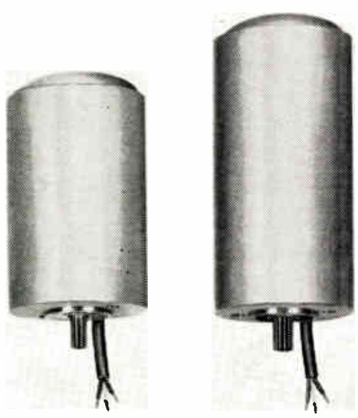


Fig. 14: The M-15 motor is explosion-proof. The 400 CPS motor conforms to MIL-M-7969A. Starting torque is 4.5 in-oz. For continuous or intermittent duty, ambient temperature is −65°F to +225°F.

Courtesy of General Controls Co.

Fig. 15: Capacitor-start motor. Shafts are treated for corrosion resistance. They can be supplied with 5/8" shaft dia. extension for special applications. Internal fan is used for ventilating the motor.

Courtesy of Emerson Electric Mfg. Co.

Class 2, group F—Atmospheres containing carbon black, coal or coke dust.

Class 2, group G—Atmospheres containing grain dust.

Class 3—locations which are hazardous because of the presence of easily ignitible fibers or flyers, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures.

The National Electrical Code further divides each of these three classes into two divisions—one of which covers the locations where the hazards exist continuously, intermittently or periodically under normal conditions, while the other covers the locations where the hazard is an abnormal condition. For complete information refer to article 500 of the "National Electrical Code."

Ordering the Motor

The motor manufacturer needs complete information on the motor's uses and working environment in order to supply the best motor for your job. He must know the load characteristics of the machine being driven so that he may match them closely with the characteristics of the motor. If full details are not provided a too large, or too expensive motor may be supplied. On the other hand, a less than adequate motor may be supplied which may fail under abnormal operating conditions.

Before ordering a motor, you should obtain answers to as many of the following questions as possible. (See Fig. 12)

1. What are the characteristics of the power supply? Is it ac or dc? If ac, what is the frequency and number of phases.
2. What power is required? What is the starting load, accelerating loads, normal running loads, overloads, reversing loads, etc.? Is overload protection required?
3. What is the end use of the motor: e.g.: fan drive, pump drive, instrument drive, timing motor, stepping motor, teleprinter, etc.?
4. What is the "duty cycle"—The duty cycle describes how long the motor is running, how long it is stopped.

Is the duty intermittent or continuous—does the motor reach steady state temperature conditions?

5. What speeds are required and what speed variations will be allowed? Is the speed constant or variable? If the speed must be variable, how must it vary

(Continued on page F39)

Since our last Reference Issue, the Precision Potentiometer Manufacturers Association has published a standard on Terms & Definitions. Here are the additions and revisions.

Potentiometers— Terms & Data

IN the June 1961 issue of *Electronic Industries*, we published an article entitled "Potentiometers —Terms & Data" by John Arnold. In his article, Mr. Arnold defined most of the terms which have since appeared in the Precision Potentiometer Manufacturers Association standard entitled "Precision Potentiometer Terms and Definitions."

In the interest of standardization within the industry, we have reviewed this document; here we present any items which have been added or revised. They have been kept within the same general headings as those in Mr. Arnold's article.

General Terms

Shaft— The mechanical input element of the potentiometer.

Shaft Position— An indication of the relative position of the wiper to a reference point.

Input and Output

Output Ratio—The ratio of the output voltage e to the total applied voltage E, Fig. 1.

Total Variable Output—The difference between the maximum and minimum output ratios, Fig. 2.

Resistance

Minimum Resistance— The resistance measured between the wiper terminal and any terminal with the shaft positioned to give a minimum value.

End Resistance—The resistance measured between the wiper terminal and an end terminal with the shaft positioned to give a minimum resistance value.

Rotation and Travel

Direction of Rotation—Shaft rotation is defined as clockwise (CW) or counterclockwise (CCW) when viewing the specified mounting end of the potentiometer. The designation of the terminals in the figure corresponds to the direction of the shaft rotation, and is shown for reference only, Fig. 3.

Direction of Translation— Shaft translation is defined as "extending" or "retracting" when viewing the specified end of the potentiometer. (Applies to translatory potentiometers only.)

End Point and Tap

End Voltage—The voltage between the wiper terminal and an end terminal when the shaft is positioned at the end point. It is usually expressed as a percentage of the total applied voltage.

Jump-off Voltage—The first measurable voltage change as the shaft moves the wiper from the overtravel region on to the actual electrical travel region. It is usually expressed as a percentage of the total applied voltage, Fig. 4.

Resolution

Travel Resolution—The maximum value of shaft travel in one direction per incremental voltage step in any specified portion of the resistance element.

Voltage Resolution—The maximum incremental change in output ratio with shaft travel in one direction in any specified portion of the resistance element, Fig. 5.

Conformity and Linearity

Function Characteristic—The relationship between the output ratio and the shaft position.

Mathematically

$$\frac{e}{E} = f(\theta)$$

(*Continued on following page*)

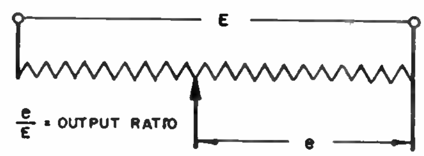


Fig. 1: Definition of the output ratio.

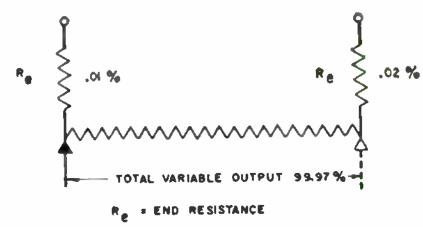
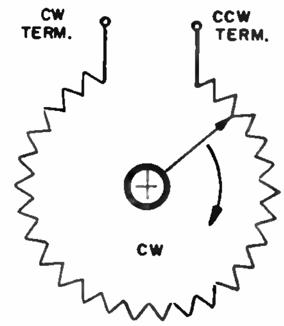


Fig. 2 (above): Illustrative voltage percentages for defining total variable output.

Fig. 3 (below): Direction of rotation is determined from this view of potentiometer.



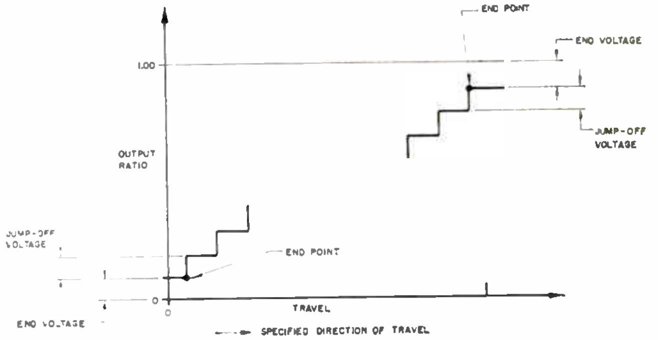


Fig. 4: Graphical presentation of the jump-off voltage.

Absolute Conformity—The maximum deviation expressed as a percent of the total applied voltage, of the actual function characteristic from a theoretical function characteristic extending between the specified output ratios which are separated by the theoretical electrical travel. An "index point" on the actual output is required, Fig. 6.

Mathematically

$$\frac{e}{E} = f\left(\frac{\theta}{\theta_T}\right) \pm C$$

$$0 \leq \theta \leq \theta_T$$

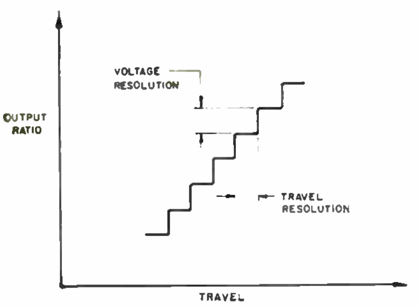


Fig. 5: Descriptive presentation of the definition of travel & voltage resolution.

Terminal Based Linearity—The maximum deviation, expressed as a percent of the total applied voltage, of the actual function characteristic from a straight reference line drawn through the specified minimum and maximum output voltage ratios which are separated by the actual electrical travel. Unless otherwise specified, minimum and maximum output ratios are respectively zero and 100% of total applied voltage, Fig. 7.

Mathematically

$$\frac{e}{E} = A\frac{\theta}{\theta_A} + B \pm C$$

where A is given slope

B is given intercept at $\theta = 0$

Unless otherwise specified

$A = 1$

$B = 0$

Tolerance Limits; Alternate Methods—There are three basic methods:

1. Constant Limits: Taken as a percentage of the total applied voltage.
2. Proportional Limits: Taken as a percentage of the theoretical output voltage ratio.
3. Modified Proportional Limits: Any combination of the first two methods.

All definitions in this document employ Method 1 for stating tolerance limits.

It should be noted that Proportional Limits may become impossibly restrictive in the vicinity of zero output, and should be modified in such cases to provide a practical tolerance in that region, Fig. 8.

Mechanical Characteristics

Backlash—The maximum difference in shaft position that occurs when the shaft is moved to the same actual output ratio point from opposite directions. Resolution effects must be excluded from this measurement, Fig. 9.

NOTE: The definitions within the asterisks apply to rotary potentiometers only.

* * * * * * *

Shaft Runout—The eccentricity of the shaft diameter with respect to the rotational axis of the shaft, expressed in inches, and measured at a specified distance from the mounting face when the body of the potentiometer is held and the shaft rotated while a specified load is applied radially to the shaft.

Lateral Runout—The perpendicularity of the mounting surface with respect to the rotational axis of the shaft, expressed in inches and measured on the mounting surface at a specified distance from the axis of rotation when the shaft is held and the body of the potentiometer is rotated while specified loads are applied radially and axially to the body of the pot.

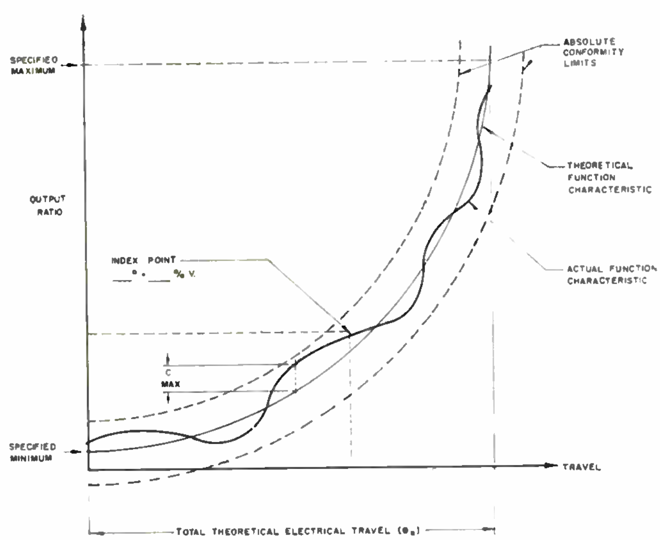
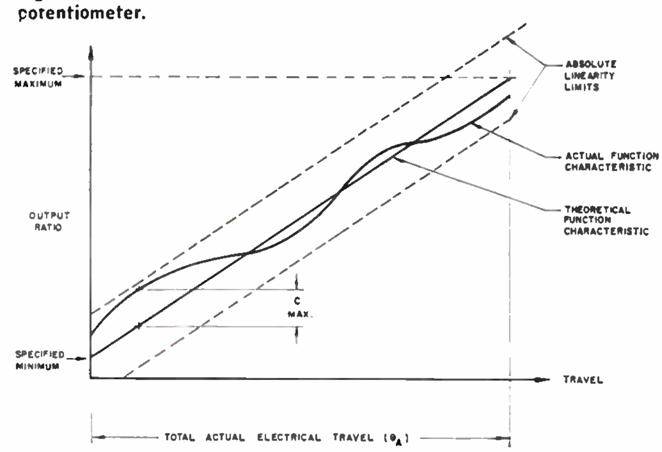


Fig. 6 (left): Parameters that one should know in determining absolute conformity.

Fig. 7 (below): Useful in determining terminal based linearity of a potentiometer.



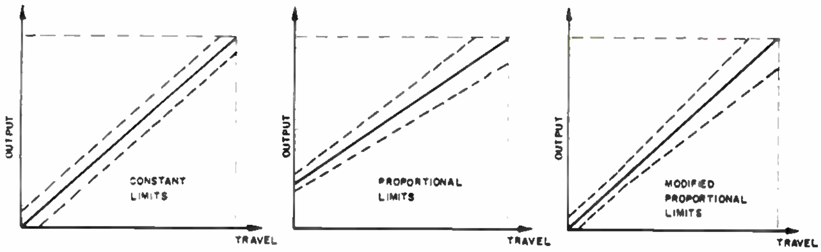


Fig. 8: The three basic methods of determining the tolerance limits of potentiometers.

Pilot Diameter Runout—The eccentricity of the pilot diameter with respect to the rotational axis of the shaft expressed in inches and measured on the piolt diameter when the shaft is held and the body of the potentiometer is rotated while a specified load is applied radially to the body of the pot.

Shaft Radial Play—The total radial excursion of the shaft, expressed in inches, and measured at a specified distance from the face of the unit, with a specified radial load applied alternately in opposite directions at a specified point.

Shaft End Play—The total axial excursion of the shaft, expressed in inches, and measured at the end of the shaft with a specified axial load applied alternately in opposite directions.

Starting Torque — The maximum moment in the clockwise and counterclockwise direction required to initiate shaft rotation anywhere in the total mechanical travel.

Running Torque — The maximum moment in the clockwise and counterclockwise direction required to sustain shaft rotation at a specified speed throughout the total mechanical travel.

Moment of Inertia—The mass moment of inertia of the rotating element of the potentiometer about its rotational axis. (Includes shaft and connected rotating members.)

* * * * * * *

Stop Strength.

Static Stop Strength—The maximum load that can be applied to the shaft at each stop without a permanent change of the stop position greater than specified.

Dynamic Stop Strength—The inertia load, at a specified shaft velocity and a specified number of impacts, that can be applied to the shaft at each stop without a permanent change of the stop position greater than specified.

Electrical Characterisitcs

Life—The life expectancy of a potentiometer is the number of shaft revolutions or translations obtainable under specific operating conditions and within specified allowable degradations of specific characteristics.

Temperature Cofficient of Resistance—The unit change in resistance per degree centigrade change from a reference temperature, and expressed in parts per million per degree centigrade as follows:

$$T.C. = \frac{R_2 - R_1}{R_1\,(T_2 - T_1)} \times 10^6$$

where,

R_1 = Resistance at reference temperature in ohms.

R_2 = Resistance at test temperature in ohms.

T_1 = Reference temperature in degrees centigrade.

T_2 = Test temperature in degrees centigrade.

Dielectric Strength — Ability to withstand a specified potential of a given characteristic between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang under prescribed conditions without exceeding a specified leakage current value.

Insulation Resistance—The resistance to a specified impressed dc voltage between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang under prescribed conditions.

Voltage Short—A segment of the resistance element over which the output ratio remains constant within specified limits as the wiper traverses the segment.

Resistance Short — A segment of the resistance element over which the resistance between the wiper and a specified terminal remains constant within specified limits as the wiper traverses the segment.

A. C. Characteristics

Total Input Impedance—The impedance between the two input terminals with open circuit between output terminals, and measured at a specified voltage and frequency with the shaft positioned to give a maximum value, Fig. 10.

Output Impedance—Maximum impedance between slider and either end terminal with the input shorted, and measured at a specified voltage and frequency, Fig. 11.

Phase Shift—The maximum phase difference measured in degrees between the sinusoidal input and output voltages measured at a specified input voltage and frequency.

Quadrature Voltage — The maximum value of that portion of the output voltage which is ±90° out of time phase with the input voltage, expressed as volts per volt applied, measured at a specified input voltage and frequency.

* * *

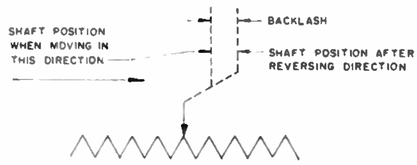


Fig. 9: Here's how to determine backlash.

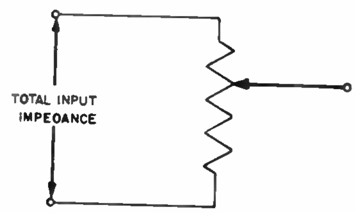
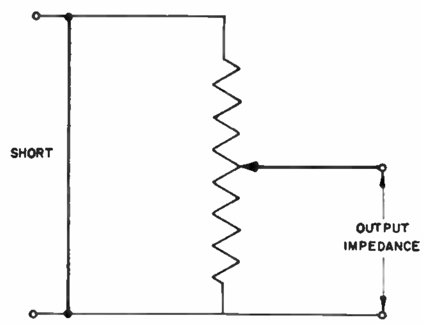


Fig. 10 (above): To determine total input impedance, measurements must be made at a specified voltage and proper frequency.

Fig. 11 (below): Here's how to determine the output impedance of potentiometers.



Relay contacts which begin to show failures after a few thousand operations could give millions of operations with proper protection. With arcing adequately suppressed, contact erosion is limited to mechanical wear and current effects.

For Relay Circuits . . .

How To Suppress The Arc

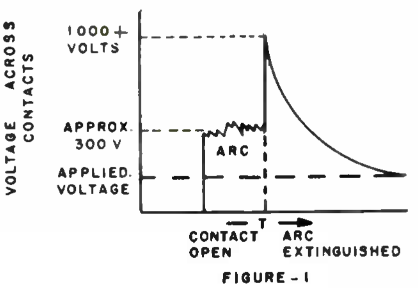


Fig. 1: Induced voltage may cause arcing as the contacts of the relay are opening.

ALL electrical circuits in which direct current flows are subject to an electrical inertia due to the inductance in the elements, wiring, etc. Just as mechanical inertia tends to maintain constant motion, inductance tends to maintain a constant current flow in the circuit. An instantaneous change in mechanical motion requires an infinite force, similarly an instantaneous change in inductive current is associated with an infinite voltage. Yet we normally expect a relay to instantly interrupt a current flow for millions of reliable operations.

Mathematically, the energy stored in an inductive field is $Li^2/2$ where L is the inductance of the circuit and i is the steady state current. When the circuit is suddenly opened, this energy must be dissipated in the arc energy, circuit resistance, and eddy currents.

The contacts separating slightly attempt to instantly reduce the current to zero. The resulting induced voltage may exceed the breakdown voltage of the small air gap (approx. 300 volts) and an arc forms. Whether one attributes the resulting arc to the induced voltage, electrical "inertia" or energy dissipation, the results are the same. As the contacts continue to part, the arc becomes unstable and is extinguished. As the arc extinguishes, the current ceases abruptly and a voltage spike appears across the contacts. The arc heats and burns the contacts and the resulting voltage spike causes further damage by transferring molten material between the contact faces. With proper arc suppression, this damage can be virtually eliminated and the contact life extended by many times.

To eliminate arcing, some device or component must be provided which either: 1. Provides a temporary path in parallel with the opening contacts which will allow a gradual decay of current rather than an instantaneous interruption; or 2. Provides a path and source for accepting the energy stored in the inductive field. Regardless of which concept is considered, the effect is to provide a slower decay of inductive current. The induced voltage is directly dependent on the rate of change of current and corresponding magnetic flux. This implies that the decay of the magnetic flux is impeded; and, it follows that arc suppression tends to slow the release of a relay across whose coil it appears. (One exception is a capacitor of optimum value which may actually speed the release.)

An accurate analysis of arcs and arc suppression is quite complex due to such variables as contact material, opening speed, surface contamination, load inductance, and other factors. Several simple methods are commonly used, not all of which result in the desired effect.

Capacitor Protection

If a capacitor is connected across a contact, Fig. 2, the voltage across the capacitor will be zero and the change will be zero while the contact is closed. When the contact first opens, the capacitor provides a momentary path to maintain the current flow and prevents the high voltage from appearing across the

Abstracted from material published by North Electric Co., Electronics Div., Galion, Ohio.

opening contact. As the capacitor charges, the voltage increases and the contact gap widens. If the capacitor is the proper value the voltage will never reach the breakdown voltage of the open contacts and no arcing will occur. This is excellent protection on contact opening. However, when the contact recloses, the charged capacitor is short circuited through the contacts and may cause excessive erosion or even contact welding.

If the capacitor is connected across the load, Fig. 3, a reverse situation occurs. With the contact closed, the voltage on the capacitor is equal to the load voltage and it is fully charged. As the contact begins to open the capacitor discharges through the load and maintains a momentary current flow and a gradual decay of current through the load. If the capacitor is the right size, the current decay will be such a rate that the induced voltage will be low enough to prevent arcing. When the contact recloses, however, a large charging current will surge through the contact and may cause welding. For these reasons, a single capacitor is not adequate protection except in rare circuits where current on contact closure can be carefully limited to a value within the contact rating. There is also the possibility that the capacitor may short, causing complete circuit failure.

Resistor-Capacitor

Adding a resistor in the arc suppression circuit, Fig. 4, limits the current surge on contact closure to a maximum value of E/R. By proper choice of R, the surge current may be kept within the contact rating. This resistance also limits the effectiveness of the capacitor on contact opening; and, therefore, should be kept as low as possible. For any given set of circuit conditions, there is an optimum R-C arc suppressor which gives maximum protection and longest contact life. This is the most popular form of arc suppression and R-C units are available in various popular values.

Resistor-Diode-Capacitor

A further modification of the above method is possible where severe arcing occurs or where the ultimate insuppression is required. This involves the addition of a diode, Fig. 5. The diode serves as a "gate" which essentially switches in the resistor to limit the surge on contact closure and eliminate the series resistance on contact opening. By proper selection of the R-D-C elements, an almost perfect arc suppression circuit is possible. This method is also very effective in eliminating switching transients in solid state circuitry or where noise radiation is a problem. R-D-C units are available as packaged units.

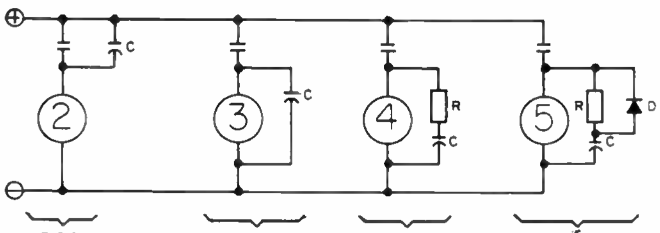


FIG.2 FIG.3 FIG.4 FIG.5

Figs. 2 to 8: The various techniques that can be used to suppress or eliminate the arcing when contacts are opening.

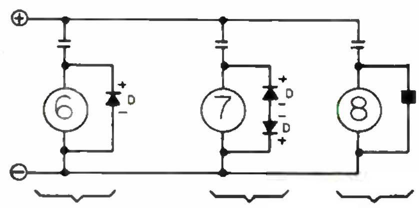


FIG.6 FIG.7 FIG.8

Rectifier Suppressors

Arc suppression by use of a single diode alone is possible in some instances, Fig. 6. While the contact is closed, only the reverse leakage current flows through the diode. When the contact opens, however, the direction of current reverses and the load is shunted by the low forward resistance of the diode. The load current therefore decays slowly and the induced voltage is small. However, unlike the R-C or R-D-C methods, there is no capacitor to limit the time during which current can flow. Not only is the initial rate of current decay reduced but the length of time current flows is materially increased. This effect will significantly increase the release time of the load relay; and, in fact, is often used for that purpose.

Back-to-Back Diodes

Back-to-back diode units are often used as arc suppressors, Fig. 7. One of the diodes is used to block the current flow when the contact is closed; the other provides a nonlinear discharge path when the contact opens. When the contact first opens, the voltage rises sharply and the back resistance is reasonably low, increasing rapidly as the current decays. This has the "limiting" effect which causes a rapid current decay and does not affect release time significantly. However, the reverse resistance of the diode is appreciable and these units do not afford the degree of protection obtainable with other methods. These units are also quite dependent upon the current and voltage conditions and should not be used as general purpose contact protectors.

Non-Linear Resistors

A form of contact protection which is gaining in popularity, due primarily to its small size, is the non-linear resistor, Fig. 8. They have approximately the same effect as the back-to-back diodes, are less expensive, and smaller in size. These units must also be carefully selected for circuit voltage. Due to their small size and low cost, many manufacturers are including these units across the coils of relays, stepping switches, and other electro-mechanical devices.

Summary

Where long life and reliable switching in dc inductive circuits are important, contact protection or arc suppression is mandatory. Most of the unreliability attributed to relays and most contact failure "data" are based upon circuit design where contact protection was nonexistent or improperly chosen.

IRVING M. GOTTLIEB
Consultant
931 Olive
Menlo Park, Calif.

Transistor circuits are often used to actuate dc electromagnetic relays. The occurrence of residual current in these circuits presents a problem. A relay circuit is given which minimizes this current.

In Transistor Relay Circuits . . .

Minimizing Residual Current

SINGLE stage transistor circuits combining the functions of power amplification and switching are often used to actuate dc electromagnetic relays. This enables the use of cheaper and less-delicate relays than would result from direct energization of the relay solenoid. The two most common configurations, the common emitter and the common collector circuits, are shown in Fig. 1.

Reliability

Reliability of these circuits is enhanced by low residual solenoid current when the transistor is in its "OFF" or non-conducting state. Otherwise, the relay armature may open sluggishly, or may even fail to operate. Unfortunately, collector cut-off current is relatively high in germanium transistors connected as dc common emitter or common collector amplifiers. This is seen when such amplifiers are used as switches by depriving the emitter-base diode of forward bias. In such circuits the collector cut-off current increases rapidly at greater than room temperatures. There is generally considerable variation from transistor to transistor. Thus, tampering with the spring tension of the relay armature would probably prove an unreliable compensation technique when production runs are involved. The economy of germanium transistors and the temperature stability of silicon transistors are required. Also required are the low collector cut-off current of the common emitter and common collector circuits. Even though these appear to be conflicting features, a good approach to their overall attainment is possible.

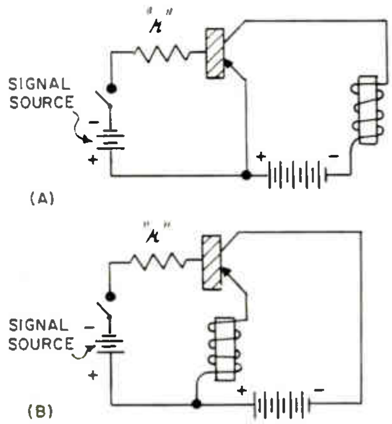


Fig. 1. Common emitter (a) and common collector (b) transistor relay circuits are shown.

Circuit Comparisons

The reason for the difference in collector cut-off current in a given transistor when it is connected in the common base circuit, and when it is connected in either the common emitter, or the common collector circuit, is to be recalled. In Fig. 2 a pnp transistor is provided with properly polarized collector-emitter bias. No connection is made to the base lead. The current meter indicates a high reading compared to the situation shown in Fig. 3. Here the same bias is now connected from collector to base instead of from collector to emitter. Due to the construction of the transistor, an important difference exists in the two situations. In Fig. 3, the emitter region is not involved in the circuit and, for practical purposes, does not contribute to the current. However, in Fig. 2, the base region, even though not connected to any external source, is in the path of the current loop. Due to thermally generated charge carriers, the depletion layer separating base and collector regions allows the flow of a small leakage current. In Fig. 2, the flow of this small current from emitter to base constitutes forward bias in the emitter-base diode. This causes charge injection from emitter to base, and normal transistor action ensues. Thus, the small base-collector leakage current is amplified by the current gain factor (B) of the transistor. It should be clear that this occurs because the transistor provides its own base signal, or bias. This being true, it appears possible to cause cut-off current in the common emitter circuit to be no more than in the common base circuit. That is, providing the effect of the internally produced base-emitter bias could be negated.

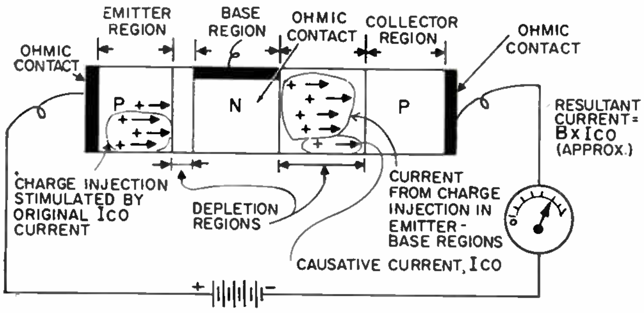


Fig. 2. Collector-emitter polarization of a pnp transistor as in common emitter and common collector circuits. No connection is made to the base lead.

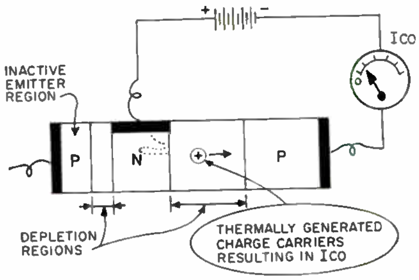


Fig. 3. Collector-base polarization of a pnp transistor as in a common-base circuit.

Minimizing Circuit

The effect of the internally produced base-emitter bias is negated in a simple and practical way. A relay circuit incorporating a technique for overcoming internally developed base-emitter bias is shown in Fig. 4. Reverse bias is applied to the base-emitter diode. Although an additional voltage source is required, it is significant that consumption of dc power by the non-conduction transistor is actually much less than without such back-biasing. The value of "R" is much greater than the dc input impedance of the transistor so that there is negligible degradation of sensitivity. With a type 2N441 germanium power transistor, a 2000 ohm value for "R" and a 1½ v. dry cell cause a reduction in collector cut-off current. Reduction is by a factor of 10 to 30 up to an ambient temperature of about 75°C. Improvement obtained will depend upon transistor leakage and current gain, as well as the ultimate temperature expected. In this example, "R" could be increased to 5000 ohms if improvement was only desired for moderate excess of room temperature, say about 10°C. In this case, current drain from the 1½ v. source would be about ⅓ ma. when the transistor was in its "ON" state from the application of external bias. It would be less when the transistor was in its "OFF" state.

Resistance "r"

Resistance "r" represents the internal resistance of the signal source plus whatever current limiting resistance might be added. "r" is low enough to permit the transistor to be driven hard enough to properly energize the relay solenoid. This may or may not imply saturation of the transistor. Aside from these considerations "r" is not critical and does not enter directly into discussion of the reverse bias technique.

Resistance "R"

Although batteries are shown in the circuits, operation from ac power supplies involve no difficulty. The current demand from the reverse bias supply is so small that little additional expense results. In many cases it is not necessary to replace the power transformer with one having an additional winding. There is frequently enough window space between transformer coils and core legs to permit the addition of several turns of wire. This makes it easy to provide an additional source of ac for subsequent rectification and filtering. The voltage is not critical—the higher it is, the higher will be the value of resistance "R". Voltages between one and ten are practical. Due to the low current demand, half-wave rectification in conjunction with several microfarads of filtering is satisfactory. The value of "R" is best determined empirically. A value is readily found below which the residual collector current is not reduced. If "R" is then chosen to be about one-half of this value, enough safety margin will exist to maintain the low current despite considerable temperature rise.

Applications

Although emitter-base reverse bias is advocated for relay circuits, it is possible that this technique may find application in computer, digital, or other switching circuitry wherein a closer approach to the ideal "OFF" state is desirable.

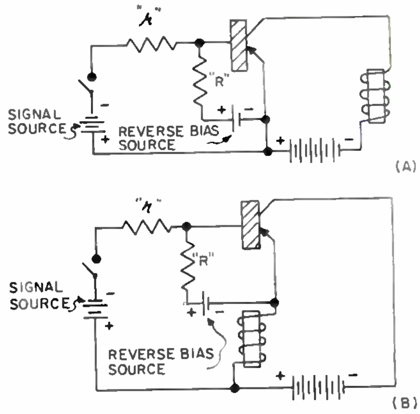
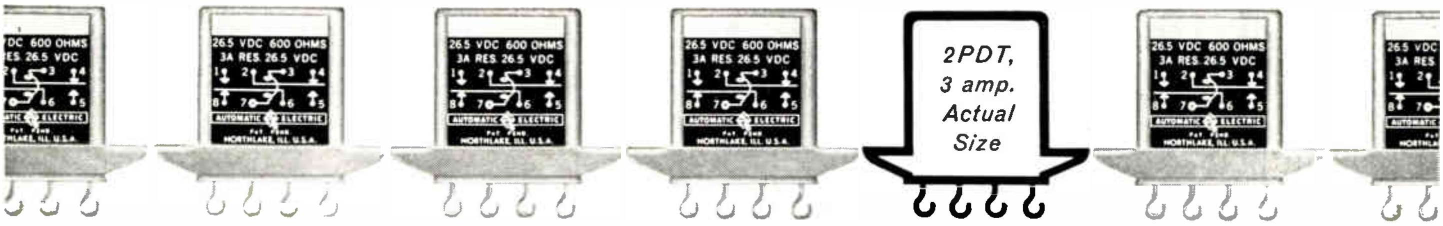


Fig. 4. Common emitter (a) and common collector (b) relay circuits with reverse bias to keep residual solenoid current low when transistor is in the "off" state.



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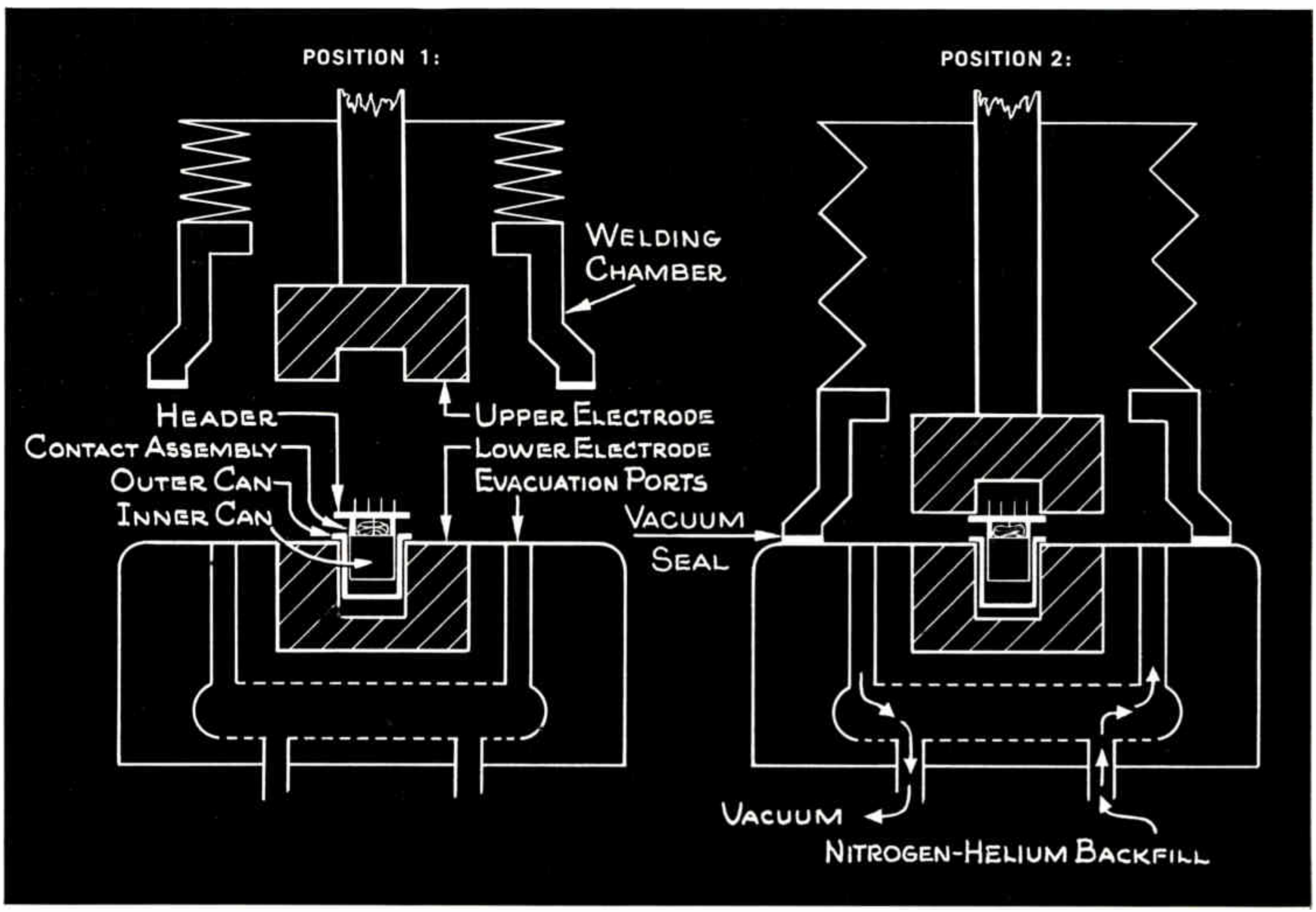

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One reason for this extreme reliability is found in AE's exclusive sealing method, graphically illustrated below. Note that no sealing hole or evacuation tube is used. After evacuation and backfilling of the welding chamber (including the relay), the outer can is resistance-welded to the relay and header assembly.

The final sealing operation is performed in a dry box containing the sealing chamber and the welding electrodes. A pure and dry nitrogen atmosphere is maintained in the dry box and all operations are performed through glove ports.

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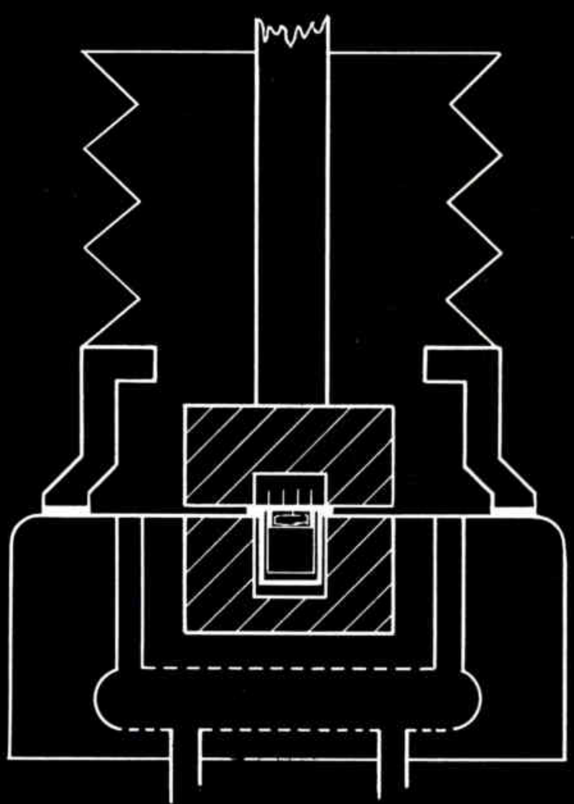

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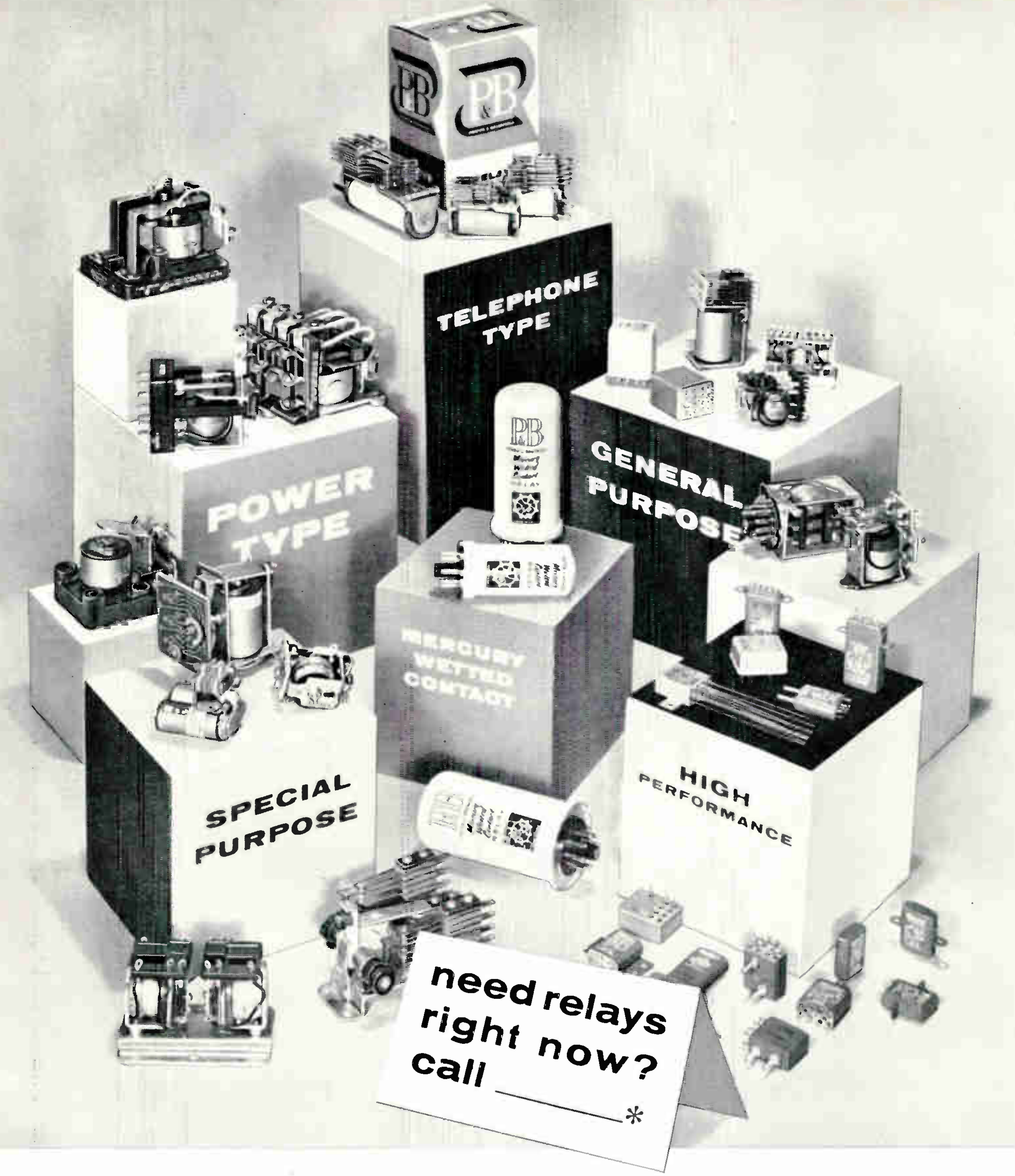
POSITION 3: Upper electrode descends, pressing relay completely into outer can and then completes the weld. Welder then reverts to Position 1 and completed relay is ejected.



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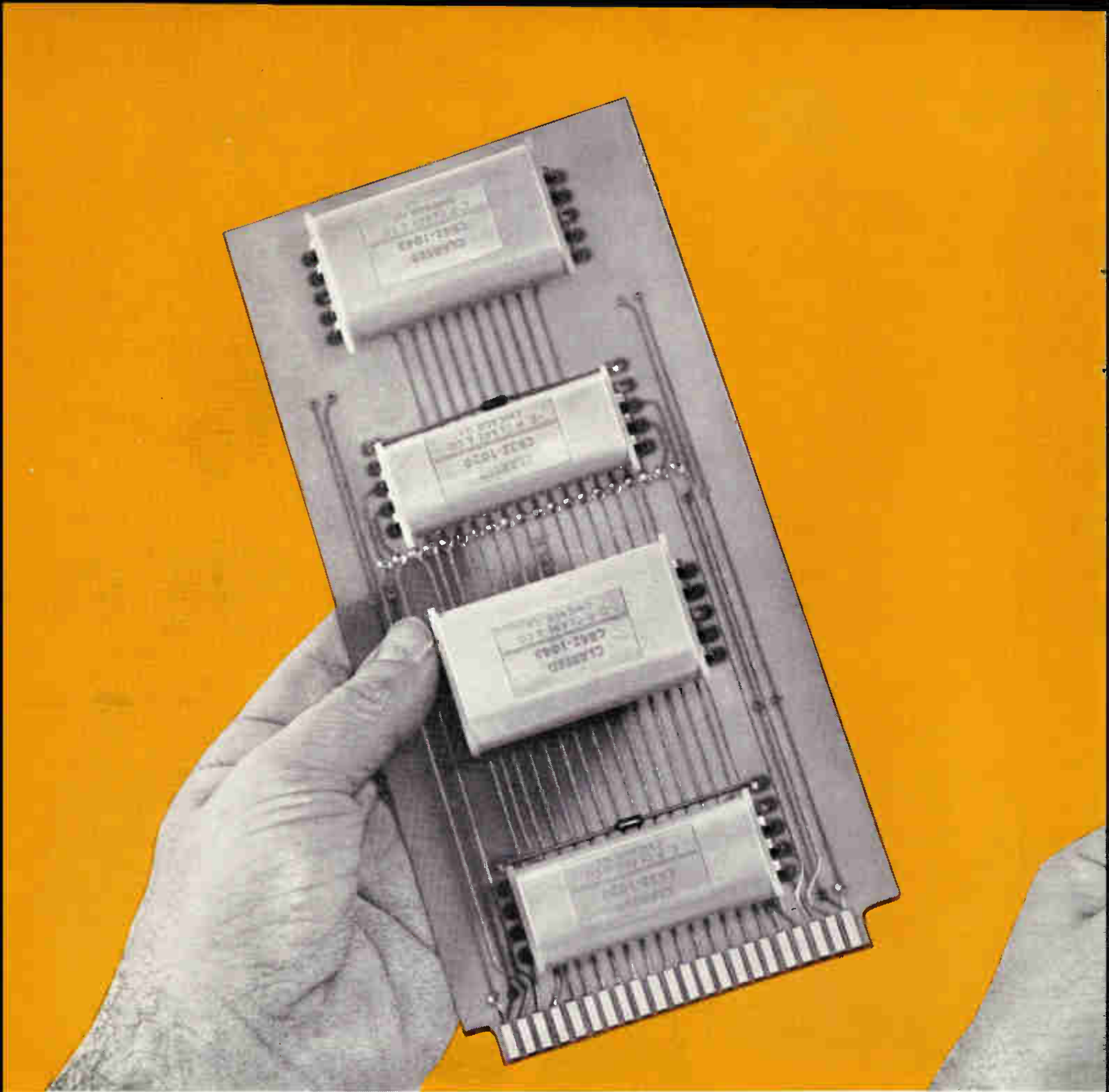

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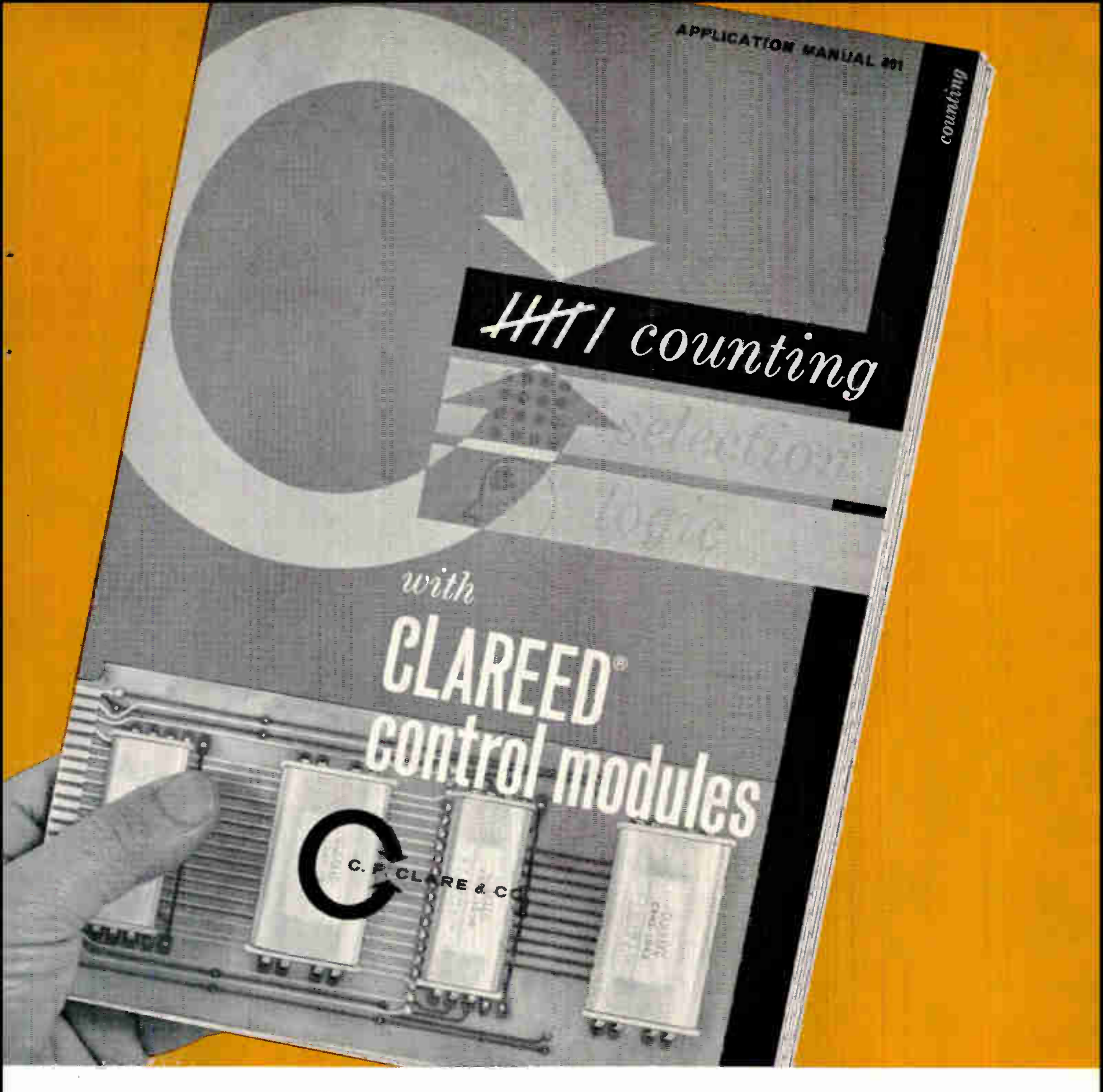

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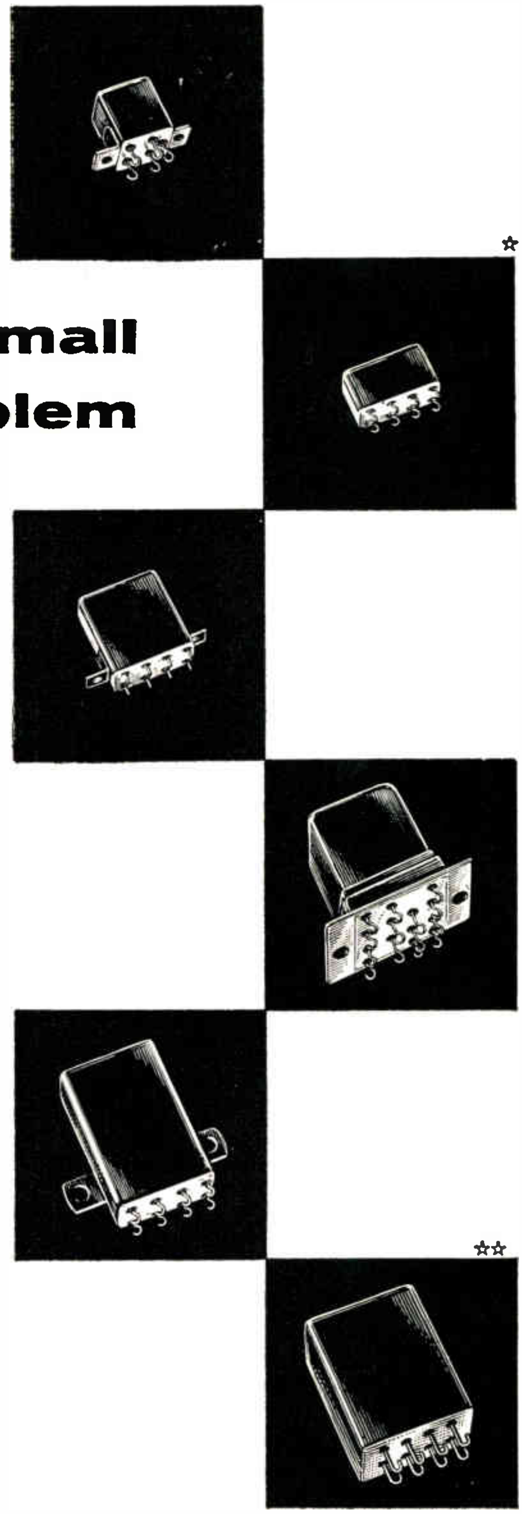

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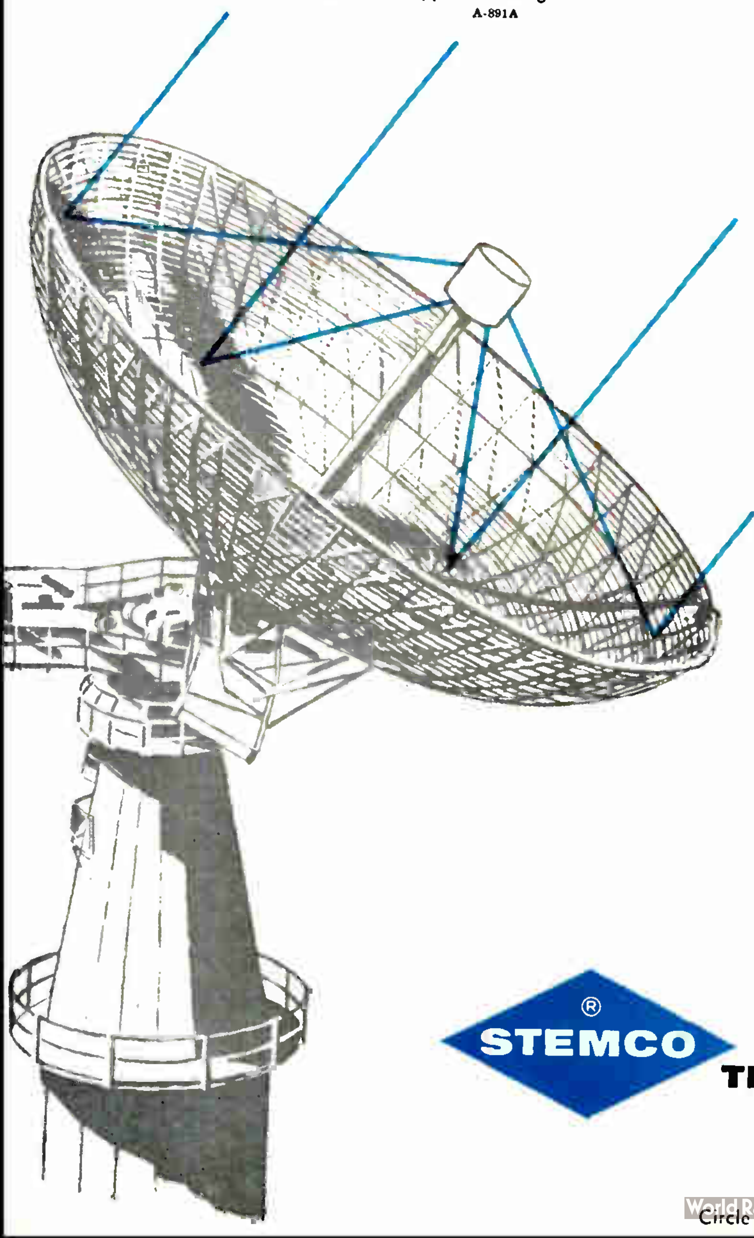

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TYPE MX semi-enclosed. Construction and rating similar to MX hermetically sealed type. Bulletin 6100.

TYPE M hermetically sealed. Bimetal disc type, snap acting thermostats. Also available in semi-enclosed. Operation from -20 to 300°F. Lower and higher temperatures available on special order. Depending on application, rated non-inductive 10 amps, 120 VAC; 3 amps, 28 VDC. Various terminals, wire leads and brackets available. Bulletin 6000.

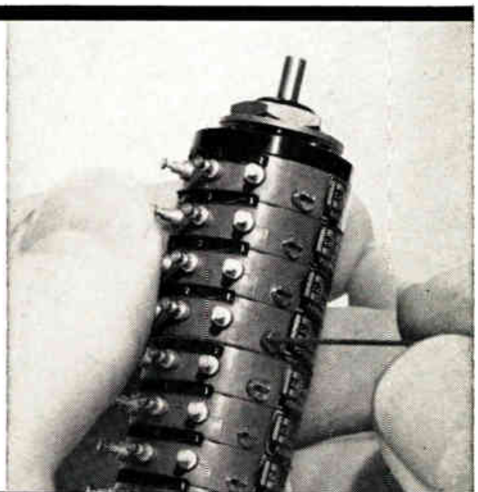
TYPE C hermetically sealed. Also semi-enclosed styles. Small, positive acting with electrically independent bimetal strip for operation from -10 to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

STEMCO® THERMOSTATS

STEVENS manufacturing company, inc.
P.O. Box 1007, Mansfield, Ohio

Circle 150 on Inquiry Card

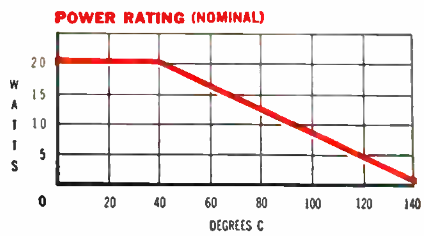
DAYSTROM ROTARY POTENTIOMETERS



GANG 24 CUPS IN 6 INCHES: ADJUST IN SECONDS AFTER GANGING!

ACTUAL SIZE
MODEL 319

The Daystrom 319 Series gangable potentiometer offers a unique advantage never before possible . . . Twenty-four of these can be ganged in a space of six inches, then individually phased *after* ganging, with no interference to adjacent cups* . . . The result is finite adjustment in a matter of seconds . . . Many hours and dollars can be saved through this feature; you can order the potentiometers already ganged at Daystrom in the number needed, then make final phasing in your circuit . . . The Daystrom 319 Series is ideal for multi-channel applications where space and weight are critical, and offers exceptional stability to shock, vibration, and other severe environmental influences . . . Resistance winding is unique Daystrom "wire-in-the-groove" method . . . Resistance ranges from 100 ohms to 200K are available; power is 2 watts *in still air* at 40°C; operating temperature –55°C to + 150°C; meets or exceeds all applicable MIL specs.

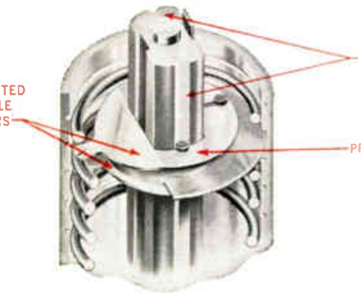


**Patents pending on adjustment method.*

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

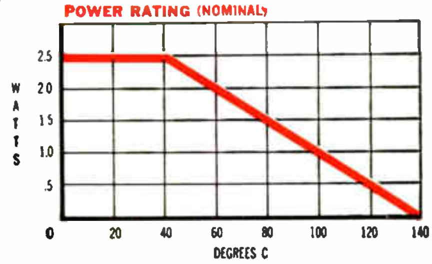
DAYSTROM
ROTARY POTENTIOMETERS

SUBMINIATURE MULTI-TURN WITH RELIABILITY OF LARGE MODELS:



ACTUAL SIZE
MODEL 341

The Daystrom 341 Series offers the unusual benefit of a high-resolution ten-turn potentiometer in a 1″x½″ package . . . Much smaller than conventional multi-turns . . . Patented V-Guide within the potentiometer eliminates backlash and resultant error . . . Patented double-wiper arrangement virtually eliminates intermittents due to shock and vibration, and effectively provides finer resolution . . . Patented precision "wire-in-the-groove" method of winding the resistance element still further assures stability to environmental stress . . . Coupled with subminiature size, these features make the 341 Series ideal for avionics systems (ASW, ballistic, and instrumentation) . . . Resistance ranges of 341 Series are from 1K to 600K; power dissipation is 2.5 watts at 40°C *in still air* . . . Meets all applicable MIL specs . . . Can be supplied with patented clutch for servo installation.



DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

Circle 151 on Inquiry Card

VARIABLE RESISTORS

Complete Line. Whatever you need, CTS has it or can make it to your Exact Requirement.

CTS' world-wide sales organization will help solve your variable resistor problems.



	DIAMETER	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	
COMPOSITION VARIABLE RESISTORS					
COMMERCIAL	15/16"	1/4-1	200Ω—10 megs	45	
	15/16"	1/4	250Ω—15 megs	Q	
	3/4"	2/10-3/10	250Ω—5 megs	70	
	5/8"	2/10-1/4	250Ω—2.5 megs	200	
	9/32"	1/10	500Ω—10 megs	M250	
	2 & 3 section side by side	1/4-1/3	250Ω—10 megs	X52	
				X53	
				U52	*Carbon-ceramic
	2 & 3 section side by side	1/4	500Ω—10 megs	X152*	
				X153*	MIL-R-94B
	2"	2	5KΩ—50 megs	HVC	
MILITARY	1-1/8"	2	100Ω—10 megs	96	RV4
	1-1/8"	2	100Ω—10 megs	95	
	15/16"	1	100Ω—5 megs	90	RV2
	15/16"	1/4	100Ω—15 megs	45	
	3/4"	1/2	100Ω—2.5 megs	65	RV5
	1/2"	3/4	100Ω—2.5 megs	300*	RV6
WIREWOUND VARIABLE RESISTORS					*Carbon-ceramic
COMMERCIAL	1-17/32"	4	3Ω—25K	25	
	1-17/64"	2	3Ω—15K	252	
	1-1/4"	2	1Ω—50K	2W	MIL-R-19
	3/4"	1-1/2 to 3	1/2Ω—5K	110	
MILITARY	1-17/32"	4	3Ω—25K	25	RA30
	1-17/64"	2	3Ω—15K	252	RA20
	1-1/4"	2	3Ω—15K	WP	RA20
CERMET VARIABLE RESISTORS					*Request Data Sheet*
(with Space Age High Stability 500°C Metal-Ceramic Element)	1-3/64"	3	100Ω—2.5 megs	400†	179
	3/4"	1-1/2	100Ω—2.5 megs	500†	180
	1/2"	3/4	100Ω—5 megs	600	175

†Semi-precision


	DIMENSIONS	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	*Request Data Sheet*
COMPOSITION TRIMMER RESISTORS					
COMMERCIAL	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	7/16x5/16x1/2	1/8	250Ω—2.5 megs	220	184
MILITARY	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	.344 Dia. x .240	1/10	250Ω—2.5 megs	380*	
CERMET TRIMMER RESISTORS					
	1/2x1/2x.260	1	100Ω—1 meg	170	178
	1-1/4x.295x.335	1	100Ω—1 meg	180	177

*Carbon-ceramic

Only P.C. sizes are shown. Lead sizes are smaller.


CERMET FIXED RESISTORS

CERAFER—Cermet resistance element. Wafers for micromodule systems. Low cost resistor and conductor layouts for printed circuitry on ceramic. 5Ω-300K per square. Request Data Sheet 181.

CERADOT—Solid cermet, .050" dia. x .030" long or as required, 1/10 watt, 50Ω-100K, with or without leads. Request Data Sheet 185.

HIGH QUALITY LOUDSPEAKERS

Complete Line

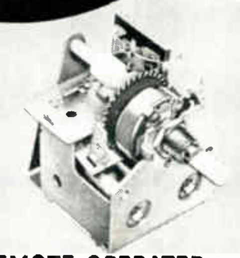
From 3" tweeter...through all-purpose round and elliptical . . . to 15" woofer. Precision workmanship produces the closest tolerances between moving coil and magnet. Modern facilities. Request Data sheet P-101 from CTS of Paducah, Inc., Paducah, Ky.

CTS®

SELECTOR SWITCHES

NON-DRIFT, COMPACT

1-1/8" dia., 2 to 12 positions, rotary wafer switches for commercial and military applications. Unprecedented switch uniformity from entirely new automated manufacturing concept. Request Data Sheet 182.




REMOTE OPERATED VARIABLE RESISTORS & SWITCHES

Variable resistors with continuous motor drive or electromagnetic step drive. Also available with attached on-off switch.

Founded 1896

CTS CORPORATION
Elkhart, Indiana

DATA SHEET REQUESTS HONORED PROMPTLY. ASK BY NUMBER

Factories coast-to-coast for your convenience: Elkhart & Berne, Indiana; South Pasadena, California; Asheville, North Carolina; Paducah, Kentucky and Streetsville, Ontario, Canada.

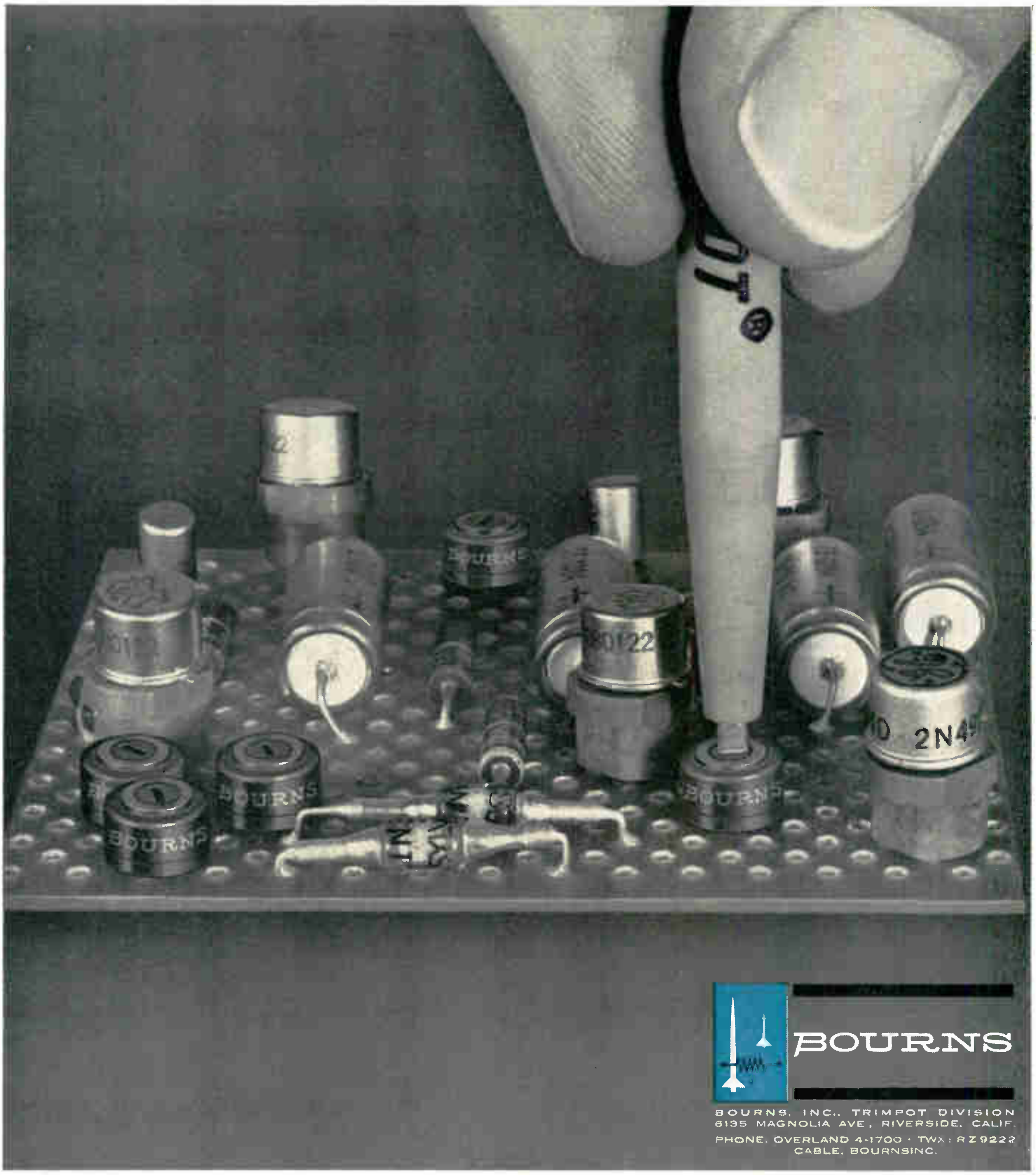
Presenting Bourns Trimpot® Model 3300 — The Only Potentiometer with All These Features:

NUMBER 20—NEW PRODUCT SERIES

(1) Smaller-than-transistor size—just 5/16" dia. x 3/16".
(2) Resistance from 50Ω to 20K.
(3) Full compliance to MIL Specs for cycling humidity, sand, dust, salt spray, fungus (meets MIL-STD-202, MIL-E-5272).
(4) Positive end stops.
(5) Precious-metal contacts.
(6) Sealed lightweight plastic case (no shorts to the board).
(7) Industry-standard pin arrangement.
(8) Exclusive Silverweld® multi-wire termination (virtually indestructible under thermal or mechanical stress).

The single-turn, 0.5 watt Model 3300 is as tough as it is tiny. It stands up to 175°C heat, 30G vibration and 100G shock. Its quality is checked by 100% inspection and double-checked by the rigid Bourns Reliability Assurance Program. In every unit, the performance you specify is the performance you get.

Production quantities available immediately with either printed circuit pins or solder lugs and bushing mount. Write for complete data.



BOURNS

BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PHONE. OVERLAND 4-1700 · TWX: RZ 9222
CABLE. BOURNSINC.

Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

Circle 153 on Inquiry Card

"Mr. Oak" on the move... your switching "right arm"!

"Mr. Oak" serving you in person: Our switch-engineering specialists tour the entire country on a regular basis. Provide on-the-spot assistance to help unravel tricky switching problems. Area by area, they conduct symposiums . . . bring examples of Oak products for close-up study by designers . . . help solve your new switching problems.

For many of you, "Mr. Oak" already has a familiar face. Frequently that of L. H. F[illegible]n, Assistant to the Vice President of Marketing.

Of course, in the fullest sense, all our people participate in the ultimate image of "Mr. Oak." You'll find them contributing in many different and significant ways to make Oak truly your switch-engineering "right arm." So whether it's straight facts you need or specialized help, a production run of switches, or the fastest prototype service, simply ring-up Oak to get the job taken care of! Feel free to request "Mr. Oak" any time you're faced with an unusually tough switching problem.

OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • Telephone: Area Code 815; 459-5000; TWX: CRYS LK 2350-U
Plants in Crystal Lake, Illinois • Elkhorn, Wisconsin

Subsidiaries: OAK ELECTRONICS CORPORATION, Culver City, Calif. • DELTA-f, INC., Geneva, Ill. • McCOY ELECTRONICS CO., Mt. Holly Springs, Pa.

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION TUNERS • VIBRATORS • APPLIANCE AND VENDING CONTROLS • ROTARY SOLENOIDS • CHOPPERS • CONTROL ASSEMBLIES

Circle 154 on Inquiry Card

Eliminate open-circuit hazards in your solid state designs!

New Spectrol Model 55 trimming potentiometer gives positive protection against open-circuit conditions with mechanical stops at both ends of the resistance element. Further protection is provided by a slip clutch that prevents damage caused by turning the shaft when the wiper contact is against an end stop.

The Model 55 conforms to the forthcoming ASESA spec. MIL-R-27208A (proposed) for all dimensional, electrical and environmental requirements.

Available in resistances from 50Ω to 50K, these trimmers are designed for optimum performance and reliability, and meet all applicable military specifications for altitude, fungus, humidity, immersion, salt spray, sand and dust, shock, vibration, and temperature cycling. Dual wiper contact on the resistance element and dual pickoff points on the collector ring assure noise-free performance and continuity during shock and vibration.

Now in distributor stocks, in over 50 locations throughout the U.S. and Canada, Model 55 trimmers are available with printed circuit pins or stranded leads. Prices in quantities of 1-9, $6.00. Non-humidity proof and 125°C version, $4.75.

Contact your nearest Spectrol distributor today for quantity prices and immediate delivery.

SPECIFICATIONS

MECHANICAL

NUMBER OF TURNS
42 standard (25 available)

ROTATION
End stops with slip clutch standard (continuous rotation available)

LIFE EXPECTANCY
1,000 full wiper cycles minimum

OPERATING TEMPERATURE RANGE
—55°C to +200°C
(125°C available at lower price)

WEIGHT
2 grams

ELECTRICAL

STANDARD RESISTANCE RANGE
50Ω to 50K

RESISTANCE TOLERANCE
±5.0% (±1.0% available)

END VOLTAGES
0.25% of 0.5Ω equivalent whichever is greater

TEMPERATURE COEFFICIENT
50 PPM/°C to 100°C nominal

POWER RATING
1 watt at 50°C

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
San Gabriel,
California

Adams Court
Plainview, L. I.
New York

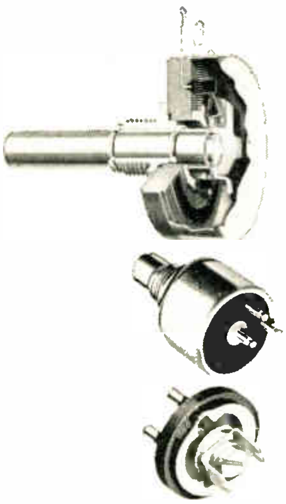
P.O. Box 130
Brampton
Ontario

Circle 155 on Inquiry Card

Centralab: a RELIABLE source for RELIABLE PRODUCTS

FOR MILITARY & COMMERCIAL APPLICATIONS

Most CENTRALAB products are available for immediate delivery in industrial quantities at factory prices, from CENTRALAB stocking distributors.



HOT MOLDED COMPOSITION VARIABLE RESISTORS

Meet MIL-R-94 environmental and test requirements. Provide smooth noise-free operation and high stability for which hot molded units are well known.

2 WATT @ 500V—Raised resistance track reduces surface contamination. Wide clearance between bushing and collector track for increased high voltage stability. Carbon collector and pick-off brushes.

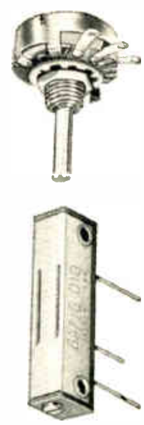
1-3/32" diam., 5/8" deep. 500 ohms—5 meg. linear taper; 10K-2.5 meg log taper.

3/4 WATT @ 350V—Metal enclosed units, available with triple "O" ring shaft seal. 23/32" diam., 1/2" deep. Same resistances as 2 watt unit.

1/2 WATT @ 350V—Similar construction as 3/4 watt. 1/2" diam., 15/32" deep. 100 ohms—5 meg. lin. taper.

1/3 WATT at 350V TRIMMER—locking type variable fixed resistor. Extremely resistant to shock vibration, acceleration, can be encapsulated. 19/32" diam., 11/32" deep. 50 ohms—5 meg. linear taper.

Write for Group G bulletins.



VARIABLE RESISTORS

1/4W. Linear Motion, wirewound 100 to 20K ohms and composition 10K to 2.5 meg. .250" x .325" x 1.250".

1/10W. Microminiature, 0.286" diam: **Ultraminiature**, 0.502" diam; **Subminiature**, 5/8" diam; 500 ohms to 10 megs. **1/4W. and 1/2W. Subminiature**—For instruments and military. 43/64" diam. 500 ohms to 2.5 megs.

1/4W. Multiple Miniature—Up to 4 variable and 9 fixed resistors on a 3/4" x 2-1/4" steatite plate. 1000 ohms to 5 megs.

1/2W. Standard—For radio, TV. Single, Twin or dual-concentric. 15/16" diam. 250 ohms to 10 megs.

1-1/2W. Wirewound—for military and instruments. 11/16" diam., 5/16" deep. 4 ohms to 30K ohms.

2-5W. Wirewound—For instruments and TV. Single or dual-concentric. 1-5/32" diam. 1 ohm thru 100K ohms. Also available as 20 watt audio L and Bridged T Pad attenuators.

Write for Group B bulletins.

ELECTRONIC SWITCHES

Subminiature rotary—15/16" diam. for military and high reliability applications. Rating 0.5 amp. at 6VDC, 100 ma. at 110VAC. Laminated phenolic, steatite, single or multiple sections.

Miniature rotary—1-1/4" diam. for military and high reliability applications. Rated 2.0 amps. at 15VDC and 250 ma. at 110VAC. Available single or multiple ceramic, Mycalex and phenolic sections.

Standard rotary—1-5/16" diam. laminated phenolic or steatite insulation, single or multiple sections. Rating 2 amps. at 15-VDC. 150 ma. at 110VAC. (Resistive load.)

Heavy-duty power—For transmitter, industrial control, laboratory testing, military, commercial. 2-13/16" diam. 7-1/2 amp. rating at 110VAC. 25,000 cycles minimum.

Spring return—1-5/16" diam., coil or C-type springs, phenolic, steatite, single or multiple sections.

Specialized—Lever, slide, tone, tuner sections, others.

Write for Group P bulletins.

CERAMIC CAPACITORS

Ultraminiature—3 to 10VDC, 0.22—2.2 mfd.—for low power factor transistor applications.

Temperature compensating—Discs, tubulars, 150 v to 6,000 VDCW. 1 mmf.—0.1 mf. Capacitance +100 to —5250 ppm.

Bypass—Coupling—Discs, tubulars, 150 v to 6,000 VDCW, 1 mmf.—0.1 mf.

High Voltage—High Accuracy—High Voltage types, up to 30,000 VDCW, High Accuracy types, ± 1% tolerance, 500 VDCW, up to 2,500 mmf.

Trimmer—Tubular or flat. Meet MIL-C-81A specifications. 1 mmf. to 400 mmf. 500 VDCW.

Feed-thru—10—5000 mmf., 500—1,500 VDCW, bushing, shoulder, ring, eyelet, resistor-capacitor combinations.

Specialties—Stand-off, button-shape, potted, other capacitors.

Write for Group D bulletins.

PACKAGED CIRCUITS

Complete computer and Radio-TV circuits, amplifiers, oscillators, detector networks, resistor networks—including transistors, capacitors, resistors, wiring and inductance, manufactured to your specific performance limits.

PEC* circuits result in substantial savings in assembly costs. These high reliability packaged circuits can be supplied in a wide variety of terminals for printed circuit board applications.

1/2W. resistors meet applicable MIL-R-11 specifications, 50 ohms to 50 megs. Capacitors up to .01 mmf.

Write for Group Y bulletins.

*Trade Mark

ENGINEERED CERAMICS

High alumina—85%, 95%, 99%—for high frequency, high temperature applications close tolerance (±.00025") designs. L6A Jan-I-10 grade.

Grade Jan-I-10-L5A steatite, Grade L2A Corderite, and Grade L2A Electrical Porcelain. For applications where high dielectric and compressive strength, high dimensional stability, low loss and low power factor are required, there is a CENTRALAB ceramic material for the job.

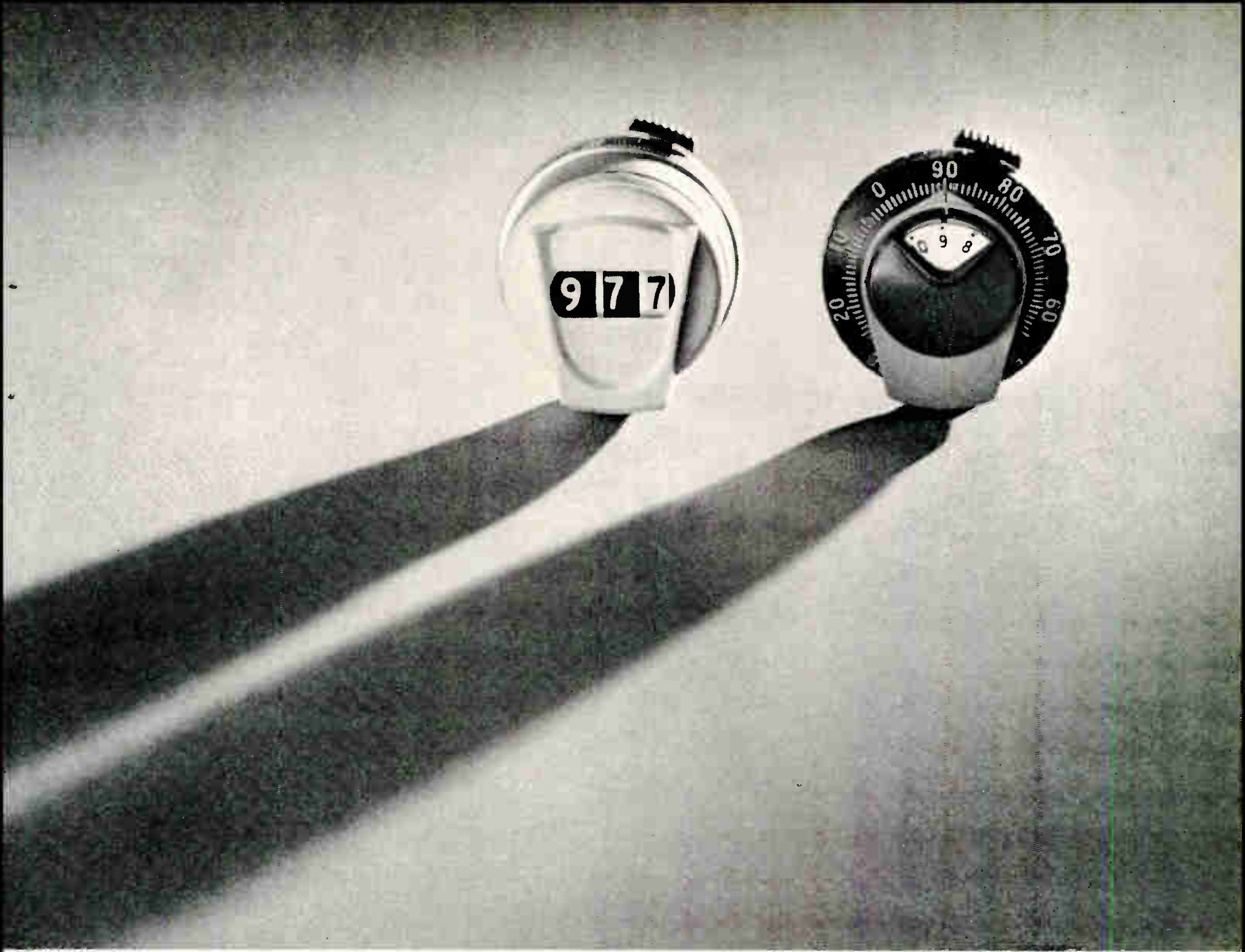
CENTRALAB also specializes in metalizing of ceramics, for hermetic seals or mechanical attachment of other ceramic or metal parts.

Write for Group X bulletins.

Centralab

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
938F EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P. O. Box 400, Ajax, Ontario

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS



How do you prefer your Microdial®: Digital or Concentric Scale?

The Borg Microdial line (broadest in the industry) offers both types—two digital series, and three concentric scale series. Whichever type you like for potentiometer control, remember:

1. Each Borg Microdial features large numerals that are well contrasted to their backgrounds for squint-free readability. 2. Each can be equipped with positive braking to prevent accidental setting changes. 3. Indexing accuracy is one part in a thousand, suitable to a potentiometer of .1% linearity, thus enabling you to get all the precision you pay for in a precision potentiometer. 4. Rugged design withstands rough handling and "panic" responses or setting changes. 5. Customization of counting wheels and gearing can give you practically any readout configuration you might require.

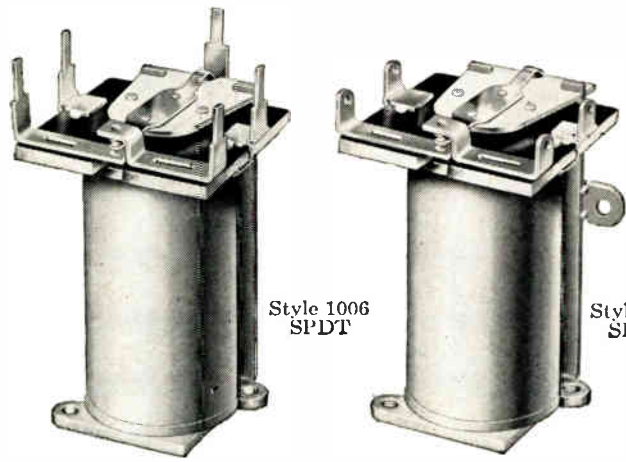
Most Microdial models come in a variety of color combinations that contribute to appearance and permit coding for fast identification in panel groupings.

The Borg Microdial line is competitive too, as you can verify by contacting your nearby Borg technical representative or omnipresent Amphenol-Borg Industrial Distributor. Or, you can address specific inquiries to R. K. Johnson, Sales Manager:

Circle 157 on Inquiry Card

BORG

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin.



Tech Data

for Engineers

Choppers

Tech data entitled "Chopper Technology: An Introduction" describes the basic forms and characteristics of choppers and defines common terms associated with them. Circuit performance and applications of electromechanical and transistor choppers are discussed. Airpax Electronics Inc., Cambridge Div., Cambridge, Md.
Circle 451 on Inquiry Card

Thermostats

Tech data is available on a line of hermetically sealed, miniature thermostats designed for stringent military applications under severe environmental conditions. George Ulanet Co., 413-415 Market St., Newark 5, N. J.
Circle 452 on Inquiry Card

Rotary Switch

Tech data covering a ½ in. Subminiature Low-Power Rotary switch is available from Oak Mfg. Co., Crystal Lake, Ill. The ½ in. rotary switch is a full 12-position unit featuring long life silver alloy contacts, gold flashed to prevent tarnish, double wiping design, and negligible contact noise and circuit resistance.
Circle 453 on Inquiry Card

Time Delay Relay

Tech data is available on the Dial Head AGASTAT time delay relay which features instantaneously recycling with a rest time of less than 0.035 sec.; easy adjustment; temp. range from -65 to $+165°F$; and repeatability accuracy to within $\pm 10\%$ of the pre-set adjustment. Elastic Stop Nut Corp. of America, Elizabeth Div., Elizabeth, N. J.
Circle 454 on Inquiry Card

Motors

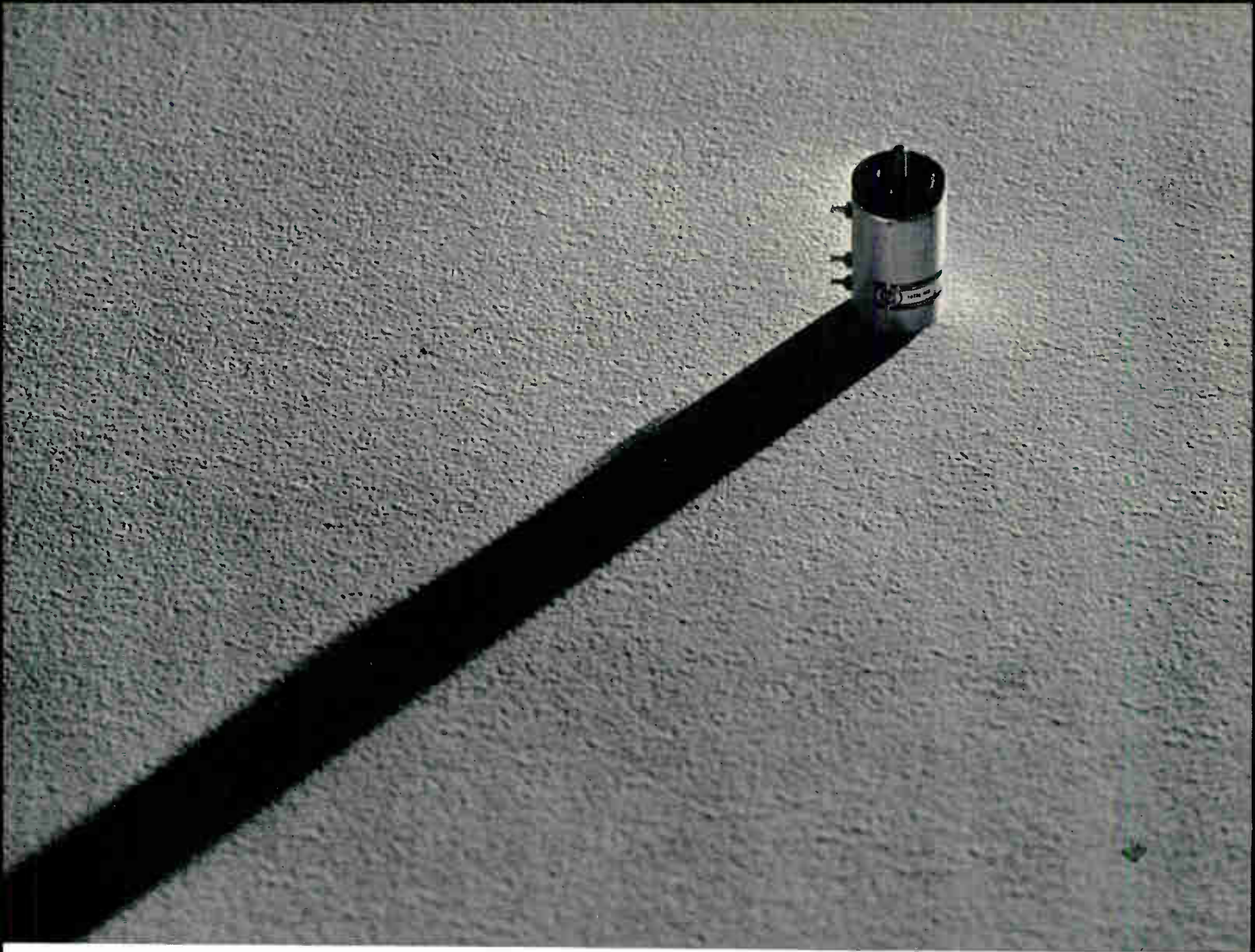
Tech data is available on hysteresis synchronous motors, induction motors, ac permanent magnet generators and tachometers, and sine wave generators. McLean Syntorque Corp., West Hurley, N. Y.
Circle 455 on Inquiry Card

AC and DC Motors

A 6-page, 2-color, booklet on ac and dc motors, pumps, blowers, and custom engineered drive assemblies is available from The Piqua Machine and Mfg. Co., Piqua, Ohio. Included is information on uses for each motor and detailed dimensional drawings and performance specs.
Circle 456 on Inquiry Card

Fractional H.P. Motors

Howard Industries, Inc., 1760 State St., Racine, Wis. offers tech data on fractional horsepower motors with ratings from 1/2000 to 1 H.P. Catalog contains information on motor parts sets, motor blowers and gear reduction units.
Circle 457 on Inquiry Card



How "complete" is a complete line?

Are you as confused about all this complete line talk as we are? What, for example, is a "complete" potentiometer line? This *should* include everything from the *cheap-and-dirty* kind you'll find on a bargain table-radio to the ultra-accurate precision type shown above. By such reckoning, our line of Borg Micropot® potentiometers is far from complete.

The Borg line is "complete" in a different way. Its range of sizes, ratings, and types makes it applicable to virtually every circuit requiring potentiometers with extreme accuracy, reliability and life expectancy along with small size, wide temperature ranges, and rugged resistance to shock, vibration and atmospheric contaminents.

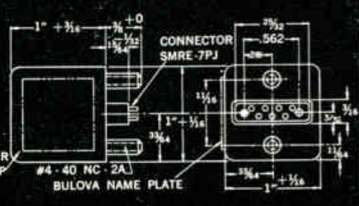
In other words, the Borg Micropot line *is* a complete line—of precision units for precision applications. This is as true of the new 2100 series shown above as of the many other series in the Borg line. As true of single-turns as of multi-turns. As true of commercial models as of military models.

There's a lot more to the Borg line than its completeness. It is *competitive.* Borg Micropot potentiometers are competitively priced, competitively distributed (through Amphenol Industrial Distributors), and competitively delivered. Find out for yourself. Contact your nearby Borg technical representative, Amphenol Distributor, or write to R. K. Johnson, Sales Manager.

Circle 159 on Inquiry Card

BORG

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin.



Tech Data

for Engineers

Chopper Catalog

This 12-page, 2-color general instrument chopper catalog gives complete data on all military and industrial choppers including miniature SPDT and DPDT models, applicable Mil specs., residual noise and drift data, mechanical and electrical specs., incoming inspection and engineering measurement techniques. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 458 on Inquiry Card

AC Generators

AC generators from less than 1 up to 1000kw are included in the Kato line, described in a colorful brochure from Kato Engineering Co., Mankato, Minn. Kato generators are made in brush or brushless types in a wide range of sizes, voltages and freqs.

Circle 459 on Inquiry Card

Relays

Complete data, 32-pages, 2-color, is given on Series A 5a and 10a max. contact rating versions, pico-miniature and pure ac relays. Included are specifications, dimensional drawings, enclosure types and ordering information for 45 typical units. Relay Div., Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

Circle 460 on Inquiry Card

Cooling Equipment

McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J., is offering a 48-page catalog on their line of packaged blowers, propeller fans, centrifugal blowers, ring fans and accessory items. All mechanical and electrical characteristics of each model are included with performance curves and engineering drawings. A special section is given to basic design information for ventilating electronic equipment using forced-air cooling. Mathematical formulae and graphs are provided for problems in cooling solid state circuitry or tube assemblies.

Circle 461 on Inquiry Card

Pressure Potentiometers

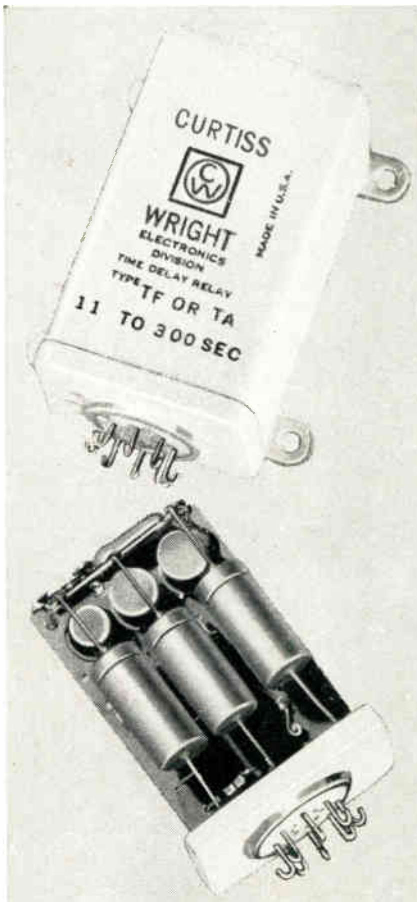
Special Product Note 2851 describes a series of plate mounted miniaturized pressure potentiometers available in ranges from 0-5 to 0-300psia in one basic miniaturized configuration. Trans-Sonics, Inc., P.O. Box 328, Lexington, Mass.

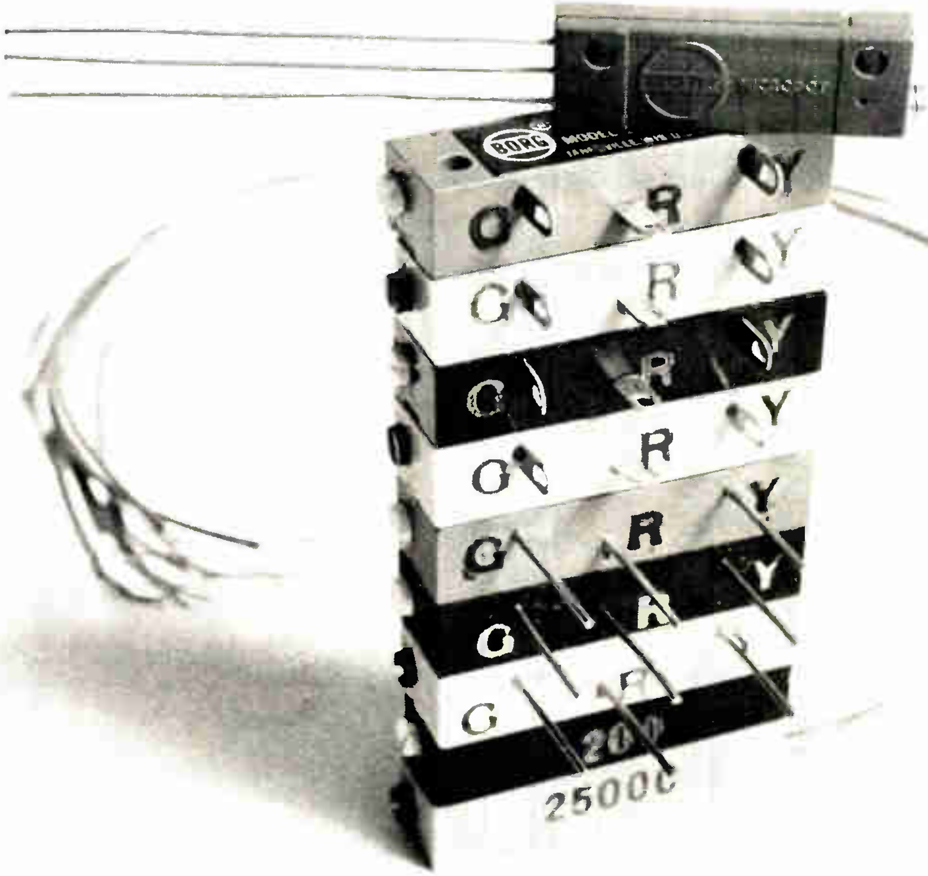
Circle 462 on Inquiry Card

Synchros

"Synchro Engineering Specification Catalog" 40 pages, 2-colors, available from The Bendix Corp., Montrose Div., So. Montrose, Pa., contains a section on design data which includes an introduction to synchros, a classification of standard synchro units and pre-standard synchro units, and a list of synchro characteristics. Also included are spec. tables on Size 11 Mil-S-20708 synchros which includes specs., and outline drawings and data on Sizes 18, 23, 30, 31, 37, and Mil-S-2335 synchros, Type 1, 3, 5, and 6.

Circle 463 on Inquiry Card





The complete Borg Trimmer line starts at the top

Everything must start someplace. The complete Borg line of Trimming Micropot® potentiometers can be said to start with its latest addition, the subminiature (1″ x 3/16″ x 5/16″) 2700 series. This new Micropot is not only tiny, but a high-temperature, humidity-proof model as well.

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2800—High temperature, humidity proof, wirewound.
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Here are some of the advantages offered by Borg Trimmers: 1. Single-piece, welded terminations. 2. Low-mass contacts. 3. 100% noise test. 4. 100% contact resistance check. 5. 100% ratcheting test. 6. Resistances from ten ohms to one meg.

Selecting the right Borg Trimmer can be a lot easier if you'll call your nearby Borg technical representative or Amphenol-Borg Industrial Distributor. Or, if you prefer, write directly to R. K. Johnson, Sales Manager:

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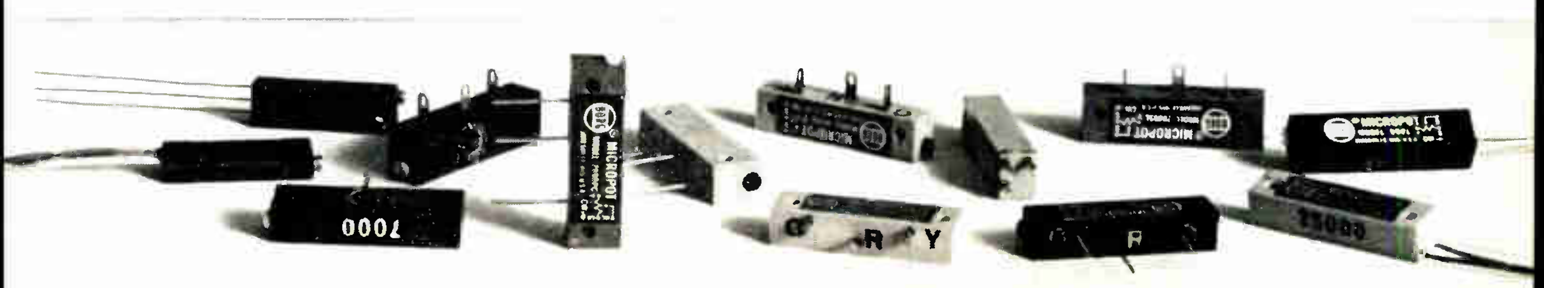
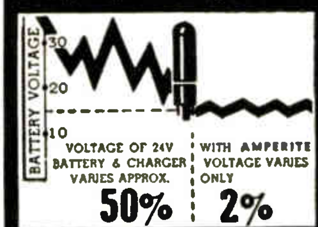
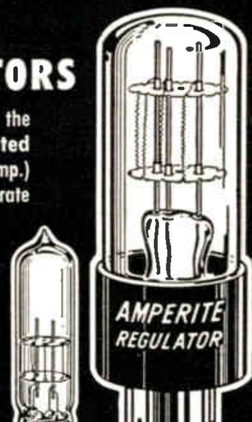
BORG

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin.







Motors *(Concluded)*

published by Bodine Electric Co., 2500 West Bradley Place, Chicago 18, Ill. (Price: $1.00).

The following companies contributed information for this article:

1. The Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.
2. Mamco Corporation, 532-542 Fourth St., Racine, Wisconsin.
3. Westinghouse Electric Corp., Industrial Motor Dept., Lima, Ohio.
4. Western Gear Corp., 132 West Colorado Blvd., Pasadena, Calif.
5. The Bendix Corp., Bendix Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
6. Thor Power Tool Co., 1421 Barnsdale Rd., LaGrange Park, Ill.
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13. Electronic Specialty Co., 4612 W. Jefferson Blvd., Los Angeles 16, Calif.
14. The Garrett Corp., Airesearch Manufacturing Div., 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.
15. Muirhead Instruments, Inc., 441 Lexington Ave., New York 17, N. Y.
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18. IMC Magnetics Corp., 570 Main St., Westbury, L. I., N. Y.
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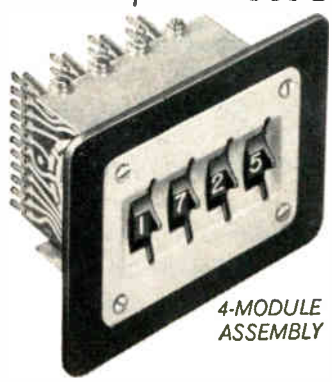
20. Small Motors, Inc., 2076 Elston Ave., Chicago 14, Ill.
21. U. S. Industries, Inc., Western Design & Electronics, 6312 Hollister Ave., Goleta, Calif.
22. The General Industries Co., Elyria, Ohio.
23. Bill Haydon Co., 232 No. Elm St., Waterbury 20, Conn.
24. Kearfott Div., General Precision, Inc., Little Falls, N. J.
25. General Controls Co., 801 Allen Ave., Glendale 1, Calif.
26. Howell Electric Motors Co., Howell, Mich.
27. The Emerson Electric Mfg. Co., 8100 Florissant Ave., St. Louis 36, Mo.
28. Gleason-Avery, Inc., 45 Aurelius Ave., Auburn, N. Y.
29. Air Marine Motors, Inc., East Bethpage Rd., Plainview, L. I., N. Y.

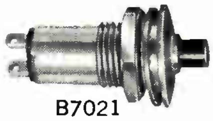


ENGINEERING NEWS - #14

FULL LINE OF MINIATURE SNAP-ACTION SWITCHES

CHECKED *Guu.*	ENGR. *Dut.*	CONTROL SWITCH DIVISION


B7001


B7021


T2106


T2108


T2150


T2151


T3103


T3106


T4203


T4205


T-3

SPECIFICATIONS

Model No.	Amps @ 28 VDC or 120 VAC Resist	Induc.	Circuitry	Approx. Weight Lbs.
B7001	7	4	S.P.N.O.	.005
B7021	7	4	S.P.N.O.	.010
T2106	10	5	2 Cir.	.010
T2108	10	5	2 Cir.	.016
T2150	3	1	D.P.D.T.	.010
T2151	3	1	D.P.D.T.	.016
T3103	5	3	S.P.D.T.	.009
T3106	5	3	S.P.D.T.	.013
T4203	1	—	S.P.D.T.	.004
T4205	1	—	S.P.D.T.	.013
T-3	7.5	2.5	S.P.D.T.	1.6 Grams

NOTE: All models above (except T-3) are available with maintained or momentary action. Self-sealing boot available for any bushing mounted model, as shown on T2150. All models available with flange or bushing type mounting. Basic switch Model T-3 is available with a wide variety of standard and special actuators.

These miniature pushbutton and toggle switches are typical examples of our complete line of miniaturized switches. Whatever your requirements for miniature hand-operated or mechanically-operated switches, we can meet your needs from our hundreds of standard and custom units. We offer an almost unlimited range of variations in configuration, actuation, ratings, operating characteristics, etc.

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CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
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TELEPHONE LUdlow 6-7500 TWX SHRN-H-502

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.

Circle 168 on Inquiry Card

SUBMINIATURE INDICATOR LIGHTS

Moisture-proof. Only 35/64 inch overall. 60,000 hour life with 5V lamp. Translucent lens colors. Available with MS or commercial type lamp. Three lens styles.


L10,000


L10,100


L10,200

ENGINEERING NEWS -- Miniature Snap-Action Switches

Tech Data

for Engineers

Relays

An 8-page catalog describing a new series of mercury-wetted contact relays is available from Potter & Brumfield Div. of American Machine & Foundry Co., Princeton, Ind. Also included are formulas for calculating contact operating characteristics, stroboscopic photo-drawings, tables of resistance values and valves of max. voltage, termination wiring diagrams and algebraic formula with nomogram for the selection of contact protection.

Circle 480 on Inquiry Card

Fans and Blowers

This 24-page Quick Reference Catalog on fans and blowers is available from Rotron Mfg. Co., Inc., Woodstock, N. Y. Included are condensed electrical and mechanical specs. with graphs on the Rotron line of fans and blowers designed for electronic and instrumentation cooling. Propeller, tubeaxial, and vaneaxial fans, and squirrel cage centrifugal, radial wheel, and multistage blowers are covered.

Circle 481 on Inquiry Card

Servo Components

A 16-page catalog offering a complete line of size 5 motors, motor tachometers and synchros; a size 8 line, including synchros and resolvers; a size 11 line including synchros and resolvers; and size 15 and 18 lines is available from Daystrom, Inc., Transicoil Div., Worcester, Pa. The catalog gives outline drawings, tabulation of electrical characteristics and information on transistorized servo amplifiers. Photographs and curves included.

Circle 482 on Inquiry Card

Static Relays

This 2-color, 4-page PS-9 product bulletin describes 3 basic "ultRelay" models: Model AIE (Thermocouple Control Type), Model AIB (Single Control Type High Resistance), and Model AIC (Double or Differential Control Types). Catalog includes application information, wiring diagrams, specs., connection diagrams, arrangements and spacing outline dimensions. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

Circle 483 on Inquiry Card

Synchro Catalog

This 15-page condensed catalog, available from Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J., describes more than 65 synchros used in a variety of applications. Units presented include synchro control transmitters, control transformers, differentials, repeaters, Bu/Ord synchros, induction potentiometers (linear synchro transmitters), and resolvers for synchro use. Components range from Size 5 to 25. Information is included on both 60 and 400CPS types.

Circle 484 on Inquiry Card

New Tech Data for Engineers

Relays

Bulletin 100-N, available from Electronics Div., Iron Fireman Mfg. Co., 2838 S.E. 9th Ave., Portland 2, Ore., contains photographs and specification tables on 100JB-N, 6PDT, sensitive, microminiature type relays. The relays have 150mw sensitivity for dry circuit to high level switching.

Circle 628 on Inquiry Card

Magnetic Clutches

Engineering and application information on Fawick Magnetic Clutches and Brakes is contained in Bulletin No. M-106, available from Fawick Magnetic, Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio. Illustrations, diagrams and detailed spec. charts in the 12-page manual explain construction and operation of all Fawick magnetic units. These include the SC clutch, the SA (power-applied) and SB (spring-engaged) brakes.

Circle 629 on Inquiry Card

Motors and Blowers

An 18-page, 3-color catalog "induction Motors and Blowers" is offered by Fasco Industries Inc., Rochester 2, N. Y. Information is included on two pole motors, 1/500 to 1/20 HP; 6 pole motors; 4 pole motors; 6 pole reversible motors; and centrifugal blowers. Included are photographs, descriptions, dimensional drawings, and performance curves.

Circle 630 on Inquiry Card

Servo Components

Diehl Mfg. Co., Small Motors Div., Somerville, N. J., is offering a condensed general catalog on servo components. The catalog covers 60 and 400CPS ac servomotors in output ratings from 1 to 750w, ac and dc tachometers, precision resolvers and phase shifters, servo amplifiers and dc components.

Circle 631 on Inquiry Card

Photoelectric Relays

New High-Speed Photoelectric Relays, SCW-136, describes versatile, high-speed, low-cost photoelectric relays activated by light increase or decrease. A table shows equipment combinations for operating ranges up to 70 ft. Diagrams and photograph show relay configuration, cabinet dimensions, knock-outs, and mounting provisions. General Electric Co., Schenectady 5, N. Y.

Circle 632 on Inquiry Card

Servo Motors

Tech. data including applications and the mechanical, and electrical characteristics of more than 60 motors from Size 5 through Size 30 is included in a 16-page condensed catalog available from Kearfott Div., General Precision, Inc., Little Falls, N. J. Types of motors discussed include standard, synchronous, stepper, inertial damped, viscous damped, braked, and blower motors. Included are 60 and 400CPS types.

Circle 633 on Inquiry Card

Thermocouples

Full specifications for 6 types of Thrift/Therm Thermocouples are described in Bulletin 207. Companion Bulletin 205 describes the Thrift/-Therm Kit, a package of 4 different units designed to measure temps. for 95% of all requirements. Thrift/-Therms sense temps. from −300 to +2000°F. Harco Laboratories, Inc., 77 Olive St., New Haven, Conn.

Circle 634 on Inquiry Card

Motor Fabrication

This 6-page folder illustrates a complete line of Possis automatic machines for electric motor fabrication. Coil winders, automatic cell and wedge inserters, armature winders, stator winders and automatic taping equipment for reproduction lines are included. Possis Machine Corp., 825 Rhode Island Ave. So., Minneapolis 26, Minn. Bulletin 6111M.

Circle 635 on Inquiry Card

Speed Reducers

Metron Instrument Co., 5302 S. Delaware St., Littleton, Colo., is offering a 12-page, 2-color brochure on their speed changing components for precision control of rotational speeds. Included are variable speed changers, speed reducers, special drives, flexible couplings, industrial tachometers, and speed changer kits.

Circle 636 on Inquiry Card

Ball Bearings

KuBar, Inc., 21 Erie St., Cambridge, Mass., is offering a 2-color, 8-page brochure entitled "Precision Ball Bearings." An interchangeability chart, referencing other bearing manufacturers and boundary dimensions and nomenclature of the basic bearings are also contained in the brochure.

Circle 637 on Inquiry Card

Variable Speed Drive

Bulletin 2200 describing ac-ac variable drive packages for 1/6 to 20 HP motors is available from Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Pa. The 3-part package discussed in the bulletin consists of a magnetic amplifier control panel, a patented solid-rotor ac motor and a manual speed-control potentiometer.

Circle 638 on Inquiry Card

Pushbuttons

General purpose pushbuttons are described in a 12-page booklet available from Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa. Booklet B-7354 describes standard and special types of general purpose pushbuttons and enclosures for various uses in flush and surface mountings.

Circle 639 on Inquiry Card

Fan Units

"Whirl-Kool" units are efficient, compact, low cost integral fans for cooling electronic equipment. These quiet, lightweight, highly reliable fans require no lubrication and maintenance. They are guaranteed for 5 years and power requirements are 105-125vac 60CPS, 1θ. Ambient temp. range is from −20 to 50°C. Deltron Inc., 4th & Cambria Sts., Phila. 33, Pa.

Circle 640 on Inquiry Card

Industrial Plastics

A 16-page booklet on products and services of The Polymer Corp. and its subsidiaries and divisions, is available from The Polymer Corp., 2120 Fairmont Ave., Reading, Pa. The booklet outlines properties, uses, and availabilities of Polypenco nylon, Teflon, Fluorosint TFE base resin and other industrial plastics. Engineering information on finishes for the Whirlclad coating system, Polymer's basic fluidized bed coating process, is also included.

Circle 641 on Inquiry Card

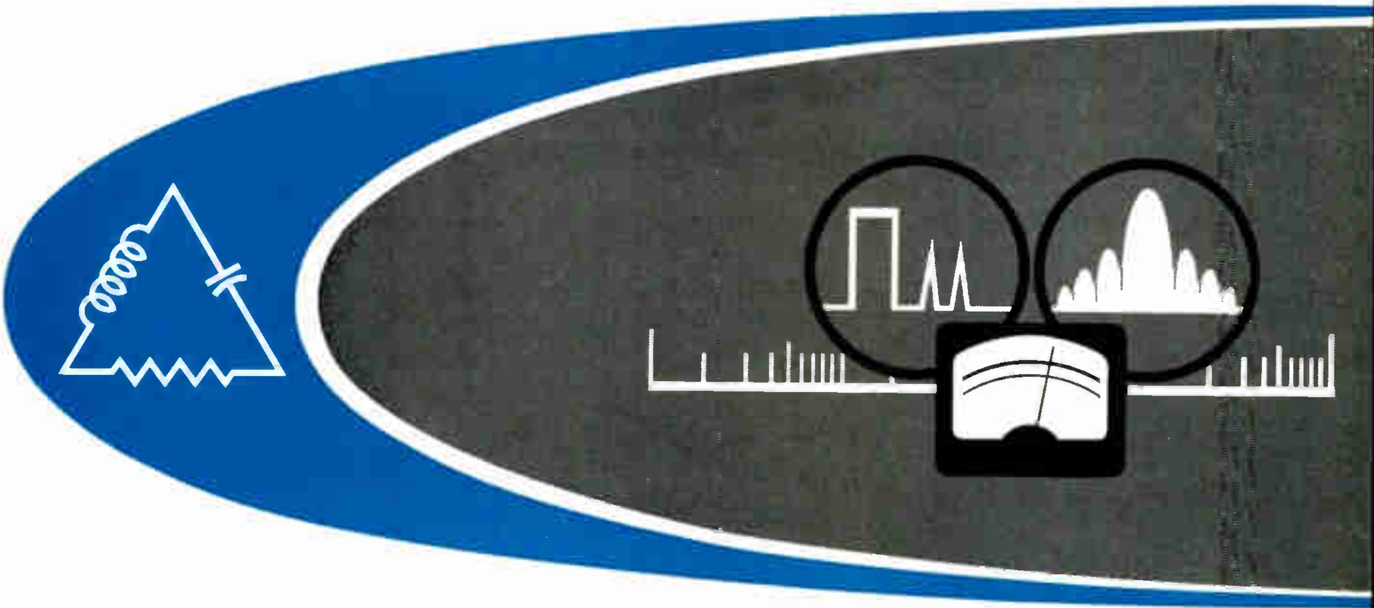
Precision Relays

Bulletin #240.00, 12 pages, gives complete tech. data on a line of precision relays (subminiature to standard sizes) including CDE's 5-p 12-position program relays, bi-stable, telephone and glass reed relays. Data is also presented on contactors and solenoids. Cornell-Dubilier Electronics, 50 Paris St., Newark, N. J.

Circle 642 on Inquiry Card

Section G

Measurement & Test



By PAT TUCCIARONE
Applications Engineer
PRD Electronics, Inc.
a subs. of Harris-Intertype Corp.
202 Tillary St.
Brooklyn 1, N. Y.

There are four basic measurements that are usually required in microwave work —VSWR and impedance, frequency, attenuation, and power. "How to" information for making these measurements is given here in simplified form.

Making Microwave

THERE are four basic measurements that one must be familiar with: voltage standing wave ratio (VSWR), power, attenuation, and frequency. At frequencies below 20 MC the measurement of VSWR is virtually unnecessary; at microwave frequencies, VSWR must be known accurately. Power, attenuation, and frequency measurements are required as they were for low frequency circuits, but the methods used to obtain these values are different.

Typical instruments required to generate microwave signals and to measure them are shown in Fig. 1. On the left is a klystron power supply (1a) and tube mount (1b) that contains an internal cavity reflex klystron. The power supply provides the necessary voltages for the operation of the klystron. In addition, there is a facility for providing modulation voltages both internally and externally. The reflex klystron is an oscillator capable of producing microwave energy when the proper voltage relationships exist between the various electrodes of the tube. The mount makes it possible to bring the required voltages from the power supply to the klystron via a cable and then, through a section of waveguide which is a part of the mount, the microwave energy is guided to the tuner (2) that follows. The power supply with its modulation circuits, klystron and mount, when combined into a single unit, is then a signal source. It is capable of providing pulse, square wave and sine wave modulated outputs in addition to CW.

Following the tuner, which is used to tune out reflections in the line, is a waveguide ferrite isolator (3), a non-reciprocal or one-way device which isolates the signal source from variable or unmatched loads. A magnetic field supplied by a permanent magnet contained within the isolator enables the ferrite materials to permit the transmission of electromagnetic waves in one direction only.

Following the isolator is a cavity frequency meter (4). These meters are essentially resonant sections of coaxial line or circular waveguide whose resonant frequency is changed by means of a movable plunger. The position of the plunger is calibrated in terms of frequency. At the lower microwave frequencies (to about 4 KMC), coaxial cavities are used; at the higher microwave frequencies, right cylindrical waveguide cavities are more practical.

The next device in the setup is a direct reading precision attenuator of the rotary vane type (5) with an attenuation range of 60 db. The vane, upon which a dissipative material has been deposited, rotates about an axis which is parallel to the direction of propagation. The attenuation is a function of the angle between the vane and a plane parallel to the wide dimension of the waveguide. The expression relating the angular position of the vane to the attenuation is:

$$\text{attenuation (db)} = 40 \log \cos \theta$$

where θ is the angle referred to above.

Following the rotary vane attenuator is a universal carriage and slotted section (6) and broadband probe (6a). The slotted section consists of a length of waveguide, with a narrow longitudinal slot in the center of the top wall. The carriage moves the broadband probe assembly along the length of the slot. Within the probe is a thin wire that forms the center of a coaxial line. The thin wire penetrates the waveguide through the slot and extracts a sample of r-f power. The probe is tunable so that it presents a shunt conductance across the transmission line. This will provide a maximum output, which is detected by a crystal. The crystal is an integral part of the probe assembly. To obtain the smallest value of shunt conductance (the smaller, the less the pickup wire reacts with the field within the waveguide), the penetration of the

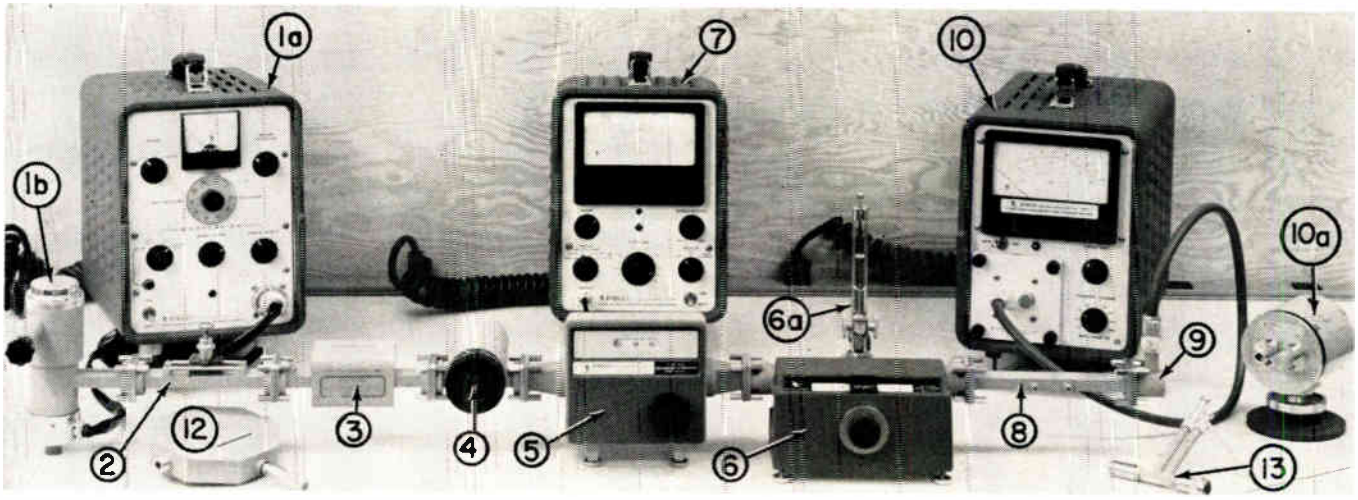


Fig. 1: Typical instruments required to generate microwave signals and to measure them are shown here.

Measurements

thin wire probe should be held to a minimum. The output of the crystal is a voltage which is directly proportional to the power sampled, provided that the crystal is operating in the square law region of its response characteristic. Square law operation of the crystal implies that its current reponse is proportional to the square of the input voltage or, in other words, the output voltage is directly proportional to the input power.

The detected output of the probe assembly is then fed to a VSWR amplifier (7). The meter of the amplifier is calibrated both in db and VSWR. The VSWR and db readings will be correct only if a square law detector is used to supply the amplifier input signal. A front panel control allows adjustment of the bandwidth from 4 to 40 cycles, centered about a 1000 CPS frequency. The amplifier gain is adjustable via a variable gain control and a switch calibrated in increments of 5 db. The amplifier is used to make VSWR or attenuation measurements.

Following the slotted section is a fixed waveguide attenuator (8) which may be used for accurate extension of the range of available power measuring equipment, or to provide isolation and padding. Affixed to the end of the attenuator is a waveguide to coax adapter (9) to provide a means for changing the transmission of microwave power from a waveguide to a coaxial line or vice-versa. The microwave power is then fed to a power meter (10) using a dry block calorimeter (10a) as a plug-in unit. The microwave power at the input to the dry calorimeter is evidenced as a dc voltage at the output terminals of the calorimeter. The power meter is calibrated to provide a direct readout of power. Other instruments, by no means an all-inclusive list, vital to the making of microwave measurements are a variable coaxial attenuator (12), coaxial tuner (13), waveguide thermistor mount, coaxial bolometer mount, standing wave detector, heterodyne frequency meter.

What follows are brief discussions of the measurement of the four basic microwave parameters.

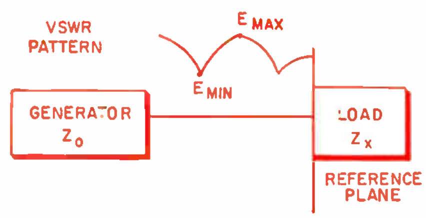
VSWR and Impedance

Standing waves in a transmission line occur when there is a mismatch or discontinuity in the line, so that some of the transmitted power is reflected back to the generator. The phase difference between incident and reflected power will cause the magnitude of the voltage at any point on the transmission line to be different from that of a point adjacent to it. Thus, a standing wave pattern results that repeats every half wavelength. The voltage standing wave ratio (VSWR) is essentially the ratio of the maximum amplitude to the minimum amplitude of the voltage standing wave pattern.

The impedance of a load, Z_x, can be determined knowing VSWR and θ where θ is the phase angle of the relection coefficient, Γ. VSWR, s, can be found by techniques described below while θ can be determined from

$$\theta = \frac{4\pi}{\lambda_g}(D - D_r) \pm \pi \text{ radians}$$

where D is a voltage minimum location along the transmission line with Z_x at the reference plane and D_r is a voltage minimum location with a short circuit at the reference plane. D-D_r, then, is the shift of the voltage minimum location as a result of the change in load impedance.



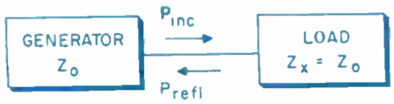
$$|\Gamma| = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{s - 1}{s + 1}$$

$$\Gamma = \frac{s - 1}{s + 1}\,\epsilon^{j\theta}$$

Measurements *(Continued)*

At the reference plane, $\frac{Z_x}{Z_o} = \frac{1+\Gamma}{1-\Gamma}$. Since the Smith chart is a plot of this relationship, and since both $|\Gamma|$ and θ can be determined, then the unknown impedance, Z_x, can be established using the Smith chart.

VSWR is the most significant of the microwave parameters in that its effect must be taken into account when the measurement of those parameters—power, frequency, attenuation—is made. For example, in the measurement of power, if a generator with output impedance, Z_o, is connected via a uniform,



lossless transmission line of characteristic impedance, Z_o, to a load whose impedance, Z_x, is not equal to Z_o, then the total output power of the generator is made up of two components: incident power, P_{inc}; and reflected power, P_{refl}. Then,

$$\frac{P_{refl}}{P_{inc}} = |\Gamma|^2 = \left[\frac{s-1}{s+1}\right]^2$$

where Γ is the reflection coefficient and "s" is the VSWR. Similarly, when frequency and attenuation are being measured, the effect of VSWR must be taken into account to maintain maximum accuracies. This will be discussed in more detail in the frequency and attenuation measurement portions of this article.

One of the most common methods of measuring VSWR is by use of a slotted section and a VSWR amplifier, such as the PRD 277B, see Fig. 2. With the modulated signal source in operation, a maximum deflection is obtained on the meter of the VSWR amplifier by adjusting the modulation frequency control of the signal source, and by tuning the probe mounted on the slotted section. The probe is moved along the slotted section to a voltage maximum position, which is indicated by an increasing meter reading. The gain control of the VSWR amplifier is adjusted for full scale deflection. The probe is then moved to a voltage minimum. If the crystal in the probe, which is used to detect the signal is in square law operation, the VSWR is read directly from the meter.

If high values of VSWR are to be measured, the reading obtained from the VSWR amplifier at the voltage maximum point along the standing wave may not be correct because the crystal is operating in the non-square law region. Instead of reading the maximum and minimum voltages, convenient intermediate voltage values, located symmetrically at either side of a minimum, are selected. (Fig. 3.) This procedure is known as the "width of minimum" technique.

For VSWR greater than 10, and with square law detection, a useful and quite accurate approximation can be used to find the VSWR:

$$VSWR = \frac{\lambda_g}{2\,\pi\,x_o}$$

where λ_g is the wavelength of the signal in the waveguide (see discussion of frequency) and x_o is the distance between the minimum and 3 db points. Thus, the probe assembly is moved along the slotted section until a minimum point is found and its location noted. The probe assembly is then moved until the meter reading on the VSWR amplifier increases by 3 db and this location is noted. The distance traveled between these two points is x_o. λ_g can be found using the methods outlined in the discussion of frequency. Substituting in the above equation will give the value of VSWR.

When measuring very low VSWR and its associated reflection coefficient angle, λ_g is difficult to determine in that both minima and maxima are very broad. Large errors could be introduced by trying to find their location by use of the VSWR amplifier. However, the expanded scale feature of the VSWR amplifier can be put to good use. A technique somewhat analogous to that used when making high VSWR measurements can be used. Symmetrical points are chosen about either maximum or minimum and unlike the method shown above, any convenient locations can be selected. Referring to Fig. 4, the maximum points shown are midway between x_1 and x_2, x_3 and x_4. Since the distance between successive maxima is one half wavelength, then

$$\frac{\lambda_g}{2} = \frac{x_4 + x_3}{2} - \frac{x_2 + x_1}{2}$$

When making VSRW measurements it is important to restate that minimum insertion of the probe into the slotted section is most desirable. This is to prevent setting up any reflections or disturbances due to the probe itself, and to insure that the crystal is not driven out of its square law region.

Some other techniques for measuring VSWR are through the use of impedance Tees and reflectometers. The latter technique is especially suitable when swept frequency measurements are to be made.

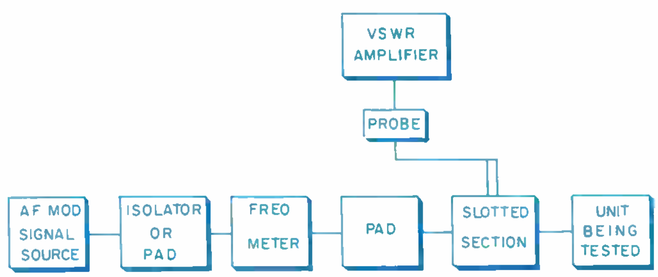


Fig. 2: Block diagram shows a VSWR measurement test setup.

Frequency Measurements

One of the properties or characteristics of an electromagnetic wave is frequency. Wavelength, λ, is related to frequency, f, by a proportionality factor, v, the velocity of propagation, which varies with the medium through which the wave is passing. Thus,

$$f\lambda = v$$

In free space, the velocity of propagation, v_o, is approximately 3 x 10^8 meters/sec. and is given by

$$v_o = \frac{1}{\sqrt{\mu_o \, \epsilon_o}}$$

where μ_o is the permeability of free space and ε_o is the permittivity of free space. When an electromagnetic wave is propagated in a rectangular waveguide in its dominant mode, it can be shown that

$$\lambda_g = \frac{\lambda_o}{\sqrt{1 - \left(\frac{\lambda_o}{2a}\right)^2}}$$

where λ_g is the apparent wavelength of the electromagnetic wave in the waveguide, λ_o is its wavelength in free space and "a" is the larger internal dimension of the rectangular waveguide. Since λ_g can be measured by the setup of Fig. 5, and v_o and the larger dimension of the waveguide "a" are known, by using the following expression, the frequency of the electromagnetic wave can be determined:

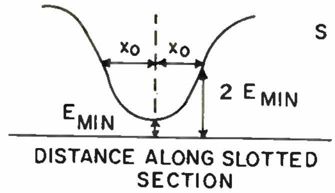
$$f = \frac{v_o \sqrt{1 + \left(\frac{\lambda_g}{2a}\right)^2}}{\lambda_g}$$

To measure the wavelength, λ_g, the distance between two successive minima or maxima is found and multiplied by two. By substituting in the above equation, then, frequency can be found to an accuracy of about 0.05%.

More direct methods of measuring frequency involve the use of cavity frequency meters or heterodyne frequency meters. Cavity frequency meters may be classified as either absorption or transmission type, see Fig. 6. A cavity frequency meter is able to measure frequency because of its resonant characteristics, which depend on the geometry of the cavity. The cavity geometry can be varied by a tuning plunger, thus allowing it to resonate at different frequencies. The absorption type frequency meter can be viewed as a band reject filter; the transmission type, a band pass filter.

When a cavity meter is used to measure frequency it should be in a well matched line so that no reflected impedances will effect the natural resonant frequency of the cavity. To reduce the reactive pulling on the cavity due to VSWR, attenuators can be used at both input and output of the cavity. Referring to Fig. 7, if an absorption type meter is used, there will be a greater deflection on the meter of the power monitor when the frequency meter is off resonance, with a marked decrease in deflection occurring when the frequency meter is tuned to the unknown frequency. The reverse is true if a transmission type of frequency meter is used. Thus, to measure the frequency, one need only adjust the tuning dial of the meter until the desired indication is obtained.

The heterodyne frequency meter technique uses a calibrated local oscillator signal, which is heterodyned with the unknown signal. The zero beat indication is determined audibly by a null or zone of silence. The beat may also be displayed on a cathode-ray tube. If the approximate frequency of the unknown signal is known, then the actual frequency is the integral multiple of the calibrated oscillator frequency which comes closest to the approximate frequency. Without any knowledge of the unknown frequency, except that it



$$S = \frac{\lambda g}{2\pi X_o}$$

Fig. 3. Measurement of a high VSWR.

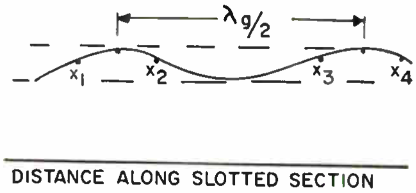


Fig. 4: Determining λ_g for a low VSWR.

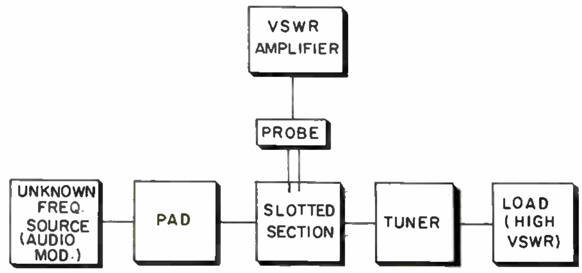


Fig. 5: Measurement of wavelength, λ_g, using slotted section.

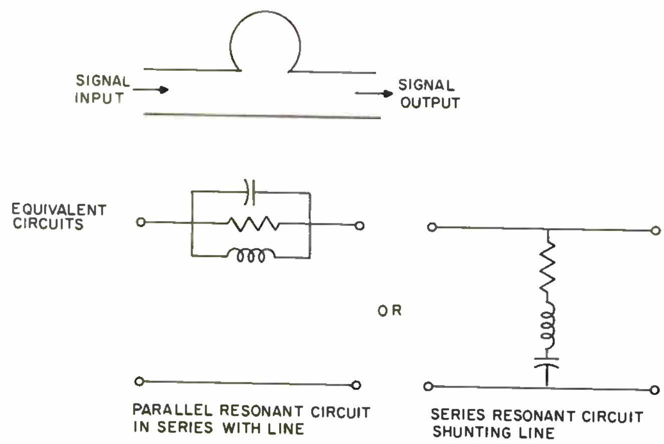


Fig. 6: Above (a) is the representation for absorption type cavity frequency meter. Below (b) is the representation for transmission type cavity frequency meter.

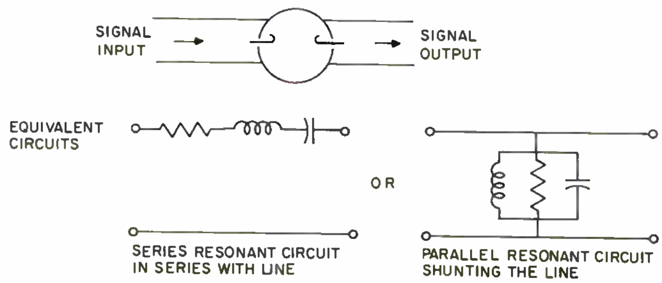
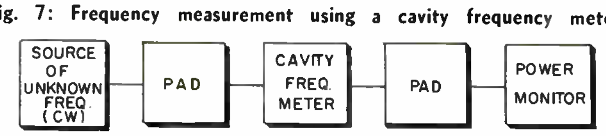


Fig. 7: Frequency measurement using a cavity frequency meter.



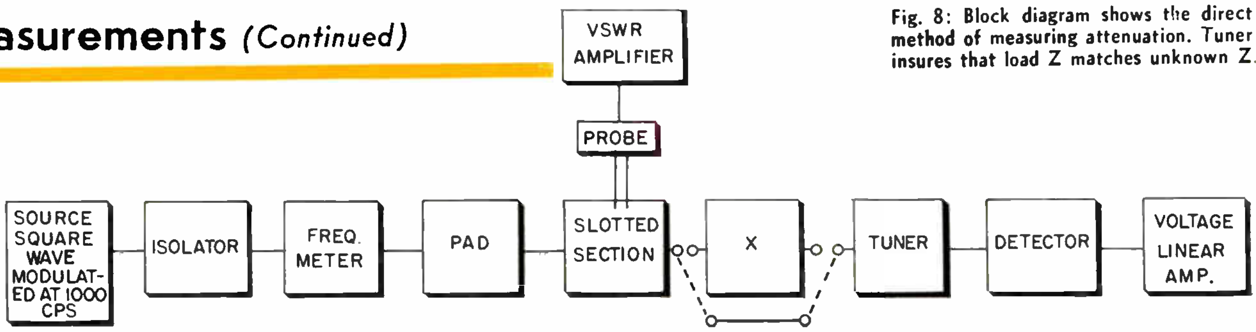


Fig. 8: Block diagram shows the direct method of measuring attenuation. Tuner insures that load Z matches unknown Z.

is higher than the maximum calibrated local oscillator frequency, the unknown may be found by the determination of two successive zero beat readings of consecutive harmonics of the local oscillator. f_x is then:

$$f_x = \frac{f_1 f_2}{f_1 - f_2}$$

where, f_x is the unknown, f_1 is the higher beat frequency reading of the local oscillator and f_2 is the next lowest.

If the unknown frequency is known to be lower than the lowest calibrated local oscillator frequency, the unknown may be found unambiguously, but the measurement technique is a bit more involved.

Normally, heterodyne frequency meters are coupled to the source of an unknown frequency through level set attenuators (pads), or are loosely coupled through use of an antenna. Maximum accuracy is obtained when the unknown is a CW signal. With a modulated unknown signal, beat notes are generated due to the modulation side band frequencies in addition to the fundamental frequency of the unknown. For this reason, heterodyne frequency meters are not generally used to measure the frequency of a pulsed signal. In the case of CW signals, accuracies as good as 0.002% can be achieved.

Attenuation Measurements

The measurement of attenuation requires that the attenuating device be inserted into a matched system, i. e., there is maximum power transfer from a generator to load. In db, then, this is expressed as:

$$A = 10 \log \frac{P_1}{P_2}$$

where A = attenuation in db

P_1 = power delivered to load without the attenuator in the line.

P_2 = power delivered to load with the attenuator in the line.

Closely related to attenuation is insertion loss (IL). Its definition is similar to that shown above, except that there is no requirement for a matched line; that is, both generator and load may be of any arbitrary impedance. Frequently the term "insertion loss" is applied (really as a misnomer) to a variable attenuator to indicate the reduction of power delivered to a load when the variable attenuator is inserted into the system with an attenuation setting of zero db.

There are several ways of measuring attenuation. These are the direct method, substitution methods, and impedance measuring method. The particular method used will permit varying degrees of attenuation range and accuracies, as determined by the cost and complexity of the equipment required. Shown is a block diagram, Fig. 8, for measuring attenuation via the direct method. Note that the tuner is required to insure that the load impedance, as seen by the unknown, is a match. The unknown sees a match looking toward

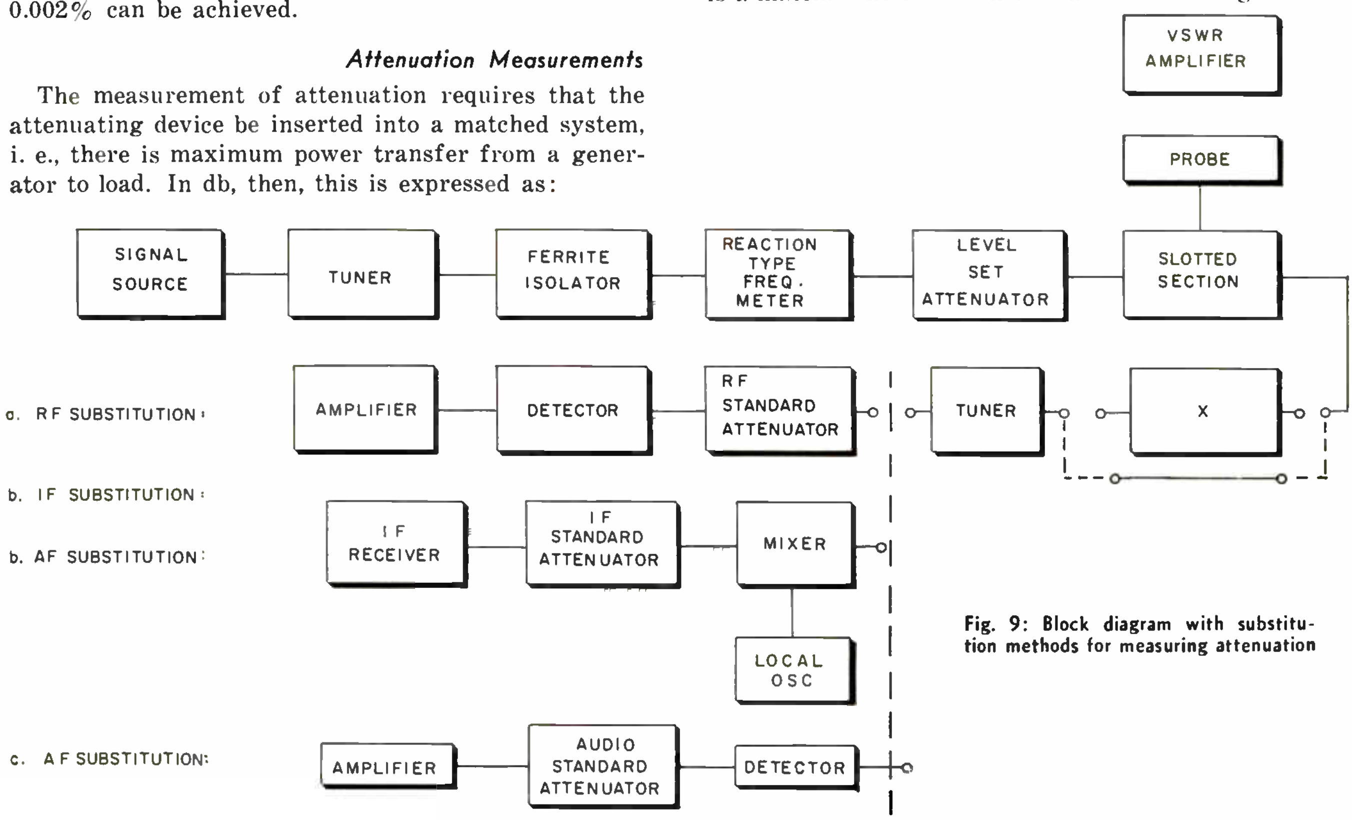


Fig. 9: Block diagram with substitution methods for measuring attenuation

the left due to the presence of the variable level set attenuator.

The direct method involves the use of (1) a square law detector and (2) a voltage linear amplifier and readout device. Changes in attenuation due to the unknown are manifested by proportional changes in the output voltage. For example, if the attenuation is increased by 3 db, the output voltage is reduced to ½ its original value. If the unknown is a fixed attenuator, the output indicator is set to read full scale without the attenuator in the circuit. The attenuator is then inserted, and the db change is noted on the indicator. Power attenuation is then ½ the voltage attenuation indicated on the meter. Note, this is true only if the detector is square law.

If the attenuator is a variable one, using the procedures as outlined above with the attenuator dial set to zero will yield the "insertion loss." Once this has been obtained, the attenuator can then be varied and the attenuation figures taken from the meter readings. The markings on the attenuator dial are thus calibrated in terms of db of attenuation. Also, it may be desirable to return the attenuator dial to zero as the attenuation measurements are being made to insure that the reference level has not shifted. This technique is useful in general lab. work where a rapid measurement is required with a minimum of equipment. With the setup shown in Fig. 8, where the detector is a bolometer, a range of about 40 db with accuracies of 0.2 db can be realized.

In the substitution methods, r-f, i-f, and audio substitution, see Fig. 9, the procedure is basically the same for all three in that the unknown is compared to a previously calibrated attenuation standard. For example, in the r-f method, the unknown attenuator is inserted into the line after a reference level has been set. A calibrated attenuator is then adjusted to restore the original signal level. The change in the setting of the standard r-f attenuator gives the attenuation of the unknown directly. Thus, the calibrated attenuator must have a range greater than that of the attenuator to be measured or, at least, equal to it.

Attenuators that are used as standards are usually either of the waveguide-beyond-cutoff or resistive film types. The former have high insertion loss, are relatively narrow band, and the attenuation characteristic is due to reflection. The resistive film type have low insertion loss, can be made to be broadband, and attenuation is mainly due to dissipation of power. However, the waveguide-beyond-cutoff type of attenuator has an attenuation characteristic which can be calculated and is linear (within limits) as a function of frequency, whereas the resistive standard is not linear and must be calibrated over its dynamic range. Wire wound or film type attenuators are used in the audio technique of measuring attenuation. The waveguide-beyond-cutoff type is used in the i-f technique; and in the r-f method, resistive film attenuators are used (rotary vane or sidewall).

In the i-f and audio substitution methods there is an inherent advantage in that the standard attenuator need be calibrated at one frequency only. In the i-f technique, an r-f signal is heterodyned with a local oscillator signal. After linear mixing, the resulting i-f frequency passes through an i-f standard attenuator into an i-f receiver with a resulting signal level established in the i-f receiver. The unknown is then inserted into the r-f line, and the i-f attenuator is adjusted to restore the former level. The change in the setting of the i-f attenuator is equal to the attenuation introduced into the system by the unknown. The accuracy of this technique requires that frequency conversion be linear, i.e., that the i-f power is proportional to the r-f power. Thus, if the r-f signal is reduced by "N" db there is a correspondingly equal reduction of power in the i-f signal.

The audio substitution technique uses a detector, such as a bolometer, ahead of a calibrated audio attenuator. As in the methods above, the output level is maintained constant. The measurement is made by establishing a level on the amplifier with the unknown removed from the line. The unknown is then introduced into the r-f line with the audio level restored via the audio attenuation standard. In this case, however, the change in the setting of the standard is equal to twice the value of the unknown because it is ac voltage (not power) input to the audio standard which is proportional to the r-f power level. However, the detector must be operating in its square law characteristic for the 2:1 relationship to hold.

Use of the substitution techniques will afford attenuation measurement ranges of about 70 db using the r-f method, up to 75 db for the i-f method, and 40 db for the audio method. In general, the accuracy of the r-f method is limited by the calibration of the standard r-f attenuator. The i-f method is limited by the dynamic range of mixer linearity. The a-f method is restricted by the range of square law response of the detector. Some of the sources of error and factors that apply to most attenuation measurements are:

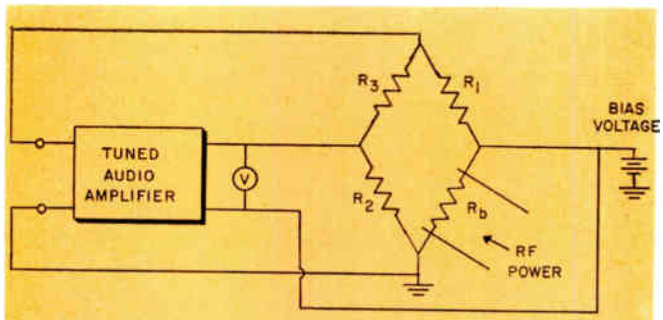


Fig. 10: Simplified drawing of a self-balancing power bridge.

1. power level variations in the r-f signal
2. line mismatches
3. amplifier non-linearity
4. db switch, movement and scale inaccuracies of the indicator
5. r-f leakage which may bypass the unknown attenuator
6. deviation of the detector from square law, and deviation of mixer from linear operation.

Power Measurements

At frequencies below approximately 300 MC, one may describe power in terms of voltage, current, and phase. However, at microwave frequencies this is no longer possible. In order to make power measurements, one must resort to thermally sensitive elements

Measurements *(Concluded)*

such as bolometers and thermistors, or calorimetric techniques must be used where microwave power is converted to a heat equivalent.

A bolometer or thermistor is a temperature sensitive device whose resistance changes due to the heating effect of r-f power being absorbed by it. Bolometers have positive temperature coefficients, while thermistors have negative temperature coefficients.

One of the common methods of measuring microwave power is through use of a power meter of the self-balancing bridge type, one arm of which is a bolometer or thermistor. Because this technique is in such widespread use, a brief description will be given of the theory of operation of the self-balancing bridge (see Fig. 10). Resistances R_1, R_2, and R_3 are resistive arms of the bridge while R_b represents the resistance of the bolometer. The equivalent circuit for a coaxial bolometer and mount is shown in Fig. 11. The bolometer resistance is 200 ohms for dc or audio power while its r-f resistance is 50 ohms. The bridge is a coupling network between the input and output of the tuned audio amplifier such that an oscillating circuit is formed. The bridge is initially balanced by biasing the bolometer with both dc and a-f power to its 200 ohm operating resistance. When r-f power is applied to the bolometer, its resistance will change due to the additional heat introduced by the r-f power. The resultant unbalancing of the bridge causes the a-f power to be reduced in order to bring the bridge back into balance. This change in audio power is a measure of the r-f power which has been applied to the bolometer and is externally evidenced as an up-scale deflection of the meter, which is calibrated in r-f milliwatts.

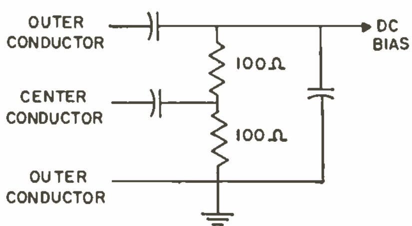


Fig. 11 (l): Equivalent circuit for bolometer and mount.

Note that before r-f power is introduced, the total bolometer power is audio (P_{audio}) plus dc power, (P_{dc}). After r-f power is injected and the bridge has returned to a balanced condition, the total bolometer power is now comprised of the sum of the same dc power as before, plus r-f power (P_{rf}) and audio power (P'_{audio}) which is less than that which was used to bias the bolometer. Expressed in an equation:

$$P_{audio} + P_{dc} = P_{dc} + P_{rf} + P'_{audio}$$

$$P_{rf} = P_{audio} - P'_{audio}$$

where P'_{audio} is less than P_{audio} by an amount equal to P_{rf}.

Thus, in order to make a power measurement on a self-balancing bridge type of power meter as shown in Fig. 1(11), with the bias current control set to Off, connect a bolometer (or thermistor) to the Bolo input terminal. If the approximate value of power to be measured is known, set the Range switch accordingly; if not, set to maximum range, 100 mw. Set the Temp Coefficient switch to its appropriate position (+ for bolometers, − for thermistors). Turn the meter on and adjust the Bias Current switch for zero indication on the meter (bridge is in balance). Connect the bolometer or thermistor mount to the source of r-f power to be measured. The meter should now deflect up scale. The reading is r-f power in milliwatts. Disconnect and check the zeroing of the meter. If not zero, repeat the measurement. Although the instrumentation accuracy is 3% of full scale, errors introduced by VSWR of the bolometer mount, mount inefficiency, and the lack of equivalence between r-f and audio heating, may permit accuracies of only 6-15%.

In order to make more accurate measurements, then, a dry block calorimeter should be used. To make a power measurement with a dry block calorimeter type of power meter, one need only zero the meter with the Power Range switch set to the lowest scale (with no r-f input). The range switch is then set to the appropriate range, the r-f is introduced at the r-f input jack and the power is read directly from the meter. Accuracies of the order of 1.5-2.5% for the calorimeter and 2% for the instrumentation of the power meter are attainable. When power measurements are made, the VSWR in the line should be known accurately so that a correction for this source of error can be calculated. Thus, if the generator VSWR is unity (generator impedance, Z_g, is equal to the characteristic impedance, Z_o, of the uniform, lossless transmission line used), the power indicated on the power meter, P_m, will be less than the available power, P_a, being transmitted by the generator (see Fig. 12). Thus,

$$P_a = \frac{P_m}{1 - |\Gamma|^2}$$

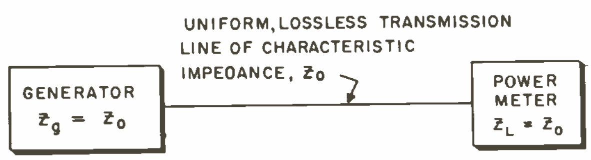


Fig. 12 (r): Matched generator to an unmatched load.

Whenever power measurements greater than 0.5w are to be made, sampling methods using directional couplers which sample a precisely known quantity of power from the main line may be used. Alternatively, the unknown power may be attenuated by a known amount with the use of a precision attenuator. The high power is then calculated from the power meter reading and the value of attenuation used.

Conclusion

The foregoing statements have only touched lightly on the various techniques of the measurements discussed. For example, atomic frequency standards for measuring frequency have not been mentioned. In the measurement of power, a volume could be written on the analysis of errors to be considered in making those measurements. Similarly, much information is available in the literature concerning VSWR, impedance and attenuation measurements. Among other sources, microwave manufacturers are eager to provide technical information which can be of great help to the engineer. A good source is the PRD Reports from which much of the information contained herein has been derived.

* * *

By W. W. WHATLEY
Senior Test Engineer
Hughes Aircraft Co.
Tucson, Arizona

Measuring Pulse Rate-of-Displacement

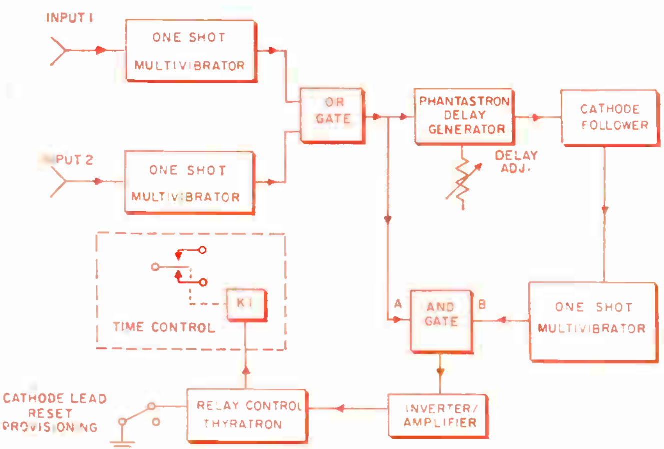
Time required to achieve a pre-selected displacement between two time related pulses must often be measured. A circuit is described which automatically makes this measurement using a simple combination of AND and OR gates, and a delay generator.

MANY pieces of equipment make use of pulses. These pulses can take on many forms in size, shape, and timing relationship. Regardless of characteristics, the pulse must be measured or analyzed during design and maintenance.

One of the tougher jobs is to measure the rate of change[1] in the intervals between two time-related pulses at certain increments in time, when one pulse is driven, or allowed to move randomly, from time coincidence with respect to the other.

With the design details given here, a circuit can be built which automatically makes the measurements. This circuitry can be adapted to other types of pulse measurements.

Fig. 1. Circuit is actuated by two synchronized pulse signals which are of sufficient amplitude to trigger the input multivibrators.



One shot multivibrators (Fig. 1) are connected in series with each input so that the OR gate will receive impulses of constant amplitude and duration at both of its inputs.

Outputs of the OR gate connect through a Phantastron delay circuit to input B of the AND gate, and directly to input A of the AND gate.

When the pulses at inputs A and B of the AND gate are in time coincidence, there is an output from the gate. This output is coupled to the Inverter/Amplifier (I/A).

The signal appearing at the output of the I/A is fed to the Relay Control Thyratron causing it to fire. Plate current, flowing in the Thyratron, energizes the timer control relay K1 which in turn controls a basic time measuring device.

A reset line is provided for the Thyratron circuit enabling remote resetting of the timer control relay.

Operation

When the two input signals are in time coincidence, the phantastron delay circuitry is energized simultaneously with the occurrence of the input signals. The delayed output signal is coupled to input B of the AND gate and the undelayed signal is coupled to input A of the AND circuit. Fig. 2 shows the time relationship between these pulses.

Since the signal being applied to input B of the AND circuit is delayed relative to the signal applied to input A of the AND circuit, there is no output

1. Rate of change is the total time required for a given time separation to occur between input pulses, regardless of directions of movement.

Rate of Displacement *(Continued)*

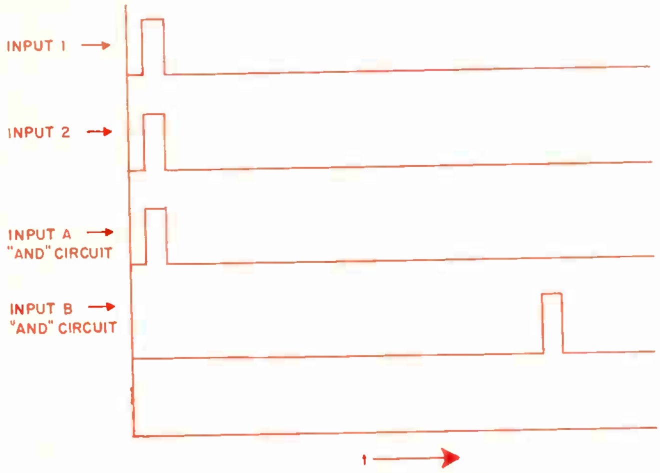


Fig. 2. Pulse time relationship when inputs 1 and 2 are in coincidence.

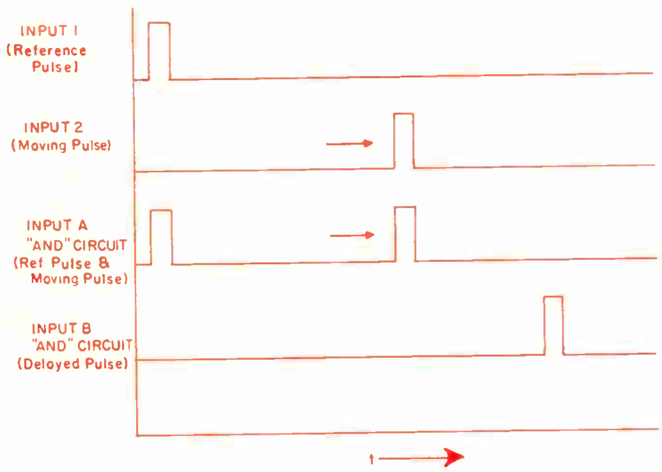
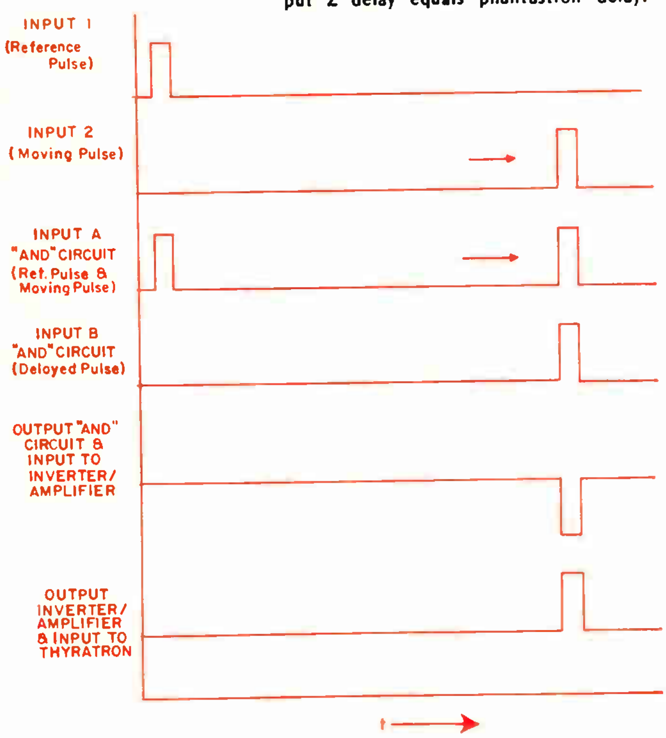


Fig. 3. Pulse time relationship when input 2 is being delayed relative to input 1.

Fig. 4. Pulse time relationship when input 2 delay equals phantastron delay.



from the AND gate. Consequently, the I/A and Thyratron remain in their quiescent states.

If it is assumed that one input signal provides a time reference and that the other input is being displaced relative to the reference pulse, it is possible to measure the time required for the second pulse to move a pre-determined distance. This is a measure of the rate of change in the time domain.

Whichever pulse occurs first will cause the phantastron delay circuit to generate one cycle of delay. During the period of this delay, the phantastron is insensitive to all other incoming trigger pulses. As long as the second input pulse does not lag the first by an amount equal to the phantastron delay, there is no output from the AND gate and the circuit remains in its quiescent state the same as when the two input pulses were in coincidence. Fig. 3 shows this relationship.

Inputs to the AND gate will be in time coincidence when the pulse being displaced from the time reference has moved an amount equal to the phantastron delay. There will then be an output signal from the AND gate, I/A, and Relay Control Thyratron, thus energizing the timer control relay K1, Fig. 4.

If the timer control circuitry is so arranged that the timer begins to operate at the instant initial coincidence is lost, and stops with the energizing of the timer control relay, the timer will then read the rate of change between the two input pulses at any discrete interval of time as selected by the adjustment of the phantastron delay circuit. That is:

$$\text{RATE OF CHANGE} = \frac{\text{TIME DISPLACEMENT}}{\text{TIMER READING}}$$

Time displacement can be set to any desired time by adjusting the phantastron delay.

Circuit Description

Waveform information was measured under conditions specified in notes of Fig. 5. Input pulses at P1 and P2 must be at least 10 volts in amplitude and 0.25 µsecs in width. Diodes CR1 and CR3 are used to limit negative voltage excursions at the grids of tubes V1 and V10. The pulse through P1 triggers one shot multivibrator V1 and the pulse input to P2 triggers one shot multivibator V10. Time constants of these multivibrators (C2, R1, R6, and C4, R16, R20) are selected so that the duration of their output pulses is approximately 0.5 µsecs. Controls R2 and R21 are used to adjust the multivibrator outputs to equal amplitudes, assuring constant amplitude and duration inputs to the OR gate V2.

Output of the OR gate is taken across R8 and coupled through C8 to the suppressor grid of phantastron tube V4, and through C15 to the control grid of the AND circuit V7.

Bias for the suppressor grid of the phantastron is obtained by plate current through cathode resistor R23 and by voltage divider R12 and R22. Bias voltage thus developed insures that the phantastron will only function upon receipt of a trigger pulse of sufficient amplitude.

Tube V3a clamps the plate voltage of V4, determining the delay characteristics of the Phantastron

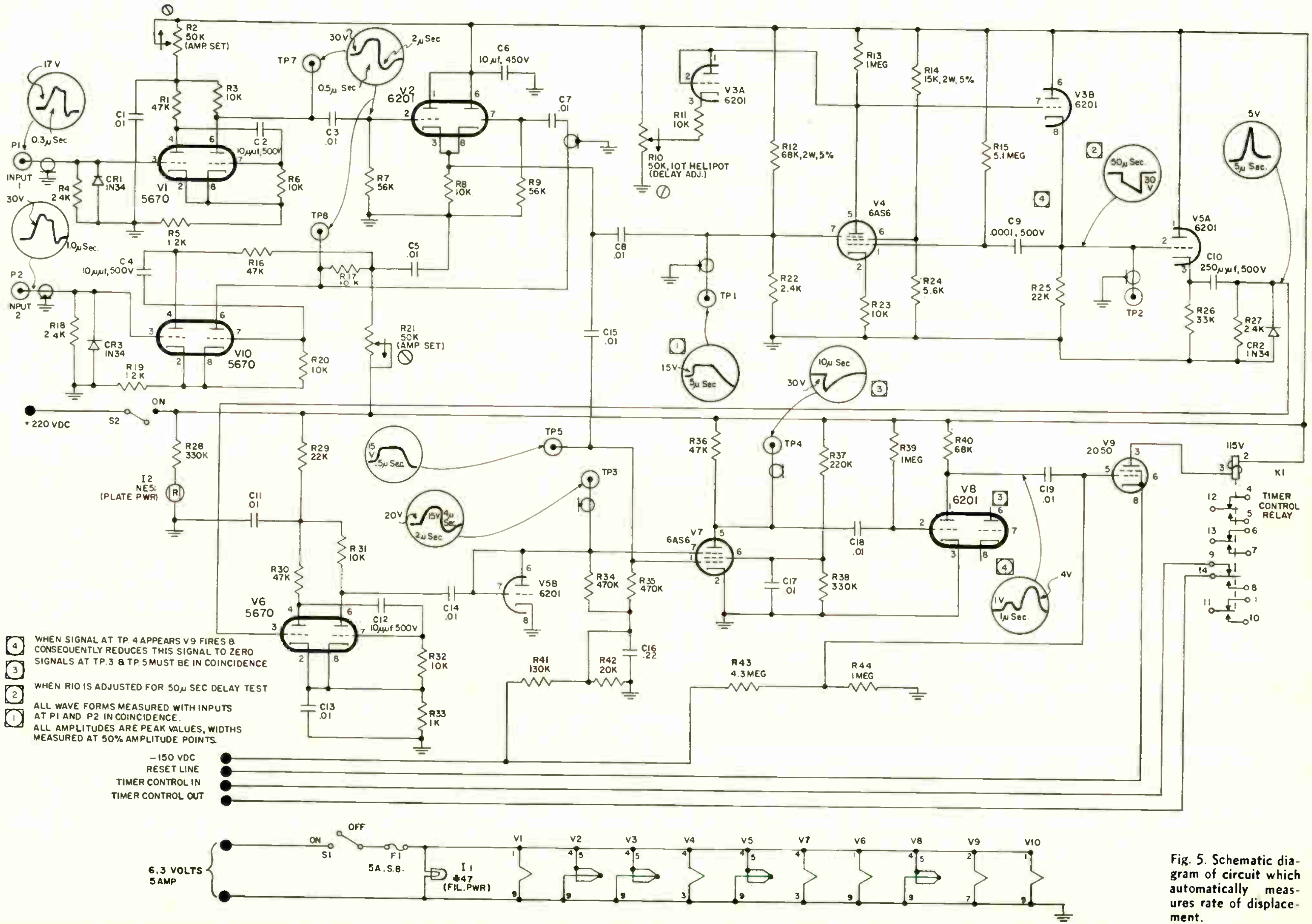


Fig. 5. Schematic diagram of circuit which automatically measures rate of displacement.

Rate of Displacement *(Concluded)*

circuit. Level of this clamp voltage can be set by adjustment of R10. Thus, discrete increments of time for which measurements are desired, may be selected.

Tube V3b serves as a recovery time cathode follower for the Phantastron circuit. In normal operation, a phantastron has a rather slow recovery time due to recovery time constant, consisting of control grid circuit capacitance and resistance. Addition of a cathode follower to the grid and plate circuits, as shown in Fig. 5, provides a low impedance discharge path for the grid circuit capacitor, greatly improving recovery time of the phantastron.

An output from the phantastron delay circuit is derived across cathode resistor R25 of the recovery time cathode follower V3b. This signal is connected to the grid of V5a, a cathode follower used for isolation purposes. Its output is coupled through a differentiating network, consisting of C10 and R27, to the grid of a one shot multivibrator V6. Diode CR2 in this grid circuit is used to clip the negative portion of the differentiated signal.

Capacitor C14 couples the output of the multivibrator V6 to the suppressor grid input of the AND gate V7. V5b is wired as a diode and is used to prevent the suppressor grid of V7 from going possitive and drawing grid current which could result in damage to the tube.

Bias voltage for both the control grid and the suppressor grid of the AND gate is obtained by means of a fixed voltage divider from the negative voltage supply.

When the inputs to the AND gate are coincident, the signal from the plate of that tube is fed through C18 to the control grid of I/A V8. Output of this stage is in turn coupled to the grid of the Thyratron V9, causing it to fire and energize timer control relay K1.

In the circuit shown, the clutch voltage to an electrical timer is fed through normally closed contacts of K1. This voltage is applied simultaneously with the beginning of drifts of the pulses whether random or forced. When the relay energizes at the end of the measured drift period, the timer stops. Thus, the rate of drift has been recorded on the electric timer.

Pin 8 of the Thyratron V9 has been connected to a terminal on the power input connector to provide a remote reset capability for the circuit. By placing a switch in this circuit its continuity to ground can be interrupted. This returns relay K1 to its initial state allowing additional measurements to be made.

Performance

The circuit described has been in use for a considerable period of time and the results have been excellent. It has been used to measure drift rates for time changes of 50 to 500 μsecs. at repetition rates of 1,000 to 2,000 cps. Maximum drift time which can be selected for measurement for a given repetition rate is approximately equal to ¾ the period of the particular repetition rate. Further, it is obvious that if delay periods radically different from those for which the circuit was initially designed are required, it will be necessary to change the time constant in the phantastron control grid circuit. This is a simple and straightforward requirement and no difficulties should be anticipated.

Relay K1 was used to control a motor-driven electrical timer. By proper selection of circuit voltages and configuration, virtually any type of timing device can be used.

Acknowledgments

The author wishes to express his appreciation to Mr. W. W. McGehee, Engineering Supervisor, California Technical Industries, and Mr. R. W. Krawec for their assistance in the conception and development of this system.

Decibels (db) and Power, Voltage, & Current Ratios

Power Ratio	Voltage and Current Ratio	Decibels
1.0233	1.0116	0.1
1.0471	1.0233	0.2
1.0715	1.0351	0.3
1.0965	1.0471	0.4
1.1220	1.0593	0.5
1.1482	1.0715	0.6
1.1749	1.0839	0.7
1.2023	1.0956	0.8
1.2303	1.1092	0.9
1.2589	1.1220	1.0
1.3183	1.1482	1.2
1.3804	1.1749	1.4
1.4454	1.2023	1.6
1.5136	1.2303	1.8
1.5849	1.2589	2.0
1.6595	1.2882	2.2
1.7378	1.3183	2.4
1.8197	1.3490	2.6
1.9055	1.3804	2.8
1.9953	1.4125	3.0

Power Ratio	Voltage and Current Ratio	Decibels
2.2387	1.4962	3.5
2.5119	1.5849	4.0
2.8184	1.6788	4.5
3.1623	1.7783	5.0
3.5481	1.8836	5.5
3.9811	1.9953	6.0
5.0119	2.2387	7.0
6.3096	2.5119	8.0
7.9433	2.8184	9.0
10.0000	3.1623	10.0
12.589	3.5481	11.0
15.849	3.9811	12.0
19.953	4.4668	13.0
26.119	5.0119	14.0
31.623	5.6234	15.0
39.811	6.3096	16.0
50.119	7.0795	17.0
63.096	7.9433	18.0
79.433	8.9125	19.0
100.00	10.0000	20.0

Power Ratio	Voltage and Current Ratio	Decibels
158.49	12.589	22.0
251.19	15.849	24.0
398.11	19.953	26.0
630.96	25.119	28.0
1000.0	31.623	30.0
1584.9	39.811	32.0
2511.9	50.119	34.0
3981.1	63.096	36.0
6309.6	79.433	38.0
10^4	100.000	40.0
$10^4 \times 1.5849$	125.89	42.0
$10^4 \times 2.5119$	158.49	44.0
$10^4 \times 3.9811$	199.53	46.0
$10^4 \times 6.3096$	251.19	48.0
10^5	316.23	50.0
$10^5 \times 1.5849$	398.11	52.0
$10^5 \times 2.5119$	501.19	54.0
$10^5 \times 3.9811$	630.96	56.0
$10^5 \times 6.3096$	794.33	58.0
10^6	1,000.00	60.0
10^7	3,162.3	70.0
10^8	10,000.0	80.0
10^9	31,623	90.0
10^{10}	100,000	100.0

To convert:
Decibels to nepers multiply by 0.1151.
Nepers to decibels multiply by 8.686.

Where the power ratio is less than unity, it is usual to invert the fraction and express the answer as a decibel loss.

How to . . .

Detect and Record

INDUSTRY has been looking more and more toward electronics as a means of providing automatic high quality production. In this field it is becoming increasingly important not only to provide a suitable control system, but also to keep an accurate permanent record of various process parameters.

Modern recorders are, for the most part, sensitive only to variations in electrical quantities. If the parameter to be recorded is not electrical, it must be converted to an electrical signal. This conversion is accomplished by a suitable transducer.

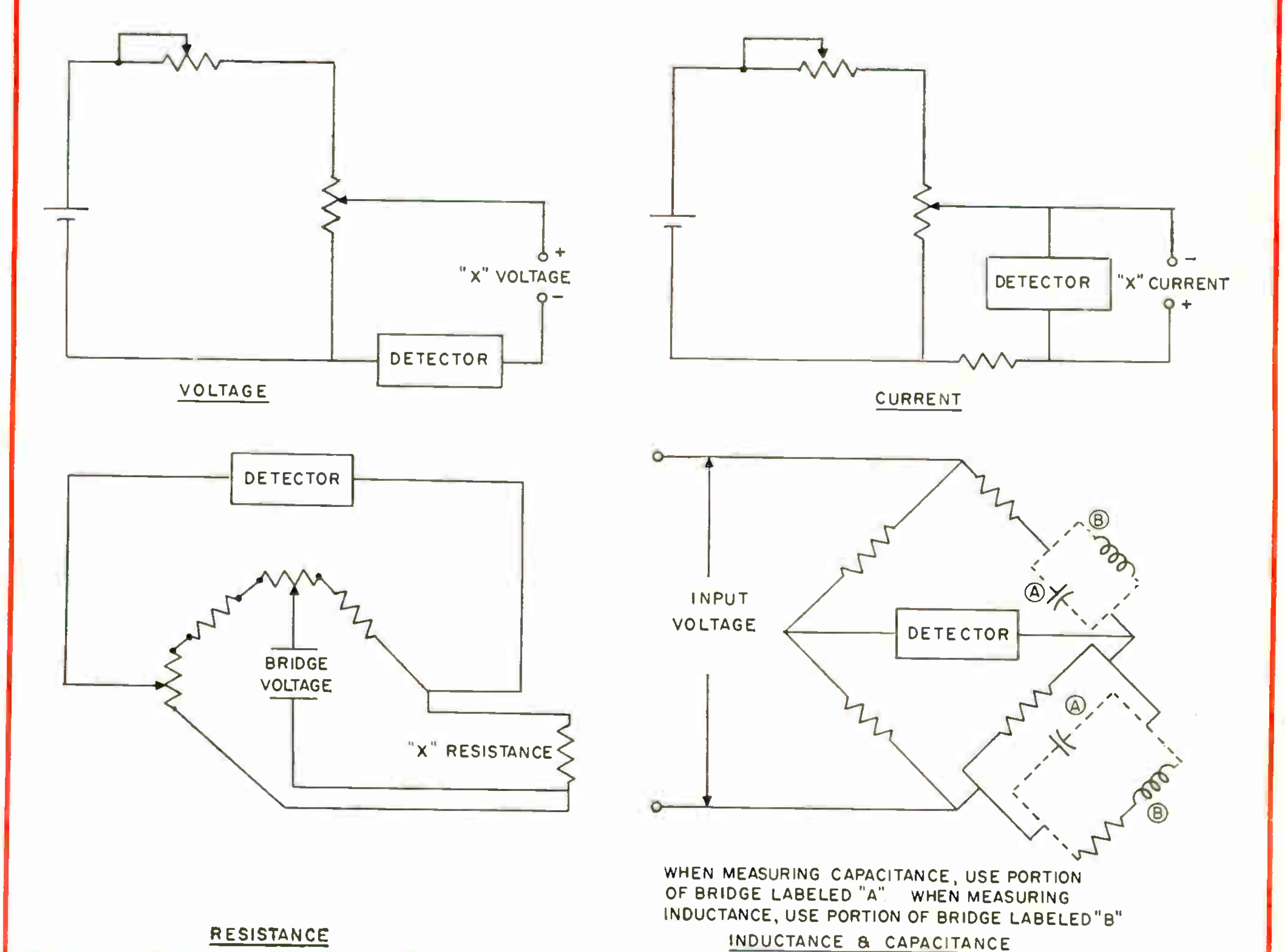
The chart on the following page lists the basic types of transducers, the physical quantity they detect and the electrical output they produce. Since different electrical outputs are produced, different electrical circuits must be employed to record these outputs.

The basic circuits are illustrated below. The most commonly used circuits for recording variations in voltage and current are of the potentiometer type. Bridge type circuits are used to record variations in resistance, capacitance and inductance.

In some cases, it is desirable to use the recorder for actual control of the process. Along these lines some recorders are designed with a control system incorporated within the recorder; in others, suitable attachments are available for adapting the recorder as a control mechanism.

(*Continued on page G14*)

BASIC RECORDER CIRCUITS



MEASUREMENT & TEST EQUIPMENT

TRANSDUCERS

Type	Measurand	Units	Output	Recommended Recorder Circuit
A–C Current, Voltage & Power Detector				
Thermal Converter	A–C volts, amps, watts	Volts, amps, watts, vars	Voltage	Potentiometer
Acceleration Detectors				
Accelerometer	Acceleration	"g's"	Resistance	Wheatstone Bridge
Accelerometer	Acceleration	"g's"	Capacitance	Wien Bridge
Accelerometer	Acceleration	"g's"	Inductance	Wien Bridge
Accelerometer	Acceleration	"g's"	Voltage	Potentiometer
Color Detector				
Phototube	Wavelength	Å	Current	Potentiometer
Conductance Detector (in liquids)				
Conductivity Cell	Electrolytic Conductance	mhos	Resistance	Wheatstone Bridge
Density Detectors				
Probe Plummet Chamber	Liquid Density	g/cc	Current	Potentiometer
Radioactive Density Gage	Gas & Slurry Density	g/cc	Current	Potentiometer
Smoke Gage	Smoke Density		Current	Potentiometer
Displacement Detector				
Displacement Gage	Displacement	Lineal	Resistance	Wheatstone Bridge
Displacement Gage	Displacement	Lineal	Capacitance	Wien Bridge
Flow Detector				
Flow Meter	Flow Rate	Note A	Resistance	Wheatstone Bridge
Flow Meter	Flow Rate	Note A	Inductance	Wien Bridge
Turbine Flowmeter	Flow Rate	Note A	Voltage	Potentiometer
Frequency Detectors				
Magnetostrictive Devices	Vibration	cps	Voltage	Potentiometer
Piezoelectric Devices	Vibration	cps	Voltage	Potentiometer
Gas Composition Detectors				
Hot-Wire Platinum Gage	Vapor Composition		Resistance	Wheatstone Bridge
Infrared Absorption Cell	Gas Composition	% Composition	Voltage	Potentiometer
Thermal Conductivity Cell	Gas Composition	% Composition	Voltage	Potentiometer
Humidity Detectors				
Coaxial Capacitor Tube	Humidity	%	Capacitance	Wien Bridge
Hygrometer	Humidity	%	Resistance	Wheatstone Bridge
Length Detectors				
Continuous Length Indicator	Length	Lineal	Voltage Pulse	Counter
Level Detectors				
Level Indicator	Liquid Level	Lineal	Resistance	Wheatstone Bridge
Level Indicator	Liquid Level	Lineal	Capacitance	Wien Bridge
Level Indicator	Liquid Level	Pressure	Voltage	Potentiometer
Light Detectors				
Barrier Layer Photocell	Light	Note B	Voltage	Potentiometer
Photoconductive Tube	Light	Note B	Resistance	Wheatstone Bridge
Phototube	Light	Note B	Current	Potentiometer
Moisture Detectors				
Bead Thermistors	Moisture	Degrees	Resistance	Wheatstone Bridge
pH Detectors				
Glass Electrode	pH Concentration	pH	Voltage	Potentiometer
Pressure Detectors				
Bellows Pressure Gage	Pressure	Pressure	Inductance	Wien Bridge
Bourdon Tube	Pressure	Pressure	Voltage	Potentiometer
Capacitive Pressure Gage	High Pressure	psi	Capacitance	Wien Bridge
Cold Cathode Ion Gage	Low Vacuum	Microns of Hg	Current	Potentiometer
Ion Gage	High Vacuum	Microns of Hg	Voltage	Potentiometer
Strain Gage	Pressure	psi	Resistance	Wheatstone Bridge
Thermocouple Pressure Gage	Abs. Pressure	Microns of Hg	Voltage	Potentiometer
Radiation Detectors				
Ion Chamber	Ionizing Radiation		Current	Potentiometer
Ohmart Cell	Ionizing Radiation		Current	Potentiometer
Speed Detector				
Photocell Gage	Velocity	Velocity	Voltage Pulses	Counter
Tachometer	Rotational Velocity	RPM	Voltage	Potentiometer
Strain Detector				
Strain Gage	Stress, Strain	Note C	Resistance	Wheatstone Bridge
Temperature Detector				
Bolometer	Temperature	Degrees	Resistance	Wheatstone Bridge
Contact Thermometer	Temperature	Degrees	Voltage	Potentiometer
Pyrometer	Temperature	Degrees	Voltage	Potentiometer
Thermistor	Temperature	Degrees	Resistance	Wheatstone Bridge
Thermocouple	Temperature	Degrees	Voltage	Potentiometer
Thermopile	Temperature	Degrees	Voltage	Potentiometer
Thickness Detectors				
Radioactivity Gage	Thickness	Lineal	Pulses	Counter
Ultrasonic Gage	Thickness	Lineal	Current	Potentiometer
X–Ray Gage	Thickness	Lineal	Voltage	Potentiometer
Viscosity Detector				
Flow Meter	Viscosity	Centipoise	Voltage	Potentiometer
Width Detector				
Phototube Gage	Width	Lineal	Current	Potentiometer

NOTE A – Depending on the application, units may be a measure of linear velocity (ft./sec., in./min., etc.) or volume velocity (gal./min., cu.ft./sec., etc.)

NOTE B – Depending on the application, units may be a measure of wavelength (Angstroms) or intensity (candles).

NOTE C – Depending on the application, units may be a measure of stress (force per unit area, e.g. – psi) or strain (deformation per unit length, e.g. – inches per inch).

Many manufacturers have developed equipments which take advantage of the excellent calibration accuracy which VLF transmissions provide. But often, the techniques required are confusing to those accustomed to high frequency and time comparison methods only. This article clarifies the situation for users and prospective users.

VLF Transmissions Aid in . . .

Calibrating Frequency Standards

By DAVID RIVKIN

Measuring Instruments
Motorola, Inc.
4501 W. Augusta Blvd.
Chicago 51, Ill.

THE missile and space age demands greater accuracies and stabilities than are obtainable from comparison with HF standards stations. In 1959, the first of the VLF stations went on the air at Balboa, Canal Zone. This station, NBA at 18.0 KC, operated by the U. S. Navy has since been joined by an ever-increasing network of VLF stations. With power outputs up to 2 megawatts, highly stable propagation characteristics, and long range reception, the current network of VLF stations provides the ability to calibrate frequency standards on a world-wide basis to within 1 x 10^{-10} in relatively short time.[1]

HF Limitations

Until a few years ago, frequency standards were calibrated against HF stations such as WWV and WWVH. Because of unstable HF radio propagation characteristics, the best accuracy that may be obtained by frequency comparison, even over a period of several days' observation, is limited to between 1 x 10^{-8} and 5 x 10^{-9}. Using either an electronic counter or stable electro-mechanical clock to count the time intervals between time ticks, *comparison* accuracy of a couple parts in 10^{10} may be obtained over a period of a few weeks. However, besides the time required for the measurements, rather complex computations are involved.

VLF and LF Characteristics

Transmissions at VLF (3-30 KC) and LF (30-300 KC) have many unique characteristics when compared to HF transmissions (3-30 MC). These traits are:

1. Remarkable phase stabilities permitting frequency synchronization to 1 x 10^{-10} or better in a relatively short time,
2. Long distance (6,000 miles or better) *reliable* reception* making single and /or double channel receivers practical and feasible,
3. Diurnal shift predictable in time of occurrence,
4. Relative immunity to disturbances caused by thermonuclear explosions,

Fig. 1: Since there is no servoloop, no shift, variation, or correction is made on the outputs but rather their accuracy is measured; measurements need a whole cycle.

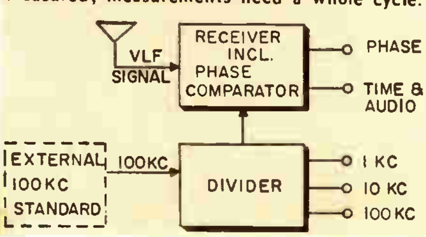
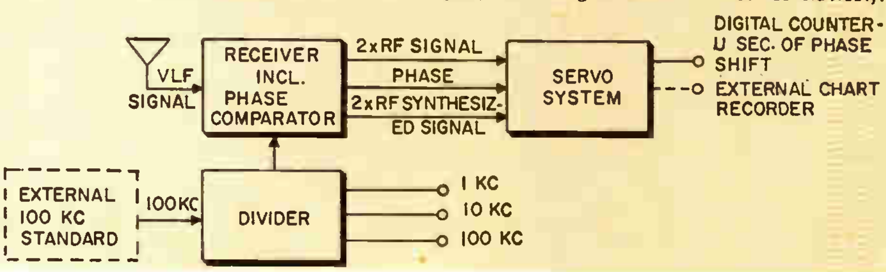


Fig. 2: By the addition of a servo system which is operated by the phase error between received VLF signal and synthesized VLF signal, measuring time is reduced considerably.



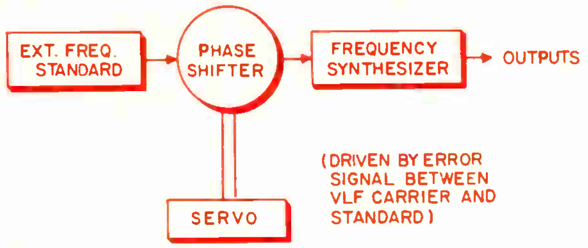
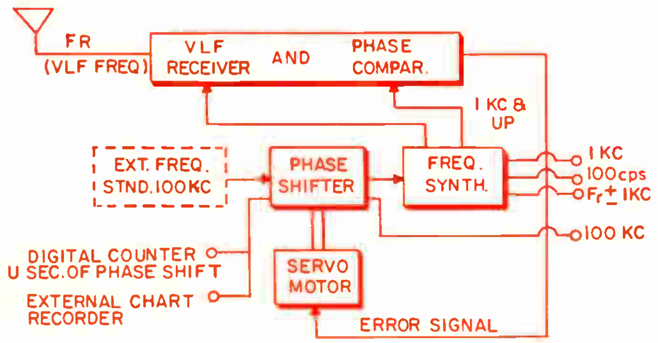


Fig. 3a: In this system the phase shifter output is apparently always phase coherent with VLF signal; however, this is not the case.

Fig. 3b: Though more expensive due to the addition of the output phase shifter, this system offers no more compensating advantages.



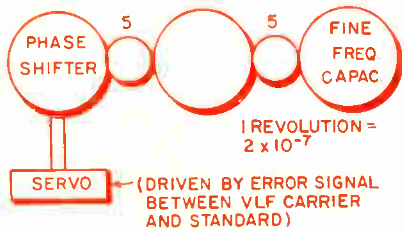


Fig. 4a: Mechanical connection between the resolver and the fine frequency capacitor.

Fig. 4b: This oscillator is continually kept on frequency by servo system operation which drives the oscillator's frequency capacitor.

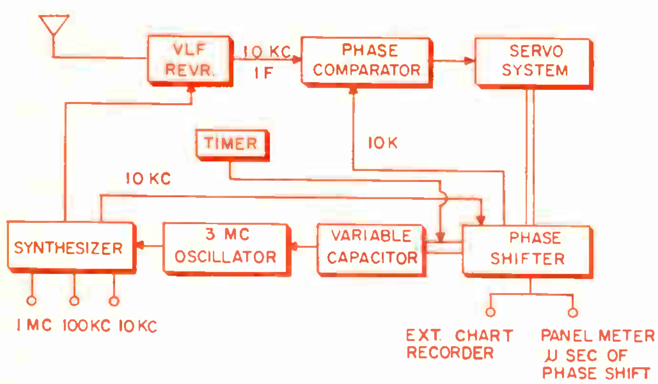
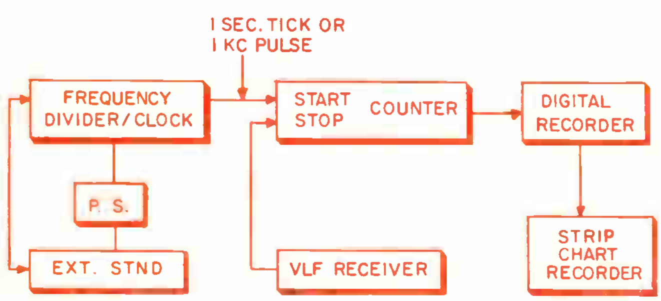


Fig. 5 (below): Though apparently most expensive of the methods suggested, this system's cost may be reduced by availability of equipment.



Frequency Standards *(Continued)*

5. Inability to synchronize clocks to better than 0.5 msec because of the high antenna rise time of the VLF pulse (15 msec at 18 KC), and
6. Transmission accuracies of 1×10^{-10} or better.

A moderately priced cesium beam standard (about $15,000) can only be set to an accuracy of 1×10^{-9} unless it is referenced to an external standard such as VLF transmissions.** We can see that the use of VLF transmissions allows one to calibrate and maintain frequency standards to an order of stability and accuracy not heretofore obtainable at a reasonable cost in equipment or time.

VLF transmission accuracy is controlled by the world's most stable crystal standards which are referenced to cesium standards. These standards are in turn compared with the speed of rotation of the earth. By putting the complex equipment at the transmitter, the VLF receiver user obtains the benefit of many tens or hundreds of thousands of dollars of frequency standards at a nominal cost. Also, state of the frequency art advances will be incorporated at the transmitter. The VLF user will, therefore, have essentially an obsolescent-free system.‡

Even though VLF transmission use for frequency standard calibration is new, the system's merits have caused several manufacturers to enter the field. A number of different approaches or methods have resulted; this caused considerable confusion, since most people are familiar only with the methods of HF and time comparison.

1. Beat Frequency-Individual Observation

This is the least expensive but most time consuming and least satisfactory method of calibrating a frequency standard. One may record the beat difference on a chart recorder. The reason for excessive time consumption is the low frequency of the received signal. If the received signal is NBA at 18.0 KC, it takes over 15 hrs to obtain one full cycle for a difference in frequency of 1 part in 10^9 or more than 7½ hrs to record one half of the beat note:

$$T = \frac{\Delta F}{F_r}$$

where ΔF is the frequency difference between the received signal, F_r, and the local oscillator, and T is the time required for one beat note cycle. Thus for NBA,

$$T = \frac{1 \times 10^9}{18 \times 10^3} = 55{,}556 \text{ sec} = 15.4 \text{ hours.}$$

If the frequencies differ by only one part in 10^{10}, then *ten times* as much time will be required.

* The Switzerland Time Observatory at Neuchatel reports uninterrupted reception of NBA since 1959, conversation with the author by J. Bonanomi, Director, at 1961 WESCON, San Francisco.

** More expensive cesium standards provide accuracies of 2×10^{-11} without reference to an external standard.[2]

‡ The accuracy to which a frequency standard may be set is limited by both its long term and short term stability. Crystal frequency standards, commercially available, have upper stability limits of a few parts in 10^{10}/day.

In Fig. 1, the phase comparison is made at twice the received frequency so that the time required to hear one beat note is one-half that calculated above.

II. Servo System Driven Recorder Outputs

The greatest drawback to Method I is the time required to achieve accuracies of parts in 10^9 and or 10^{10}. This can be improved by adding a servo system, Fig. 2, operated by the phase error between the received VLF signal and the synthesized VLF signal (here twice the VLF signal). This permits accuracies of parts in 10^{10} in only a few hours.

A counter dial calibrated in microseconds accumulates the phase shift error which may be converted into frequency:

Table 1

METHOD	APPROXIMATE PRICE	ADVANTAGES	DISADVANTAGES	RATING
I. Best Frequency Individual observation.	\$1,500 & up	Price	Very long time required to make measurements to parts in 10^9 and 10^{10}.	Not recommended.
II. Servo System Driven Recorder outputs. (Drift Time Measuring).	\$2,500 & up	Measurements to accuracies of a few parts in 10^{10} within a few hours.	External Standard must be manually adjusted.	Recommended for manual setting of external frequency standard on frequency.
III. Phase shifting the output.	\$3,000–\$4,700	Same as Method II.	1–Very poor short term stability. 2–Follows diurnal shift. 3–More expensive than Method II with no compensating advantages.	Not recommended for operating frequency standard. Acceptable for use as in Method II.
IV. Internal local oscillator. Fine Frequency capacitator adjusted by Servo System.	\$5,900	1–Completely automatic frequency standard. 2–Good short term stability. 3–Eliminates diurnal shift problem. 4–Can also be used as in Method II.	More expensive but includes internal oscillator.	Recommended for operating frequency standard and/or manually setting external frequency standard.
V. Electronic Counter	\$10,500	Same as Method II.	1–Most expensive. 2–Most complex.	Acceptable only when all or most of equipment required is already available.

Table 2

PRINCIPAL LF AND VLF FREQUENCY AND TIME STANDARDS STATIONS

CALL SIGN	NAA	GBR	NBA	NPG	NPM	WWVL	NSS	WWVB	MSF
PLACE	Cutler, Me., U.S.A.	Rugby. U. K.	Balboa, C. Z., Panama	Jim Creek, Wash., U. S. A.	Lualualei. Hawaii, U. S. A.	Sunset, Colo., U. S. A.	Annapolis, Md., U. S. A.	Boulder, Colo., U. S. A.	Rugby, U. K.
LATITUDE LONGITUDE		52° 22′N 1° 11′W	9°04′30″N 79°34′30″W			40°02′15″N 105°27′05″W		39°59′30″N 105°15′55″W	52°22′N 1°11′W
FREQUENCY ACCURACY STABILITY	14.7 KC $\pm 2\times10^{-10}$ 5×10^{-11} in 1962	16.0 KC	18.0 KC $\pm 2\times10^{-10}$ 5×10^{-11}	18.6 KC $\pm 2\times10^{-10}$ 5×10^{-11}	19.8 KC $\pm 2\times10^{-10}$ 5×10^{-11}	20.0 KC $\pm 5\times10^{-11}$ 2×10^{-11}	22.3 KC $\pm 2\times10^{-10}$ 5×10^{-11} in 1962	60.0 KC $\pm 5\times10^{-11}$ 2×10^{-11}	60.0 KC
OFFSET	-13×10^{-11} during 1962	-130×10^{-10}	Same	Same	Same	Same	Same	Same	Same
MAXIMUM POWER STATUS SCHEDULE	2000 KW Stabilized Continuous Maint. as required	300 KW Stabilized Daily approx. 22 hrs,	300 KW Stabilized Continuous Down for Maint. Wed. 1200–2100	1000 KW Stabilized Continuous except 1600–2400 UT on Thurs.	500 KW Stabilized Continuous except 1800–2300 UT on Wed.	15 Watts Stabilized Continuous	500 KW Stabilized Continuous Maint. as required	2 Watts Stabilized Continuous except 1430–1530 UT daily	10 KW Stabilized Daily 1430–1530 UT
MODULATION	CW	Int. time signals telegraphic traffic	CW-Time Pulses	CW	CW	CW Call sign at min. 00. 20, 40 each hour	CW	CW Call sign at min. 00, 20, 40 each hour	1000 cps for 5 min. in each 15 min.
TIME SIGNALS	—	0955–1000 1755–1800 UT	Yes	—	—	None at present	—	None at present	—
SPECIAL TRANSMISSIONS	30–40 min. past each hour	—	Vary—see current Time Service Announcement	40–50 min. past each hour, also tests on other frequencies	50–60 min. past each hour	—	50–60 min. past each hour	—	—

Frequency Standards *(Concluded)*

$$\frac{\Delta F}{F} = \frac{\Delta T}{T}.$$

If there were a drift of 36 μsec in 5 hrs (18 x 10^9 μsec), the drift rate of the external standard would be

$$\frac{36\ \mu\text{sec}}{18 \times 10^9\ \mu\text{sec}} = 2 \text{ parts in } 10^9/\text{day}.$$

An external strip chart recorder provides a more reliable and certain method of accumulating the phase shift difference. This gives a permanent record and eliminates the need of separately accumulating time as required when using the dial. The line slope shows the rate at which the external standard is drifting. The external standard can then be *manually* adjusted until a line with zero slope is obtained from the chart recorder.

In this approach, *a servo system is an absolute must for using* VLF *stations to their maximum usefulness.* The addition of the servo system, however, merely speeds up the gathering of data and reduces the time required for measuring. It does not by itself provide an accurate or corrected output; the local external standard must still be *manually* adjusted to achieve this result.

III. Phase Shifting the Output

Besides indicating the cumulative error, or drift, of the external frequency standard as done in Method II, the third, system also phase shifts the output of the external standard so that the output from the phase shifter is apparently always phase coherent with the VLF signal, Fig. 3a.

Phase shifting the output greatly reduces and appears to eliminate the need of manually correcting the local external standard to maintain the standard on frequency as compared to the VLF stations. This advantage is more apparent than real because of the very poor short term stability, caused by feeding the frequency standard output through the phase shifter as explained below. Since the output signals follow the VLF transmissions, including the diurnal shift, this system cannot be effectively used as a 24 hour-a-day or even 12 hour-a-day frequency standard.

Because the phase shifter is rotating at the difference frequency between the external standard and the VLF station, the signal frequency at the phase shifter output has apparently been corrected to be identical with the VLF station. On a long term average basis, this correction is accurate. The instantaneous or short term frequency stability for a 0.1 to 10 sec measuring period will, however, be very poor due to servo system jitter with noise, propagation variations, and hysteresis in the servo system. Thus, if the output signal at 100 KC is used as the controlling signal for a counter, it is doubtful if frequency measurements having a stability of even ± 5 parts in 10^8 can be made.

Assume that a noise burst causes the phase shifter to move at a linear rate for 5 sec, and during that period the phase shifter moves a total of 6° (1/300 rps). If the phase shifter operates at 100 KC, the noise burst will cause the frequency at the phase shifter output to be in error by $(1/300)/10^5$, or 3.3 parts in 10^8, for a time interval of 5 sec.

Since all other outputs are derived from the 100 KC signal, all signal outputs will have the same frequency error.

Presently, good standards have short term stabilities between 1 and 5 parts in 10^{10}.‡‡ Thus, this method has a potential to degrade the short term stability of a high stability frequency standard by 60 to 300 times. Also, as the phase shifting frequency is lowered, the degradation of stability becomes worse. If the phase shifting were done at 10 KC, the short term stability would be 10 times worse than shown above at 100 KC.

The long term, or *average* accuracy, is comparable to that obtained in Method II when the external standard is *manually* adjusted according to an average line drawn through the data from the strip chart recorder. Likewise, the accuracy directly out of the external standard is unaffected by the phase shifter. It would appear then that this method offers no real advantage over Method II.

IV. Internal Oscillator-Fine Frequency Capacitor Adjusted by Servo System

This approach, the most complex of the 4, is unique in one major respect: it is the only method which offers a complete within itself operating frequency standard. At a slightly higher price, an internal high stability oscillator has been added. This oscillator is continually kept on frequency by servo system operation driving the oscillator's fine frequency capacitor, Fig. 4b. Because of the extremely high servo system gear ratio and resulting long time constant of the system, the short term stability of the standard is not affected by noise and/or short term variations in VLF carrier propagation.

This system may be used as in Method II with an external oscillator. Compared to Method III, the advantages are:

1. Complete self-contained automatic frequency standard with internal high stability oscillator.
2. Better short term stability as outputs do not go through phase shifter driven by servo system.
3. Timer to disable servo correction of local oscillator during diurnal shifts. This provides greater frequency accuracy by eliminating frequency shifts during that time.

This appears to be similar to Method III which results in such poor short term stability. Going through the same calculations points up the significant difference. The simplified block diagram, Fig. 4a shows the mechanical connection between the resolver and the fine frequency capacitor.

It takes 25 revolutions of the resolver to produce a frequency change of 2 x 10^{-7}. Making the same assumption as in Method III, i.e., a 6° variation from zero phase error occurring in 5 seconds, we calculate the frequency error:

$$\text{Stability}\left(\frac{\Delta F}{F}\right) = R \times \frac{1}{K} \times \Delta f$$

$$\frac{\Delta F}{F} = \frac{6}{360} \times \frac{1}{25} \times (2 \times 10^{-7}) = 1.3 \times 10^{-10}$$

‡‡ One limit of the VLF system, or any frequency setting system, is the stability of the local oscillator. A poor local oscillator cannot be made into an excellent unit by adding a VLF receiver.

Where R is the number of revolutions of the phase shifter, K is the gear ratio constant between the capacitor and phase shifter, and Δf is the change in oscillator frequency for one revolution of the capacitor

The short term error in the previous system under the same conditions was calculated to be 3.3×10^{-8} or 250 times as bad. As already shown, the lower the frequency at which the phase shifting is done, the worse the comparison becomes.

Method IV may be analyzed in a second manner to help point up the difference between it and Method III. In Fig. 4b, we see that the servo system drives the phase shifter and this phase shifted output is fed to the phase comparator. The phase shifter, as in Method III, thus follows the short term variations in VLF carrier, noise bursts, etc. The crucial difference is that the movement of the phase shifter does not directly affect the frequency outputs of the synthesizer. The synthesizer outputs are affected by the movement of the fine frequency adjust capacitor which is geared down from the phase shifter.

The result is to provide a double servo loop; the first consisting of the rapidly moving phase shifter and the second of the slowly moving fine frequency capacitor. The result is tremendously improved short term stability or instantaneous frequency accuracy.

V. Electronic Counter

These four methods of using VLF transmissions were all directly related to one another, each being more complex than the preceding. This method takes a different tack. In equipment used, it is the most complex; and, the most expensive approach—about two to one. On the other hand, much of the equipment may already be available; then, the additional investment may be equal to or less than in the preceding methods.

The external frequency standard under test, or calibration, is used to drive a frequency divider, Fig. 5. This in turn furnishes the start signal for the time interval meter, or electronic counter. The stop signal is supplied by one of the VLF carrier cycles. For Station WWVL, which broadcasts CW, a 1 KC pulse is used to trigger the counter. The NBA carrier is keyed at a 1 pps repetition rate with carrier on for 0.3 seconds and off for 0.7 seconds. Here, a one second tick from the divider is used to trigger the counter. The frequency drift of the standard may then be calculated from the data accumulated on the digital recorder; or more conveniently, from the analog record of the strip chart recorder using the formula,

$$\Delta \frac{F}{F} = \Delta \frac{T}{T}$$

If there were a drift of 8 μsec in 3 hrs (10.8×10^9 μsec) the drift rate of the standard would be

$$\frac{8 \mu \text{ sec}}{10.8 \times 10^9 \mu \text{ sec}} = 7 \text{ parts in } 10^{10}/\text{day.}$$

Selection Criteria

After deciding which 1 of the 5 methods best meets your needs, one must still select the specific brand or manufacturer whose product will be purchased. General criteria would seem to include both communications and frequency standard experience on the manufacturer's part since the product must function as both a receiver and standard. Conservative design including adequate reserve gain to allow for future component aging and degradation is advisable. Also, a solid state product for longer trouble-free life seems almost axiomatic. Other characteristics are:

1. Modular construction using plug-ins—simpler repair and ease of adding future reception of additional stations.

2. Narrow r-f bandwidth—required to permit reception in noisy areas. Don't be misled by narrowness of entire system including servo portion. A good way to check-compare signal outputs of various units on an oscilloscope.

3. Good AGC action—required for operation over varying signal strength conditions; again check with a unit.

4. Servo system to drive recorder output—advisable for greatest use as shown under Methods I and II.

5. High gear ratio in servo system—improves short term stability in Methods III and IV and gives better results in general.

6. High quality servo components—better performance and reliability.

7. Superheterodyne receiver—more stable, easier to change frequency and preferable to have gain at more than one frequency.

8. Chart recorder output—the best way to accumulate data.

9. Signal operated relay disabling servo system—servo system to be disabled on loss of signal so that system will not hunt through noise and build up system errors.

10. Fine frequency adjust alarm indicator—applies only to Method IV. Alarm to indicate when servo system has driven oscillator out of fine frequency adjustment range. Adjustment of coarse frequency control to be at minimum of 6 month intervals.

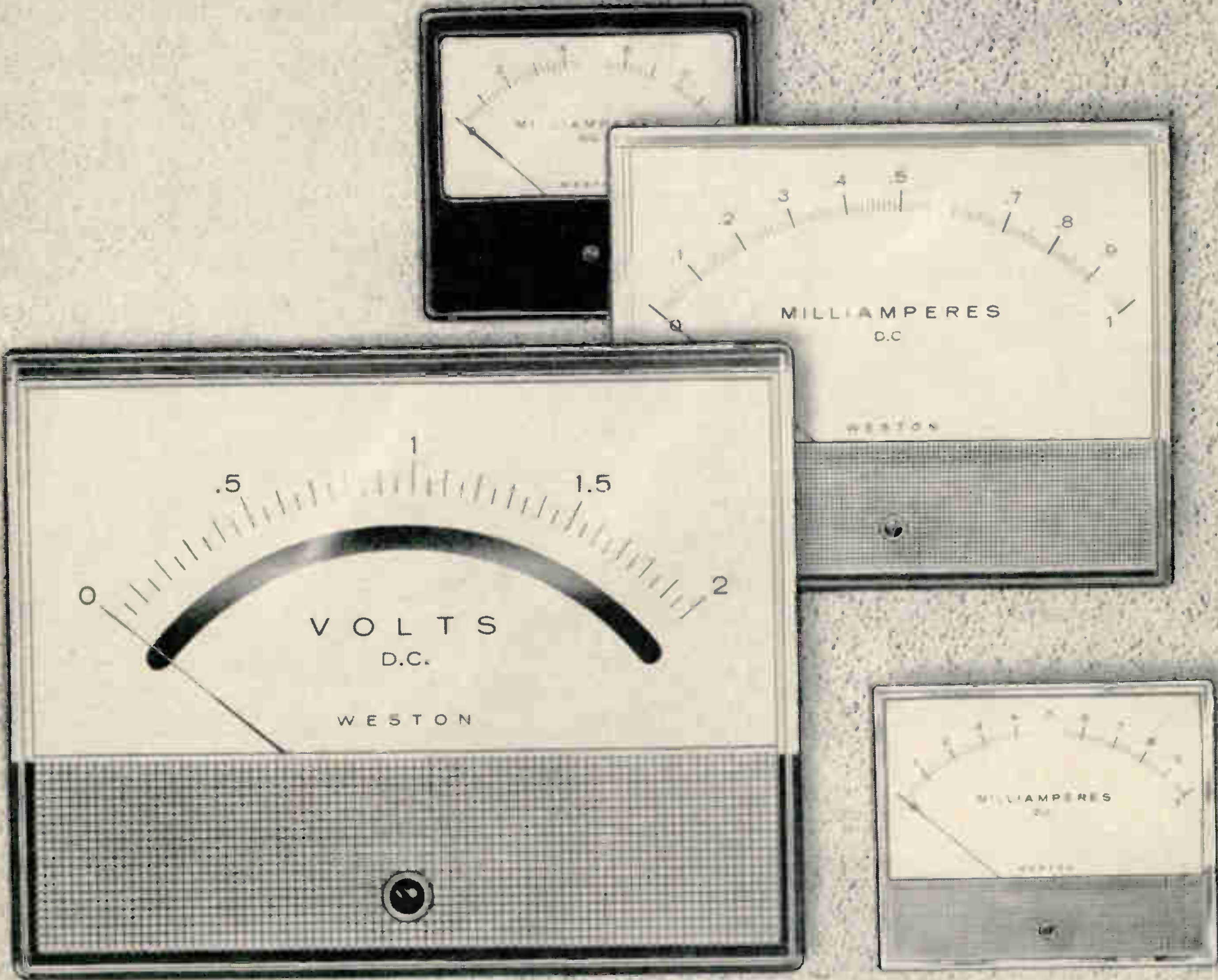
11. Solution to diurnal shift problem—applies mainly to Methods III and IV. A means is required to eliminate the frequency shift caused by the twice daily diurnal shift.

Bibliography

1. Markowitz, Dr. William, "Precise Time and Constant Frequency," *SIGNAL;* October 1960
2. Holloway, J. H., "The Cesium Atomic Beam Frequency Standard," *NEREM RECORD*, p. 122; 1961
3. Morgan, Alvin H., "Precise Time Synchronization of Widely Separated Clocks," NBS Technical Note 22, OTS, U. S. Dept. of Commerce, Wash. 25, D. C.; July, 1959
4. Pierce, J. A., "Intercontinental Frequency Comparison by Very Low Frequency Radio Transmission," *Proc. IRE*, vol. 45, pp. 794-803; June, 1957
5. Richardson, John M., "National Standards of Time and Frequency in the United States," *Proc. IRE*, vol. 48, pp. 105-106; January, 1960
6. A. H. Allan, D. D. Crombie, and W. A. Penton, "Frequency variations in New Zealand of 16 kc/s transmissions from gbr Rugby," *Nature*, vol. 177, pp. 178-179; January 28, 1956
7. L. Essen, "Standard frequency transmissions," *Proc. IEE*, vol. 101, pp. 249-255; July, 1954
8. Looney, Jr., Chesley H., "A Very Low Frequency (VLF) Synchronizing System," *Proc. IRE;* February, 1961
9. R. R. Stone, Jr., W. Markowitz, and R. G. Hall, "Time and Frequency Synchronization of Navy VLF Transmissions," *IRE Transactions on Instrumentation*, vol. 1-9, No. 2; September, 1960
10. McCoubrey, A. O., "Frequency Control by Microwave Atomic Resonance," *The Microwave Journal;* November, 1961
11. Hastings, Harris F., U. S. Naval Research Laboratory, letter of 7 March 1962
12. Markowitz, Dr. William, U. S. Naval Observatory, letter of 9 March 1962
13. United States Naval Observatory Circular No. 49, Wash. 25, D. C., 8 March 1954

NEW

FROM WESTON



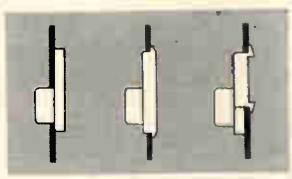
TAUT BAND

WESTON TAUT-BAND SUSPENSION SETS NEW STANDARD FOR PANEL METERS

Weston Series 1900 is the most versatile line of panel meters ever produced for general use. Instruments with taut-band mechanisms are free from friction and inertia, and offer outstanding sensitivity, reliability and uniformity from zero to full scale. 1% and 2% accuracies are standard . . . higher on special order.

Here are the facts: Weston exclusive taut band Co-planar™ suspension is the only method which assures complete control of ribbon length and tension, uniformity of torque, precise centering of moving coil, and positive protection against excessive axial and lateral motion. The instruments require extremely low driving energy, are highly resistant to vibration and shock, and may be operated in any position.

Series 1900 also sets a new standard in flexibility. Instruments with taut-band and conventional movements are completely interchangeable. They are available with Bakelite or modern, static-free plastic cases in sizes 2½" to 7½", and offer the widest choice of functions and ranges available in a single matching line. Write today for details. Dept. 62.



ANOTHER EXCLUSIVE: Only Weston Series 1900 Instruments can be mounted in three ways — conventional, flush, and recess with provision for internal illumination.

WESTON INSTRUMENTS *Division of Daystrom, Incorporated, Newark 14, New Jersey*

Aerospace Instrumentation • Bimetal Thermometers • Calibration & Test Equipment • Panel & Switchboard Meters • Photosensitive Devices • Precision Metal Film Resistors • Relays & Tachometers • Systems Design & Development

Circle 172 on Inquiry Card

New Tech Data for Engineers

Measuring Equipment

This 38-page catalog lists all physical and electrical specs. on a complete line of accelerometers, cathode followers, transistorized accelerometer-amplifiers, G-monitor power amplifiers, linear variable differential transformers and multi-channel shock and vibration measuring systems. The 1962 catalog is available from Columbia Research Laboratories, McDade Blvd. & Bullens Lane, Woodlyn, Pa.

Circle 643 on Inquiry Card

Ultrasonic Measurement

The Magnaflux Pulse Ultrasonic PS-800 tester is for internal flaw detection and wall thickness measurements. The compact lightweight unit uses longitudinal wave, shear wave, through transmission, or surface wave ultrasonic methods with contact or immersion techniques. The flaw detection provides 5 freq. ranges from 0.5 to 15MC. with video presentation on 5 in. CRT. Power is 115v, 60cps, ϕ current. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

Circle 644 on Inquiry Card

Potentiometers

Three precision potentiometers are described and illustrated in tech. data available from Cambridge Instrument Co. Ltd., 13 Grosvenor Place, London, S.W.1, England. The Microstep and Vernier Potentiometer are designed for very high precision work. Both have an accuracy of 0.001% and a smallest direct reading of 0.1μv. The Slidewire Potentiometer for use as a general purpose instrument for thermocouple testing has an accuracy of 0.01% and a smallest direct reading of 2μv.

Circle 645 on Inquiry Card

X-Ray System

Field Emission Corp., 611 3rd St., McMinnville, Ore., is offering tech. data on a Flash X-ray System for quality control. The system can be used to inspect switches, transistors, tubes, coils, relays, diodes, and plastics.

Circle 646 on Inquiry Card

Temperature Chambers

Harris Mfg. Co., 308 River St., Cambridge, Mass., is offering tech. data, 4 pages, 2-color, on their environmental testing equipment for use on a production basis. Information and equipment for such tests as fatigue resistance, electrical conductivity, control of brittleness, and resistance strength at high operating temps. is included.

Circle 647 on Inquiry Card

Instrument Catalog

A new 6-page short form catalog describing latest additions to the Krohn-Hite Corp.'s line of precision electronic instruments is now available. Included in the illustrated 2-color catalog are condensed tech. specs. on transistorized, tube regulated power supplies, ac power sources, wide-range R-C oscillators, variable electronic filters, and laboratory power amplifiers. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.

Circle 648 on Inquiry Card

Demagnetizers

This 6-page engineering bulletin covers a line of magnetizing, demagnetizing, and test equipment. Information is included on the production line permanent magnet testers (PMT 200 and PMT 400) which measures magnetic flux within ¼% repeatability. Other magnetizers described include a capacitor discharge magnetizer with models ranging from 2.5 to 8.0nf. Indiana General Corp., Magnet Div., Valparaiso, Ind.

Circle 649 on Inquiry Card

Weight/Force Measuring

"Performance Specification Guide for the Procurement of Weight and Force Measuring Systems" is made available to assist in better definition and standardization of performance specs. on weight and force measuring systems. Available from Society of Aeronautical Weight Engineers, Inc., 3946 Osler Ave., Long Beach 8, Calif. Write for the brochure under company letterhead.

Circle 650 on Inquiry Card

Current Indicator

The Elcor Current Indicator and Integrator measures and displays digitally the integral of an input current, whether constant or fluctuating. It can also be used to integrate voltages. Information is also included on a current indicator, and a current source—both offer accuracies to 1%. Elcor, Inc., 1225 W. Broad St., Falls Church, Va.

Circle 651 on Inquiry Card

Vacuum Pumps

Tech data is available on a variety of vacuum pumps, basic pumping units of 2, 4, and 6 in. systems, ionization gauge controls, and a thermocouple gauge. International Pump and Machine Works, 81 Dorsa Ave., Livingston, N. J.

Circle 652 on Inquiry Card

Level Transmitters

Tech. data describing the Bailey Mini-Line® Level Transmitting Mechanisms are available from Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio. The Mini-Line level transmitting mechanism translates the mechanical motion of a measuring mechanism (which is directly proportional to level) into a dc or ac electrical signal depending on the type used. Standard ranges, operating characteristics, indicating scale and physical characteristics are included.

Circle 653 on Inquiry Card

Temperature Measuring

Catalog No. 176, 12 pages, 2-colors, covers the complete Pyrometer line of precision temp. measuring instruments and contains full descriptions, specs., prices and uses of each. Included is the Pyro Optical Pyrometer, the Pyro Surface Pyrometer, the Pyro Micro-Optical, and a full line of interchangeable thermocouples and other accessories. Pyrometer Instrument Co., Inc., Bergenfield, N. J.

Circle 654 on Inquiry Card

Pressure Switches

This 36-page booklet is divided into 9 sections: Section I, a general glossary with definitions concerning pressure, vacuum, gauge pressure, absolute pressure, etc.; Section II, a glossary applicable to pressure actuated switches; Section III is characteristics of Meletron pressure actuated switches; Section IV, V, VI, VII and VIII include characteristics, methods, numerical designations, circuit symbols, functions and interesting uses of pressure actuated switches. Section IX includes data and reference tables on pressure including properties, conversion factors, and general reference information. Dept. 30, Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif.

Circle 655 on Inquiry Card

Electron Accelerators

Microwave linear electron accelerators (linacs) for physics, biology and chemistry research, radiography, radiation processing and therapy, are described in a 44-page booklet available from High Voltage Engineering Corp., Burlington, Mass. The illustrated 3-color brochure includes comprehensive sections on principles of operation, areas of application, specs. and performance of more than 20 HVEC machines providing 7 to 130 million electron volt energy. Available on request under company letterhead.

Circle 656 on Inquiry Card

Get the exact test signal

Hewlett-Packard pioneered and developed the resistance-capacity oscillator, available today in these versatile instruments.

A feature of the R-C oscillator circuit is its automatically varied negative feedback which provides low distortion, excellent frequency response and amplitude stability. R-C oscillators are extremely simple to operate and, because of their high stability and wide frequency range, require no tedious resetting or adjustment during operation. They are lightweight, portable, compact in size. Dependable operation is assured by clean, simple circuitry and painstaking construction from quality components.

Hewlett-Packard's years of experience in design and development of oscillators, plus continuous improvement of components and manufacturing techniques, assure you of the most dependable, rugged, useful oscillators available today.

204B Portable Oscillator, 5 cps to 500 KC.

Use it on the bench, carry it anywhere. This solid state portable oscillator offers battery or optional ac operation, is small and lightweight, gives you highly stable signals from 5 cps to 500 KC. Internal heat is small, warmup drift is negligible. Output is fully floating, isolated from both power line ground and chassis. The 204B will drive balanced and unbalanced loads and loads referenced either above or below ground.

204B maintains excellent frequency stability even with rapidly changing loads. Frequency stability over the entire 5 cps to 500 KC range is better than ±0.03%/°C from 0° to 55°C. Output is flat within ±3% at all settings of dial and range switch. Distortion less than 1%, hum and noise less than 0.05%. Output 10 mw (2.5 v rms) into 600 ohms; 5 v rms open circuit. 204B, with batteries, $275.00. AC operation optional, $25.00 extra.

200AB Audio Oscillator, 20 cps to 40 KC.

Ideal for amplifier testing, modulating signal generators, testing transmitter modulator response. Covers its range in four overlapping bands. Simple operation, just three controls. No zero setting required. High stability, with accurate tuning circuits. Output 1 watt (24.5 v) into a 600 ohm load. 200AB (cabinet), $165.00; 200ABR (rack mount) $170.00.

200CD Wide Range Oscillator, 5 cps to 600 KC.

Subsonic to radio frequencies covered in five overlapping decade bands. Used for testing servo and vibration systems, medical and geophysical equipment, audio amplifiers, video frequency circuits, etc. 85 dial divisions for reading convenience. Distortion rating less than 0.5% below 500 KC. Output 160 mw (10 v/600 ohms); 20 v open circuit. 200CD (cabinet), $195.00; 200CDR (rack mount), $200.00.

201C Audio Oscillator, 20 cps to 20 KC.

Especially designed for testing amplifiers, speakers, cross-over networks, this high power oscillator offers an output of 3 watts or 42.5 v into 600 ohms over its full frequency range. Response is 1 db full range. Attenuator adjusts output 0 to 40 db in 10 db steps, provides either low impedance or constant 600 ohm impedance. 201C (cabinet), $250.00; 201CR (rack mount), $255.00.

you need from hp

202A Function Generator, 0.008 to 1,200 cps.

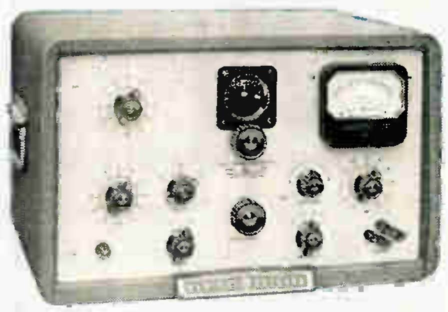
Source of transient-free sine, square and triangular waves, frequency continuously variable through 5 bands for electrically simulating mechanical, physical, medical phenomena. Stability within 1%, distortion less than 1% up to 100 cps. Sine, square or triangular waves selectable by front panel switch. Output 28 mw or 30 v p-p/4,000 ohms. 202A (cabinet), $550.00; 202AR (rack mount), $535.00.

202C Low Frequency Oscillator, 1 cps to 100 KC.

Especially convenient for measurements in the subsonic, audio and ultrasonic regions such as vibration, electro-cardiograph, electro-encephalograph. Distortion less than 0.5%, hum voltage less than 0.1%, short recovery time. Output 10 v/600 ohms. 202C (cabinet), $300.00; 202CR (rack mount), $305.00.

205AG Audio Signal Generator, 20 cps to 20 KC.

Six basic instruments combined in one for high power audio tests, gain measurements. Two voltmeters measure input and output of the device under test. Output 5 watts, adjustable. Output impedance selected by front panel switch. 205AG (cabinet), $600.00; 205AGR (rack mount), $585.00.



206A Low Distortion Audio Signal Generator, 20 cps to 20 KC.

Distortion less than 0.1% makes the 206A ideal for use in testing of FM broadcasting units and high fidelity audio systems. Metered output, variable in 0.1 db steps, +15 dbm into 50, 150, 600 ohms. 206A (cabinet) $900.00; 206AR (rack mount), $885.00.

650A Test Oscillator, 10 cps to 10 MC.

Metered output flat within 1 db full range. Voltage range is 0.00003 to 3 v. 600 ohm impedance, voltage divider furnished for 6 ohm impedance. Distortion less than 1% to 100 KC. 650A (cabinet), $550.00; 650AR (rack mount), $535.00.

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HERE IS A PRECISION "WORKHORSE"

With an order of magnitude—BETTER STABILITY of 1 x 10^{-9} per day!

0.1 to 5.0 mc high stability oscillator

Here are basic operating facts:
• 1 x 10^{-9} per day stability • 5 x 10^{-10} per hour stability • Warm up at −40°C, 11 min. to 1 x 10^{-8} • 26 VDC ±4, input voltage • At −55°C, 7 watts power consumption • −55°C to 77°C operating temperature range • Meets MIL specifications

This precision oscillator is on the job in hundreds of applications . . . and stands ready for action wherever your projects call for a precision frequency source under rugged operating conditions. Proven under rigid military environments, backed by over 2 decades of Motorola volume crystal production experience, you can count on this oscillator for unexcelled stability . . . fastest warm-up . . . lowest power needs in • Single Side-Band • Missile Systems • Navigation • Telemetering • Instrumentation

Model SLN6039A Prices on request

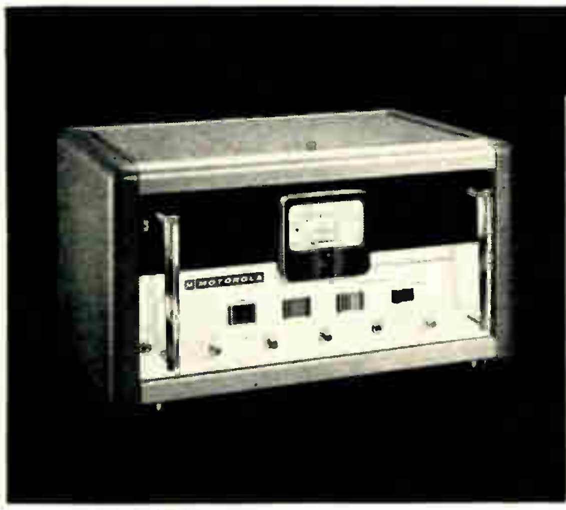
battery/AC powered portable frequency standard

You can use this versatile, portable standard with full confidence for calibration and checking of instruments, in the lab, on the production line and in the field.

Throughout the all-transistor circuitry, these proven highly stable, lightweight units provide • Highest accuracy in their price range • 117VAC/26VDC operation • Low power drain • 1 Mc and 100 kc simultaneous outputs.

Here are the basic operating facts: • 5 x 10^{-10} per day (S1054B) • 1 x 10^{-9} per day (S1054A) • Optional nickel-cadmium standby batteries • Completely transistorized • Rack mounting same price • Fine frequency adjustment parts in 10^{10} • Includes detachable front cover.

Model S1054A . . . . . . $1,600 • Model S1054B $1,800



SOLID STATE fully automatic VLF receiver frequency standard

Where maximum accuracy and precision is required in such applications as missile systems, navigation equipment, telemetering, single side-band communications equipment and others, this new Motorola Standard provides constant combined accuracy and stability within 2 x 10^{-9}.

The first and only complete solid state standard that automatically corrects its local oscillator to VLF stations. Using VLF transmissions from station NBA or WWVL, you are assured of long-term stability for laboratory requirements that cannot otherwise be provided by other types of standards.

Here are the basic operating facts: • Precise *no-drift* standard • Completely transistorized • Receives NBA (18 kc) or WWVL (20 kc) VLF signals • Expandable up to 6 station reception • Automatic servo tracking and correction • 10 kc, 100 kc, 1 mc and recorder outputs • 2 x 10^{-9} *constant accuracy* • 5 x 10^{-10} short term stability • Eliminates diurnal shift problem • Internal High Stability Oscillator.

Model S1055A $5,850

MOTOROLA ***PRECISION MEASURING INSTRUMENTS***

Motorola Communications & Electronics, Inc.
4501 Augusta Blvd., Chicago 51, Ill. A Subsidiary of Motorola, Inc., Spaulding 2-6500

For full precision facts, contact your nearest Motorola Instrument Representative or Write Dept. AEI222

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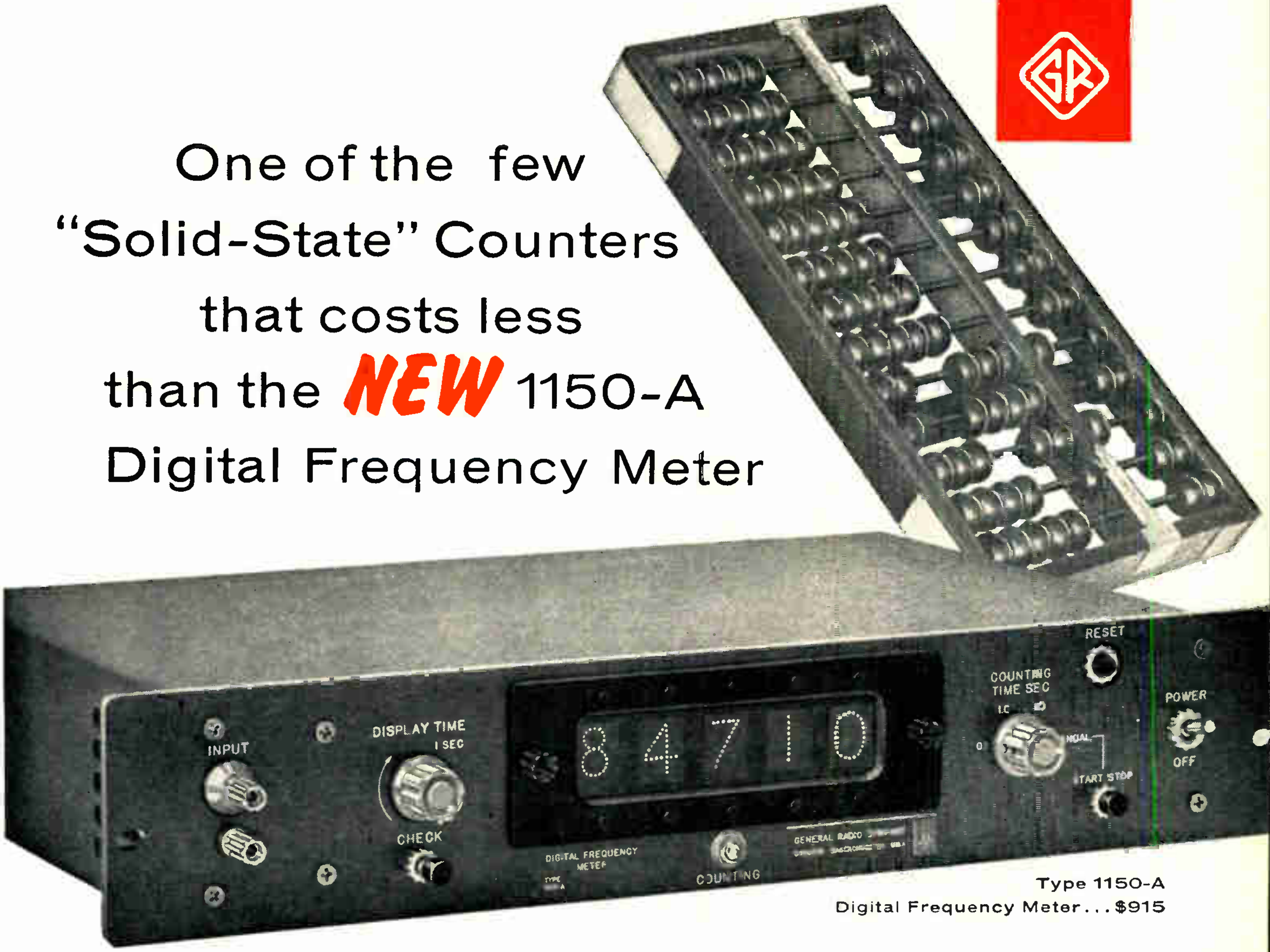
One of the few "Solid-State" Counters that costs less than the *NEW* 1150-A Digital Frequency Meter



Type 1150-A
Digital Frequency Meter . . . $915

- Totalizes events or measures frequency to 220 kc.
- New, brilliant, always in focus, NUMERIK* in-line display. 120° viewing angle . . . 5000-hour lamp life in counting service.
- Fail-safe ring counting circuits eliminate fussy feedback codes and critical voltage levels.
- *Oven-controlled* 100-kc crystal oscillator with ½ ppm stability. Temperature stability better than 5 ppm over an ambient range of 0° to 50°C.

Write for NEW 1150-A Counter Bulletin

*TRADE MARK

GENERAL SPECIFICATIONS

Frequency Range: 10 cps to 220 kc

Accuracy: ±1 count ± time-base stability

Time Base: Internal 100-kc crystal oscillator with ½ ppm stability. Provision for external 100-kc time base

Sensitivity: Better than 1 volt, peak-to-peak. For pulses, duty ratio should be between 0.2 and 0.8. Input impedance is 0.5 MΩ shunted by less than 100 pf.

Gate Times: 0.1, 1, and 10 seconds. Also manual start/stop

Reset: Automatic or manual

Display Time: Adjustable from 0.1 to 5 seconds, or infinite

Self Check: Has provision for counting own 100-kc frequency

Small Size: Only 3½" x 19" x 10"

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

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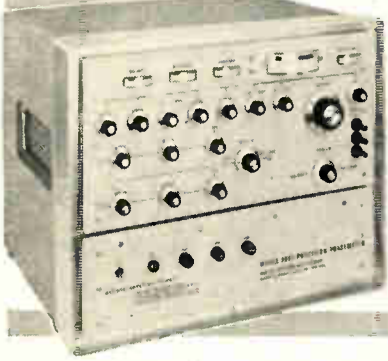
Circle 175 on Inquiry Card

ELECTRONIC & ELECTROMECHANICAL INSTRUMENTATION & COMPONENTS

MAXSON INSTRUMENTS DIVISION



PRECISION PHASEMETER MODEL 1010

The most accurate Phasemeter available:

- 0.1° Absolute, 0.01° Incremental Accuracy
- Frequency Range: 30 to 20,000 cps
- Phase Range: 0 to 360° without ambiguity
- Modular construction

APPLICATIONS:

TESTING and INSPECTION of polyphase systems, goniometers, feedback amplifiers, filters, transformers and phase shifting networks
MEASUREMENT of residual L and C in resistors
CALIBRATION of production line phasemeters
HIGH ACCURACY TESTING of servo and synchro systems
CONTINUOUS MONITORING of phase changes with chart recorder

UHF WIDE RANGE - HIGH POWER OSCILLATOR AND POWER SUPPLY MODEL 1241

The only instrument featuring wide band coverage at high power levels

OUTPUT: Varies with frequency
- 200-500 mc. 40 watts
- 500-1000 mc. 25 watts
- 1000-2800 mc. 10 watts

Power output approximately 1 db down between 200-300 mc. and 2500-2800 mc.

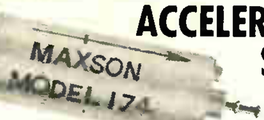
APPLICATIONS:

MEASUREMENT of wave filter, antenna radiation patterns, noise & interference, VSWR & impedance
TESTING of general purpose R-F
SIGNAL SOURCE for attenuation measurements, power meter calibration, R-F cable testing, frequency meter calibration
LOW POWER TRANSMITTER where portability is convenient

ACCELERATION SWITCHES

DAMPED TYPE — SNAP ACTION TYPE

MINIATURE ACCELERATION SWITCH MODEL 174



ACTUAL SIZE

Unidirectional, Single-Axis Switch Closes Electrical Circuit at a Preset Value of Acceleration
APPLICATIONS: Arming switch in missiles, parachute release, sensing element in recording type accelerometers

MODEL	DESCRIPTION
104	Multi-Step, Bidirectional switches. Successive closure of contacts occur at preset acceleration levels each contact remaining closed as long as preset acceleration is sustained.
149	Bidirectional switch precisely set by customer over a range of —3g to +6g by means of external micrometers. Curve showing "g" level vs. micrometer setting is supplied with each switch.
180	Miniature unidirectional switch making a circuit after a specified delay time at a preset acceleration.
200-1	Precision, unidirectional, 4-step switch, successively closing each of 4 contacts at their respective preset acceleration levels.
209	Precision unidirectional switch breaking a circuit at a preset acceleration and then making a circuit at a higher acceleration.
216	A bidirectional version of model 174 switch.
219	Compact unidirectional switch requiring sustained acceleration for a preset time before closing a circuit. Contacts remain closed until reset manually.

ACCELERATION SWITCH MODEL 1-085A

Precision proved in critical missile propellent systems

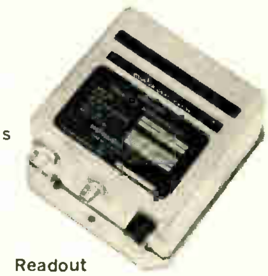
- Small Size
- Positive Action
- Rugged Construction
- Precise Operation

APPLICATIONS:
"g" limiting switch for autopilots; emergency crash exit light control; safety devices based on the sensing of dangerous levels of acceleration or vibration; control devices in guided missiles; "g" indicator for flight-test recording.

MODEL	DESCRIPTION
131, 154, 133*, 185	Close at a preset acceleration level and open when acceleration drops below the preset value.
132, 54*	Provide manual reset so that the switch will remain closed after the preset acceleration is exceeded.
161, 165B	Dual unit models consist of 2 switches packaged to permit bi-directional sensing.

* Feature customer setting of acceleration level by means of an external micrometer. Curve showing "g" level vs. micrometer setting is supplied with each switch.

FOUR CHANNEL STATISTICAL RECORDER MODEL 210



For "g" analysis of electronic equipment in transit

- Direct Digital Readout
- Four Digit Display Channel
- Wide Environmental Range
- Long Term Continuous Recording

Temp. Range: —60°F to 250°F
Vibration: 20-2000 cps, 10g, no counting
Impact: 25g, 12ms, no counting
Radio Interference: Meets MIL-1-6181B requirements
Power Requirements: 28VDC, 0.6 amp
Dimensions: 6 x 5 x 3½ inches
Weight: 54 ounces

APPLICATIONS:
When used in combination with a suitable transducer such as the Maxson Model 200 four-channel acceleration switch, the Model 210 recorder can be used for statistical analysis of "g" loadings in the fields of aircraft design, surface transportation, highway and road engineering and crash and safety analyses.

WRITE TODAY FOR COMPLETE LITERATURE AND SPECIFICATIONS

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PRECISION FORK OSCILLATORS and FREQUENCY STANDARDS

Whatever your need . . . whatever your problem . . . in frequency ranges from 1 to 40,000 cycles, American Time Products has the package and/or the experience to assist you. For over 20 years American Time has been engineering and manufacturing reliable, accurate and rugged frequency standards, fork oscillators, etc. Some are off-the-shelf items. Others are custom developed units and systems such as: 1) tuning fork filters, 2) inverters, 3) precision power supplies, 4) timers, 5) fork optical choppers. For additional information on the sampling of units shown, on American Time's line, or regarding your own special needs, write Department 2613.

BULOVA
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Precision Fork Oscillators					
TYPES	5	25	2001-2	50N	30
FREQUENCY	200 to 1,000 cps	200 to 1,400 cps	200 to 4,000 cps	50 to 360 cps	240 to 20,000 cps
ACCURACY	±.002% to ±.5%	±.002% to ±.5%	±.001%	±.05% to ±.01%	±.002% to ±.5%
TEMPERATURE RANGES	−65° to +125°C	−65° to +125°C	+20° to +30°C	−55° to +85°C +15° to +35°C	−65° to +125°C
OUTPUT	Dependent on external circuitry used	Dependent on external circuitry used	Approx 5 at 250,000 ohms	Dependent on external circuitry used	Dependent on external circuitry used
INPUT	28 volts or less	28 volts or less	Heater Volt. 6.3, 12, 28	28 volts or less	28 volts or less
B VOLTAGE			100 to 300V at 5 to 10 ma		
SIZE	5/16x3/4x3"	23/32x3"	3-3/4x4-1/2x6"	1x4-1/4"	1-19/22x 1-19/22x1-1/3"
WEIGHT	1-1/2 oz.	2 oz.	26 oz.	4 oz.	3-1/3 oz.

Precision Frequency Standards						
TYPE	10	27	15	32	52	15P Portable
FREQUENCY	360 or 400 cps	360 to 1,300 cps	360 cps 400 cps	240 to 2,000 cps	30 to 360 cps	360 or 400 cps
ACCURACY	±.005%	±.002% to ±.5%	±10 ppm ±250 ppm	±.002% to ±.5%	±.05°C ±.01%	±50 ppm
TEMPERATURE RANGE	+10° to +35°C	−65° to +125°C	−40° to +71°C −40° to +71°C	−65° to +125°C	−55° to +35°C +15° to +35°C	0° to 40°C
INPUT	1.4v at 6 microamps	28 volts or less	1.4v at 6 microamps	28 volts or less	28 volts or less	Self-contained Battery
OUTPUT	0.1 volt	8 volts RMS	1 volt	5 volts	5 volts	1 volt
LOAD	50,000 ohms or more	70,000 ohms or more	50,000 ohms or more	50,000 ohms or more	70,000 ohms or more	50,000 ohms or more
SIZE	1-3/8x1-3/8x3/8"	23/32x3"	1x2x2-1/4"	1-19/32x 1-19/32x1-1/5"	1x4-1/8"	1x2x3-1/2"
WEIGHT	3/4 oz.	2 oz.	4 oz.	3-1/2 oz.	4 oz.	4 oz.

Circle 177 on Inquiry Card

BALLANTINE VOLTMETERS

and other Electronic Measuring Instruments

ELECTRONIC VOLTMETERS

MODEL	FREQUENCY RANGE	VOLTAGE RANGE	INPUT IMPEDANCE	ACCURACY	Notes	PRICE
300	10 cps-150 kc	1 mV-100 V	0.5 MΩ shunted by 30 pF	2%	Sensitive, general purpose VTVM	$220
300E 300F	30 cps-100 kc	300 μV-300 V	2 MΩ shunted by 20 to 30 pF	2%	9½ inch wide panel, with panel insulated from chassis. 300F is militarized version of 300E	$260 $320
300G	10 cps-250 kc	1 mV-1000 V	2 MΩ shunted by 10 to 25 pF	1% 20 cps-20 kc, 1 mV-250 V, 2% elsewhere	The most accurate and highly stabilized instrument in the Ballantine line of direct reading VTVM's	$315
300H	10 cps-1 Mc	30 μV-300 V	2 MΩ shunted by 15 to 25 pF	2% 10 cps-700 kc 3% 700 kc-1 Mc	Similar to 300G except 2% accuracy over a wider frequency band. Replaces 300D	$230
302C Battery Operated	2 cps-150 kc	100 μV-1000 V	2 MΩ shunted by 10 to 25 pF	3% 5 cps-100 kc; 5% elsewhere	Very sensitive, battery operated, for use where isolation from power line is essential. 60 db gain, no hum	$255
305A Peak Reading	5 cps-500 kc, sine waves. Pulses 0.5 μs up, and 5 pps up	1 mV-1000 V Peak or Peak-to-Peak	2 MΩ shunted by 5 to 15 pF	2% sine waves, 20 cps-200 kc; 4% elsewhere; 3% pulses above 3 μs and 100 pps; up to 5% elsewhere	Peak or peak-to-peak VTVM for use on short pulses, noise, or sinusoidal signals	$415
310A	10 cps-2 Mc; 5 cps-4 Mc as a null detector	100 μV-100 V (Down to 40 μV as null detector)	2 MΩ shunted by 9 to 19 pF	3% 15 cps-1 Mc; 5% elsewhere	Very sensitive wide-band VTVM for wide range of voltage measurements. 10 μV sensitivity as null detector	$250
314 Wide Band	15 cps-6 Mc	1 mV-1000 V (100 μV-1 mV without probe)	11 MΩ shunted by 8 pF with probe or 1 MΩ shunted by 25 pF without probe	3% 15 cps-3 Mc; 5% elsewhere	Wide-band, sensitive instrument equipped with probe for use 1 mV to 1000 V, or without probe to as low as 100 μV	$300
316 Infrasonic	0.05 cps-30 kc; 0.01 cps with corrections supplied	0.02 V-200 V Peak to Peak	10 MΩ shunted by 17 to 40 pF	3%	Measures peak-to-peak voltages at frequencies as low as 0.01 cps and up to 30 kc on square waves or distorted sinewaves. Negligible "flutter"	$330
317 Wide Band	10 cps-11 Mc	300 μV-300 V (Down to 100 μV as null detector)	10 MΩ shunted by 7 pF with probe, 2 MΩ shunted by 11 to 24 pF without probe	2% 20 cps-2 Mc 4% 10 cps-6 Mc 6% 10 cps-11 Mc	Broadest frequency coverage VTVM in the line. Sensitive, accurate as VTVM or amplifier. Cathode follower probe makes possible accurate measurements several feet from the instrument	$495 with probe
320 True RMS	5 cps-500 kc	100 μV-320 V	10 MΩ shunted by 8 to 18 pF	3% 15 cps-150 kc, 5% elsewhere	Measures true rms of wide range of signals including pulse, noise, or distorted sinewaves. Accurate on signals having crest factor up to 15	$445
350 True RMS	50 cps-20 kc	0.1 V-1199.9 V	2 MΩ shunted by 15 to 45 pF	¼% 0.1 V-300 V 100 cps-10 kc, ½% outside these limits	Measures true-rms of distorted or pure sinewaves. ¼% accuracy. Excellent as a laboratory reference or transfer standard for calibration of VTVM's or signal sources	$[illegible]20

ACCESSORIES

for use with VTVM's are available to extend voltage range from 10 μV to 20.000 V, or to measure currents from 0.1 μA to 10 A.

ELECTRONIC TEST EQUIPMENT

220C DECADE AMPLIFIER — Exceptionally low noise VT amplifier, X10 or X100, 10 cps-150 kc, 2%. Particularly useful as pre-amplifier to extend sensitivity of VTVM's or scopes. Price: $115

420 DC and AC PRECISION CALIBRATOR — Provides accurate, convenient way of calibrating voltmeters, oscillographs, and other voltage-sensitive devices. Voltage range: 0-10 V, rms, peak-to-peak, or dc. Frequency: 1 kc. Accuracy: better than 0.25%. Distortion and Hum: less than 0.25%. Output impedance (ac): 2-20 ohms. Output impedance (dc): 0-4000 ohms. Price: $365

520 DIRECT READING CAPACITANCE METER — Provides one of the most convenient ways of measuring capacitance over an extremely wide range of values as encountered in paper, plastic, mica, ceramic, and air-dielectric types. Capacitance range: 0.01 pF to 12 μF. Accuracy: 2% above 0.1 pF. Price: $335

700 SENSITIVE INVERTER — An instrument for measurement of dc potentials as low as 10 microvolts by converting the dc to ac. Input voltage range: 10 μV-100 V dc. Accuracy: better than 1% above 100 μV. Input resistance: 10 megohms for 1:100 or 50 megohms for 10:1. Price: $365

710 LINEAR AC to DC CONVERTER — Accurately converts an ac voltage to a dc voltage which can be measured with a dc device such as a Digital Voltmeter. Features accuracy better than 0.25%. Input voltage range: 1 mV-1000 V. Frequency range: 30 cps-250 kc. Input impedance: 2 megohms shunted by 15 pF to 25 pF. Accuracy ±0.25% 50 cps-10 kc; ±0.5% 30 cps-50 kc; ±1% above 50 kc. Price: $450

LABORATORY STANDARDS

390 — The Selby-Behrent NBS design. 1 V to 300 V, 10 Mc to 1000 Mc. A basic laboratory standard to measure high voltages at these frequencies. Price: $2250

393 — The Hermach NBS design. 1 V to 50 V, 25 cps to 20 Mc. A basic laboratory standard particularly suited to calibration of voltmeters and signal sources. Price: $950 (with 5 probes)

440 — The Selby NBS design. 15 μV to 1.5 V, 0 to 900 Mc. Possibly the most basic laboratory standard device for determining ac voltages in this range. Price: $250 (for each thermocouple-radial resistor combination)

Write for brochure giving many more details

— Since 1932 —

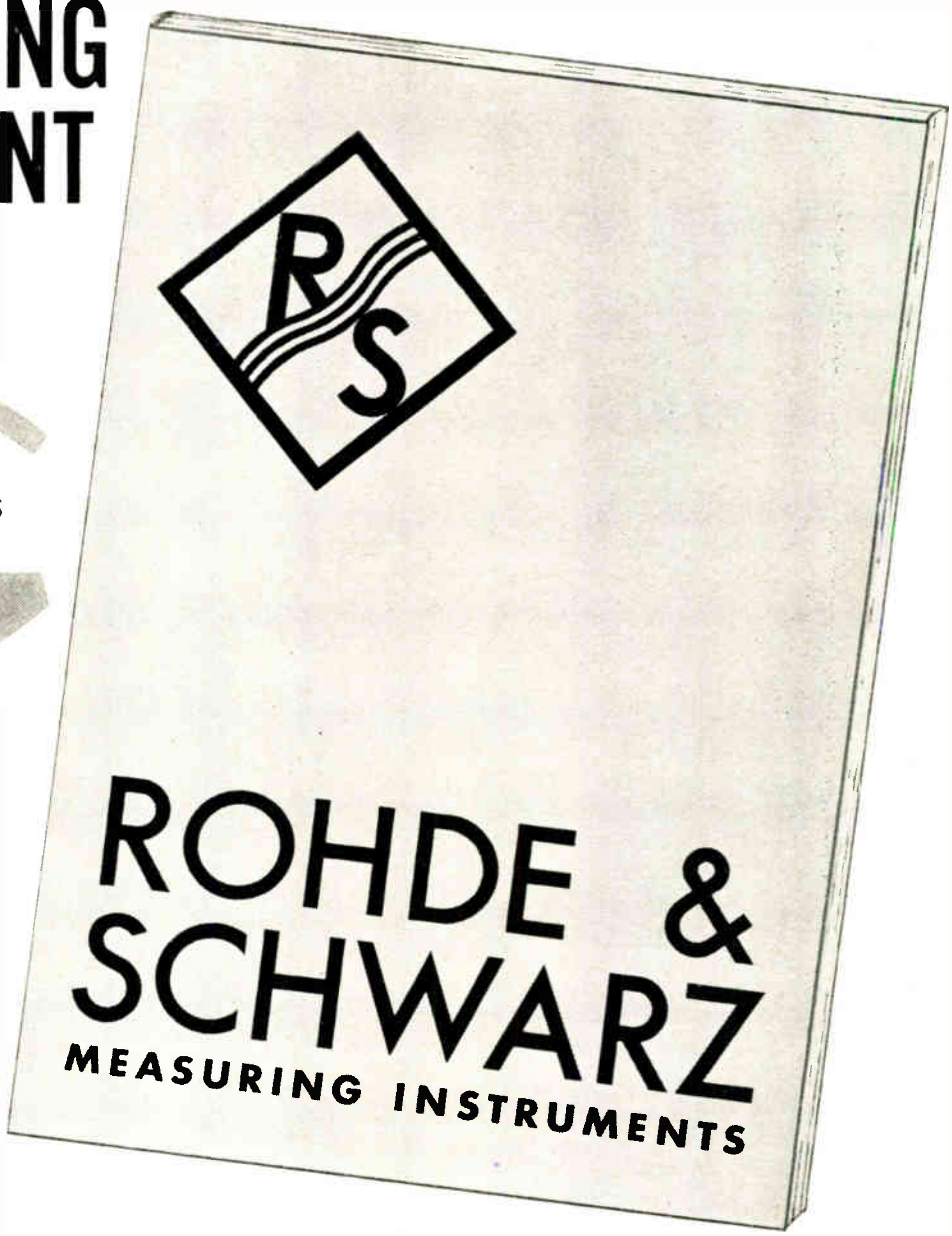
BALLANTINE LABORATORIES, Inc.

Boonton, New Jersey
Phone: DEerfield 4-1432 TWX: BONTN 831

A Complete Technical Guide
to the Selection of

ELECTRONIC MEASURING EQUIPMENT

133 photographs



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ROHDE & SCHWARZ

ELECTRONIC MEASURING EQUIPMENT FOR THE UNCOMPROMISING

111 Lexington Ave., Passaic, N. J. • PRescott 3-8010

Tech Data

for Engineers

Transistor Tester

This Single Position Automatic-(SPA)Transistor Tester features automatic testing and sorting (manual load and unload) of up to 2000 transistors/hr. Other features include up to 100 ac or dc parameters (10 tests x 10 type specs.) and flexible, versatile programming by plug-in modules. This 2-color brochure includes photographs, specs., and optional features. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 485 on Inquiry Card

Chopper Circuits

Tech. report of test techniques and compiled data on residual noise present in chopper circuits is available from James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 486 on Inquiry Card

Noise Analysis

A Tech. Report, entitled "A Practical Approach to Transistor Noise" is available from Quan-Tech Laboratories, Inc., Boonton, N. J. The report deals with the origin and nature of the various types of electrical noise generated in transistors. Specific methods for the quantitative analysis of transistor noise are treated in detail.

Circle 487 on Inquiry Card

RF Power Levels

Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., has available a brochure on precise methods of determining r-f power levels, which discusses the sources of error of these methods. Entitled, "RF Power Bridges and Thermistor Mounts," the brochure also describes their line of precision power bridges, thermistor mounts and X-band power standards.

Circle 488 on Inquiry Card

Spectrum Analyzers

A detailed engineers' product handbook on counters, oscilloscopes, frequency meters, and spectrum analyzers is available from Lavoie Laboratories, Inc., Morganville, N. J. Included are photographs, specs. and schematics. Also included is a section on automatic test equipment.

Circle 489 on Inquiry Card

Atomic Instruments

Baird-Atomic, Inc., 33 University Rd. Cambridge 38, Mass., is offering their Atomic Instrument Catalog. Included are analytical scintillation systems, scalers, analyzers, rate and survey meters, amplifiers and power supplies.

Circle 490 on Inquiry Card

Vibration Measuring

This 8-page, 2-color brochure offers tech data on a "Vibration Measuring System," which records complete data from accelerometer signals, including phase, distortion and amplitude. Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.

Circle 491 on Inquiry Card

NLS DIGITAL VOLTMETERS

most complete line... by purpose... by price

As originator of the DVM and leading manufacturer of precision digital measuring instruments, Non-Linear Systems, Inc., offers you the world's most complete line of DC and AC digital voltmeters, digital ratiometers, digital ohmmeters, and multi-purpose instruments. Look to NLS for the instrument you need in the price range you desire. Only NLS provides the benefits of dealing with a company that's been in the DVM business for more than a decade — unmatched servicing follow-through, use-proven design superiority, and uncompromising instrument quality. Contact any of the 19 NLS sales and service offices listed in this buyers guide for complete engineering information on standard instruments and custom instrumentation systems.

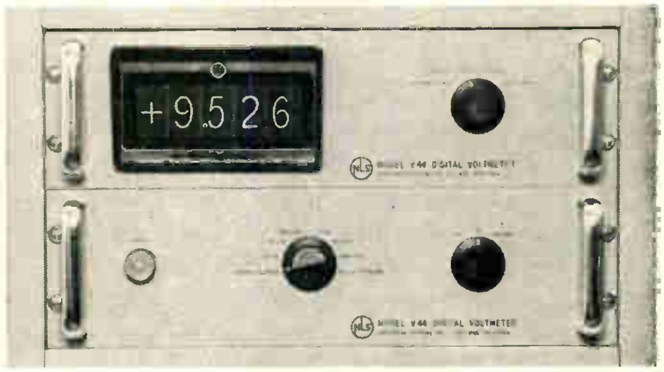
INSTRUMENT SELECTION GUIDE

To Measure	Model	Digits	Speed, Sec./Reading	Range	Type of Digital Output	Price
Volts, Ratio and Ohms	M25	5	1.1 constant	100μv-1kv. .00001:1-99.999:1 .1Ω-1 meg.	Decimal voltages	$5,985
	M24	4	.33 constant	100μv-1kv. .0001:1-.9999:1 .1Ω-1 meg.	Decimal voltages	$5,585
Volts and Ratio	V35B	5	2.3 max.	100μv-1kv. .00001:1-.99999:1	Decimal contacts	$3,985
	V35RB	5	2.3 max.	100μv-1kv. .00001:1-.99999:1	Decimal voltages	$3,385
	484A	4	1 avg.	1mv-1kv. 00.01%-99.99%	Decimal voltages	$1,460
	RS2	4	1 avg.	1mv-1kv. 00.01%-99.99%	Internal printer	$3,635
Volts	15	4	$67x10^{-6}$ constant	100μv-100v.	B-C-D or binary volts	$4,985-$5,485
	V44	4	$5x10^{-3}$ constant	1mv-1kv.	Decimal & B-C-D volts	$6,185
	CH2	4	$1x10^{-2}$ approx.	1mv-1kv.	Decimal & B-C-D volts	$6,585
	V64B	4	0.75 avg.	1mv-9.999v. special to 1kv.	None	$885
Voltage Ratio	R65A	5	1.5 avg.	00.001%-99.999%	None	$2,135
	R65B	5	1.5 avg.	00.001%-99.999%	Decimal voltages	$2,335
Millivolts	V60	4	1.5 avg.	10μv-99.99mv.	None	$1,660
	V60A	4	1.5 avg.	10μv-99.99mv.	Decimal voltages	$1,960
Ohms Deviation	DO24	4	.33 constant	00.01%-99.99%	Decimal voltages	$5,585
Ohms	784	4	1 avg.	.1Ω-10 meg.	Decimal voltages	$1,460
Digital-Analog	16	4	$4x10^{-6}$ constant	.001v.-9.999v.		$3,085
AC, Low-Level DC, Data Logging, Go/No-Go Testing	Plug-in accessories are available for high accuracy measurement of AC and low-level DC, data logging, and go/no-go testing. Also, NLS offers a wide range of custom instrumentation for special applications.					

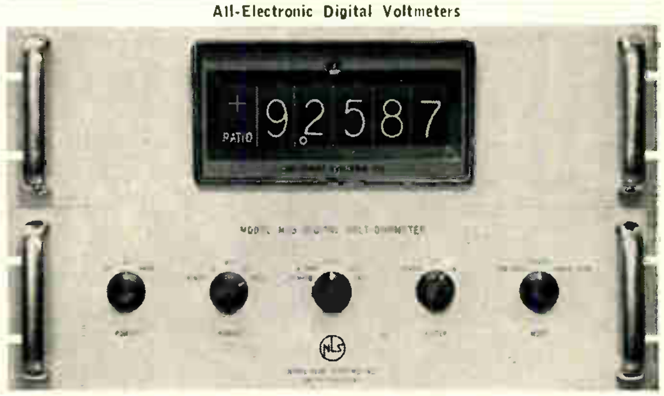
Prices and specifications are subject to change without notice. Prices F.O.B. destination U.S.A.

Accuracy is ±0.01% of reading ±1 digit except for millivoltmeters which have accuracy of ±0.1% of reading ±1 digit (precision is ±1 digit). V35B-V35RB ratio accuracy is ±0.005% of reading or ±1 digit. Input impedance is generally 10 megs for voltage measurements, 1,000 megs for ratio (10 megs on M25's two highest ratio ranges). Input impedance of Models 15 and 15B is 625 ohms/volt. Decimal digital outputs are 10 lines/decade.

High-Speed A/D Converters



All-Electronic Digital Voltmeters



Five-Digit and 4-Digit Instruments that measure Volts, Ratio and Ohms

Five-Digit and 4-Digit medium-priced Voltmeter-Ratiometers

Low-cost Industrial DVMs and Ohmmeters

Originator of the Digital Voltmeter

NLS non-linear systems, inc.

Del Mar, California

Tech Data

for Engineers

Oscilloscopes

Tech data is available on the Primer-Scope Mark I and Mark II which are small, portable oscilloscopes. The Mark II is a Dual-Trace oscilloscope. Also included are condensed specs. on industrial oscilloscopes, and cathode ray tubes. Waterman Products Co., Inc., 2445-63 Emerald St., Phila. 25, Pa.

Circle 492 on Inquiry Card

Spectrum Analyzer Techniques

This 58-page booklet, offering detailed measurement techniques using spectrum analyzers, along with a history and general theory of operation, is offered by Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y. A portion of the handbook describes and lists the specs. and applications of Polarad Spectrum Analyzers currently available, including the new lightweight, transistorized, Model SA-84T.

Circle 493 on Inquiry Card

Power Resistor Decades

Clarostat Mfg. Co., Inc., Dover, N. H., is offering a new catalog on power resistor decades. Complete electrical and mechanical specs. are described. The Clarostat power resistor decade permits the accurate decading of resistance under actual heavy-load conditions in test, experimental, or component circuitry.

Circle 494 on Inquiry Card

Angle Repeater

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J., has tech. information available on their Precise Position Repeater, Model PPR-10 which provides both a visual readout and binary coded data output of the angular position with 20 sec.-of-arc accuracy and 4 sec.-of-arc resolution.

Circle 495 on Inquiry Card

Microwave Test Equipment

A booklet describing a line of microwave test equipment is now available from the Westinghouse Electronic Tube Div., Box 284, Elmira, N. Y. The 10-page, illustrated, 2-color booklet describes test sets used for testing klystrons, magnetrons, TWT's and switch tubes. In addition, traveling-wave pulser and missing-pulse-detector equipment is included. Booklet ET-6109.

Circle 496 on Inquiry Card

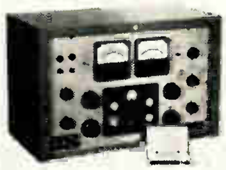
Capacitance Bridge

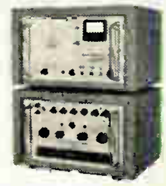
Precision capacitance bridges for testing solid tantalum, foil tantalum, wet tantalum, aluminum electrolytic, and metallized paper capacitors are described in Engineering Bulletin No. 90,010 available from Special Products Div., Sprague Electric Co., North Adams, Mass. Included are outline drawings, specs., and descriptions.

Circle 497 on Inquiry Card

WORLD'S WIDEST SELECTION OF
Instrument Calibration Consoles

Choice of direct-comparison, regulated-power-supply and AC-DC transfer methods of calibration. Feature simplified operation, wide electrical ranges, safety circuits and accuracies to meet all requirements for working or reference standards. Accuracy is certificated by RFL and traceable to primary standards at National Bureau of Standards.



MODEL 829 calibrates AC and DC instruments from 0.25 mV to 2000 V and 2 μA to 20A; direct reading accuracy of 1% or 0.5% using charts supplied.
MODEL 829D is similar but with 0.5% direct reading FS accuracy and 0.25% with charts. Most popular calibrator, some 1000 Model 829 series units are in service.

MODEL 1900 is a semi-automatic, servo-type unit for calibrating DC ammeters and voltmeters to .05% of reading. 21 ranges from 150 μV to 1500 V and 20 ranges from 15 μA to 30 A.
MODEL 1967 is similar for AC meters with 20 ranges from 1.5 mV to 1500 V and 19 ranges from 15 μA to 75 A; 50 to 3200 c/s.

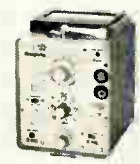
MODEL 1605 calibration/transfer standard for measuring to 15 A and 1500 V DC and AC from 30 c/s to 50 kc/s (to 30 mc/s with adapters). Includes voltbox, shunt-box, potentiometer, standard cell, galv. and thermal converter. Accuracy 0.1% direct reading.
MODEL 1605A similar except .05% direct reading accuracy.

MODEL 2120 AC-DC precision power supply for use with Model 1605/A, or any AC-DC transfer standard, accurate meter or suitable monitoring system for instrument calibration. Provides stable outputs to 30 A and 1500 VDC and AC from 50 c/s to 50 kc/s at 10 to 100 VA with low harmonic distortion and high stability.

and Magnetics Equipment

Electronic magnetizers operating on capacitor discharge principle with pulse lengths from 2 to 30 milliseconds, precisely controllable demagnetizer systems and solid state, laboratory quality magnetic measuring instruments.



MODEL 107A provides 12,000 and 24,000 ampere-turns to magnetize most instrument and medium size magnets using standard bar or special adapters.
MODEL 1221 provides 10,000 ampere-turns for small magnets.
MODEL 1500 supplies 40,000 ampere-turns for magnetizing barium ferrite and large meter magnets.

MODEL 942 saturates Alnico magnets to 34 lbs. and high flux ceramic shapes of any pole configuration. Produces charging currents from 100.000 to 200,000 ampere-turns with plug-in transformers; up to 3600 watt-seconds with wire-wound fixtures. Equipped with safety interlocks for operator protection. Low power consumption.

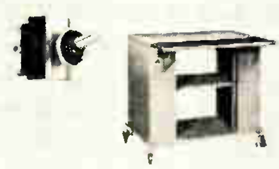
MODEL 889A used with Model 206A Booster Unit or Model 107A Magnet Charger to demagnetize permanent magnets to any desired flux level. Provides a precision method for treating instrument assemblies, including core type mechanisms, to within fractions of a per cent. Employs DC pulsing principle with vernier control.

MODEL 1890 employs flat and axial InAs Hall effect probes for direct measurements of magnetic flux densities over 14 ranges from 1 gauss FS to over 20 K gausses. Accuracy better than 3%.
MODEL 2000 uses two flat InAs probes for magnetic field gradient measurements and has 17 ranges from 0.1 gauss FS to 20 K gauss.

Manufacturers of Crystal Impedance Meters, Var. Freq. Power Supplies, Special Hardware and . .

MODEL 459A (Improved TS-330) measures resonance and anti-resonance of quartz crystals for capacitance, inductance and performance index over frequency range of 800 kc to 15 mc.
MODEL 531 (TS-683) covers range of 10-140 mc. **MODEL 541A** (TS-710) from 10-1100 kc and **MODEL 1207** (AN/TSM-15) from 75-200 mc.

MODEL 250 variable freq. power supply provides regulated 115 V output over freq. range of 40-3000 cps with harmonic distortion less than 0.3% at 100 VA and stability 0.1% to 0.2%. Choice of four plug-in oscillators. Maximum load 250 VA. With external oscillator, output can be varied from 0 to 115 V.



SEALNUTS perform dual function of mounting and sealing electrical switches. Eleven stock styles fit most toggle, rotary and push-button types. Meet Spec. MIL-B-5423.
MODEL 10 Cart provides versatile mounting facility for elect. equip. Heavy gauge steel, one side takes 19″ panels, inside shelf adjustable.

CARRIER EQUIPMENT
for
Voice, Telegraph, Data, Control and Telemetering Applications
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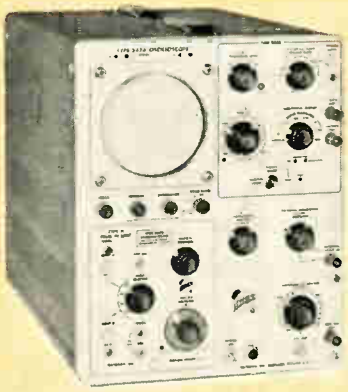
Write to Test & Service Prod. Div. for complete data on any product groups of interest. Factory approved representatives in 21 countries can arrange demonstrations and help with applications. All products are warranted for one year.

RFL EST. 1922
Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

These Tektronix DC-to-30 MC Oscilloscopes

TYPE 541A
—rack-mount Type RM41A



TYPE 543A
with 100X Magnifier
—rack-mount Type RM43A

TYPE 545A
with Sweep Delay
—rack-mount Type RM45A

TYPE 555 DUAL BEAM
with Sweep Delay
(Includes Indicator Unit, Power Unit, 2 Time-Base Units, 4 Probes, Time-Base Extension, 7 other accessories.)

Similar Characteristics

Risetime—12 nsec with fast-rise plug-in units • Calibrated Sweep Range—0.1 µsec/cm to 5 sec/cm • Fastest Sweep (Magnified)—20 nsec/cm • Amplitude Calibrator—18 square-wave voltages • Accelerating Potential—10 Kilovolts • Triggering Facilities—Fully automatic or amplitude level selection

Tektronix 5-inch CRT • Balanced Signal-Delay Network • DC-Coupled Unblanking • Illuminated Graticule • Beam-Position Indicators • Electronically-Regulated Power Supply • Low-Frequency Reject • High-Frequency Sync • Output Waveforms available from front panel • (Rack-Mount Models fit into a standard 19-inch rack.)

Tektronix Type	*Calibrated Sweep Magnifier*	*Calibrated Sweep Delay*	*Single Sweep*	*Vertical Scale*	*Price (without plug-ins)*
555	5X	½ µsec to 50 sec	YES	6 cm with 2 cm overlap	$2650
545A		1 µsec to 10 sec		4 cm	1550
RM45A					1650
543A	2X, 5X, 10X, 20X, 50X, 100X	NO			1300
RM43A					1400
541A	5X		NO		1225
RM41A					1325

Other Tektronix Oscilloscopes also accept the letter-series plug-ins:

Type	*Description*	*Passbands with fast-rise units*	*Features*	*Price (without plug-ins)*
585	High-Speed Fast-Rise Oscilloscopes	dc-to-30 mc	Normally designed for dc-to-95 mc applications with other plug-ins, these oscilloscopes accept letter-series plug-ins—when used with Type 81 Plug-In Adapter at $135. Type 585 has additional facility for sweep-delay applications.	$1725
581				1425
551	Dual-Beam Oscilloscope	dc-to-25 mc	Common X—Independent Y Deflection. Otherwise, characteristics similar to Type 555 Dual-Beam Oscilloscope, but no sweep delay.	1850
536	XY Curve Tracer	dc-to-11 mc	Requires 2 plug-in units. Uses Type T Time-Base Unit (40 nsec/div with 5X Magnifier to 2 sec/div) at $240, in horizontal amplifier, other letter-series plug-in in vertical amplifier, for conventional oscilloscope operation.	1085
535A	*General Purpose Oscilloscopes	dc-to-15 mc	Except for risetime/passband characteristics, the Type 530-Series Oscilloscopes and their rack-mount counterparts, have capabilities similar to the Type 540-Series Oscilloscopes and their rack-mount counterparts.	1400
533A				1125
531A				995

*Type 530-Series Oscilloscopes also available in rack-mount models. Prices without plug-in units: Type RM35A at $1500, Type RM33A at $1225 and Type RM31A at $1095.

Tektronix, Inc.

P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX

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TEKTRONIX CANADA LTD: Montreal, Quebec • Toronto (Willowdale) Ontario.

ENGINEERING REPRESENTATIVES: Kentron Hawaii Ltd., Honolulu, Hawaii. Tektronix is represented in twenty-five overseas countries by qualified engineering organizations.

European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A.G., Terrassenweg 1A, Zug, Switzerland, for the name of your local engineering representative.

Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX.

Circle 184 on Inquiry Card

accept *any* of these Tektronix Plug-In Units

Change the plug-in unit and you equip these Tektronix Oscilloscopes with high performance needed for particular applications.

The oscilloscope with various letter-series plug-ins through Type M, the four-trace unit, fits general-purpose applications. The oscilloscope with other letter-series plug-ins—from Type N, the pulse-sampling unit, through Type Z, the differential-comparator unit—fits special-purpose applications.

Each oscilloscope and plug-in combination performs simply and reliably in the many laboratory applications within its capabilities. For complete information on the characteristics of any of these combinations, please call your Tektronix Field Engineer.

TYPE B **$145**

General-Purpose Wide-Band High-Gain Unit • Calibrated Sensitivity—5 mv/cm to 50 mv/cm • Risetime—30 nsec • Passband—2 c to 12 mc • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—18 nsec • Passband—dc to 20 mc.

TYPE CA **$260**

General-Purpose Dual-Trace DC Unit • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—15 nsec • Passband—dc to 24 mc.

TYPE D **$170**

General-Purpose High-Gain DC Differential Unit • Calibrated Sensitivity—1 mv/cm to 50 v/cm • Risetime—0.18 μsec • Passband—dc to 350 kc—increasing to 2 mc.

TYPE E **$190**

General-Purpose Low-Level AC Differential Unit • Calibrated Sensitivity—50 μv/cm to 10 mv/cm • Risetime—6 μsec • Passband—0.06 c to 20 kc—increasing to 60 kc.

TYPE G **$190**

General-Purpose Wide-Band DC Differential Unit • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—18 nsec • Passband—dc to 20 mc.

TYPE H **$185**

General-Purpose Wide-Band High-Gain DC Unit • Calibrated Sensitivity—5 mv/cm to 20 v/cm • Risetime—23 nsec • Passband—dc to 15 mc.

TYPE K **$145**

General-Purpose Fast-Rise DC Unit • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—12 nsec • Passband—dc to 30 mc.

TYPE L **$210**

General-Purpose Fast-Rise High-gain Unit • Calibrated Sensitivity—5 mv/cm to 2 v/cm • Risetime—15 nsec • Passband—3 c to 24 mc • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—12 nsec • Passband—dc to 30 mc.

TYPE M **$455**

General-Purpose Four-Trace Unit • Calibrated Sensitivity—20 mv/cm to 10 v/cm • Risetime—17 nsec • Passband—dc to 20 mc.

TYPE N **$625**

Pulse-Sampling Unit—for displaying repetitive high-speed signals by the sampling process • Calibrated Sensitivity—10 mv/cm • Risetime—0.6 nsec • Passband—dc to 600 mc.

TYPE O **$475**

Operational-Amplifier Unit—for displaying operations of integration, differentiation, function generation, linear and non-linear amplification • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—14 nsec • Passband—dc to 25 mc.

TYPE Q **$325**

Transducer and Strain-Gage Unit—for displaying mechanical quantities converted to a change in resistance, capacitance, or inductance • Calibrated Sensitivity—10 μstrain/div to 10,000 μstrain/div • Risetime—60 μsec • Passband—dc to 6 kc.

TYPE R **$325**

Transistor-Risetime Unit—for displaying simultaneously delay, rise, storage, and fall times of transistors • Calibrated Sensitivity—0.5 ma/cm to 100 ma/cm • Risetime—12 nsec • Passband—dc to 30 mc.

TYPE S **$260**

Diode-Recovery Unit—for displaying forward and reverse switching characteristics of semiconductor diodes • Calibrated Sensitivity—1 to 20 ma forward current, 0 to 2 ma reverse • Risetime—12 nsec • Passband—dc to 30 mc.

TYPE Z **$525**

Differential-Comparator Unit—for displaying an *equivalent* vertical scale length up to ±2000 cm at 50 mv/cm • Calibrated Sensitivity—50 mv/cm to 25 v/cm • Risetime—24 nsec • Passband—dc to 13 mc.

TEST UNIT AND POWER SUPPLY UNITS ALSO AVAILABLE

TYPE P FAST-RISE UNIT . . . $90
For checking vertical amplifier response, 4-nsec risetime.

TYPE 127 POWER SUPPLY UNIT . . $650
For powering one or two plug-in units, 18-nsec risetime (with fast-rise units).

TYPE 132 POWER SUPPLY UNIT . . $390
For powering one plug-in unit, 23-nsec risetime (with fast-rise units).

TYPE 133 POWER SUPPLY UNIT . . [illegible]
For powering one plug-in unit, dc-to-100 kc frequency response, ±5 volts output, 2-ohm source impedance.

U.S. Sales Prices f.o.b. Beaverton, Oregon

HOW DO YOU TEST AN X-Y PLOTTER

In an automobile, transmissions can be designed to give top speeds by sacrificing acceleration—but it's a poor bargain, as a quick road test will show. Similarly, in an X-Y analog plotter high slewing speeds can be obtained by sacrificing acceleration. Again it's a poor bargain because highest plotting accuracy depends upon high static accuracy combined with a *perfect balance between acceleration and velocity limits.* EAI's Model 1100E Variplotter has this desired balance as a simple 'road test' developed by EAI engineers can graphically demonstrate.

As a matter of fact, everything about the Model 1100E Variplotter has been engineered to give you the utmost in plotting performance. Developed to speed up engineering control, testing and design operations, it consistently produces faster, more accurate plots of X-Y related data.

The development of the Model 1100E has resulted from EAI's years of pioneering research and development in the field of automatic plotting. It provides outstanding accuracy of 0.075% F.S. — less than the width of the line drawn by the pen. Arm acceleration is 250 inches/sec.². Pen acceleration is 750 inches/sec.². The high velocity of the 1100E is augmented by this faster acceleration to assure outstanding dynamic performance.

Repeated testing under actual operating conditions proves that the principle of the Variplotter, Model 1100E design virtually eliminates backlash, and provides drift-free operation for periods of 8 hours or more. This superior repeatability has been amply testified by users who report that even after overnight shut-down, the Model 1100E resumes plotting with no noticeable drift.

A complete line of accessories—including bi-variant function generator, digital data plotting (manual or automatic) and time base generator — makes the EAI Variplotter the most versatile automatic plotting method available. The Model 1100E can be easily converted to operate as a function generator — or will plot digital information manually from a keyboard as well as automatically from punched cards or paper tape — by simple addition of compatible components.

Check these features...
- Portable desk-top size—
- Large plotting surface (11" x 17") —
- Vacuum hold down—
- High dynamic and static accuracy—
- Rugged construction—
- Ease of maintenance—
- Differential input—
- Plug-in input network—
- Superior repeatability.

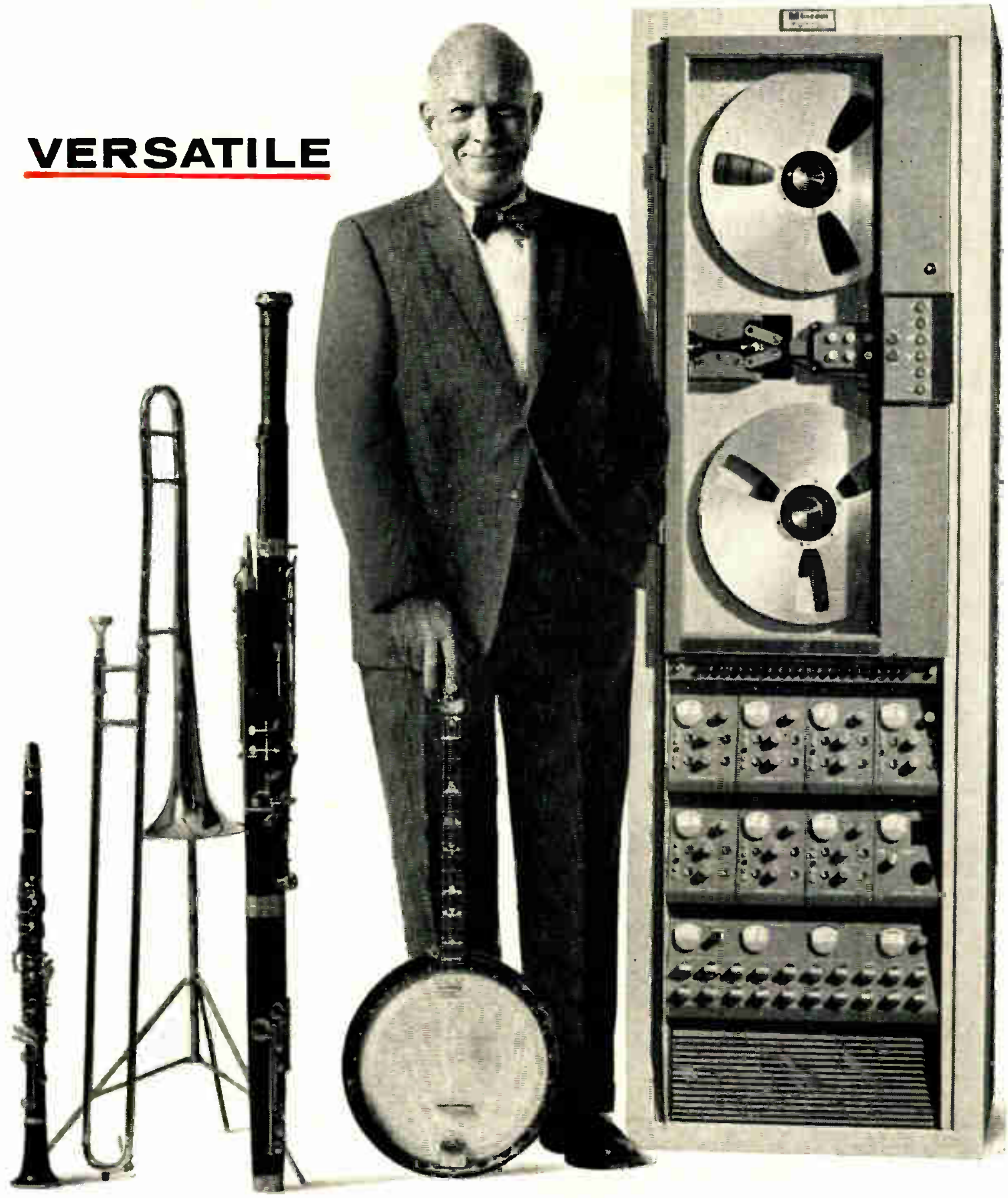
Ask your EAI representative to show you the simple laboratory test that proves the superiority of the Model 1100E Variplotter,—or write for Bulletin AP 810-1.

EAI

ELECTRONIC ASSOCIATES, INC.

Long Branch, New Jersey

VERSATILE



You can play practically any instrumentation tune you want on the versatile **Mincom CM-100 Magnetic Tape Recorder/Reproducer.** Seven or fourteen tracks, 1 or 1.2 mc at 120 ips—with the rugged reliability possible only with Mincom's longitudinal recording on fixed heads. Analog recording/reproducing, or simultaneous post- and predetection capabilities in FM/FM modulation, PCM, PCM/FM and virtually all other FM-type carrier systems. CM-100 is mechanically simple: Mincom's exclusive DC tape transport provides dynamic braking, plus instant push-button choice of six speeds with no belt changes. With its system flexibility, its minimum down time and maintenance, the CM-100 can be the answer to your instrumentation requirements for years to come. Write today for specifications.

Mincom Division 3M COMPANY

Los Angeles 25, California • Washington 4, D.C.

Circle 186 on Inquiry Card

Tech Data

for Engineers

Panel Meters

A completely revised, up-to-date series of technical catalog sheets on panel meters is available from General Meters, Inc., P.O. Box 1701, Grand Junction, Colo. The sheets are color coded for easy reference and contains specs., Mil specs, types of movements, and commercial and military accuracies. Illustrations are reproduced actual size for convenience of case and instrument designers.

Circle 498 on Inquiry Card

Microwave Measurement

Wilton Co., 717 Loma Verde Ave., Palo Alto, Calif., has an article on analysis and measurement of phase characteristics in microwave systems. This article contains phase information valuable to engineers doing work with microwave tubes, components, and semiconductors and in physical science research areas such as linear accelerators.

Circle 499 on Inquiry Card

Magnetic Field Probe

Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill., is offering tech. data #156, which illustrates and describes an ac magnetic field evaluation probe. Included is information on its construction and calibration.

Circle 500 on Inquiry Card

Hall Effect Generators

Data Sheet No. 62400, 4 pages, describes Beckman® Hall Effect Generators. Information includes operating theory, suggested uses, detailed specs., dimensional drawings, illustrations and ordering information. The Beckman device has typical input resistances of 100 to 600Ω, simplifying load matching and give more efficient use of output power. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 501 on Inquiry Card

DC Null Sensor

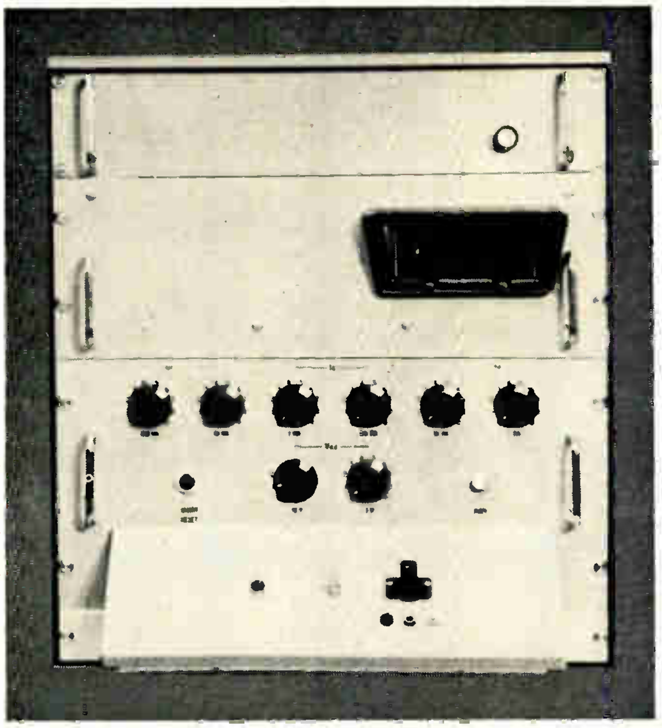
Verco Inc., 1430 130th N.E., Bellevue, Wash., is offering data on their solid state electronics for measuring and monitoring. Included is information on a hazardous current monitor, voltage limit detector, freq. source, overspeed indicator, battery voltage tester, ripple meter, load meter and linear ammeter.

Circle 502 on Inquiry Card

Temperature Sensing

This 28-page bulletin includes information on temp. sensing such as representative specification drawings, degree-by-degree tables of typical resistance vs. temp. ratios, the REC temp. conversion chart covering °C, °F, °R and °K from absolute 0 to 16,000°C, and a bibliography. Included is a detailed discussion on the theory, design and application of platinum resistance sensors, and a comparison of other types of temp. sensors. Rosemount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn. Bulletin 9612.

Circle 503 on Inquiry Card



FAST
ACCURATE
FULL RANGE

NEW
1μA TO 10 AMP PULSED TRANSISTOR
BETA TESTER

FEATURES:

300μSEC. PULSED-DIRECT READING DIGITAL PRESENTATION of h_{FE} from 2—999 with an accuracy of ±1 digit. No conversion charts necessary.

EASY SET-UP AND PROGRAMMING allows even inexperienced operators to perform the complete load, test, unload cycle in about 3 seconds on all types of NPN, PNP transistors.

EXTREME CIRCUIT, CALIBRATION STABILITY is attained by closed loop, feedback system. Output cable provided to drive permanent test recording equipment.

SELF-PROTECTING, LONG-TERM RELIABILITY features result from built-in short detector which locks out system, protects both the equipment and transistor being tested. High reliability Fairchild Silicon Planar transistors and diodes used throughout all measurement, detector and logic circuits.

APPLICATIONS:

INCOMING INSPECTION OPERATIONS, where small lots of different transistor types are received, are simplified and speeded. Makes 100% inspection feasible.

ENGINEERING EVALUATION TESTING. Transistors can be remoted in hot or cold environments to test h_{FE} under temperature stress conditions. This tester permits data taking for rapid h_{FE} characterization over a wide range of collector currents and collector to emitter voltages.

SPECIFICATIONS FAIRCHILD TYPE 840-1
DIRECT READING h_{FE} TESTER

READOUT RANGE:	h_{FE} from 2 to 999 (read directly)
READOUT ACCURACY:	2% or 1 digit
PROGRAM RANGE:	I_C—1 μA to 10 amp. (in 1 μA steps). V_{CE}—.1 volt to 29 volts (in .1 volt steps).
STANDARD PULSE DUTY CYCLE:	0.7% (approx.)

FAIRCHILD
SEMICONDUCTOR

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Circle 188 on Inquiry Card

Tech Data

for Engineers

Transistor Testing

Tech. data is available from Sanders Associates, Inc., 95 Canal St., Nashua, N. H. on their Universal Transistor Circuit-mount. The mount in Tri-Plate® Strip Transmission Line is for the evaluation of high freq. transistors at either UHF or microwave freq. and permits accurate measurement of cutoff freq., rise time and other critical circuit parameters.

Circle 504 on Inquiry Card

Non-destructive Testing

This 16-page catalog, titled "Non-destructive Inspection Equipment and Modern Industry," covers products of the Norelco Industrial Radiographic Equipment Div., and is available from Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y. Included in the brochure are sections on 150 and 300kv units (MG 150 and MG 300), Constant Potential Radiography with high resolution, Fractional Focus and Rod Anode X-ray tubes, X-ray tube suspension systems, and Self-Contained Portables (PG 260 300). Photographs and descriptions are included.

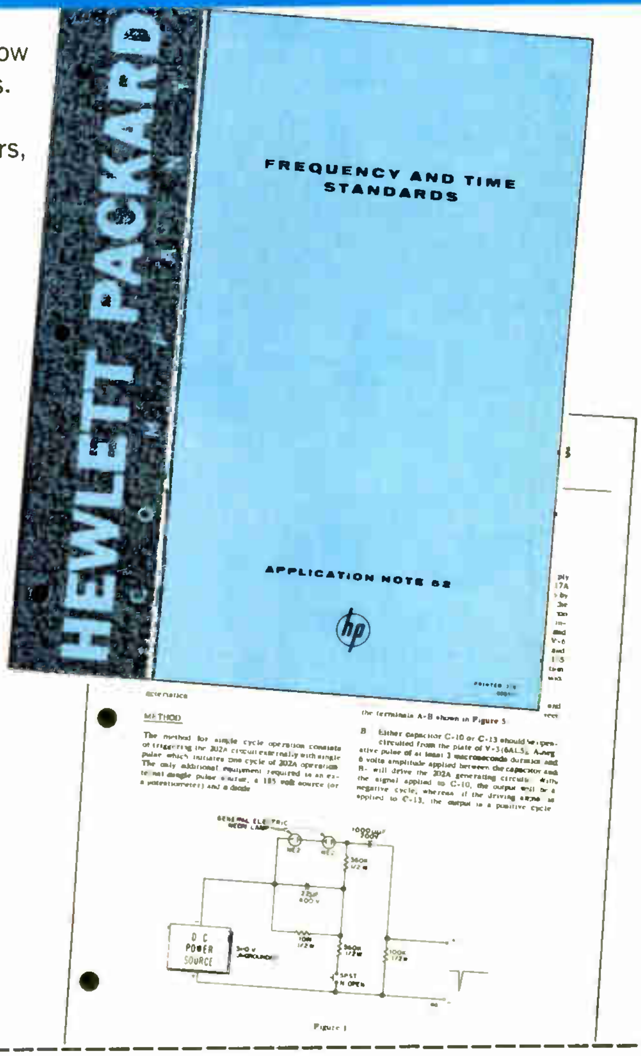
Circle 505 on Inquiry Card

SEND—without obligation—for this valuable technical information on advanced measuring techniques:

hp APPLICATION NOTES

Hewlett-Packard Application Notes include theoretical and "how to do it" information on a wide variety of measuring techniques. These notes are available to you without cost or obligation. Application Notes are derived from the experience of hp engineers, both in general areas of measurement and in solving specific measurement problems. Here is a partial list of titles:

- **#25** Cathode Ray Tube Phosphors
- **#44D** Sampling Oscilloscope Accessories and How to Use Them
- **#52** Frequency and Time Standards
- **#53** Transmission Line Testing Using the Sampling Oscilloscope
- **#54** Improvements in Microwave Swept Frequency Techniques
- **#56** Microwave Mismatch Error Analysis
- **#57** Noise Figure Primer



Other Application Notes cover such subjects as measuring FM signals, measuring rf pulse carrier frequency, microwave spectrum synthesis, waves on transmission lines, square wave and pulse testing, measurement of cable characteristics, instruments for transducer applications, distortion and intermodulation. The Application Notes Index gives a complete listing.

Fill in and mail the attached postcard for Application Notes of interest to you, or for the complete index of titles.

See the reverse side of this page for other helpful hp publications

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TYPICAL JOURNAL SUBJECTS

- **How doppler shift records provide satellite range and height data**
- **The effect of μ-circuit non-linearity on the amplitude stability of RC oscillators**
- **A new frequency/time standard with 5×10^{10}/day stability**
- **Increased accuracy in hp meters through servo calibrating methods**
- **A parallax-free no-glare CRT for hp oscilloscopes**
- **Broader information capabilities in the clip-on dc milliammeter**
- **The transistorized RC oscillator**

Please send these hp APPLICATION NOTES:

☐ #25 ☐ #44D ☐ #52 ☐ #53 ☐ #54 ☐ #56 ☐ #57 ☐ Complete Index

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☐ Ask my hp representative to send me the 1962 hp Short Form Catalog

☐ Ask my hp representative to send me the hp Microwave Catalog

Please print your complete address, giving mail station or other delivery code.

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The above is ☐ my company address ☐ my home address

NEW!

Now available . . . the new 1962 Hewlett-Packard Short Form Catalog, incorporating data and pictures on new hp instruments, plus virtually the entire hp line. Available, too, is the hp Microwave Catalog, offering complete information on Hewlett-Packard's array of full-range tested instruments and equipment, for microwave measurement. Just contact your nearest hp representative for your copy, or check the appropriate box on the return postcard.

Tech Data

for Engineers

Noise Control

"The Why and How of Noise Control" discusses fundamentals of industrial noise control. The 16-page booklet shows how to set up a noise control program and the equipment needed in setting up the program. H. H. Scott, Instrument Div., Dept. "P," 111 Powdermill Rd., Maynard, Mass.
Circle 506 on Inquiry Card

Test Instruments

Tech data is available on r-f voltmeters, dc voltmeters, capacitance and inductance bridges, ac and dc null detectors, r-f distortion meters and UHF grid dip meters. Included are photographs, an specs. Boonton Electronics Corp., Morris Plains, N. J.
Circle 507 on Inquiry Card

Voltage Calibration

Ballantine Laboratories, Inc., Boonton, N. J., is offering an 8-page technical report entitled, "Techniques and Errors in High Frequency Voltage Calibration." This paper discusses the techniques and errors involved in applying a group of high-freq. voltage standards developed by NBS to typical problems such as the calibration of electronic voltmeters. Photographs, outline drawings, schematics, characteristics, and charts are included.
Circle 508 on Inquiry Card

Cryogenic Equipment

This 8-page, 2-color booklet presents data on Sulfrian Cryogenics' line of low temp. containers, vessels and equipment. Cutaway illustrations show construction characteristics of liquid nitrogen vessels, helium and hydrogen containers and open dewars. Sulfrian Cryogenics, Inc., 1290 Central Ave., Hillside, N. J.
Circle 509 on Inquiry Card

Digital Ohmmeters

This 6-page, pocket-size, folder gives brief descriptions and specs. on a line of 4 and 5 digit, all-solid-state, digital voltmeters and ohmmeters. Electro Instruments, Inc., 8611 Balboa Ave., San Diego 11, Calif.
Circle 510 on Inquiry Card

Meter-Relays

Specs. including dimensions, sensitivities, case styles and prices are included in a catalog on locking contact meter-relays. Bulletin No. 5, 23 pages, 2 colors, includes operating features and standard circuits and is available from Assembly Products, Inc., Chesterland, Ohio.
Circle 511 on Inquiry Card

Frequency Standard

The Hill Reference Frequency Standard System 81000 series is described in an 8-page 2-color booklet. Modular components included are: 2.5MC primary freq. reference source; 7YLF phase comparator models; inter-oscillator phase comparator; and a time-correction panel. Hill Electronics, Inc., Mechanicsburg, Pa.
Circle 512 on Inquiry Card

Tech Data

for Engineers

Ratio Transformers

Tech. brochure, 2 colors, describes precision, general purpose ratio transformers, featuring an accuracy of 0.001%, high imput impedance, low effective series impedance, and very low phase shift. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Circle 513 on Inquiry Card

Voltmeter

Potentiometric Voltmeter Model 951 is described in tech. data, 3 colors, available from Smith-Florence Inc., P.O. Box 717, Redmond, Wash. Specs include input voltage and power, 117v, 60CPS, 1θ, 10w; potentiometer accuracy, 0.005%; and instrument accuracy 0.01% absolute.

Circle 514 on Inquiry Card

Sweep Generator

Model 501 Sweep Generator, with a freq. range of 100CPS to 32MC, is described in tech. data available from Northeastern Engineering, Inc., 25 So. Bedford St., Manchester, N. H. Two plug-in heads cover the range and give high overlap in the 10 separate bands provided. The all electronic sweep eliminates the problems associated with sweep motors and mechanical type sweeps.

Circle 515 on Inquiry Card

Tech Data

for Engineers

Instrument Brochure

A 6-page, 3-color illustrated folder, Instruments for Industry, is available from General Radio Co., W. Concord, Mass. Instruments described include continuously adjustable autotransformers, sound and vibration measuring equipment, and stroboscopes.

Circle 516 on Inquiry Card

Thermocouple Catalog

This 56-page catalog on a line of thermocouples for industrial use is available from Wheelco Industrial Instruments Div., Barber-Colman Co., Rockford, Ill. The catalog not only carries descriptive information on these products, but also includes engineering information concerning thermocouple usage and application. Catalog TC13A.

Circle 517 on Inquiry Card

Microwave Test Set

PRD Electronics, Inc., 202 Tillary Street, Brooklyn 1, N. Y., is offering a 10-page report entitled "A Microwave Calibration Test Set For A Seven Octave Band." The equipment described is capable of making all fundamental measurements, i.e., power, frequency, VSWR, and attenuation in the freq. range from 300 to 40,000 MC.

Circle 518 on Inquiry Card

Digital Voltmeter

Six-page Bulletin 311 describes Model 550 Digital Voltmeter. Illustrations of individual plug-in modules, as well as internal views of the complete instrument are shown. Franklin Electronics, Inc., Bridgeport, Pa.

Circle 519 on Inquiry Card

Test Equipment

The Triplett Electrical Instrument Co., Bluffton, Ohio, has available test equipment catalog No. 43-T, covering their complete line of volt-ohm-milliammeters, combination V-O-M and VTVM's, signal generators, sweep generators, transistor testers, and their 5 in. oscilloscope Model 3441-A.

Circle 520 on Inquiry Card

Panel Instruments

Circular Z-69 discusses the features and specs. of a complete line of panel meters available as stock items from Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

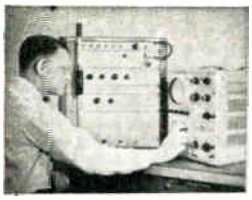
Circle 521 on Inquiry Card

Core Testing

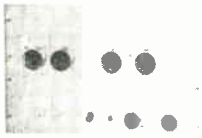
Application Bulletin No. 200 describes a method of making a low cost test system for fast switching memory cores by adding the output pulse currents of 4 Rese Model 203 Pulse Generators. Included is a block diagram of the test system, a drawing of the positive and negative current pulses and a photographic illustration of the 4 generators connected to an oscilloscope and to a core under test. Rese Engineering Inc., A and Courtland Sts., Phila. 20, Pa.

Circle 522 on Inquiry Card

Circle 198 on Inquiry Card



ACCURATE RESEARCH STARTS WITH Rutherford PULSE INSTRUMENTATION

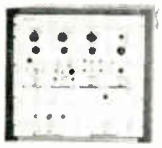


Model B-11 REMOTELY PROGRAMMABLE PULSE GENERATOR

Designed specifically for automated check out systems, this all-purpose Pulse Generator may be programmed to fill a broad range of requirements.

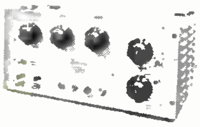
Model B-10 TRANSISTORIZED PORTABLE HIGH-SPEED PULSE GENERATOR

A versatile, general purpose portable unit for field and laboratory use featuring a self-contained, rechargeable battery pack which allows independent operation "in the field" as well as from standard line voltage.



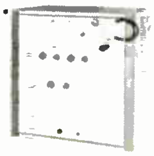
Model B-9 HIGH QUALITY PULSE AND TIME DELAY INSTRUMENTATION

Designed on the modular building block concept and featuring accurate transistorized circuitry in a wide range of specifications. It provides special purpose generators to meet any pulse requirement.



Model B-7B HIGH REPETITION RATE PULSE GENERATOR

High performance and wide versatility—50v into 50 ohms @ 30% duty factor, rep. rate to 2 mc, widths .05 us to 10,000 us, delays to 10,000 us. Rack mountable new single unit construction.

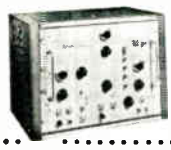


Model B-5A 10 MEGACYCLE PULSE GENERATOR

Built to the most exacting standards of precision engineering, offers an unparalleled combination of good clean pulses and high repetition rate with no greater than 8 mus rise and fall time.

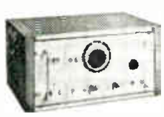
Model B5-2 HIGH SPEED 10 MEGACYCLE OOUBLE...PULSE GENERATOR

Producing 2 pulse trains derived from a single oscillator—featuring output pulse adjustable in width from 20 mus to 12.5 us, rise and fall time no greater than 8 mus.



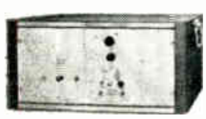
Model B-2A A GENERAL PURPOSE PULSE INSTRUMENT

Produces pulses of accurately controlled widths, amplitude and time delay at low impedance. Internal oscillator gives rep. rates from 10 cycles to 100 kc. Pulse widths from .08 us to 1,000 us.



Model A-2 and Model A-4 TWO TIME DELAY GENERATORS

Feature low jitter, linear scales, small repetition rate effects, external connector provided for delay voltage so that unit may be externally time modulated, easily read dial controls.



Model A9 PULSE AND TIME DELAY SYSTEMS

A highly accurate, jitter free time delay generator featuring time delays from 0.8 to 100,000 usec. Multiple outputs including gates and ramp available at front panel connectors.

For complete bulletin on Rutherfords Instruments write to Dept. EI-662

Rutherford ELECTRONICS CO.

8944 Lindblade Street • Culver City, California • TWK-CVR-CY-4133

pulse generators / pulse systems / accurate time delay generators

Circle 199 on Inquiry Card

21 separate C-BAND frequency signals with ±0.0001% accuracy!

Model G110C Signal Generator

This unique laboratory instrument from Frequency Engineering combines both precise frequency control at a large number of points AND maximum operating simplicity. Any one of 21 frequency signals can be selected and peaked by the single front panel control... **ideal** for quality control requirements in microwave tube testing!

Exact frequency is derived from a standard crystal oscillator by multiplication and mixing circuits followed by a high-sensitivity gang-tuned filter to eliminate spurious signals.

SPECIFICATIONS

Frequency Range	5000-6000 mc
Accuracy	±0.0001%
Generator Power Output	1 mw minimum
Output Signals	21 frequencies in increments of 25 mc
Spurious Responses	60 db down
Oimensions	19" Rack Panel, 12" High

For complete details, ask for Bulletin A10162

We invite your inquiries on custom frequency control equipment and components for laboratory, field, or system use. For information on microwave stalos, multiplexers, filters, wavemeters, reference cavities, discriminators, and stable signal sources write:

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Circle 200 on Inquiry Card

Tech Data

for Engineers

Deviation Meter

Deviation Meter Model 140 is covered in tech data available from Measurements, a McGraw-Edison Div., Boonton, N. J. Specifications include a carrier freq. range of 25 to 1000MC; and sensitivity of 25 to 100-mv at freqs. to 500MC; 100 to 1000mv at freqs. to 1000MC.

Circle 523 on Inquiry Card

Spectrum Analyzers

Tech. data is available on: audio spectrum analyzers; CW oscillators; a complete line of high freq. attenuators; precision random noise generators; and a noise measurement test set. Specs. and photograph included. Kay Electric Co., Dept. EEM-5, Maple Ave., Pine Brook, N. J.

Circle 524 on Inquiry Card

Harmonic Measurement

Tech. data is available on EMTECH Harmonic Measuring Set HMS-L1 offering fundamental freq. range of 755-985MC; harmonic freq. range of 1500-3000MC.; a minimum detectible signal, 1mw.; accuracy of harmonic amplitude measurement, ±3db.; and simplicity of operation. Electromagnetic Technology Corp., 1375 California Ave., Palo Alto, Calif.

Circle 525 on Inquiry Card

High Voltage Testing

A complete engineering application analysis, entitled "High-Voltage Testing: It Can Be Nondestructive" is available from Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. The bulletin details the causes of insulation breakdown, the minimizing of destructiveness by current limiting and many other pertinent aspects of insulation testing. Bulletin 5-15.4.

Circle 526 on Inquiry Card

Test Instruments

Short Form Catalog 1962 available from Marconi Instruments, 111 Cedar Lane, Englewood, N. J., includes photographs and specs. on their line of: signal generators — AM, FM, and sweep; bridges—L C & R; FM deviation meters, Q meter and accessories, receivers—FM and AM; and systems test gear: multi-channel, and SSB.

Circle 527 on Inquiry Card

Miniature Recorder

The Amprobe Recorder is a rugged, compact instrument for making permanent records of any variables such as voltage, current, power, temp., pressure, or flow, etc. It weighs 20 oz., holds enough paper for 360 hours of continuous recording and gives an accuracy of ± 2% (dc) and ± 3% (ac) full scale. The unit measures 5 21/32 x 3 1/32 x 1 11/16 in. Amprobe Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.

Circle 528 on Inquiry Card

New Tech Data for Engineers

Pulse Generators

Argonaut Associates Inc., P. O. Box 273, Beaverton, Ore., are offering a 1962 instrumentation catalog describing characteristics of a modular group of differential preamplifiers, electrometers, intermediate and output amplifiers, single ended and differential isolation units, pulse generators, calibrators, and regulated power supplies.

Circle 657 on Inquiry Card

Commutating Switch

Tech. data on the Rotary Commutating Switch is available from Precision Specialties, Inc., P.O. Box 118, Pitman, N. J. Information includes photograph and dimensional drawing, as well as background information, complete description, specs. and uses. The unit is for measuring low level signals from transducers or thermocouples at high speed.

Circle 658 on Inquiry Card

Laboratory Amplifiers

An 8-page tech. brochure describing Glennite Transistorized Laboratory Amplifiers is available from Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. The illustrated booklet gives information on the company's combination interchangeable power supply and rack-mounting chassis which accommodates 6 interchangeable plug-in modules. Four different modules are available, including a voltage amplifier, voltage amplifier and meter, ac galvanometer amplifier and dc galvanometer amplifier.

Circle 659 on Inquiry Card

Sensing Equipment

Schaevitz Engineering, P.O. Box 505, Camden 1, N. J., is offering a 16-page short form catalog describing their sensing, indicating, recording, and controlling equipment. Using a "building-block" concept, the equipment can be applied to the measurement and control of most physical quantities such as displacement, pressure, force, acceleration, weight, thickness, contour, level, flow stress and strain.

Circle 660 on Inquiry Card

Casting Resin

Stycast 1264 is a clear, almost water white casting resin which when fully cured has high characteristics of toughness and impact strength. Preliminary Tech. Bulletin 7-2-26 gives specs. and makeup instructions. Emerson and Cumming, Inc., Canton, Mass.

Circle 661 on Inquiry Card

Digital Voltmeter

Digi-Tec Model 200, a small, low cost portable digital dc voltmeter is primarily for production use. Certified accuracy is 0.2% full scale. Manually selected voltage ranges run from 0.000 to 1020vdc. Resolution and readability is ½ digit (0.05% full scale) United Systems Corp., 918 Woodley Rd., Dayton 3, Ohio.

Circle 662 on Inquiry Card

Glass Processing

Revised edition of Bulletin S-1057, "Processing Glass with Selas Gradiation® Heating," is available from Selas Corp. of America, Dresher, Pa. This 16-page bulletin includes updated information on new developments in the field of glass processing and complete description of how Gradiation® heating is used in a variety of operations from annealing to tempering, fire-polishing to processing.

Circle 663 on Inquiry Card

Phenolic Resins

A 12-page illustrated catalog for 1962 (CDC-381-A), describing Lexan[T.M.] polycarbonate resins and pholic resins, varnishes and molding powders, is available from the Chemical Materials Dept., General Electric Co., 1 Plastics Ave., Pittsfield, Mass. Also included are phenolic foundry resins, industrial resins, laminating varnishes and resins, and Methylon® coating resins.

Circle 664 on Inquiry Card

Electronic Enclosures

Tech. data is available on both Military Type (26 in. deep) and Commercial Type (24 in. deep). Included in the information is general specs., notes, basic frames, components and accessories, ventilation and cooling and ordering information as well as dimensional drawings. Holbrook Merrill Co., 1150 Kifer Rd., Sunnyvale, Calif.

Circle 665 on Inquiry Card

Bobbin Coil Winders

Two types of automatic bobbin coil winders, for winding 400 to 1,000 coils/hr. with wire sizes of AWG 16 to 50 and finer, are described in tech. data from Leesona Corp. 333 Strawberry Field Rd., Warwick, L. I. The No. 115 is a high-speed, single-head winder for spool-wound coils used in high sensitivity instrument relays and field coils for small motors. The No. 116 is a multi-head, automated winder for the same types of coils.

Circle 666 on Inquiry Card

Silicone Catalog

A new and revised 8-page, 2-color catalog describing the complete line of GE's silicones and their uses is available from General Electric Co., Silicone Products Dept., Waterford, N. Y. The 1962 catalog, CDS-129D illustrated with photos and tables, contains data pertaining to the various silicone products, including a useful selector guide for silicone rubber.

Circle 667 on Inquiry Card

Cushioning Tape

TESA Foam Stik Tape cushions components and electronic assemblies against damage. It is self-adhesive and quickly applied by pressure. The tape is also designed to keep out dust, soot, and insects and is available in rolls of varying thicknesses, widths and lengths. It has high resistance to chemicals, fumes, rot, rust and mildew. United Mineral & Chemical Corp., 16 Hudson St., New York 13, N. Y.

Circle 668 on Inquiry Card

Ultrasonic Generators

Product Bulletin 150 gives information and specs. on a complete line, plus optional accessories, of 4 sizes of ultrasonic generators for conveyorized, batch or manual production line cleaning and degreasing. All generators are designed to operate either transducerized tanks or immersible transducers, interchangeably. National Ultrasonic Corp., 95 Park Ave., Nutley 10, N. J.

Circle 669 on Inquriy Card

Soldering Irons

Tech data is available on Weller Magnastat® Controlled Temperature Soldering Irons. Information includes specifications, tables, outline drawings on both soldering irons and soldering iron tips. Weller® Electric Corp., 601 Stone's Crossing Rd., Easton, Pa.

Circle 670 on Inquiry Card

Crystal Crucibles

Information is available on the production of single crystal crucibles, using Magnesium Oxide single crystals as the actual crucible itself. With the purity of 99.97+%, they are being produced in 2 sizes: one which has an internal dimension of 1cm. in dia. x 1cm. deep and another which has internal dia. of 0.5 cm. and a depth of 0.5cm. Semi-Elements, Inc., Saxonburg Blvd., Saxonburg, Pa.

Circle 671 on Inquiry Card

Tech Data

for Engineers

Counting Systems

Proportional Counting Systems and associated equipment described in Bulletin PC-62, 16 pages, is available from Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind. The systems and equipment are used for precise detection and measurement of alpha, beta and gamma radiation in the industrial and nuclear research fields. Information is included on proportional counting converters, dual proportional counter, radiation laboratory systems, decade scalers, accessories and replacement parts.

Circle 529 on Inquiry Card

DC Parameter Tester

Model #TM-101 is a manual tester for measuring 5 transistor dc parameters on both npn and pnp transistors. Tests performed are collector to base leakage (I_{CBO}); emitter to base leakage (I_{EBO}); emitter to base breakdown voltage (BV_{EBO}); collector to base breakdown voltage (BV_{CBO}); and collector to emitter breakdown voltage (BV_{CEO}). Accuracy is ±1% of full scale with worst case combination of load variation, ±10% line voltage variation, and ±25°C temp. variation from 20°C amb. Indamer Electronics, 1038 W. Evelyn, Sunnyvale, Calif.

Circle 530 on Inquiry Card

Frequency Standard

Tech. data is available on Montronics Inc.'s Model 200 Synchronized Frequency Standard for use in communications systems, standards, laboratories, navigation and guidance systems and precision measurements laboratories. Model 200 features: locked to NBS or U. S. Naval Observatory; all electronic servo for max. reliability; all solid state circuitry; and absolute accuracy to 2 x 10^{10}. Montronics Inc., 1212 W. Main, P. O. Box 135, Bozeman, Mont.

Circle 531 on Inquiry Card

Test Instruments

Tech data is available on a line of impedance bridges, distortion analyzers, noise analyzers, ac and dc, voltmeters, signal generators, displacement and vibration analysis, and control system analysis systems. Wayne Kerr Corp., 1633 Race St., Phila. 3, Pa.

Circle 532 on Inquiry Card

Standards Catalog

A catalog containing more than 2,000 American standards as well as recommendations of the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) is available from the American Standards Assoc., Dept. P 298, 10 E. 40th St., New York 16, N. Y. This 76-page brochure provides reference to approved American Standards in areas of acoustics, symbols and abbreviations, electrical engineering, ferrous materials and metallurgy, nuclear energy, and safety.

Circle 533 on Inquiry Card

Tech Data

for Engineers

Ozonators

OREC 03C Series Ozonators have high ozone output for use in transistor oxidation processes. They produce ozone up to 36 grams/hr. and may be used for both laboratory and production process applications. Ozone Research and Equipment Corp., 3840 N. 40th Ave., Phoenix, Ariz.

Circle 534 on Inquiry Card

Monitor System

Descriptions of uses and performance data on the Electra Operations Monitor System, a versatile solid-state system for checking and controlling low-level signals is included in a 4-page technical bulletin available from Electra Systems Corp., Electra Way, Fullerton, Calif. The unit was developed for continuous, precise monitoring of operating levels of industrial processes, instrumentation systems and military checkout equipment.

Circle 535 on Inquiry Card

Limit Testing

Trio Laboratories, Inc., Plainview, L. I., N. Y., is offering a "Handbook of Limit Instrumentation," a 20-page manual devoted to the theory and application of limit testing. In addition to general considerations of limit testing, the handbook gives detailed specs. of TRI/LIM, Trio/lab's new line of modular limit test systems.

Circle 536 on Inquiry Card

Gyro Test Equipment

Static and dynamic test equipment for complete performance evaluation of gyros, accelerometers, and similar instruments are described in a 7-page catalog available from Micro Gee Products, Inc., 6319 W. Slauson Ave., Culver City, Calif. Included are tech data sheets on static tilt tables, linear acceleration tables, oscillating rate tables and other instruments.

Circle 537 on Inquiry Card

DC Ratiometer

Tech data is available on a new low-cost DC ratiometer with full five-digit resolution. The R65A offers plug-in stepping switches, precision wire-wound resistors and snap-out readout for fast bulb replacement. It will measure dc voltage ratio from 0.00001:1 to 0.99999:1 with an accuracy of 0.01% of reading plus 1 digit. Balancing time averages 2 sec. Input impedance is 1000 megs. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 538 on Inquiry Card

Spectrometer Systems

Varian Assoc., 611 Hansen Way, Palo Alto, Calif., is offering a catalog covering its line of Nuclear Magnetic Resonance and Electron Paramagnetic Resonance Spectrometer systems and components. The 12-page catalog is illustrated and contains a brief description of the technique of NMR and EPR spectroscopy.

Circle 539 on Inquiry Card

Tech Data

for Engineers

Environmental Closures

Packaging Pointers No. 2, 4 pages, discusses the importance of correct closure design for military containers for proper environmental protection. Included are 6 design criteria for a suitable closure. Also included are 5 drawings of typical Zero closure extrusions. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Circle 672 on Inquiry Card

Bearing Catalog

A quick reference 8-page condensed catalog listing miniature, instrument, spindle, and turbine bearings is available from The Barden Corp., 200 Park Ave., Danbury, Conn. Catalog C-4 includes information in a wide range of low torque, high speed, high temp. and extended life bearings in open shielded and sealed, flanged and unflanged types.

Circle 673 on Inquiry Card

Ultrasonic Machining

This 16-page illustrated booklet explains the theory of ultrasonic machining and details applications in drilling, slicing, engraving, trepanning and shaping hard and brittle materials such as glass, ceramics, germanium, stainless steel, tool steel, and precious jewels. Bulletin 2-300 available from Commercial Apparatus and Systems Div., Raytheon Co., 225 Crescent St., Waltham 54, Mass.

Circle 674 on Inquiry Card

Subminiature Connectors

Tech. data is available on subminiature electronic connectors, constant contact printed circuit board connectors, and right angle printed circuit board connectors. Included are dimensional tables, photographs, and outline drawings. Winchester Electronics, Inc., Willard Road, Norwalk, Conn.

Circle 675 on Inquiry Card

Terminals

This 12-page, 2-color, catalog gives complete engineering data and tabulations for 500 different types, sizes and configurations of Trinseel Teflon terminals, including miniature and subminiature stand-offs, feed-thrus, plugs and connectors. Alisco Co., 809 Stewart Ave., Garden City, N. Y.

Circle 676 on Inquiry Card

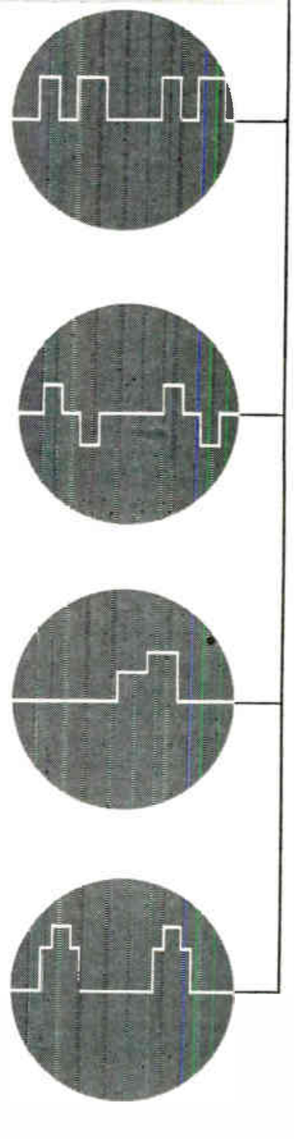
ADS OF INTEREST IN OTHER SECTIONS . . .

dealing with "Measurement & Testing"

Reeves Instrument Corp. ....p. F20

Alford Mfg. Co. ....p. J24

NOW! FULL PLUG-IN VERSATILITY WITH LAVOIE'S MODULAR PULSE GENERATOR



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from $1,200. with plug-ins as illustrated (R-1, WD-1, O-1)

Lavoie's new **dual pulse** Modular Pulse Generator offers plug-in versatility to cover the full range of pulse instrumentation. Repetition rates from 0.01 cps-10mc in variable and crystal controlled decade steps ... pulse widths and delay from 2 nanoseconds to greater than 1 second. Features dual channel output—separate or parallel—provides independent amplitude control for each channel.

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Fast rise times of 1 nanosecond as well as ample outputs to 1 amp across 50 ohms makes this instrument outstanding for either bench or rack mounted applications.

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JKFS-1100T Frequency Standard, and (right) JKFS-1100TP 115 V AC Power Supply with emergency battery that provides up to 12 hours stand-by power. Optional 7"x19" panel available for rack mounting.

Write for technical brochure to

THE JAMES KNIGHTS COMPANY, Sandwich, Illinois

Circle 204 on Inquiry Card

Section H

Military Electronics

ELECTRONIC INDUSTRIES

1962 MILITARY ELECTRONIC PROCUREMENT DIRECTORY

This is an up-to-date listing of key AIR FORCE, NAVY and ARMY procurement and other personnel, indicating the organizational placement of these men, many of whom are concerned with electronic procurement.

U. S. ARMY

The Pentagon Wash 25 D C
Phone LIberty 5-6700 or dial OX and the extension

The U S Army is reorganizing its commands. In the new concept, procurement will be handled by the **U S ARMY MATERIEL DEVELOPMENT & LOGISTIC COMMAND.** It may be June '62, or later, before this plan will be in complete operation. In the meantime, the interim data below covers, to a certain extent, the facilities we formerly reported under the heading U S

ARMY ORDNANCE CORPS

	Extension
CHIEF OF ORDNANCE	
Lt Gen J H Hinrichs	56261
INDUSTRIAL DIV Maj Gen G C Carlson	55371
SMALL BUSINESS OFC H M Evans	72774

U.S. ARMY MISSILE COMMAND

Redstone Arsenal Ala
Phone JEfferson 6-4411

COMM GENERAL Maj Gen A Schamberg
DEP COMMANDER Maj Gen F J McMorrow
INDUSTRIAL OPERATIONS Col J S Jefferds
PROCUREMENT L R McGary
SMALL BUSINESS J Darwin

DIAMOND FUZE LAB

Conn Ave at Van Ness St NW Wash 25 D C
Phone EMerson 2-8000

COMMANDER Lt Col R W McEvoy
PROCUREMENT F T Rainier
SMALL BUSINESS J R Amata

FRANKFORD ARSENAL

Bridge and Tacony Sts
Philadelphia 37 Pa
Phone JEfferson 5-2900

COMM OFF Col Charles W Eifler	X3100/5200
DEP CO Col R E Le Roy	X6115/6215
CIV ADM T C Kempin	X4201/4205
PROC DIV	
Maj J H Machik	X4101
RESEARCH & DEVELOPMENT GRP	
C C Fawcett	X3103/5140
INDUSTRIAL GROUP	
Lt Col J E Mitchell Jr	X3225/21121
FLD SRVC GRP	
Col Earnest A Benser	X4216
NATL MISSION IND GRP	
Chief Maj W A Anderson	X23120
Deputy D W Hood	X22118
SMALL BUSINESS SPCLST	
W Travis Jr	X7220

U. S. ARMY SIGNAL MATERIEL SUPPORT AGENCY

Ft Monmouth N J
Phone: LIberty 2-4000

MISSION: Provides technical support toward procurement and production of equipment and publications required to perform the Army Signal Corps field mission and toward operation and maintenance of this equipment in the field

COMM OFF Col H E Price	X81111
DEP CO Col R I Ulans	X81452
EXEC OFF Lt Col J N Kopke	X81165
ADJ Maj W J Brownlee	X81230
COMD MAINT INSP OFC	
CHIEF Maj J M Trammell	X81242
TECH ASSTC OFC	
CHIEF Maj W E Dixon	X81205
ENG OFC	
CHIEF J W Weselah	X81202
DEP CHIEF H R Nooe	X81112
PROD ENG DEPT	
DIR W J Laverick	X81622
MAINT ENG DEPT	
DIR R P Iannarone	X81214
PUB ENG DEPT	
DIR J H Creutz	X22105
ARMY FIELD PRINT PLANT	
SUPT R L Dentler	X23052

U. S. ARMY SIGNAL RESEARCH AND DEVELOPMENT AGENCY

Ft Monmouth N J
Phone LIberty 2-4000

MISSION: Responsible for Signal Corps research and development; awards research and development contracts; furnishes engineering supervision

COMM OFF Col J M Kimbrough	X51111
DEP CO Col R H Bates	X51126
CH SCIENTIST Dr H K Ziegler	X51268
EXEC OFF J S Crull	X51144
DIR ENG S E Petrillo	X51171
DIR MGMT F A Kineavy	X51131
DIR RSRCH Dr H A Zahl	X51136
DIR TECH PLANS H W Parmer	X52112
ADMIN DIV	
CHIEF H E North	X51177
ADJ Maj H W Killam	X51333
LIAISON DIV	
CHIEF C L Francis	X52782
LOG DIV	
CHIEF Maj W J Lawlor	X51196
SEC DIV	
ACT CHIEF C E Taylor	X51641
TECH LIST	
CHIEF B H Christenson	X51409
TECH INFO DIV	
CHIEF L Rakow	X52159

U.S. ARMY SIGNAL RESEARCH AND DEVELOPMENT LABORATORY—USASR & DA

COMM DEPT	
DIR R S Boykin	X51186
ELCT COMPT DEPT	
DIR W L Doxey	X51181
ENG SCNC DEPT	
DIR E J Fister	X52525
INST EXPLRTRY RSRCH	
DIR Dr E M Reilley	X52608
SURVL DEPT	
DIR Col T K Trigg	X61232
SPT BTN	
CO Maj O E Pribram	X23940
SIG OP ACTV	
CO Maj W R King	X27732
SIG RSRCH ACTV	
CO Lt Col G W Olson	X61148
SIG PATENT ACTV	
DIR J C Keppler	X61146

U. S. ARMY SIGNAL SUPPLY AGENCY

HEADQUARTERS
225 South Eighteenth St.
Philadelphia 3 Pa
Phone: KIngsley 6-3200
MISSION: To supply equipment and maintenance parts required to support the communications and electronics systems of the Army and, as authorized, of other federal and foreign establishments. Principal functions carried out to this end include formulating procurement policies, procurement, quality assurance, centralized supply and stock control for equipment and parts

COMM GEN
Brig Gen Charles S Hays X8000
DEP CO
Col Douglas O Toft X8001
EXEC OFF
Lt Col Harry A Stuart X8101
DEP FOR SMALL BUS & LABOR SURPLUS
E J O'Neill X749
DEP FOR IND PREP
L A Kapust X300
DEP FOR SUPPLY MGMT
J. G. Melvin X200
DEP FOR INT DATA SYS
J Bergman X231
DEP FOR QUALITY ASSURANCE
Col F J Coffey X600
DEP FOR PROCUREMENT
Col Joseph G Bent X500
ASST DEP FOR PROC
S Rabinowitz X501
ASST DEP FOR PROC (CONTRACTING)
A Schuster X8372
PROC MGMT DIV A
Chief A Testa X8176
PROC BR A-1, 2
Radio, TV and related equipment
Chief Maj L E Ganter X8198
Asst J W Robinson X8197
PROC BR A-3
Electrical measuring and testing equipment, relays, contacts, solenoids
Chief Maj B F Stone X8179
Asst D Shuman X678
PROC BR A-4, 5
Recorders, reproducers, intercoms, speakers, coils, resistors, transformers
Chief Capt R E Frye Jr X508
Asst Michael Curce X507
PROC MGMT DIV B
Chief N Creager X410
PROC BR B-11
Electron tubes, transistors, crystals
Chief vacant
PROC BR B-12
Dry storage and thermal batteries
Chief R Miller X468
PROC BR B-13, 14
Meteorological and photographic equipment and supplies
Chief Maj H Rogers X466
Asst Mrs M Regan X467
SPCL PRCHS BR
Purchases under $2500, EPDO's
Chief L Karafin X543
TECH ASSTC & SPCL PRDCTS PROC BR
MWO's Tech Rep prgrm
Chief C Maurer X457
PROCUREMENT MGMT DIV C
Chief Lt Col G P Sunshine X8047
Asst H Oakley X8048
COM PROC BR C-21-24
Telephone and telegraph equipment, wire cable and cord assemblies and reels
Chief Maj R P Schafer X482
Asst H Walton X758
COM PROC BR C-22, 23, 25
Teletype and facsimile equipment, engine and transmission equipment mounting hardware, hand and measuring tools
Chief Maj W L Clay Jr X480
Asst F Toscano X481
MISSILES SYTM PROC BR
Chief C Fravel X739
PEM & FAC PROC BR C
Chief L Mizdail X8059
PROCUREMENT SRVCS DIV
Chief M Wexler X453
BIDDERS INFO BR
E A Jalley X488
CONTRACT PRGRM COORD BR
Chief H Loose X8340
PROCESSING BR
Chief I Scott X475
ECONOMICS DIVISION HQ
Chief H E Moore X368
Asst H Shein X369
PROPERTY & ADMIN DIV
Chief F J McAdams X8152

REGIONAL AND BRANCH PROCUREMENT OFFICES

MIDWESTERN REGIONAL OFICE—USASSA
400 South Jefferson St
Chicago 7, Ill
Phone ANdover 3-0234
MISSION: This office has sole procurement responsibility for approximately 100,000 items of communications and electronics equipment covering 23 major commodity groups in a 20 state area. The groups covered include telephone teletype, electrical components and hardware, antennas, photographic equipment and supplies, meteorological equipment, waveguides and related equipment. It is responsible for contract administration, industrial preparedness and quality assurance activities in this area
COMM OFF Lt Col J F Reilly X102
DEP CO Maj T J O'Neill X102
EXEC OFF Maj T J O'Neill X103
PROC DIV
Chief J E Nylin X240
Asst Capt D D Rudd X241
PROC MGMT BR A
Chief L Sirt X220
PROC MGMT BR B
Chief M Hora X254
PROC MGMT BR C
Chief R H Tauhey X250
PROC SPEC GRP
Chief J Fijolik X223
PROP BR
Chief A L Peruzza X252
ECONOMICS BR
Chief R D Haag X61
LEGAL DIV
Chief J Cale X116
QUALITY ASSURANCE DIV
Chief G E Schreck X140
FIELD BR
Chief L O Kaiser X142
TECH BR
J E MacDougall X141
IND PREPAREDNESS
Chief F D Temple X271
TRANS & TRAF MGMT
Chief G Emitz X160
SEC OFF
E J Prislinger X114
SMALL BUSINESS SPECIALIST
E Wack X106
COMPTROLLER
E F Slominski X120

WESTERN REGIONAL OFFICE—USASSA
124 South Grand Ave
Pasadena Calif
Phone: Sycamore 6-0471
MISSION: The Western Regional Office is responsible for administering Army Signal Corps contracts placed with firms within a 13 state area; however, it does not have an awarding mission. Administration includes modifications, pricing, expediting and maintenance of govt. property records. It also has quality assurance and industrial preparedness responsibilities. West coast suppliers are encouraged to visit this office for assistance in contract clarification, for guidance in getting an bidders' lists, and for counsel in submitting bids on current solicitation
COMM OFF Col B R Painter X664
EXEC ASST A Scarpa X664
SMALL BUS & IN REL OFC
Chief A Scarpa X663
WESTERN FLD OFC USASIMSA
Nathan Levine X255
PROCURMENT DIV
Chief Lt Col A T Burke X651
Dep Chf Anthony Bogart X651
ECONOMICS BR
Chief John Caruthers X623
PROP BR
Chief Jack Cody X231
PROC MGMT BR
Chief Capt M J Sansky X678
IND PREP DIV
Maj G A Gibson X250
QUALITY ASSURANCE
Chief Paul Haynik X667
TECH BR
Chief James B Lee X667
SRVCS BR
Chief Margaret Ayer X672
LOS ANGELES AREA SUPERVISOR
Edward J Drabek X672
SAN FRANCISCO SUPERVISOR
David Schwimmer JO 1-2855

U S ARMY ELECTRONIC PROVING GROUND PROCUREMENT OFFICE—USASSA
Post Office Box 748
Fort Huachuca Ariz
Phone GLadstone 8-3311
MISSION: Responsibility for placing and administering special equipment contracts and contracts for services and studies as required for performance of the mission assigned to the U S Army Electronic Proving Ground. Purchases commercial type signal equipment and supplies in support of U S Army Missile Support Agency, White Sands, N M, for which local procurement authority exists
COMM OFF Lt Col A E Barnsbee X3916
PROCUREMENT SPECIALIST GRP
F Saunders X5938
LEGAL OFC
Robert Roubol X2231
MGMT SRVCS OFC
J Horstman X2819
IND PROP OFC
C K Walker X4166
FIN EVAL & ECONOMICS OFC
Capt Albert Gorelick X4118
CONTRACTS DIV
Chief Maj James E Dempsey X2817
Asst V Suarez X5117
LARGE PRCHS BR-COST
Chief J M Kelly X5518
Contracting Ofcr P Davis X2815
Contracting Ofcr M Werth X4117
Contracting Ofcr J Maliniak X4120
LARGE PURCHASES BR—FIXED PRC
Chief Maj C L Rishell X5013
Contracting Ofcr R Sevy X3131
Contracting Ofcr L M Poss X4115
SMALL PURCHASES BR
Chief Maj C E Crabill X5838
Asst S Kornegay X5027
Asst R Drew X3917
SMALL BUS SPCLST
J Horstman X3919

FT MONMOUTH PROCUREMENT OFFICE—USASSA
Ft Monmouth N J
Liberty 2-4000
MISSION: Processes prime contracts for research and development in field of communications, radar, surveillance, electrical and electronic components and other related fields. These procurements ar normally initiated by the U. S. Army Signal Research and Development Agency
COMM OFF Col L M Reiser X51115
DEP Lt Col H F Cleary X52049
ASST TO CO A J Dalton X51010
DIR PROC OPS Maj J J Daly X51964
SML BUS & IRO C Hoyt X51729
MGMT OFC
Chief Capt D Chirafisi X52954
ADM SERV OFC
Chief CWO G O O'Connell X51989
PROC SP GP
F J Coria X52244
IND SCTY
Chief R T Brower X52754
LGL OFC
J P Hintelmann X51828
BUS ANAL OFC
Chief K Napier X51549
ADVENT PROC SPT OFC
Chief Maj C W Johnson X23963
RECEPTIONIST/INFO OFC X51779/52972

WASHINGTON PROCUREMENT OFFICE—USASSA
Main Navy Building
Washington 25, D. C.
Phone OXford 6-7802
MISSION: As a special mission procurement activity, this office serves agencies located at the seat of government. It DOES NOT place production contracts or contracts involving items of military specifications. It primarily buys standard commercial communications equipment and materials, installations of fixed-plant communications equipment, and leases equipment
COMM OFF Lt Col R L Holloway X67802
CIV CHIEF T Palm X67802
CONTRACT ADMINISTRATION BR
Chief R Kihm X67634
Contract Administrator C Cummings X67634
Contract Specialist R Williamson X64044
CONTRACT PLACEMENT BR
Chief Miss S Thomas X67197
Contract Specialist Mrs J Hensley X67197
Contract Specialist 2/Lt J A Hommeyer X67197
FINANCIAL REVIEW & ANALYSIS BR
Business Acct R Knott X67634

LEXINGTON INVENTORY CONTROL OFFICE—USASSA
Lexington Signal Depot
Lexington, Ky.
Phone LExington 2-2220
MISSION: As a national inventory control point (NICP), this office manages items assigned by USASSA under provisions of Army Regulations, which assigns functional responsibility for cataloging, direction, requirements computation, procurement direction, distribution management, rebuild direction and disposal direction
Chief S Johnson X2105

U. S. ARMY ADVENT MANAGEMENT AGENCY

Ft Monmouth N J
Phone LIberty 2-4000

MISSION: Responsible for over-all program management and direction for Army's entire Project Advent complex, including over-all system engineering, examination of sub-system engineering, technical direction to insure systems' compatibility and performance. Also planning and supervision of flight tests. Ft Monmouth Reg Office of USASSA has an Advent Procurement Support Office. Agency works with USAR&D Lab, Navy, Air Force and NASA in developmental phases, including procurement

COMM OFF Col J Wilson Johnston X21228
DEP CO Col J W Schroder X21452
CH SCIENTIST S P Brown X21336
EXEC OFF Lt Col H G Price X23288
SCTY OFF H W Fowler X21907
ADMIN OFC CHIEF Maj S I Andresen X22440

PLANS & PROG OFC
DIR Col L G Forbes X21347
DEP DIR R L Schultheis X22434

SYSTEMS ENG OFC
DIR Col R E Kimball X23030
DEP DIR G F Senn X23430

MISSION EQUIP DEPT
DIR Col R H Goodrich X21642
DEP DIR P T Maresca X21828

BOOSTER VEH DEPT
DIR Lt Col W G Kussmaul X21659
DEP DIR W P LaFaye X22263

MTL DEPT
DIR Lt Col H E Porter X21528
DEP DIR G A Broms X21745

TECH LSN DIV
DIR Lt Col C W Huff X21844

TEST OPS DEPT
DIR Col G S Waterman X21743
DEP DIR J T Evers X21744

U. S. AIR FORCE

The Pentagon Wash 25 D C
Phone LIberty 5-6700 or OX and the desired extension

	Extension
CHIEF OF STAFF Gen C E LeMay	79225
CONTRACT PLACEMENT DIV	
Col D E Sowle	71136
PROCUREMENT RELATIONS DIV	
Col A J Dreisezun	79096

AIR FORCE SYSTEMS COMMAND HEADQUARTERS

Andrews A F Base Wash 25 D C
Phone 981-9111 or dial 981 and the extension
MISSION: Responsible for military space development mission, complete acquisition program for Air Force Systems, from development, test and production through installation and checkout

	Extension
COMMANDER Gen B A Schriever	6209
VICE COMM Maj Gen C H Mitchell	
DIR OF PROCUREMENT	
Col H G Macdonald	2309
DEP CHIEF OF STAFF RES & ENG	
Col J M Silk	
CONTRACT MANAGEMENT C H Meyer	3367
Exec for Small Business J C Eiden	

AIR FORCE LOGISTICS COMMAND

Wright-Patterson A F Base Ohio
Phone CLearwater 3-7111

	Extension
COMMANDER Gen W F McKee	6-0333
VICE COM Lt Gen K B Hobson	5-6103
CHIEF OF STAFF Col N C Spencer Jr	5-6226
DEP CHIEF OF STAFF Col R A Wys	6-1306
ASST FOR SPECIAL WEAPONS	
Brig Gen J W White	5-3112

DIRECTORATE OF SUPPLY

	Extension
DIRECTOR Maj Gen M L McNickle	5-0224
DEP DIRECTOR	
Brig Gen R C Rockwood	5-0222
EXEC Lt Col R G Walker	5-7133
MATERIAL MANAGEMENT DIV	
Col A J Clocksin	5-9106
MISSION SUPPORT DIV	
Col J S Olsson	7-3134
SUPPLY REQUIREMENTS & METHODS DIV	
Col J Hallock	5-4114
INDUSTRIAL ENG & OPERATIONS DIV	
Col D K Smith	7-3137

DIRECTORATE OF PROCUREMENT & PRODUCTION

Wright-Patterson A F Base Ohio
Phone CLearwater 3-7111

DIRECTOR Maj Gen R G Ruegg	7-0100
DEP FOR PRODUCTION Col J J Treacy	7-0200
ASST TO DIRECTOR R D Lyons	7-3247
EXEC Lt Col W R Joyner	7-1157
PROGRAM MNGMT OFC	
Col W S Collinson	5-0128
OFC OF PROCUREMENT COMMITTEE	
S Arnovitz	7-4100
POLICY CONTROL OFC L R Poe	5-4190
PROD ENG DIV Col R O Mitterling	7-0293
PROCUREMENT DIV Col R A Johnson	7-7141

AIR PROCUREMENT DISTRICTS

SAN FRANCISCO
Oaklond Army Terminal
Oakland 14 Calif
Phone TWinoaks 3-4100
Qualifies manufacturers of electronic equipment for central procurement activity of A F which includes all of U S and qualifies bidders for res and dev in the electronics field
COMMANDING OFF Lt Col R E Hails
SMALL BUSINESS R Quinn

INDIANAPOLIS
2355 S Tibb Ave
Indianapolis 41 Ind

ATLANTA
41 Exchange Pl SE
Atlanta 3 Ga

BOSTON
Boston Army Base
Boston 10 Mass

CHICAGO
5555 S Archer Ave
Chicago 38 Ill

DALLAS
500 S Ervay
Dallas 1 Tex

CLEVELAND
113 St Clair Ave NE
Cleveland 14 Ohio

DAYTON
Wright-Patterson AFB
Ohio

DETROIT
6233 Concord Ave
Detroit 11 Mich

LOS ANGELES
1206 S Maple Ave
Los Angeles 15 Calif

MILWAUKEE
770 N Plankinton Ave
Milwaukee Wisc

NEWARK
218 Market St
Newark N J

NEW YORK
111 E 16th St
New York 3 N Y

OGDEN
Hill AFB Utah

ORLANDO
Orlando AFB Fla

PHOENIX
2875 Sky Harbor Blvd
Phoenix Ariz

PHILADELPHIA
1411 Walnut St
Philadelphia 2 Pa

ROCHESTER
P O Box 1669
Rochester 3 N Y

SAN DIEGO
3054 Rosecrans Pl
San Diego 10 Calif

ST LOUIS
1114 Market St
St Louis 1 Mo

AIR MATERIEL AREAS

There is a Directorate of Procurement at each Area

WARNER ROBINS AMA
Maj Gen W T Hefley
Robins A F Base Ga
WAlker 6-1110 Ext 2121

ROME AMA
Maj Gen C B Root
Griffiss A F Base N Y
Rome FF 6-3200

SACRAMENTO AMA
Maj Gen R B Landry
McClellan A F Base Calif
WAbash 2-1511

SAN BERNARDINO AMA
Maj Gen B I Funk
Norton A F Base Calif
TUrner 9-4411

SAN ANTONIO AMA
Maj Gen W T Hudnell
Kelley A F Base Texas
WAlnut 3-5411

OKLAHOMA CITY AMA
Maj Gen L L Mundell
Tinker A F Base Okla
PErshing 2-7321

OGDEN AMA
Brig Gen D Coupland
Hill A F Base Utah
TAylor 5-5215

MOBILE AMA
Brig Gen E B Cassady
Brookley A F Base Ala
HEmlock 8-6011

MIDDLETOWN AMA
Maj Gen F H Miller
Olmsted A F Base Pa
WHitney 4-5521

DAYTON A F DEPOT
Brig Gen W W Veal
Gentile A F Sta
Dayton Onio
CLearwater 2-6551

AIR MATERIEL FORCE PACIFIC AREA
Brig Gen S Huston
APO 323
San Francisco Calif

EASTERN CONTRACT MANAGEMENT REGION
Col H J Mattia
Olmstead A F Base Pa
WHitney 4-5521

CENTRAL CONTRACT MANAGEMENT REGION
Col D W Graham
Wright-Patterson A F Base Ohio
CL 3-7111 Ext 5-2208

WESTERN CONTRACT MANAGEMENT REGION
Brig Gen G F Keeling
Mira Loma A F Station Calif
OVerland 5-5211 Ext 355

USAF OFFICE OF SCIENTIFIC RESEARCH

Tempo D Bldg 6th & Independence Ave SW
Wash 25 D C
Phone LIberty 5-6700 or OX and the extension

DIRECTOR Dr K Millsaps	66257
DIR OF PROCUREMENT	
Lt Col G W Bollinger	61513

OFFICE OF AEROSPACE RESEARCH

Tempo D Bldg 6th & Independence Av SW
Wash 25 D C
Phone LIberty 5-6700 or OX and the extension

COMMANDER Maj Gen D E Hooks	64400
DIR OF PROCUREMENT	
Maj J F Greenwood	65482

SPACE SYSTEMS DIV

Mail A F Unit Post Office Los Angeles 45 Calif
Location 5800 Arbor Vitae St Los Angeles Calif
Phone SPring 6-1444
MISSION: Responsible for handling A F Space programs and development projects in support of other military branches and governmental agencies

U. S. AIR FORCE

COMMANDER Maj Gen O J Ritland
VICE COM Brig Gen R E Greer
PROCUREMENT Col C E Moore

BALLISTIC SYSTEMS DIV

Mail A F Unit Post Office Los Angeles 45 Calif
Location 5800 Arbor Vitae St Los Angeles Calif
Phone ORchard 0-1444
MISSION: Responsible for Atlas, Titan and Minuteman programs including design, construction and supervision of all site activities in the field
COMMANDER Maj Gen T P Gerrity
DEP COMM Maj Gen D R Ostranger
DIR OF PROCUREMENT Col J A O'Leary

AERONAUTICAL SYSTEMS DIV

Wright-Patterson AFB Dayton Ohio
Phone CLearwater 3-7111
MISSION: Responsible for developing aeronautical systems such as Skybolt, Dyna-Soar, C-141 Jet Transport
COMMANDER Maj Gen W A Davis
VICE COM Brig Gen A T Culberson
PROCUREMENT Col H A Budd

ELECTRONIC SYSTEMS DIV

L G Hanscom Field Bedford Mass
Phone CRestview 4-6100
COMMANDER Brig Gen C H Terhune Jr
DIR OF PROCUREMENT Col R A Scurlock

ARNOLD ENG DEVELOPMENT CENTER

Tullahoma Tenn
Phone: GLendale 5-2611
COMMANDER Maj Gen W L Rogers
VICE COMM Col J O Cobb
PROCUREMENT J F Fuqua

A F MISSILE DEVELOPMENT CENTER

Hollomon A F Base New Mexico
Phone: (At Alamogordo) GRanite 3-6511
COMMANDER Col R S Garman
VICE COMM Col W H Cleveland
DIR OF PROCUREMENT Lt Col J B Turner

AIR PROVING GROUND CENTER

Eglin A F Base Fla
COMMANDER Maj Gen R H Warren
VICE COMM Col H M West Jr
DEP FOR PROCUREMENT
Lt Col K H Brittle

ROME AIR DEVELOPMENT CENTER

Griffiss A F Base N Y
Phone FF 6-3200
COMMANDER Maj Gen D C Doubleday
DIR OF PROCUREMENT Col H Burhanna

A F SPECIAL WEAPONS CENTER

Kirtland A F Base N Mex
Phone CH 7-1711
COMMANDER Maj Gen C M McCorkle
PROCUREMENT DIR Lt Col M N Myrick

A F MISSILE TEST CENTER

Patrick A F Base Fla
Phone (Coca Beach) UL 7-6701
COMMANDER Maj Gen L I Davis
PROCUREMENT DIR Col P R Cornwall

A F FLIGHT TEST CENTER

Edwards A F Base Calif
Phone CLifford 8-2111
COMMANDER Brig Gen I L Branch
DIR OF PROCUREMENT Lt Col J M Venable Jr

ROME AIR DEVELOPMENT CENTER

Griffiss A F Base N Y
Phone FF 6-3200
COMMANDER Maj Gen D C Doubleday
DIR OF PROCUREMENT Col H Burhanna

DEPARTMENT OF THE NAVY

BUREAU OF NAVAL WEAPONS

18th & Constitution Ave NW Wash 25 D C
Offices at Main Navy Bldg Munitions Bldg and "W" Bldg
Phone LIberty 5-6700 or dial OXford and then the desired extension
MISSION: Responsible for research, development, design, test, operating standards, manufacturing, alteration, repair, overhaul, material effectiveness, disposition and salvage of all naval weapons, naval and Marine Corps aircraft, airborne targets, drones, etc., and supporting equipment and functions relating thereto

Extension
CHIEF OF BUREAU RAdm P D Stroop 62465
DEP CHIEF RAdm K S Masterson 62430
ASST CHIEF FOR RES DEV TEST
RAdm F L Ashworth 63343
Avionics Branch Col A C Lowell 64324
ASST CHIEF FOR CONTRACTS
RAdm J W Bottoms 62436
Small Business Specialist J F Lenahan 64972
PURCHASE DIV DIR Capt K L Jeffory Jr 62905
GROUND ELECTRONICS DIV DIR
Cdr J A Duncan 64275
ASST CHIEF PRODUCTION & QUALITY CONTROL Capt J D Arnold 66225

BUREAU OF SHIPS

Wash 25 D C
Phone LIberty 5-6700 or dial OXford, then the extension desired
MISSION: Responsible for shipboard apparatus, radio, radar, sonar, electric end-items; also shores responsibility for equipment with BuWeap

Extension
CHIEF OF BUREAU RAdm R K James 62058
DEP & ASST CHIEF RAdm R L Mare 63391
DIV OF CONTRACTS Capt G C Wells 62112
Asst Dir of Contracts D E Weatherly Jr 64568
Electronics A Heck 61437
Electronics Purchasing Branch E H Koch 61803
ASST CHIEF FOR TECH LOGISTICS
RAdm R B Fulton (acting) 61714
Electronics Materials Branch F M Berg 61446
ELECTRONICS DIV
Dir Capt R B Bradley Jr 64586
Radar Branch Cdr D B Wilder Jr 65577
Communications Branch Capt S Swacker 64056
Sonar Branch Capt J Wallace 61230
Electronic Warfare & Parts Branch
Cdr E L Hurd 66752

OFFICE OF NAVAL RESEARCH

Bldg Temp 3 17th & Constitution Ave NW Wash 25 D C
Phone LIberty 5-6700 or dial OXford then the desired extension
MISSION: Responsible for basic and applied research bearing on naval problems
CHIEF OF NAVAL RESEARCH
RAdm L D Coates 64911
DEP & ASST CHIEF Capt J M Ballinger 62525
DEP & CHIEF SCIENTIST Dr F J Weyl 64356
DIR OF PROCUREMENT SERVICES
Cdr H D Moore 65321
ASST CHIEF FOR RESEARCH
Capt W H Keen 64049
RESEARCH DIR Dr S Silverman 61181
PHYSICAL SCIENCES DIV Dr W E Wright 65673
Electronics Dr A Shostak 64301

NAVAL RESEARCH LABORATORY

4554 Overlook Ave Anacostia Wash 25 D C
Phone JOhnson 3-6600
COMMANDER Capt A E Kropf
DIR OF RESEARCH Dr R M Page
SUPPLY DIV Capt T H Neel
Technical Purchases R R Block

NAVY ELECTRONICS SUPPLY OFFICE

Building 3400 Great Lakes Ill
Phone DE 6-3500
COMMAND & PURCHASE DIV
Capt W W Schleef
Buying Branch Lcdr J C Goetzman

SELECTED GOVERNMENTAL AGENCIES

NATIONAL AERONAUTICS & SPACE ADMINISTRATION*

1520 H St NW Wash 25 D C
Phone EXecutive 3-3260, also DU 2-and the extension

Extension
ADMINISTRATOR J E Webb
DEP ADMINISTRATOR Dr T K Dryden 6411
PROCUREMENT & SUPPLY DIV
E W Brackett 6376
Procurement at field branches listed below
*Booklet "Selling to NASA" available free from J M Roey, at above address
AMES RESEARCH CENTER
Moffett Field Calif
Procurement Officer A S Hertzog
NASA FLIGHT RESEARCH CENTER
Edwards Calif
Procurement Officer M E Bowling
GODDARD SPACE FLIGHT CENTER
Greenbelt Md
Procurement Officer G H Tyler
LANGLEY RESEARCH CENTER
Langley Station Hampton Va
Procurement Officer S L Butler
LEWIS RESEARCH CENTER
Cleveland 45 Ohio
Procurement Officer J R Biggs
MARSHALL SPACE FLIGHT CENTER
Huntsville Ala
Procurement Officer W S Davis
WESTERN OPERATIONS OFFICE
Santa Monica Calif
Procurement Officer E J Sample
NASA WALLOPS ISLAND CENTER
Wallops Station
Wallops Island Va
Procurement Officer L T Birch
MANNED SPACECRAFT CENTER
Houston I Texas
Procurement Officer D Long
JET PROPULSION LAB
Calif Inst of Tech
Pasadena 3 Calif
Procurement Officer T W Condee
LAUNCH OPERATIONS CENTER
Office of Procurement & Contracts
Cocoa Beach Fla
Procurement Officer G A Michaud

SPACE NUCLEAR PROPULSION OFFICE
AEC Headquarters
Germantown Md (Wash 25 D C)
Procurement Officer G Kimball
HEADQUARTERS PROCUREMENT BRANCH
NASA Wash 25 D C
Procurement Officer A A Clagett

ADVANCED RESEARCH PROJECTS AGENCY

Reports direct to Dir of Defense, Res & Eng
The Pentagon (Rm 3E160)
Phone: LIberty 5-6700 or dial OX and the extension
MISSION: Responsible for research in ballistic missile defense, detection and identification of underground and high altitude nuclear tests, propellant chemistry, materials, energy conversion, remote area conflict and technical aspects of arms control

Extension
DIRECTOR Dr J P Ruina 78255
DEP DIRECTOR (Science) (Not assigned)
DEP DIRECTOR (Management) W H Godel
(All contracting is done through the Services)

FEDERAL AVIATION AGENCY

1711 New York Ave NW Wash 25 D C
Phone STerling 3-2100
ADMINISTRATOR N E Halaby
DEP ADMINISTRATOR H W Grant
MATERIAL PROGRAM DIV (Contracts)
C M Estep Rm 2402 Tempo 5 Wash D C

ATOMIC ENERGY COMMISSION*

Germantown Md
Mail Wash 25 D C
Phone HAzelwood 7-7831

Extension
CHAIRMAN Dr G T Seaborg 3251
GEN MANAGER A R Luedecke 4174
DIV OF HEADQUARTERS SERVICES (Purchasing)
E H Glade 5540
*Booklet "Selling to AEC" available from Div of Contracts, Att J H Wells
(Continued on page H-14)

Government Contract Awards

The following list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies from January to December 1961. These contract awards appeared in "Commerce Business Daily" (Synopsis of U. S. Government Proposed Procurement Sales and Contract Awards,) issued daily by the U. S. Department of Commerce. It does not list classified contracts or awards for less than $25,000.

Accelerators	323,532
Accelerometers	119,284
Altimeters	95,134
Amplifiers	7,697,098
Analyzers	908,422
Antennas & systems	15,343,230
Astro trackers	1,821,807
Attenuators	205,657
Audio multiplex units	35,637
Batteries	22,351,054
Beacons	936,770
Buffers	44,156
Brushes	52,042
Cable assemblies	5,185,386
Cable, coaxial	419,441
Cable, R-F	661,187
Cable, special purpose	125,309
Cable, telephone	5,476,859
Call sign cipher device	781,333
Calibration set	1,761,008
Calibrators	1,313,299
Calorimeter	75,913
Capacitors	1,333,596
Cells, fuel	57,097
Chamber, cable terminal	88,052
Chest set	259,350
Chopper, electronic	67,250
Coder/decoder	12,681,752
Coil assemblies	26,568
Coils	79,467
Communications equipment	15,029,507
Comparators	593,522
Compensators	3,210,874
Computers	13,127,010
Connectors	853,432
Consoles	390,112
Control, equipment	451,699
Control group	725,154
Controls	1,940,623
Converters	3,237,143
Coordinate data set	1,691,862
Cores, magnetic memory	49,888
Correlators, Video	207,677
Counters	173,172
Coupling units	260,148
Crystal units	115,872
Data key generator	306,996
Data link, time div.	500,000
Data plotter, electronic	79,900
Data processors	3,503,825
Delay lines	305,253
Demodulator	115,402
Detection system	70,000
Detectors	268,891
Dewars, cryogenic	27,294
Digital tape handlers	38,250

Discriminators	281,815
Drone surveillance system	2,227,988
Dummy load	141,268
Duplexer tee assembly	42,004
Duplicator, magnetic tape	98,413
Echo box	83,655
Echo sounders	436,002
Electron beam welding equipment	173,431
Electronic ovens, microwave	37,156
Facsimile set	53,369
Ferrite isolator	260,500
Filters	928,279
FM/FM system	40,520
Frequency changer, automatic	41,065
Frequency divider and clock	104,139
Frequency synthesizer	63,091
Fuses, radar	181,006
Ground readout equipment	66,000
Guidance systems	350,000
Gyroscopes	8,433,541
Handsets	115,735
Headset-handset	2,022,619
Headsets	1,853,014
Hydrophones	46,875
IFF equipment	58,725
Indicators	10,272,621
Infrared equipment	58,800
Intercommunications equipment	1,398,821
Interrogator sets	150,000
Inverters	667,177
Jammer, transportable	600,000
Lie detectors, recording	52,099
Loudspeakers	707,609
Magnetic tape	385,248
Measuring set	551,459
Measuring system	206,268
Meters	8,377,486
Microanalyzer, electron probe	59,630
Microphone assemblies	31,675
Microphones	2,978,595
Microscopes	158,445
Microwave terminal equipment	87,953
Mode selectors	245,022
Module, digital	61,917
Monitors	771,847
Motors	271,899
Multicouplers, antenna	858,004
Multiplex equipment	295,215
Navigation equipment	4,401,399
Oscillators & assemblies	2,889,442
Oscillographs	401,640
Oscilloscopes	7,070,345
Page printer sets	1,201,128
Patching system, R-F	89,631
Phase shifter	26,936

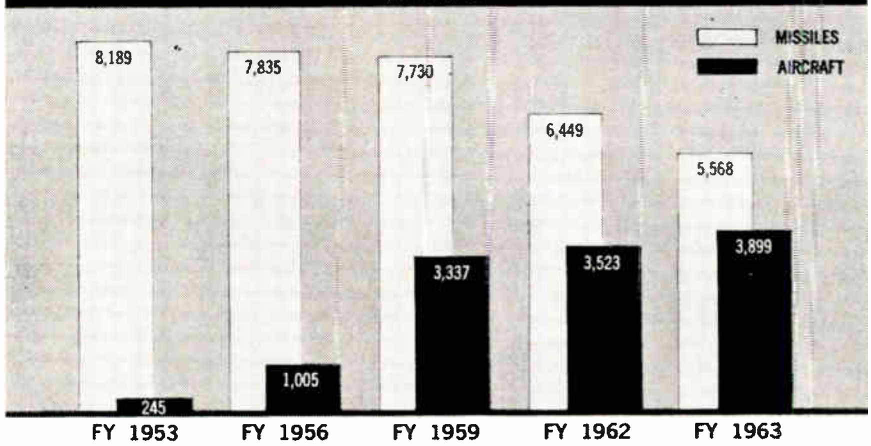
Plotting board, tactical display	467,906
Power monitor	44,530
Power supplies	2,939,102
Preproduction equipment	4,075,363
Pulse networks	116,344
Radar	94,219,294
Radiac sets	319,379
Radiacmeter	736,785
Radio direction finders	3,809,721
Radio sets	36,984,279
Radiosonde sets	3,834,794
Radomes	591,791
Reactor	44,485
Receivers	21,792,034
Receiving system	2,207,942
Recorder/reproducer	6,672,647
Recorders	3,302,112
Recording equipment	1,467,073
Rectifiers	124,129
References, AC	43,226
Regulator, voltage	29,162
Relay armatures	1,311,068
Relays & assemblies	1,447,370
Reproducer units	339,453
Resistors	2,451,201
Resolvers	683,894
Resonator, selector cavity	34,981
Semiconductor device set	30,326
Semiconductor devices	1,547,764
Servo equipment	2,515,329
Signal generators	3,072,107
Simulators	2,083,758
Solenoids	153,014
Sonar Equipment	11,630,095
Sonobuoys	1,198,440
Sounding Equipment	156,923
Spectrometers	355,392
Spectrometry system	52,327
Spectrum analyzer	781,321
Stablization equipment	655,000
Standards	449,401
Static frequency changers	147,892
Switchboards	3,617,188
Switches	3,190,019
Switching system	485,930
System analyzer, R-F	130,000
Systems, digital	193,575
Systems, microwave relay	41,195
Systems, processing	180,000
Systems, radio	10,296,626
Systems, telemetering	90,967
Tape handler, digital	30,578
Tape, magnetic	1,238,192
Telegraph equipment	3,727,938
Telemetry equipment	3,897,507
Telephone equipment	16,414,193

Govt. Awards (cont.)

Teletype equipment	6,434,079
Terminals	116,864
Test equipment	9,484,680
Test sets	9,599,745
Thermocouple	32,520
Timers	439,458
Towers	3,627,454
Tracking system, infra-red	42,787
Trainers	6,723,790
Transceivers	9,023,589
Transducers	2,748,691
Transformers & assemblies	858,218
Translator, magnetic tape	46,460
Transmission line system, Coaxial	64,808
Transmission system, photo	1,250,000
Transmitters	19,242,033
Transponders	2,663,400
Tropospheric scatter equipment	1,500,000
Tubes, electron	45,040,648
Tubes, klystron	2,319,915
Tubes, magnetron	6,304,604
Tube, TWT	110,775
Tuner	140,601
Tuning drives	230,160
Tuning forks	36,358
TV equipment	1,309,151
Ultrasonic cleaners	80,174
Vibrators	56,489
Waveguide equipment	187,252
Wind measuring sets	521,355
X-Ray equipment	1,233,509

MILITARY PROCUREMENT

AIRCRAFT, MISSILE EXPENDITURES
(In Millions)



Comparative expenditures for aircraft and missiles show that missile expenditures increased nearly sixteen times during the period of FY 1953-FY 1963 while aircraft expenditures declined about one-third during the same period. The amounts prior to FY 1963 have been adjusted to reflect the new budget structure used in FY 1963.

Source: Aerospace Industries Association

CONTRACT AWARDS—FIRST QUARTER OF 1962

Accelerometers	64,375
Actuators	253,697
Amplifiers	5,170,017
Analyzing systems	69,191
Antennas & systems	2,655,227
Attenuators	59,350
Batteries	851,030
Blowers	64,122
Cable assemblies	595,514
Cable, R-F	43,010
Cable, telephone	54,458
Calibration equipment	84,943
Calibrators	156,991
Capacitors	107,304
Cavity, tuned	48,969
Chaff, countermeasures	397,562
Chopper, electronic	43,194
Communication statellite mobile ground stations	5,000,000
Communications equipment	8,676,964
Computers	29,895,720
Connectors	1,098,243
Control systems	339,583
Controls	324,596
Converters	535,503
Counters	421,964
Coupling units	1,011,499
Data processing equipment	879,350
Decoders	40,778
Demodulation equipment	83,984
Detectors	693,387
Digital system	355,901
Discriminator	50,840
Discriminator system, subcarrier	36,959
Display system, remote	355,600
Drone system	500,000
Duplexer	64,343
Dynamic demonstrators	99,022
Encoder system	99,443
Filters	1,001,726
Fire control system	4,000,000
Global tracking network	2,500,000
Gyroscope equipment	9,186,829
Handsets	550,390
Headsets	1,870,992
Hydrophones	35,123
Indicators	3,421,182
Intercommunications system	40,364
Loudspeakers	640,532
Magnetic tape dataplotter system	52,500
Magnetron assembly, stabilized	27,423
Measuring systems	6,990,774
Meters	1,019,159
Microphone assemblies	47,971
Monitors, R-F	76,804
Multicouplers	678,554
Navigation equipment	2,284,521
Oscillators	624,820
Oscillographs	29,650
Oscilloscopes	168,033
Plotting system, digital	54,960
Power supplies	99,845
Printers	84,101
Public address system	57,558
Radar	26,758,264
Radiacmeters	203,645
Radiac set	996,614
Radio direction finder	1,312,000
Radio sets	29,847,239
Radio terminal sets	6,283,790
Radiosonde sets	497,663
Radomes	2,914,622
Receivers	4,877,227
Receiving system	1,299,818
Record reproduce mechanism	51,000
Recorders	2,173,932
Recorder/reproducer	637,258
Recording oscillograph system	37,169
Regenerators, time code	99,950
Relay armatures	150,835
Relays & assemblies	1,246,351
Resistors	313,140
Semiconductors	173,840
Servo equipment	575,049
Shelters, electric equipment	1,974,409
Signal generators	306,065
Simulators	2,088,733
Sonobuoys	34,468,519
Standards	164,900
Spectrum surveillance system	352,581
Switchboard	70,982
Switches	400,229
Switching equipment	1,307,490
Tape, recording	283,482
Tape transports	51,000
Target location system	133,091
Telegraph equipment	509,674
Telemetry equipment	1,259,081
Telephone equipment	515,810
Teletypewriter equipment	2,735,288
Test equipment	9,487,776
Test sets	553,091
Timers	69,850
Tracking system, beacon	53,008
Trainers	2,899,169
Transceivers	3,623,934
Transducers	1,634,076
Transformers	288,781
Transmission systems	5,187,242
Transmitters	942,889
Transponders	1,074,985
Tuning units	818,197
Tubes, electron	7,966,525
Tubes, klystron	1,382,334
Tube, magnetron	2,409,590
Tubes, TWT	420,679
TV equipment	302,835
Viewing set, infrared	375,166
X-Ray equipment	227,578

Key Guided Missile Contractors

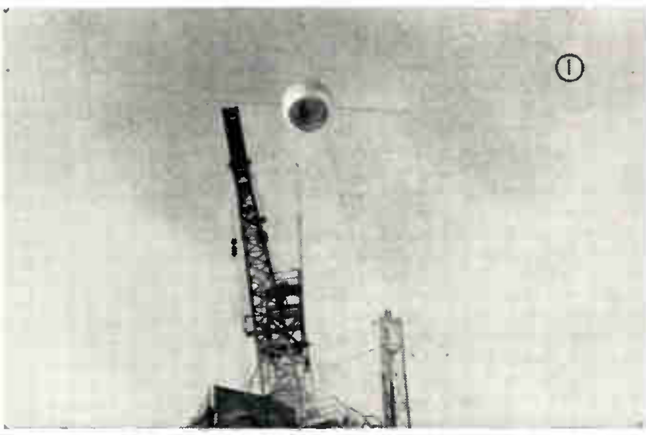
(With names of their top GM men and their Personnel Directors)

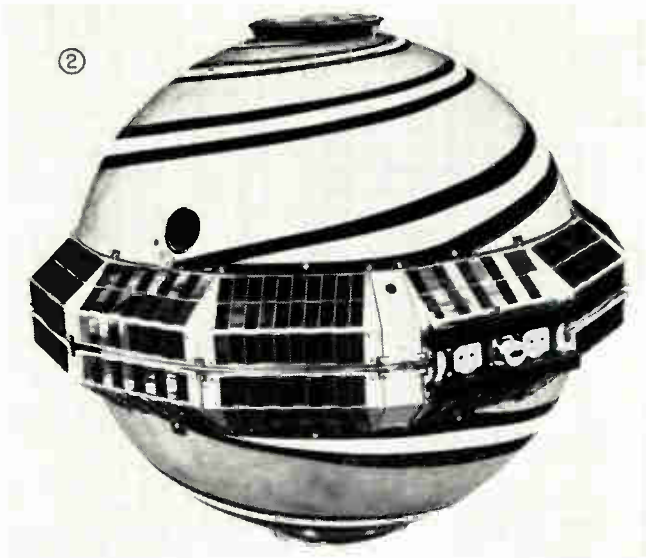
COMPANY	ENGINEERING EXECUTIVE	PERSONNEL MANAGER
Aerojet-General Corp. 332 Irwindale Ave., Azusa, Calif.	C. C. Ross, V. P. Engineering	L. L. Thompson
Aeronutronic, Div. of Ford Motor Co. Ford Road, Newport Beach, Calif.	R. P. Jackson, Mgr. Marketing	R. F. Fallon
Avco Corp. 201 Lowell St., Wilmington, Del.	Dr. C. J. Burton V. P. Defense & Ind. Prods. Group	E. W. Stupace
Beech Aircraft Corp. Wichita, Kan.	R. H. Anselm, Mgr. Missile Eng.	J. E. Isaacs
Bell Aero Systems Co. Buffalo 5, N. Y.	W. M. Smith, V. P. & Mgr. Rockets Div.	N. C. Euler
Bendix Corp. Bendix Prods. Aerospace Div. South Bend 20, Ind.	R. E. Whiffen, Gen. Mgr.	D. L. Kirkpatrick
Boeing Co. Seattle 14, Wash.	L. A. Woods V. P. & Gen. Mgr. Aerospace Div.	F. Huleen
Douglas Aircraft Co. Santa Monica, Calif.	C. R. Able V. P. & Gen. Mgr., Missile & Space Div.	L. W. Tixier
General Dynamics/Astronautics San Diego 12, Calif.	M. Rosenbaum, Ch. Eng.	R. M. Smith
General Electric Co. Washington, D. C.	G. P. Metcalf, Regional V. P.	J. K. Swanson G. E. Co., Valley Forge Space Tech. Center P. O. Box 8555 Phila. 1, Pa.
General Precision, Inc. 1150 McBride Ave. Little Falls, N. J.	R. N. Brown, Exec. V. P. Kearfott Div.	P. Kull
Goodyear Aircraft Corp. Akron, Ohio	E. A. Brittenham, Chief. Eng.	C. Jones
Grumman Aircraft Eng. Corp. Bethpage, L. I., N. Y.	R. M. Carbee, Asst. Chief Missile Eng.	J. G. Gavin, Jr.
Hughes Aircraft Corp. Culver City, Calif.	N. I. Hall, V. P. Eng.	N. W. Gibson
Lear, Inc. Santa Monica, Calif.	K. R. Hahn, Exec. V. P.	H. Perryman
Ling-Temco-Vought P. O. Box 6267, Dallas 22, Texas	J. R. Clark V. P. & Gen. Mgr. Astronautics Div.	R. C. Farmer
Lockheed Missiles & Space Co. Sunnyvale, Calif.	R. R. Kearton, V. P. & Gen. Mgr. Space Systems Div.	W. R. Wilson
Marquardt Corp. Van Nuys, Calif.	S. E. Weaver, V. P. Marketing	J. F. Stengel
Martin Co., The Baltimore 3, Md.	A. C. Hall, V. P. Space Systems Div.	D. V. Dorman
McDonnell Aircraft Corp. St. Louis, Mo.	B. G. Bromberg, V. P. Space & Missile Eng. Div.	W. R. Orthwein, Jr.
Minneapolis, Honeywell Reg. Co. Minneapolis, Minn.	C. L. Davis, V. P. Military Prods. Group	R. E. Marceau
North American Aviation, Inc. Los Angeles, Calif.	H. R. Raynor, Exec. V. P. Space & Info. Systems Div.	A. F. Urbiha
Northrop Corp. Hawthorne, Calif.	W. E. Gasich Asst. Gen. Mgr., Tech.	J. Richardson
RCA Camden, N. J.	W. G. Bain, V. P. & Gen. Mgr. Communications & Aerospace	N. J. Cappello
Republic Aviation Corp. Farmingdale, L. I., N. Y.	A. R. Crawford, V. P.	C. Ketson
Ryan Aeronautical Co. San Diego, Calif.	F. W. Fink, V. P. Eng.	W. Wagner
Space Technology Labs. P. O. Box 95001 Los Angeles 45, Calif.	Dr. E. B. Doll	R. C. Potter
Sperry Gyroscope Co. Great Neck, L. I., N. Y.	S. Agabian, V. P.	R. Hamlett
Thiokol Chemical Corp. Bristol, Pa.	H. R. Ferguson, Exec. V. P.	J. Lorenz
Thompson Ramo Woolridge, Inc. Canoga Park, Calif.	Dr. R. P. Johnson, V. P. Electronics Group	F. P. Melograno
United Aircraft Corp. E. Hartford, Conn.	C. M. Kearns, V. P. & Gen. Mgr. Corp. Systems Center	N. B. Morse
Westinghouse Electric Corp. Wash., D. C.	R. O. Schlegelmilch Tech. Director	D. C. Lee Baltimore 3, Md.

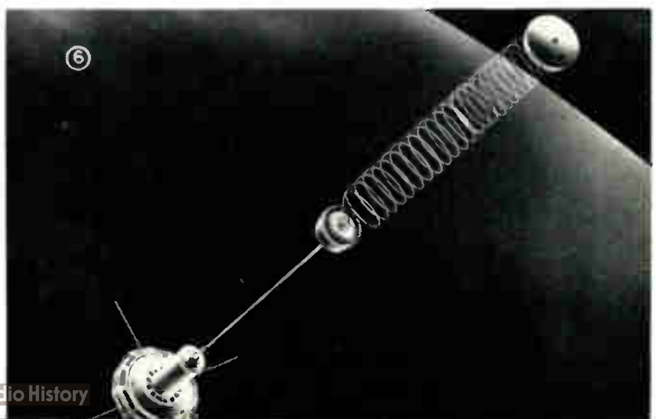
SATELLITES CURRENTLY IN

Photo No.	Project	Project Director	Launch Date	Estimated Life (years)	Perigee Apogee (miles)	Orbiting Time (minutes)	Instrumentation
1	Vanguard I	U. S. Navy	3-17-58	200	406 2444	133.8	2 transmitters; external temp. sensors.
2	Transit II-A	U. S. Navy	6-22-60	50; transmitting – 1	389/665	101.7	5 transmitters; 2 ultra-stable oscillators; infrared scanner; electronic clock; Canadian receiver to measure galactic noise.
3	Courier I-B	U. S. Army	10-4-60	Several; transmitting – 1	501/658	107	4 transmitters; 4 receivers; 5 tape recorders; 2 microwave antennas; transitorized telemetry generator; FM VHF telemetry transmitters; 4 whip antennas; VHF diplexer; command decoder.
4 (bottom)	Transit IV-A	U. S. Navy	6-29-61	1	534/623	103.7	4 transmitters; memory system; electronic clock.
4 (middle)	Injun	U. S. Navy	6-29-61	Indefinite	534/634	103.8	1 transmitter; 12 particle and proton detectors.
5	Transit IV-B	U. S. Navy	11-15-61	5	582/700	105.6	Stable oscillators; 4 transmitters; phase modulators; memory system; clock.
5 & 6	TRAAC	U. S. Navy	11-15-61	5	562/720	105.6	Gravity gradient stabilization equipment; satellite design experiments; back-up for parts of Transit experiments; particle detectors; 1 transmitter.
7	Tiros IV	NASA	2-8-62	4 months	471/525	100.4	5 transmitters; 2 camera systems with clocks and recorders for remote pictures; infrared sensors; heat budget sensors; magnetic orientation control; horizon sensor; North indicator.
8	Orbiting Solar Observatory	NASA	3-7-62	6 months	343/369	96.15	Devices for 13 different studies of solar electromagnetic radiations; dust particles; and thermal radiation on spacecraft surface materials. 2 independent and parallel transmitters.

* As of the date this issue went to press.

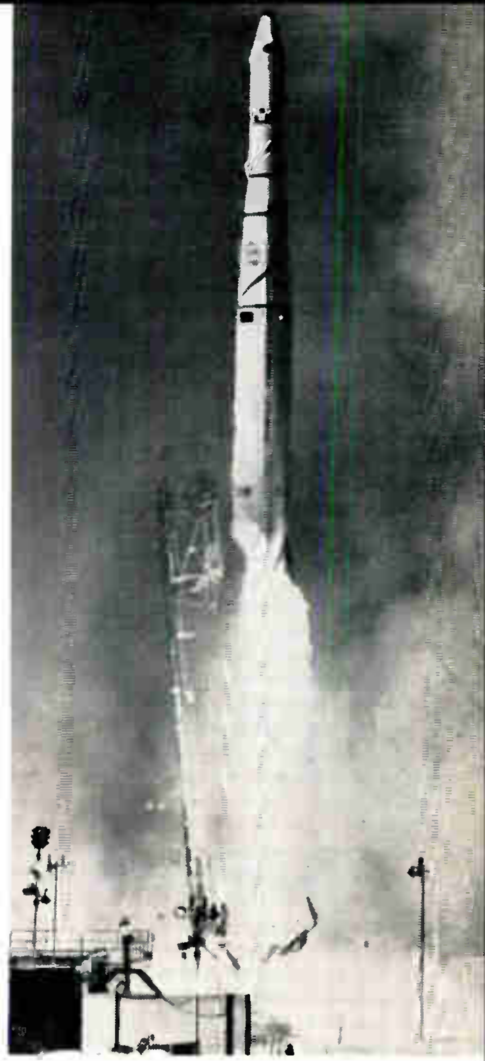


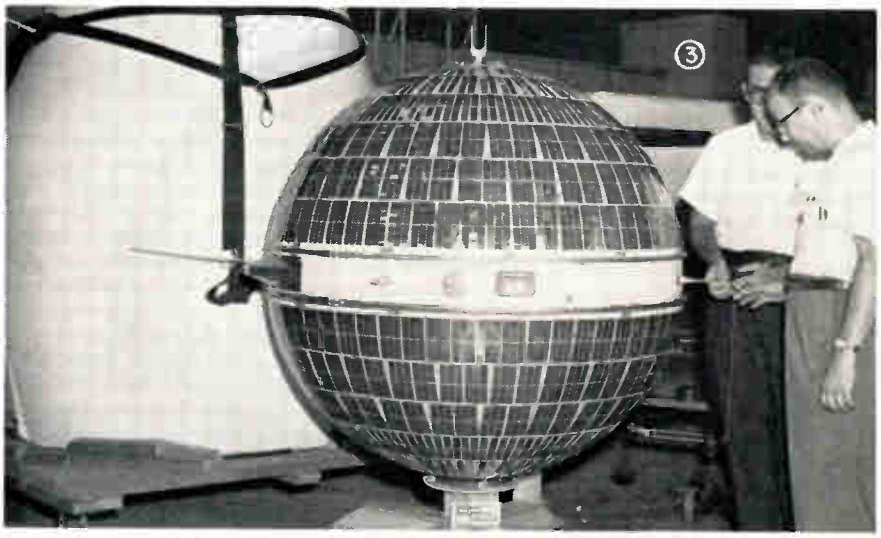


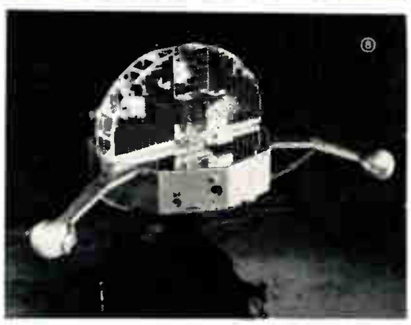


ORBIT AND TRANSMITTING*

Transmitting Frequency (MC)	Power Supply	Comments
108.024	Mercury batteries charged by 6 groups of solar converters.	Revealed Earth to be pear-shaped. Corrected geographical map errors.
162; 216	Completely solar powered. Nickel cadmium battery for power storage.	Data being analyzed.
107.9709	19,200 solar cells; nickel cadmium batteries for power storage.	Several messages successfully received and transmitted. Test feasibility of "delayed repeater" satellites.
54; 150; 324; 400	Solar cells; nickel cadmium batteries. Pu 238 thermoelectric generator.	First satellite to use nuclear generator (SNAP). Test all-weather global navigation system.
136.5	Solar cells.	Injun failed to separate from Greb III. Injun to measure cosmic radiation.
54; 136.8; 150; 324; 400	SNAP; solar cells; nickel cadmium battery.	SNAP furnishing current for 2 transmitters. R & D all-weather global navigation system.
54; 136.65; 324	Solar cells; nickel cadmium battery.	Test gravity system for satellite attitude control. Obtain data on the Inner Van Allen Belt.
136.23; 136.92	9,260 solar cells; 63 nickel cadmium batteries	R & D of weather satellite system. Data from TV cameras was used for current operational weather analysis and forecasting. Only the beacons are still transmitting.
136.744	Nickel cadmium batteries and 1860 solar cells.	Measure solar electromagnetic radiation in the ultra-violet, x-ray, and gamma ray regions. Investigate dust particles in space and improve future spacecraft design.







PROCUREMENT

(Continued from page H5)

NATIONAL BUREAU OF STANDARDS

(Commerce Dept)
Conn Ave & Von Ness St NW Wosh 25 D C
Phone EMerson 2-4040
DIRECTOR Dr A V Astin
DEPUTY DIR Dr R D Huntoon
SUPPLY DEPT G B Kefover
Procurement Sect C B Kipps

PUBLICATIONS HELPFUL IN SELLING TO THE MILITARY & GOVERNMENT

1. **"Selling To Novy Prime Controctors"** (July 1961) p. 89. Helpful suggestions, followed by listing of hundreds of prime controctors. Obtoinoble from Supt. of Documents, U. S. Govt. Printing Office, Wosh. 25, D. C., price 50 cents.

2. **"General Procurement Information"** (July 1961) p. 32. Lists hundreds of items from mony guided missiles together with the nomes of their prime controct suppliers. U. S. Govt. Printing Office, price 15 cents or free from Off. Secty. Defense, Informotion Office, Wosh. 25, D. C.

3. **"Selling To The Military"** p. 27. Generol Informotion. Items Purchosed. Locotion of Military Purchosing Offices, etc. U. S. Govt. Printing Office, price 25 cents.

4. **"How To Sell To The Armed Forces In Europe"** (Jon. 1959) p. 14. Listing of whot is being bought ond the locotion of the foreign purchosing offices for these items. Believed to be obtoinoble from Off. Secty. of Defense, Informotion Office, free.

5. **"Air Force Small Business Specialists"** p. 10. A listing of nomes, oddresses ond phone numbers. From Secty. of Defense, Informotion Office, Air Force Desk, free.

6. **"Armed Services Procurement Regulations."** Informotion Office, Sec. of Defense, Wosh. 25, D. C., free.

7. **"The Army Procurement Procedure."** Informotion Office, Sec. of Defense, Wosh. 25, D. C., free.

8. **"The Air Force Procurement Procedure."** Informotion Office, Sec. of Defense, Wosh. 25, D. C., free.

9. **"Navy Procurement Directives."** From U. S. Govt. Printing Office ot $7 per yeor, subscription.

10. **"Doing Business With The Federal Government"** (Jon. 1961) p. 58. Contents: Govt. procurement methods; Militory procurement Generol Services odministrotion; Other civil ogencies with supply octivities responsibility of the govt. controctor. Believed ovoiloble from Generol Services Administrotion, Wosh. 25, D. C., free.

11. **"Commerce Business Daily."** A doily list of govt. procurement invitotions, subcontrocting leods, controct owords, etc. Published by Dept. of Commerce. Subscription $20 per yeor. U. S. Dept. of Commerce, Room 1300, 433 West Von Buren St., Chicogo 7, Ill.

12. **"How To Sell To Agencies Within The Department Of Defense"** (Morch 1958) p. 52. Generol Procurement Policies, followed by helpful list of multitudinous items purchosed together with their purchosing locotions. U. S. Govt. Printing Office, 40 cents.

13. **"Federal Purchasing Directory,"** o 6-poge folder ond chort, showing principol ogencies ond moteriols bought. Obtoinoble from Generol Services Administrotion, Regionol Office Bldg., Wosh. 25, D. C., free.

14. **"Procurement Hondbook"** (1959). By Generol Services Adm. A very generol book but helpful to those selling to GSA. From U. S. Govt. Printing Office, price $1.50.

15. **"Selling to NASA."** Avoiloble free from J. M. Roey, NASA, 1520 H St., N.W., Wosh. 25, D. C.

16. **"Selling to AEC."** Avoiloble free from J. H. Wells, Div. of Controcts, Atomic Energy Commission, Wosh. 25, D. C.

DC-10 Mc

16 lbs.

$365

Avnet

Specifications of Model S32A Oscilloscope

VERTICAL AMPLIFIERS
FREQUENCY RESPONSE: DC—1 mc at 10 mV/cm
DC—10 mc at 100 mV/cm
RISE TIME: 35 nS
Max. VERTICAL DEFLECTION: 5 cms at all frequencies. The vertical amplifiers are adjusted for optimum response to a fast squarewave.

INPUT ATTENUATOR
9 position frequency compensated, direct reading in volts per cm. 10/100 mV, 20/200 mV, 50/500 mV, 1V, 2V, 5V, 10V, 20V, 50V/cm.
Input Impedance 1MΩ + 30 pf
Voltage measuring accuracy 5%

TIME BASE
18 calibrated Sweep Speeds plus continuously variable.
500, 200, 100, 50, 20, 5, 2, 1 milliseconds per cm
500, 200, 100, 50, 20, 10, 5, 2, 1 microseconds per cm
—expansion control gives X10 increase. Slower speeds can be obtained by internal adjustment.
Time measurement accuracy 10%.

X EXPANSION
Continuously variable up to over 10 screen diameters (50 cms). Trace expands symmetrically about center of screen. X-shift control positions any portion of expanded trace on screen.

TRIGGERING
Automatic for repetitive signals up to about 1 Mc.

TRIGGER LEVEL CONTROL
Selects any point on input signal slope for repetitive, random, or single shot triggering.

TRIGGER SELECTOR
Positive, negative, or TV Line and Field. Internal or external.

BUILT IN CALIBRATOR
Stabilised 1V p-p (± 2%) 60 cps squarewave for checking voltage and time calibration.

CATHODE RAY TUBE
3" flat faced, PDA tube operated at 3.5 kV.
Screen phosphor, P1 Medium persistence normally supplied. Long Persistence P7 to order.
Removable green filter improves contrast at high ambient illumination.

SIZE
13¾" x 8" x 6½" Weight 16 lbs.

HIGH IMPEDANCE PROBE
P32. A X10 voltage divider with an input impedance of 10MΩ + 8 pf. Price $10.

The Avnet System

MEN / METHODS / MATERIALS / MANAGEMENT

AVNET INSTRUMENT CORP. *subsidiary* — AVNET ELECTRONICS CORP.

LOS ANGELES, CAL.; SUNNYVALE, CAL.; SEATTLE, WASH.; SALT LAKE CITY, UTAH; PHOENIX, ARIZ.; CHICAGO, ILL.; WESTBURY, L. I.; BURLINGTON, MASS.

AVNET markets from its stocking facilities:	BENDIX SCINTILLA CONNECTORS	MECHANICAL PRODUCTS	SPERRY SEMICONDUCTORS	BABCOCK RELAYS	SILICON TRANSISTORS
GREMAR CONNECTORS	SPRAGUE CAPACITORS	U. S. SEMCOR SEMICONDUCTORS	SCOPES OSCILLOSCOPES	CLARE RELAYS	MICRODOT CONNECTORS LERCO HARDWARE
AVNET AUTO CONNECTOR AND CABLE TESTER	AVO MULTIRANGE METERS	WIDNEY DORLEC CONSTRUCTION SYSTEM	GENALEX TUBES	SULLIVAN PRECISION MEASURING APPARATUS	SERVO DESIGN AND TESTING EQUIPMENT

Rush me further information on the S32A Oscilloscope.

NAME ____________________

TITLE ____________________

Clip this section to your letterhead and mail to:

East of Mississippi:
THE AVNET SYSTEM, Publications Section
70 State Street, Westbury, Long Island
West of Mississippi:
THE AVNET SYSTEM, Publications Section
5877 Rodeo Rd., Los Angeles 16, Cal.
Your request will be expedited within 90 minutes of receipt.

New Tech Data for Engineers

Laminate Guide

A guide listing Synthane Grades for tubes, rods and sheets corresponding to NEMA, Mil Spec., Mil Spec. Type, Navy Type, Type LTS, Federal Spec., Bureau of Aeronautics, AAF Spec. and ASTM Specs is available from Synthane Corp., Oaks, Pa.

Circle 678 on Inquiry Card

Terminal Blocks

Catalog No. 162, 2-color, 16-pages, describes a complete line of more than 373 terminal blocks including new fully insulated feed-through and track-type blocks. Also included are specs., blueprints, and prices of both parts and complete blocks. Curtis Development & Mfg. Co., 3218 N. 33rd St., Milwaukee 16, Wis.

Circle 679 on Inquiry Card

PC Board Connectors

A line of 50Ω Printed Wiring Board Connectors is described in a 10-page catalog available from Micon Electronics, Inc., Roosevelt Field, Garden City, L. I., N. Y. The connectors are available in straight and right angle configurations, male and female snap-on and screw-on types, and are designed to fit standard 0.100 printed circuit board holes.

Circle 680 on Inquiry Card

Nylon to Nylon Bonding

A solution to the problem of bonding nylon to nylon surfaces is obtained by the use of RAISEAL 5002, newest of a series of adhesives. Because it is a thermosetting resin, the bond's heat stability is high at temps. up to and above the softening points of most plastics. This material may also be used in the bonding of nylon to most metal and plastic surfaces. Radiation Applications, Inc., 36-40 37th St., L. I. City 1, N. Y.

Circle 681 on Inquiry Card

Computer System

"Honeywell 1800 Facts and Figures" describes the Honeywell 1800 electronic computer system. Features of the 1801 Central Processor, including Parallel Processing and Orthotronic Control, the 1801B Floating Point Arithmetic option, the various input-output equipment and automatic programming aids are included. Minneapolis-Honeywell Regulator Co., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills 81, Mass.

Circle 682 on Inquiry Card

Tapes

The illustrated 6-page folder describes numerous ways double-coated tapes can be used in industry. Included are 35 illustrations which tell how "Scotch" brand double-coated paper, cloth, transparent film, plastic film and adhesive transfer tapes are used. Folder P-DNF(915) LP from Dept. J1-10, Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 683 on Inquiry Card

Epoxy Stripper

Information is available on specially formulated cold stripper to remove epoxy coatings and almost all types of synthetic finishes, including japans, wrinkles, and baked enamels. Fidelity #931 Epody and General Purpose Stripper is particularly effective in the stripping of epoxy encapsulated electronic components. Fidelity Chemical Products Corp., 470 Frelinghuysen Ave., Newark 14, N. J.

Circle 684 on Inquiry Card

Wires & Cables

Rockbestos Wire & Cable Co., Div. of Cerro Corp., Nicoll and Canner Sts., New Haven 4, Conn., is offering tech. data on their line of aerospace and electronic wire and cables. Included are airframe wires, hook-up wires, ground support cables, coaxial cables, and miniature high temp. wires.

Circle 685 on Inquiry Card

Insulators

Coors Porcelain Co., 600 Ninth St., Golden, Colo., has a 22 page brochure available on Ceramic Insulators. Subjects covered in the booklet are: How Ceramic-to-Metal Seals are Made, Mechanical and Electrical Properties of High Strength Alumina Ceramics and information on Coors "B," "C," "D," Line Standard Terminal Insulators. Photographs, line drawings and specs are included.

Circle 686 on Inquiry Card

Coaxial Connectors

Plugs, receptacles, hoods, caps, jacks, adapters, and terminals are described in an 8-page, 3-color brochure available from Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif. Bulletins CX-5 through 12, include diagrams and specs. on plugs that can be obtained in straight or angle screw-types and slide-on versions and receptacles including printed circuit and bulk head feed-thru types.

Circle 687 on Inquiry Card

Connectors

Features of the Series 610, 710, and 810 miniature non-environmental connectors are described in a new 10-page bulletin from the Data Recorders Div. of Consolidated Electrodynamics Corp., sub. of Bell & Howell Co., 360 Sierra Madre Villa, Pasadena, Calif. These connectors are for military and commercial uses where environmental characteristics are not required.

Circle 688 on Inquiry Card

Plastic Catalog

Revised 68-page catalog of plastic sheets, rods, tubes, films, blocks and flat tubings is available from Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich. Catalog lists available sizes, weights, color ranges, textures, purchasing specs. grades and prices. Includes revised and expanded 2-page comparison table of chemical, electrical, and mechanical properties of 14 plastics families.

Circle 689 on Inquiry Card

RFI Shielding

Information concerning TECK CELL T.M., metal honeycomb structure for combining RFI shielding and free air cooling for electronic packages is presented in tech. data available from Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J. Data Sheet RF-16 includes uses, limitations, controlling rates, material specs. price ranges and ordering instructions.

Circle 690 on Inquiry Card

Precision Wire

Molecu-Wire Corp., Eatontown-Freehold Pike, Scobeyville, N. J., are offering an 8-page, 2-color brochure on precision wire covering the properties, characteristics and possible uses of Protoloy and Electroloy. Protoloy is a nickel chromium alloy and Electroloy, a nickel-chromium-iron alloy. Included are illustrations, charts and diagrams of detailed relationships; temp. resistance curves; physical characteristics and mechanical properties.

Circle 691 on Inquiry Card

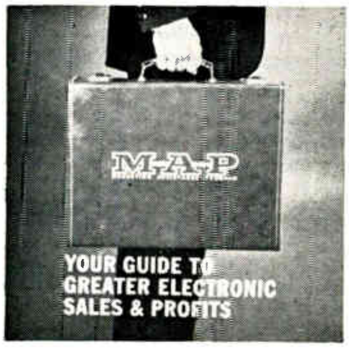
Plastic Capabilities

A 16-page catalog lists products and capabilities for advanced military and industrial applications. It covers firm's line of laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products. Catalog A-61. Continental-Diamond Fibre Corp., Newark, Del.

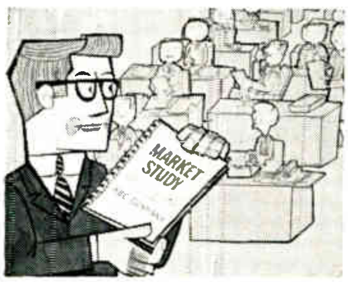
Circle 692 on Inquiry Card

ELECTRONIC INDUSTRIES M-A-P

MARKETING ASSISTANCE PROGRAM



The full story of how ELECTRONIC INDUSTRIES' M-A-P (Marketing Assistance Program) can help you—is now available for viewing in a 14-minute film presentation. A phone call to your nearest "EI" Representative will bring him to your office.



A Complete Market Research Department at Your Disposal: The services of ELECTRONIC INDUSTRIES' Research Department are available to you, together with a corps of over 250 experienced, strategically located, field investigators. They can help you determine:

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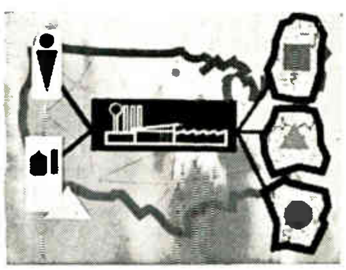

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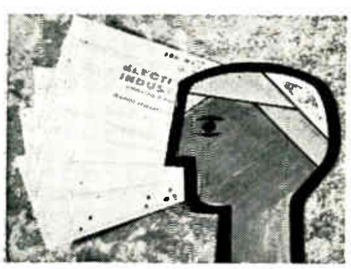

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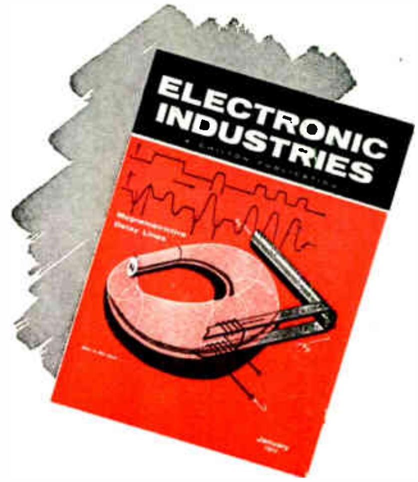

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Frequency Standards

Comprehensive manual of freq. and time standard systems is available in Application Note No. 52 from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. The textural portion of this 46-page manual is divided into 5 main sections. The first section contains a general discussion of freq. and time control, radio propagation, time scales, etc. The second, third and fourth contain detailed considerations of system operation, freq. determination, and time determination. The 5th section includes information on system stability and spectral purity. Illustrations, charts and tables are also included.

Circle 540 on Inquiry Card

Rectifier Testers

Bulletin #TAO includes information on a complete line of test instruments designed for testing controlled rectifiers. Units covered are Direct Reading I_{gt}/V_{gt} meters, Dynamic Test Sets, and High Current Pulse V_F Meters. Also included is a modular test instrument for conducting operating life tests at elevated temps. under different load conditions. Triconix, Inc., Bear Hill Rd., Waltham, Mass.

Circle 541 on Inquiry Card

Strain Recording

Brush Instruments Div., of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio, is offering a 20-page illustrated booklet entitled, "Strain Recording with Brush Direct Writing Recorders." Described are applications of strain gages and strain gage based transducers for measuring strain, tension, thrust, load, torque, etc. Photographs, circuit charts and diagrams are included.

Circle 542 on Inquiry Card

Signal Generators

Empire Devices Inc., Amsterdam, N. Y., is offering Catalog No. 614, with an 8-page supplement, covering their line of microwave signal generators, noise and field intensity meters, impulse generators, power density meters, modulation meters, crystal mixers, and microwave components.

Circle 543 on Inquiry Card

Instrument Catalog

A Short Catalog ES-10, 24 pages, 2 colors, on precision test instruments, lists the complete Bruel & Kjaer line of integrated sound, vibration and data analysis instrumentation. B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 544 on Inquiry Card

Servometers

A different approach offering accuracy response and versatility of indication and control instruments is explained in a 4-page brochure available from Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y. Exploded views show how a new film-pot meter movement operates. Schematics explain how the movement, with a low-inertia coil and low-torque wipers, works with an infinite resolution feedback pot and solid-state servo amp.

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Pressure Instruments

A 16-page catalog available from Glassco Instrument Co., 777 So. Arroyo Pkwy., Pasadena, Calif., explains the operation and characteristics of Bourdon Helix pressure instruments and their major uses. In addition, standard "off the shelf" pressure gauges, switches, and switch and gauge combinations are illustrated and described in detail.

Circle 546 on Inquiry Card

Oscillographs

Revised Product Digest No. 160 contains pictures and brief descriptions of Midwestern Instruments' complete line of products. General performance information is contained on both wet-process and direct-readout oscillographs, galvanometers, bridge balance units and galvanometer amplifiers. Midwestern Instruments, Inc., P. O. Box 7509, Tulsa 18, Okla.

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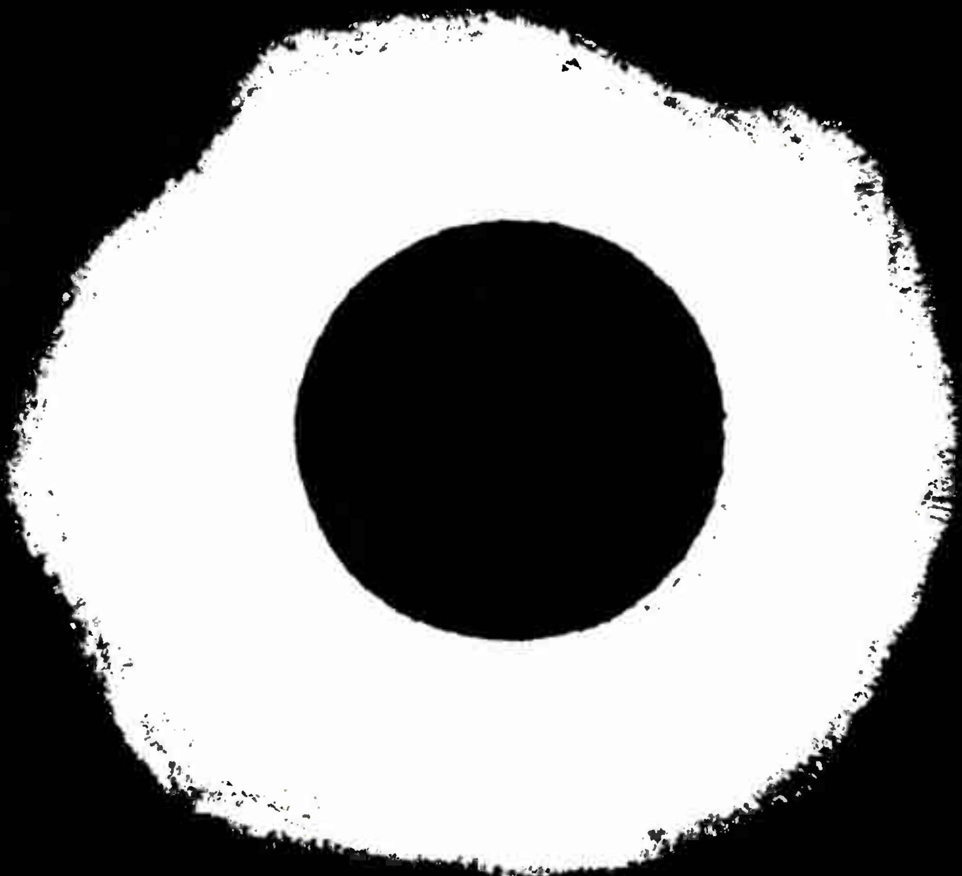

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The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name ______________________ Tel. No. ______________

Street Address ______________________ Zone ______________

City ______________________ State ______________

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth ______________

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area ______________

Salary Desired to Change Jobs and relocate in another area ______________

Professional Memberships ______________

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

State any facts about yourself that will help a prospective employer evaluate your experience and job interests. Include significant achievements, published papers, and career goals.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia 39, Pa.
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800 801 802 803 804 805 806 807 808 809 810

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- 1 BLISS NO. S-100—100 TON 10″ STROKE PNEUMATIC CUSHION 15 TON
- 1 BLISS NO. 305 90 TON 10″ STROKE PNEUMATIC CUSHION 15 TON
- 3 NIAGARA NO. H 3 ½A—45 TON
- 2 NIAGARA NO. H 2 ½—25 TON
- 1 BLISS NO. 20B—32 TON
- 3 BLISS NO. 18 HORN
- 2 BLISS NO. 18 INCLINABLE
- 3 BLISS NO. 18C INCLINABLE
- 1 CONSOLIDATED NO. 72 PNEUMATIC CUSHION—5 TON
- 1 LOSHBOUGH & JORDAN NO. 2 SPECIAL
- 1 LOSHBOUGH & JORDAN NO. 3 SPECIAL
- 1 ZEH & HANNEMAN NO. 4
- 1 ZEH & HANNEMAN NO. 2 INCLINABLE

SPINNING LATHES
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- 1 GRABO GAP LATHE 24 to 60
- 1 PRYBIL LATHE 26
- 1 GRABO LATHE 26
- 1 HAAG LATHE 22
- 3 GRABO LATHES 22
- 1 GRABO LATHE 16

LATHES
- 1 MONARCH—12 x 30
- 1 MONARCH—16 x 54
- 2 LE BLOND—17 x 54
- 1 SOUTH BEND—14 x 36
- 2 SOUTH BEND—10 x 36
- 2 SOUTH BEND—9 x 36
- 1 CINCINNATI—26 x 60
- 1 LE BLOND—22 x 48

MILLING MACHINES
- 1 MILWAUKEE RAM HD. 5 HP
- 1 MILWAUKEE VERT. 2 HP
- 1 MILWAUKEE UNIV. 2 HP
- 1 HARDINGE PLAIN
- 2 BRIDGEPORT ½ HP
- 2 CINCINNATI TOOLMASTERS
- 3 BRIDGEPORT 1 HP
- 1 SIMMONS HORIZONTAL PRODUCTION

GRINDERS
- 1 CINCINNATI UNIVERSAL 14 x 36 INTERNAL EXTERNAL HYDRAULIC
- 2 BROWN & SHARPE NO. 5 6 x 12 x 18 SURFACE
- 1 THOMPSON—6 x 12 x 18 SURFACE HYDRAULIC
- 1 REID—6 x 12 x 18 SURFACE
- 1 NEVEN BENCH GRINDER COMPLETE WITH DIAMOND WHEEL
- 1 MONOSET TOOL & CUTTER GRINDER

SAWS
- 1 GROB BAND FILING FAB NO. 18
- 2 GROB BAND DIE CUTTING
- 1 MARVEL POWER 6 x 8
- 1 MARVEL POWER 10

JIG BORER
- 1 PRATT & WHITNEY 1 ½B

SHEARS
- 1 NIAGARA SQUARING SHEAR 6′
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- 1 FOOT SHEAR 3′
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- 1 PEER 15 KVA & TIMER
- 1 EISLER 10 KVA & TIMER
- 1 TAYLOR WINFIELD 50 KVA

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- 1 MULMAT HIGH SPEED SENSITIVE DRILL PRESS
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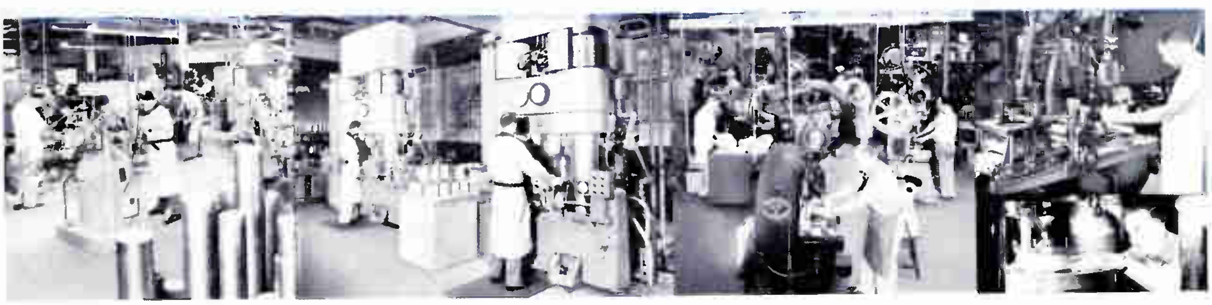

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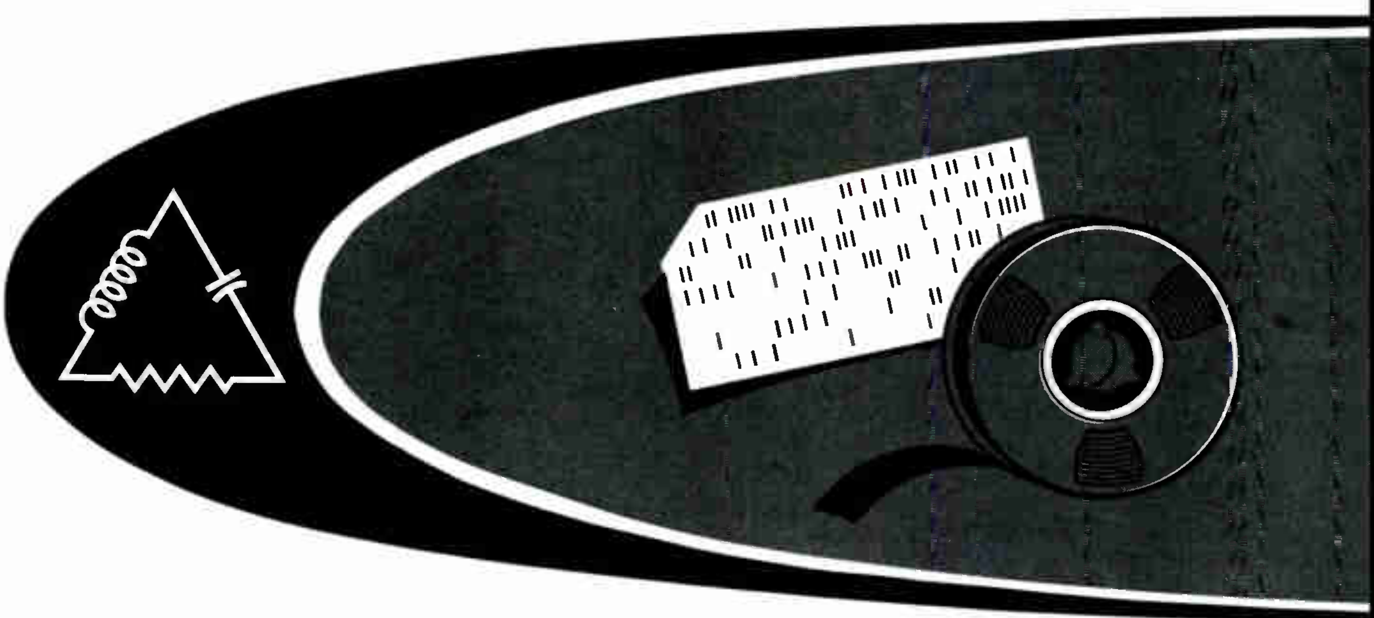
Section I

Data Processing & Automation



By RICHARD G. STRANIX
Features Editor
Electronic Industries

AUTOMATION—

THE word automation usually brings to mind thoughts of complex systems—replacing scores of workers at a time—requiring vast initial investments.

Does automation necessarily mean severe unemployment?

We've probably all heard the pros and cons of automation but a little history lesson on the development of our present telephone system might prove awakening!

Legend and Fact

There is a story that goes something like this. Years ago when telephones had just been accepted, young men operated the cumbersome switchboards. As time passed, these men were replaced by women—and the cries of *male employment only* champions. But it soon became the accepted thing to hear a pleasant feminine voice when placing a call. Then came the dial system—and the cries of *employment* champions. The story continues—it is conservatively estimated that for today's satisfactory, 24-hour telephone service every working female in this country would have to be an operator had not the dial system been installed!

Although this story greatly aided the public relations of the telephone systems, they were the first to pre-

Fig. 1: By segmenting the vibratory bowl feeder, different parts can be handled and obsolescence avoided upon part redesign.

Automation is a bug-a-boo for two basic reasons: one, employees think it will cost them their job; two, employers think it will cost them a fortune. Here are some interesting, and revealing, facts.

What It Really Means

sent a more accurate account. Here's the way they presented the story. Dial service is now a little more than 40 years old. If the ratio of operators to the number of telephones handled remained the same, we would now need one million operators. It is estimated that 250,000 new operators would be required each year—retraining costs would be $180 million annually. And even then we probably would not have the service efficiency which we have today.

There are approximately 175,000 operators in the Bell System alone today; 50,000 new operators are required each year.

Now, there are very few people who object to the dial system.

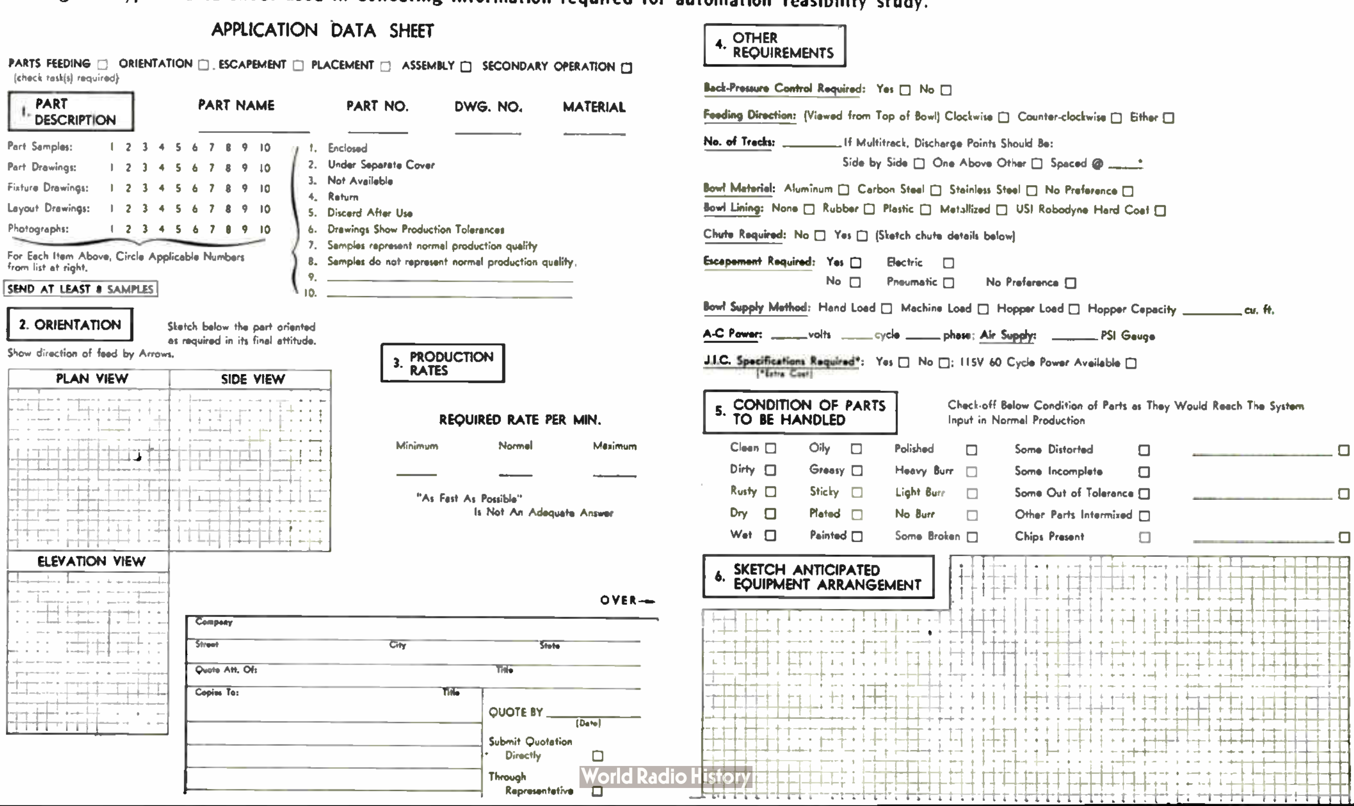
That's just a sample of how history can prove first thoughts wrong. As a followup—what about all the people that are employed at making the dialing and switching system equipment? New jobs were created for them!

We do not have our head buried so far in the sand that we cannot see there will be many cases of unemployment—nor are we so heartless as to say, "So what?" Automation can and will cause some unpleasantness.

But I think we are deviating from what we started to say. Let's go back to those original thoughts of large, complex machines.

Why do we immediately think of automation as big, somewhat clumsy, machinery? Probably because that is the facet that has received the limelight. And that may be why the little manufacturer thinks that he will never be able to go the automation route.

Fig. 2: Typical data sheet used in collecting information required for automation feasibility study.



APPLICATION DATA SHEET

PARTS FEEDING ☐ ORIENTATION ☐ ESCAPEMENT ☐ PLACEMENT ☐ ASSEMBLY ☐ SECONDARY OPERATION ☐
(check task(s) required)

1. PART DESCRIPTION

PART NAME ______ PART NO. ______ DWG. NO. ______ MATERIAL ______

Part Samples: 1 2 3 4 5 6 7 8 9 10
Part Drawings: 1 2 3 4 5 6 7 8 9 10
Fixture Drawings: 1 2 3 4 5 6 7 8 9 10
Layout Drawings: 1 2 3 4 5 6 7 8 9 10
Photographs: 1 2 3 4 5 6 7 8 9 10

For Each Item Above, Circle Applicable Numbers from list at right.

1. Enclosed
2. Under Separate Cover
3. Not Available
4. Return
5. Discard After Use
6. Drawings Show Production Tolerances
7. Samples represent normal production quality
8. Samples do not represent normal production quality.
9. ______
10. ______

SEND AT LEAST 8 SAMPLES

2. ORIENTATION

Sketch below the part oriented as required in its final attitude.

Show direction of feed by Arrows.

PLAN VIEW | SIDE VIEW

ELEVATION VIEW

3. PRODUCTION RATES

REQUIRED RATE PER MIN.

Minimum ______ Normal ______ Maximum ______

"As Fast As Possible" Is Not An Adequate Answer

OVER→

Company
Street City State
Quote Att. Of: Title
Copies To: Title

QUOTE BY ______ (Date)
Submit Quotation Directly ☐
Through Representative ☐

4. OTHER REQUIREMENTS

Back-Pressure Control Required: Yes ☐ No ☐
Feeding Direction: (Viewed from Top of Bowl) Clockwise ☐ Counter-clockwise ☐ Either ☐
No. of Tracks: ______ If Multitrack, Discharge Points Should Be:
Side by Side ☐ One Above Other ☐ Spaced @ ______"
Bowl Material: Aluminum ☐ Carbon Steel ☐ Stainless Steel ☐ No Preference ☐
Bowl Lining: None ☐ Rubber ☐ Plastic ☐ Metallized ☐ USI Robodyne Hard Coat ☐
Chute Required: No ☐ Yes ☐ (Sketch chute details below)
Escapement Required: Yes ☐ Electric ☐
No ☐ Pneumatic ☐ No Preference ☐
Bowl Supply Method: Hand Load ☐ Machine Load ☐ Hopper Load ☐ Hopper Capacity ______ cu. ft.
A-C Power: ______ volts ______ cycle ______ phase; Air Supply: ______ PSI Gauge
J.I.C. Specifications Required*: Yes ☐ No ☐; 115V 60 Cycle Power Available ☐
(*Extra Cost)

5. CONDITION OF PARTS TO BE HANDLED

Check-off Below Condition of Parts as They Would Reach The System Input in Normal Production

Clean ☐	Oily ☐	Polished ☐	Some Distorted ☐	______ ☐
Dirty ☐	Greasy ☐	Heavy Burr ☐	Some Incomplete ☐	
Rusty ☐	Sticky ☐	Light Burr ☐	Some Out of Tolerance ☐	______ ☐
Dry ☐	Plated ☐	No Burr ☐	Other Parts Intermixed ☐	
Wet ☐	Painted ☐	Some Broken ☐	Chips Present ☐	______ ☐

6. SKETCH ANTICIPATED EQUIPMENT ARRANGEMENT

Attacking the Problem

Does automation have to always be a bug-a-boo? Can't it be considered a blessing? Can't it be put within the reach of the little manufacturer? Can't it be looked for, instead of feared by, the employee?

Let's attack the problem systematically: one, get the employee to help; two, keep the costs low.

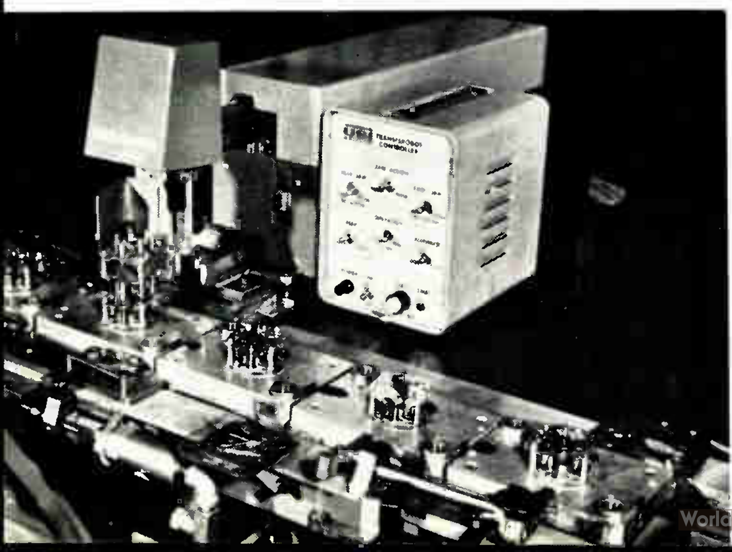
All production lines, large or small, have repetitive operations. Repetition leads to monotony and dissatisfaction. That last condition can almost always be directly related to quality control problems. To relieve the situation, let's get the human element out of the repetitive act.

How do we get employee assistance? Run a suggestion program, if necessary. Have the employees describe their most monotonous tasks. Then see if this can't be eliminated—and the worker used to better advantage elsewhere. If the worker complained of the monotony, he doesn't have cause for complaint should the task be eliminated, or reduced—and he still has another job to undertake.

But what if some jobs are abolished and the worker has no other job to undertake? And how about union complaints? We recently carried a news item (*Electronic Industries,* May 1962, Page 207) which told of how U. S. Industries, Inc., is trying to nip this problem in the bud. It has established a labor-management foundation with the International Association of Machinists. The foundation's first assignment will be to make a study to determine how automation-displaced workers can be retrained. USI will finance the foundation by paying "dues" for every automation machine that it sells or leases to another company in the U. S. It is estimated that dues will range in annual amounts from $25 to $1,000 per machine.

While the idea of retraining workers displaced by automation is not in itself new, the establishment of a foundation jointly with labor is unique. Actually, the government and many of the larger corporations affected by automation have recognized the problem for years and have been quietly pouring thousands of dollars into their own retraining projects. A few companies have used retraining to remove the automation dispute from bargaining tables.

Transfer machine used to oil clock movements on the production line.



That's some general background on automation. Now for the real job. How do you go about automating a task?

How to Automate

You could call in your production engineer (if you have one), and ask him. But he probably won't know how—otherwise he would have approached you on it before. Or maybe he just doesn't know how to do it inexpensively.

How about a consultant? He might know—but his retainer might be a little stiff.

Why not call in an automation machine manufacturer? He's got the "know-how," the team, and the desire to compete economically.

With some thought—usually, at no charge—this manufacturer's team can tell you if automation of the monotonous task is feasible, practical, and what it will cost.

Impressed by the news item already mentioned, we recently visited U. S. Industries, Inc., Automation Div., Silver Springs, Md. Here's the way their team usually operates.

The "outside" man—field representative, sales engineer, or what-have-you—views the operation and gets enough information to thoroughly understand the problem. In fact, he gets all the information that he can—because the particular operation may be so closely connected to another, perhaps a non-monotonous machine operation, that with a little thought two operations can be automated at once—by the one piece of machinery. To ensure that he has all the necessary information, he completes an application data sheet, Fig. 2, and sends it, along with samples of the item, or items, to be handled, to the "inside" man.

The "inside" man may actually be many men; but initially, he is the application engineer in the marketing department. This engineer reviews the data sheet to see if the operation can be handled by items directly "off the shelf." This is usually not the case because the field man would have recommended these items immediately. However, the application engineers are specialists and they might be able to see something in the requirement that the field man did not. Also, if stock items with minor modifications can do the job, the application engineer so specifies.

Assuming that the requirement cannot be satisfied by "off the shelf" items, the applications engineer studies the data sheet to determine the feasibility of automating the operation. If not feasible, he so advises the field man.

But let's assume that automation is feasible. The data sheet and any other information that the application engineer may have obtained are directed to custom engineering. Remember, this department is involved only if major modifications, or complete systems, are involved.

As in any other engineering study, a project engineer is assigned. It is his responsibility to study the specifications, consider all the possible courses of action, develop each possibility, and after a thorough analysis, present his concept of how the operation should be automated. In support, he prepares an estimate of the time requirement to complete the job.

(*Continued on page* I-16)

By ARTHUR FREILICH

Vice President,
Chrono-Log Corp.
Broomall, Pa.

The computer process control field is growing rapidly. This is indicated by the number of computers now available for process control applications. This up-to-date comparison covers characteristics of these computers.

1962 Computer Control Survey

ON February, 1960, ELECTRONIC INDUSTRIES published a comparison table covering the characteristics of nine digital computers that were available at that time for process control applications. These computers were being applied to the control of batch and continuous processes in the petroleum, chemical and power industries. In order to provide an up-to-date comparison of process control computer hardware, a new survey of these machines has been prepared.

The rapid growth of the computer process control field in the last two years is indicated by the fact that there are now 24 digital computer systems being offered for use in these applications. Of these 24 systems, 20 are designed specifically for process control. Similarly, in early 1960, there were approximately 20 computers on order or installed in process control applications. Latest estimates of control computers presently on order or installed in process control range as high as 180 machines.

In this report, "digital computer process control" is defined as on-line control, calculation, or logging of variables in chemical, petroleum, steel, ceramic, power, utility, and other continuous-flow processes.

Explanation of Table

Table compares major characteristics of the several makes of computers offered for process control. But because of different machine configurations, it is impossible to draw exact comparisons on all characteristics. So be sure to read carefully the footnotes by which we attempt to introduce, where necessary, some common comparison basis for divergent data. Where possible, data were obtained from the manufacturer; where other sources were used, that fact is indicated.

Most points of comparison are the same as those in the February, 1960, report.[1] Only the *new* items of comparison will be explained in this report; the reader is referred to the original report for other details.

This article is based on an article by the author which appeared in the July, 1959, issue of the ISA Journal (Instrument Society of America).

[1] "General Purpose Digital Computing Systems," Arthur Freilich, p. 70, *Electronic Industries*, Vol. 19, No. 2, Feb. 1960.

Working Memory

Process control requires the storage of large amounts of data. To reduce cost, many computers utilize inexpensive bulk storage. However, such lower-cost bulk storage (generally a drum or disk) has the disadvantage of relatively-slow average access time. To circumvent this problem, many computers provide high-speed working memory with less capacity than the bulk memory, but much shorter access times. Working memory consists of a core memory or fast-access registers. Where there is no difference in the working memory and the bulk memory, such as in machines using only core storage, the memory is termed "homogeneous."

Block Transfer Bulk to Working Memory

Since access time for data in a bulk memory is slow, it is desirable to transfer blocks of data occurring in successive bulk memory locations between bulk memory and the working memory. In this way, bulk memory access time applies only to the waiting time for the *first word* of data; succeeding words are transferred as fast as they can be read from, or written in, the bulk memory. *Variable* block transfer allows the programmer to determine the length of the block to be transferred; that is, the number of words of data. *Fixed* block transfer limits the programmer to a single block size for transfers.

Time to Perform Calculations #1 and #2

The calculations used are shown in Figs. 1 and 2. Fig. 1 is a typical operating-guide type calculation, exclusive of input switching. Fig. 2 is the same calculation, taking into account input switching. Because of various input-output configurations and because of different ways of handling the computation, the times shown in the table should be used only as a general guide.

Priority Interrupt Logic

Process control applications generally preclude use of a fixed program sequence since the program must

(*Continued on page* 18)

Digital Computers Available for Process Control

MANUFACTURER	AUTONETICS DIV. NORTH AMER. AVIATION Long Beach, Calif.		BENDIX COMPUTER Los Angeles, Calif.		COMPUTER CONTROL CO. W. Los Ang. Calif.	DAYSTROM, INC. La Jolla, Calif.		FERRANTI ELEC. INC. Hempstead, N.Y.	GENERAL Phoenix,
Computer	RECOMP II	RECOMP III	G-20	G-15	DDP	50-49	100-136	ARGUS (9)	GE-312
Internal Number Base	Binary	Binary	Octal	Binary	Binary	Binary	Binary	Binary	Binary
Operating Mode	Serial	Serial	Parallel	Serial	Parallel	Serial	Serial-Parallel	——	Serial
Word Length (Plus sign)	40 bits	40 bits	33	29	19 (35)	20	24	11	19
Bulk memory type	Disc	Disc	Core	Drum	Core	Drum	Drum	Core (8)	Drum
Bulk memory cap., min. (words)	4,096	4,096	4,096	2,176	4,096	32,000	32,000	1,024	8,000
Bulk memory cap., max. (words)	4,096	4,096	32,768	2,176	16,384	100,000 per drum	100,000 per drum	3,072	54,000
Bulk memory average access time	9 ms	9 ms	3 μs	14 ms	2.5 μs	25 ms	25 ms	2 μs	6.25 ms
Working memory type	Homogeneous plus Fast Access	Homogeneous plus Fast Access	Homogeneous	Homogeneous	Homogeneous	Core	Core	(8)	Fast Access Registers
Working memory capacity, min. (words)	16	16	N/A	N/A	N/A	1024	1024	N/A	128
Working memory capacity, max. (words)	16	16	N/A	N/A	N/A	16,384	16,384	N/A	128
Working memory average access time	0.95 ms	1.75 ms	N/A	N/A	N/A	20 μs	20 μs	N/A	0.78 ms
Is block transfer from bulk to working memory available?	Fixed, 8 Words	Variable, 1 to 8 Words	N/A	N/A	N/A	Yes	Yes	N/A	——
Instruction type	Single Address	Single Address	Single Address	Modified Oble. Address	Single Address	Single Address	Single Address	Single Address	Single Address (10)
Memory words/instruction	1/2	1/2	1	1	1	1	1	1	1 or 2
Instruction complement, normal	72	49 (1)	106	500	50	49	115	54	80
Instruction complement, max.	——	——	106	500	128	49	136	64	——
Clock frequency	160 kc	160 kc	1 mc	107 kc	1 mc	100 kc	100 kc	500 kc	250 kc
Add time, w/o access	0.54 ms	0.54 ms	2 μs	0.27 ms	2 μs	0.66 ms (20)	0.056 ms (20)	apr. 18 μs	0.098 ms
Multiple time, w/o access aver.	10.8 ms	10.8 ms	42 μs	2.9 ms	40 μs	5.06 ms (20)	1.4 ms (7) (20)	apr. 95 μs	2.16 ms
Time to perform calculation #1	83.0 ms (15)	78.0 ms (15)	1.48 ms	127 ms	5 μs	39.38 ms	3.08 ms	——	34.4 ms (15)
Maximum input switching speed (Low-level mv inputs)	(2)	(2)	(2)	(2)	——	30 to 500/sec	30 to 500/sec	——	114/sec (12)
Time to perform calculation #2	(2)	(2)	(2)	(2)	63 μs	57.7 ms	3.53 ms	——	78.4 ms (15)
Is priority interrupt logic available?	No	No	Yes	No	Yes	Yes	Yes	——	No
Can I/O operations proceed simultaneously with arithmetic and logical functions?	No	No	Yes	Yes	Yes	No	Yes	——	Yes
Weight (lbs)	197	250	2,000	965	1,300	2,000	3,000	——	2,730
Power required	115 v, 3 amps	115 v, 3 amps	3.5 kva	3.8 kva	115 v, 1 kw	$<$2 kw	$<$3 kw	——	6 kva
Internal temperature control	Blowers	Blowers	Blowers (34)	Blowers (34)	Forced Air	——	——	——	Optional. Air Cond.
Can computer be isolated from ambient atmosphere?	No	No	No	No	No	Yes	Yes	——	Yes
Price (approximate)	$95,000 (3)	$65,000 (3)	$389,600 (3)	$56,300 (3)	$130,000	(2)	(2)	——	$100-450,000

NOTES

(1) Plus floating point commands (optional).

(2) This is a general purpose computer not specifically designed for, but applicable to, process control. Input conditioning equipment, A/D and D/A conversion, and input-output switching systems must be added to make a complete process-control system.

(3) For computer, typewriter, tape I/O.

(4) Four digits.

(5) On a multiple basis, according to manufacturer.

(6) Per A/D input unit-several parallel units optional.

(7) Includes serial access; with parallel access, 0.08 ms.

(8) Argus has pegboard instructions for program steps and constants (128 constants and up to 4,096 program steps). Core memory is for data only. Drum memory up to 50,000 words also available.

(9) Data from source other than manufacturer.

(10) Also 1 + 1 instructions.

(11) 8.3 ms of total time shown is to store the result.

(12) Assumes eight parallel amplifier channels.

(13) Assumes filter on each line, but single amplifier and A/D converter for system.

(14) Assumes 20 filters and input amplifiers.

(15) Based on optimum coding.

(16) 0.1% accuracy with one amplifier/point, 0.5% accuracy with one amplifier for system.

(17) Includes A/D conversion, first 8 input channels, typewriter and paper tape.

(18) Some instructions require two words.

(19) 80 instructions are available from a total of several hundred.

(20) Includes access time.

(21) Results stored in main memory since bulk memory normally used only for program storage.

(22) An additional 1.5 kw required for air conditioner.

(23) Bailey 755 system uses PB-250 computer. See Bailey 755 for input switching of Bailey system.

(24) Uses Packard-Bell PB-250 computer.

(25) For first drum; additional drums available to 8,000,000 words.

(26) For first core unit. Multiple core units available.

(27) Exclusive of transfers to bulk memory. With bulk memory transfers, calculation time is 23.5 ms.

ELECTRIC CO. Arizona	INFORMATION SYSTEMS, INC. Skokie, Ill.	LEEDS & NORTHRUP CO. Philadelphia, Pa.	LIBRASCOPE DIVISION GENERAL PRECISION INC. Burbank, Calif.		MINNEAPOLIS-HONEYWELL REG. CO. Pottstown, Pa.	PACKARD-BELL COMPUTER CORP. Los Angeles, Calif.	BAILEY METER CO. Cleveland, Ohio	RADIO CORP. OF AMERICA Natick, Mass.	TRW COMPUTER CO. Canoga Park, Calif.	
GE-412	609	LN-3000	L-500	L-1000	290	PB-250	755	RCA 110	RW-300	TRW-330
Binary	Binary	Binary	Binary	Binary	Binary and BCD	Binary	(24)	Binary	Binary	Binary
Parallel	Serial	Serial	Serial	Serial	Parallel	Serial		Serial	Serial	Serial
19	39	22	30	31	17	21		24	18	28
Drum	Disc	Drum	Drum	Drum	Drum (32)	Delay Lines	Drum	Drum	Drum	Drum
16,384	4,000	——	4,096	7,808	8,192	2,320	——	4,096	8,000	4,000
57,344	100,000	16,256	4,096	15,232	32,768	15,888	28,000/drum	32,000 (25)	16,000	100,000
8.3 ms	——	8.3 ms	8.3 ms	8.3 ms	17 ms		16.7 ms	8.3 ms (9)	8.3 ms	8.3 ms
Core	Core	Fast Access Registers	Homogeneous	Fast Access Registers	Core	Delay Lines		Core	Fast Access Registers	Fast Access Registers
4,096	4,096	4	N/A	200	1,024	2,320		256	16	128 + 1
8,197	16,384	16	N/A	200	4,096	3,856		4,096 (26)	32	256 + 1
20 μs	24 μs	0.5 ms	N/A	1 ms	<20 μs	12 μs		10 μs	2.08 ms	2.08 ms (29)
Variable, 128 to 1024 Words	Yes	No	N/A	Fixed, 8 Words	Variable, Up to 256 Words	Variable		Variable, Up to 4096 Words	No	Yes (Variable)
Single Address	Single Address	Single Address (10)	Single Address	Double Address	Single Address	Single Address		Single Address	1 + 1 Dbl. Addr.	Single Address
1	0.5	1	1	1	1 (18)	1		1	2	1
> 100	64	16	16	43	85	57		68	21	35
——	64	64	——	——	< 100 (19)	——		75	>35	>70
400 kc	167 kc	170 kc	136 kc	123 kc	50 kc	2 mc		936 kc	153.6 kc	246 kc
20 μs	720 μs	0.52 ms	0.23 ms	0.25 ms	0.14 ms (20)	12 μs		58 μs (20)	0.39 ms	0.13 ms
440 μs	2.8 ms	2.7 ms	18 ms	18 ms	0.8 ms (20)	276 μs		751 μs (20)	2.99 ms	4.1 ms
12.1 ms (11)	31.7 ms	58.9 ms (15)	915 ms	193 ms	9 ms (21)	< 9 ms		6.5 ms (31) (27)	42 ms (15)	31 ms (15)
114/sec (12)	40/sec (13)	16/sec (14)	60/sec (16)	60/sec (16)	up to 200/sec	1000/sec	5/sec	60/sec	480/sec (30)	480/sec (30)
56.1 ms (11)	57 ms	58.9 ms (31)	——	210 ms	14 ms (21)	(2) (23)	46 ms	6.5 ms (31) (27)	42 ms (31) (15)	31 ms (31) (15)
Yes	Yes	Yes	Yes	Yes	Yes	——	——	Yes	No	Yes
Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4,000	1,000	450	1,100	1,250	1,600	130	——		645	600
< 10 kva	2 kw	500 w	2 kva	2 kva	1.4 kw (22)	110 w	——	5 kva	500 w	285 w
Optional Air Cond.	——	——	——	Internal Air Cond.	Internal Air Cond.	Not Required	——	Heat Exchangers	Not Required	Air Cond. Optional
Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$150-750,000	$130,000	$100,000 (3)	$84,500 (17)	$97,400 (17)	$175,000 (33)	$40,000 (3)	——	$125,000 (28)	——	——

(28) Computer with 256 words of core memory.

(29) Time shown is random access in a 256-word block. Access time is 0.5 ms in an 8-word block.

(30) Assumes 1024 inputs, 32 filters and amplifiers.

(31) Input selection and conversion are independent of program. Computer has access to latest data.

(32) Magnetic tape I/O also available as standard, with transfer rate of 15,000 characters/second.

(33) Nominal figure; price varies with memory capacity, and does not include peripheral equipment.

(34) These figures apply to central processor only.

(35) 25 bits available.

(36) 12 characters per instruction.

(37) Computer with paper tape I/O, 12k character memory and typewriter.

(38) Assumes data from last point is in storage and conversion in progress.

Assume all data, instructions, etc., are in working memory, if non-homogeneous memory is used:

1. Read in new input X (exclusive of input switching time, input selection time, settling time, or A/D conversion)
2. Calculate (A) (X) + B = Y
3. Compare Y to C to insure that Y < C
4. Compare Y to D to insure that Y > D
5. Calculate $Z = \sqrt{(E)(Y)}$ (with accuracy of 10 bits – 0.1%)
6. Calculate J = (ZF – G) (K)/H + L
7. Store J in bulk memory (use average access time)
8. Store Z in bulk memory (use average access time)

Figure 1. Sample Calculation No. 1—a typical problem used to compare computation speed of the several computers.

Same as Calculation #1, but assume that input X must be obtained from an analog-input, low-level, process-signal from a thermocouple-type transducer; include selection time, switching time, settling time, and A/D conversion time.

Figure 2. Sample Calculation No. 2—same as Figure 1, but including input switching.

Digital Computers Available for Process Control

MANUFACTURER	TRW COMPUTER CO., Canoga Park, Calif.	IBM, San Jose, Calif.	WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa.	
Computer	TRW-340	IBM-1710	PRODAC 510	PRODAC 580
Internal Number Base	Binary	Decimal	Binary	Binary
Operating Mode	Serial-Parallel	Serial	Parallel	Parallel
Word Length (Plus Sign)	28	Variable	18 bits	18 bits
Bulk memory type	Drum		Drum	Drum
Bulk memory cap. min. (words)	8,000		16,000	16,000
Bulk memory cap. max. (words)	100,000		64,000 per drum	64,000 per drum
Bulk memory average access time	8.3 ms		8.3 ms	8.3 ms
Working memory type	Core	Core	Core	Core
Working memory capacity min. words	4,000	20,000 Characters	4,096	4,096
Working memory capacity max. words	16,000	60,000 Characters	16,384	32,768
Working memory average access time	8 μs	20 μs	4 μs	4 μs
Is block transfer from bulk to working memory available?	Yes variable	N A	Yes variable	Yes variable
Instruction type	Single Address	2 Address	Single Address	Single Address
Memory Words instruction	1	36	One	One
Instruction complement, normal		36	65	73
Instruction complement, max.		49	83	91
Clock frequency	490 kc		1.5 mc	1.5 mc
Add time, w o access	16 μs	0.48 ms (4)	12 μs (20)	12 μs (20)
Multiple time, w o access aver.	131 μs	3.4 ms (4)	38 μs (20)	38 μs (20)
Time to perform calculation (1)		20 ms	1.586 ms	1.524 ms
Maximum input switching speed low-level mv inputs		20 sec	75 sec (6)	75 sec (6)
Time to perform calculation (2)		25 ms (38)	2.400 ms	1.934 ms
Is priority interrupt logic available?	Yes	Yes	Yes	Yes
Can I O operations proceed simultaneously with arithmetic and logical functions?	Yes	Yes	Yes	Yes
Weight (lbs)		2,000		
Power required	500 w	208 v. 15 a	< 7 kva	< 7 kva
Internal temperature control	Not required	Blowers	Air Cond. Optional	Air Cond. Optional
Can computer be isolated from ambient atmosphere?		No	Yes	Yes
Price (approximate)		75,000 (37)	\$150 (400,000)	\$200 (500,000)

(*Continued from page 15*)

be responsive to ever-changing process conditions. Priority interrupt logic permits a change in process conditions to interrupt the computer program and, without losing any part of the previous calculation, switch the computation to that portion of the program which is designed to handle the new condition. Various process conditions are assigned priority ratings, and interrupt is based on performing the highest priority computations first, followed by those of lower priority. Emergency conditions in the process would have priorities dependent on the urgency of action required.

When no high-priority tasks are required, the computer can perform system checks, process studies and other routine tasks. Although programmed priority interrupts are possible, the inclusion of priority interrupt logic in the computer eliminates the need for complex programming and conserves program space and computing time.

Simultaneous Input/Output and Computation

Where input/output (I/O) computations can proceed *simultaneously* with computations, the computer can perform computations without waiting for input data; the computer has available to it the latest input data. To the extent that these operations can proceed simultaneously, the computer can conserve computing time.

EDWARD GLENN McCOY

Senior Engineer, Data Systems Div., Radiation, Inc., Melbourne, Florida

How to Design . . .

Counters Using

Inhibiting logic can control the functions of a flip-flop counter. Here is a method which uses it to provide flexible counter operation. This non-standard tool requires a minimum of components.

A COUNTER having a count-down capability of ten, six, and five can be mechanized by the addition of two diodes to a standard counter configuration.

The following "ground rules" apply:

(1) A "True" logic level is defined as —5 vdc.

(2) A "False" logic level is defined as 0 vdc.

(3) Positive clock-pulses or sources are used to turn the flip-flops "off" to minimize "turn off delay time."

(4) In the analysis, only the involved gates will be shown for each application.

(5) Since the maximum count-down requires ten states, four flip-flops will be required to mechanize the counter. They are designated A_1, A_2, A_4 and A_8—where the subscripts designate the binary value of the flip-flop when it is set at "1".

TRUTH TABLES

Count-down by 10

	A_1	A_2	A_4	A_8
t +0	0	0	0	0
t +1	1	0	0	0
t +2	0	1	0	0
t +3	1	1	0	0
t +4	0	0	1	0
t +5	1	0	1	0
t +6	0	1	1	0
t +7	1	1	1	0
t +8	0	0	0	1
t +9	1	0	0	1

Count-down by 6

A_1	A_2	A_4	A_8
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0

Count-down by 5

A_1	A_2	A_4	A_8
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0

Fig. 1: Desired modes of operation of the Counter are defined by the Truth Tables.

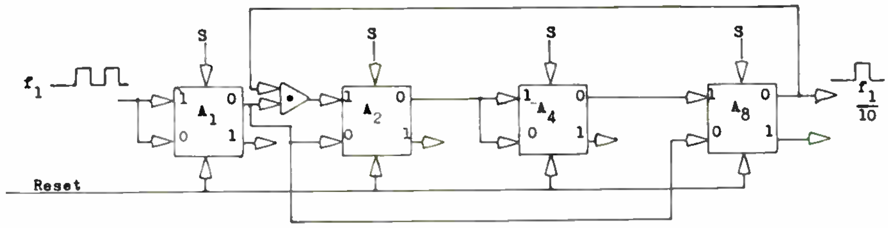


Fig. 2: Representation of the logic required to implement a count-down by 10.

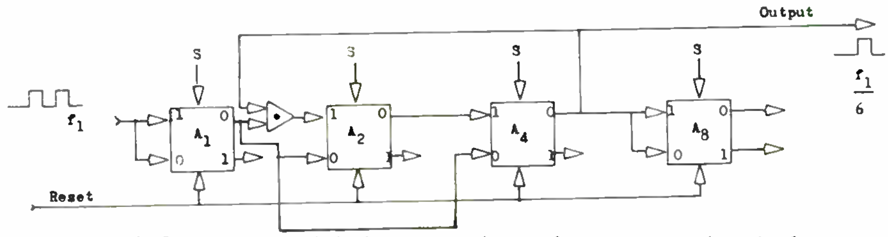


Fig. 3: Representation of the logic required to implement a count-down by 6.

Inhibiting Logic

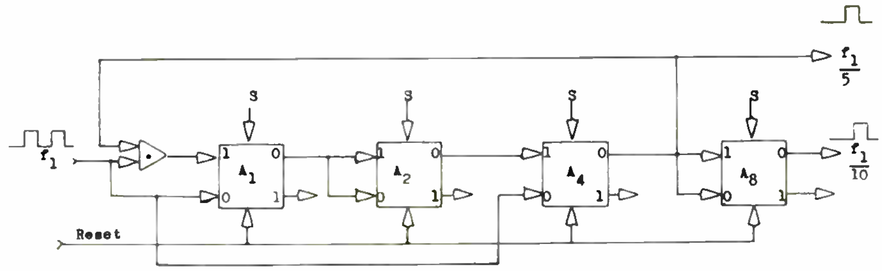


Fig. 4: Representation of the logic required to implement a count-down by 5.

Desired modes of operations of the counter are defined by the Truth Table, as shown in Fig. 1.

Count-down by 10

Reference should be made to Fig. 2, which is a representation of the logic required to implement a count-down by 10.

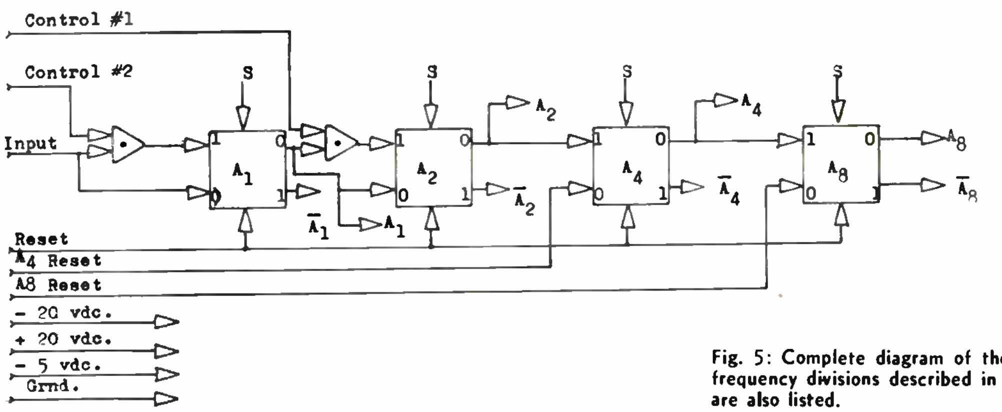
The counters are initially shown in the reset condition. A positive input source of clock-pulses or triggers—from another counter decade—sequences the flip-flops A_1 through A_8 until a binary count of nine is reached. At time t+9 (Fig. 1), binary counters A_1 and A_8 are set "1". Therefore, the output of flip-flop A_8, which is at a —5 v., inhibits the input control gate associated with the set "1" input of flip-flop A_2.

Consequently, although the next input clock-pulse sets flip-flop A_1 "0", the positive output waveform of A_1 is inhibited from setting the A_2 flip-flop. However, the output of flip-flop A_1 (approximately +5 v.) resets flip-flop A_8 to re-enable the set "1" input control gate of flip-flop A_2 for subsequent recount operations. An output frequency of one-tenth the input frequency is derived from the True output of the A_8 flip-flop, as shown.

Count-down by 6

Reference should be made to Fig. 3, which is a diagram of the logic required to implement a count-down by 6. It is pointed out, for the reader's benefit, that only the control of the input AND gate associated with flip-flop A_2 has been changed.

An input of "f_1" clock-pulses sequences the counters until a binary count of five is reached at t+5. At this time interval (Fig. 1), flip-flops A_1 and A_4 are set "1". The True output of flip-flop A_4 which is set at —5 v., inhibits the input control gate of the set "1"



Input Requirements

4 Set "1" Inputs
4 Voltages: ± 20; - 5; Grnd.
1 Reset
1 Input
2 Inputs to And Gates
8 Logic Outputs: A_1 thru A_8
2 Inputs to A_4 and A_8
22 (Standard connector)

Fig. 5: Complete diagram of the Counter which performed all of the frequency divisions described in the article. Required outputs per card are also listed.

Inhibiting Logic *(Concluded)*

input of flip-flop A_2. The next input clock-pulse at t+6 resets flip-flop A_1. The positive output (+5 v. pulse) is inhibited from setting flip-flop A_2, but resets flip-flop A_4 and the counter is returned to a state suitable for re-counting.

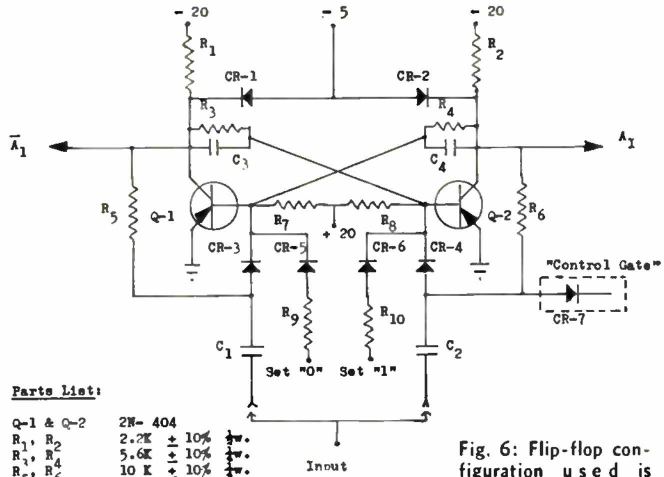
An output derived from the True side of flip-flop A_4 provides an output which is one-sixth the input frequency. Although flip-flop A_8 is set and reset every six time interval, this caused no difficulties in the specified application.

Count-down by 5

The last mode of operation to be described is the count-down by five, which is represented by the logic diagram shown in Fig. 4.

This counter counts in a normal binary fashion until a binary count of four is reached (refer to Fig. 1) at t+4. At this time interval, the True output of flip-flop A_4 (which is set at —5 v.) inhibits the input AND gate of the set "1" side of flip-flop A_1. However, the next clock-pulse or trigger resets flip-flop A_4 which removes the inhibitor. An output derived from the True side of flip-flop A_4 provides an output which is one-fifth the input frequency.

An additional feature is that a division by ten can be derived by taking the output from the True side of the A_8 flip-flop instead of the A_4 flip-flop. A symmetrical output waveform from the True side of the A_8 flip-flop is a biquinary division of the input frequency.



Parts List:

Q-1 & Q-2	2N- 404
R_1, R_2	2.2K ± 10% ½ w.
R_3, R_4	5.6K ± 10% ½ w.
R_5, R_6	10 K ± 10% ½ w.
R_7, R_8	82 K ± 10% ½ w.
R_9, R_{10}	470 ohms ± 10% ½ w.
C_1, C_2	470uuf. 100 wv.
C_3, C_4	100uuf. 100 wv.

CR-1 through CR-7 CO-1 (Texas Instruments)

Fig. 6: Flip-flop configuration used is shown with the input AND control gate shown enclosed by dotted lines.

Logic Diagram and Schematic

A complete logic diagram of the counter which performed all of the frequency divisions described in this article (at 100 KC.) is shown in Fig. 5. Also shown in Fig. 5 are the required twenty-two outputs per card. A schematic diagram of the flip-flop configuration used is shown in Fig. 6. The input AND control gate is shown by dotted lines on the schematic.

While the counter was designed for a specific application, the methods employed to derive the desired operation can be used to provide other modes of operation depending on the design requirements.

New Tech Data for Engineers

Program Timer

Model PT-96 is basically a master decade counting device, capable of generating selective timed outputs within a range of from 0 to 10,000 sec., with time spacing of 10msec. Accuracy of timing through the full range is ±0.01%. Block diagram, dimensional drawings, connector data, photographs and definition of signals are included. Electronic Products Corp., 2315 Cecil Ave., Baltimore 18, Md.

Circle 599 on Inquiry Card

Digital Modules

This 28-page catalog, S-1, contains information on S-PAC Digital Modules. Included are schematics, technical descriptions and details spec. of 2 complete series of approx. 60 different compatible, high-reliability plug-in modules for digital computers and systems. Operating freq. range is from dc to 1 and 5MC. Also included are loading rules, typical waveforms, mechanical packaging features, information on logic symbol stickers, core memory systems, and related products. Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

Circle 600 on Inquiry Card

Delay Lines

Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J., has tech. data available on their Wee® Lines. Wee Lines are sectionalized delay lines. Each section is designed and manufactured to be a discreet value of delay time. The total number of sections of the delay line determines the overall delay time.

Circle 601 on Inquiry Card

Shift Register Brochure

This 4-page brochure describes a line of standard magnetic shift registers. Features included in the brochure are low power dissipation, operational stability, packaging flexibility and low cost. EPSCO-Components 275 Massachusetts Ave., Cambridge 39, Mass.

Circle 602 on Inquiry Card

Magnetic Core Memory

A line of magnetic core memory components and systems described in a full-color brochure is available from Fabri-Tek, Inc., P. O. Box 8046, Minneapolis 16, Minn. Information is included on core memory planes, stacks, temperature-controlled stacks and complete memory systems.

Circle 603 on Inquiry Card

Computer Reports

Applied Dynamics, Inc., 2275 Platt Rd., Ann Arbor, Mich., is offering a 12-page Computer Application Report entitled "Analog Component Requirements for Solving the Six-Degree-of-Freedom Orbital Flight Equations." It illustrates how this important and complex simulation can be done on an analog computer with a total of 179 operational amplifiers, 37 potentiometers, 93 quarter square multipliers, and 23 function generators.

Circle 604 on Inquiry Card

Magnetic Programming

Bulletin B contains complete details on a digital pattern generator, which gives all magnetic programming without switches, contacts or patch cards. Information includes uses, features, general description, electrical and mechanical specs., optional equipment and accessories, and photographs. Cybetronics, Inc., 132 Calvary St., Waltham, Mass.

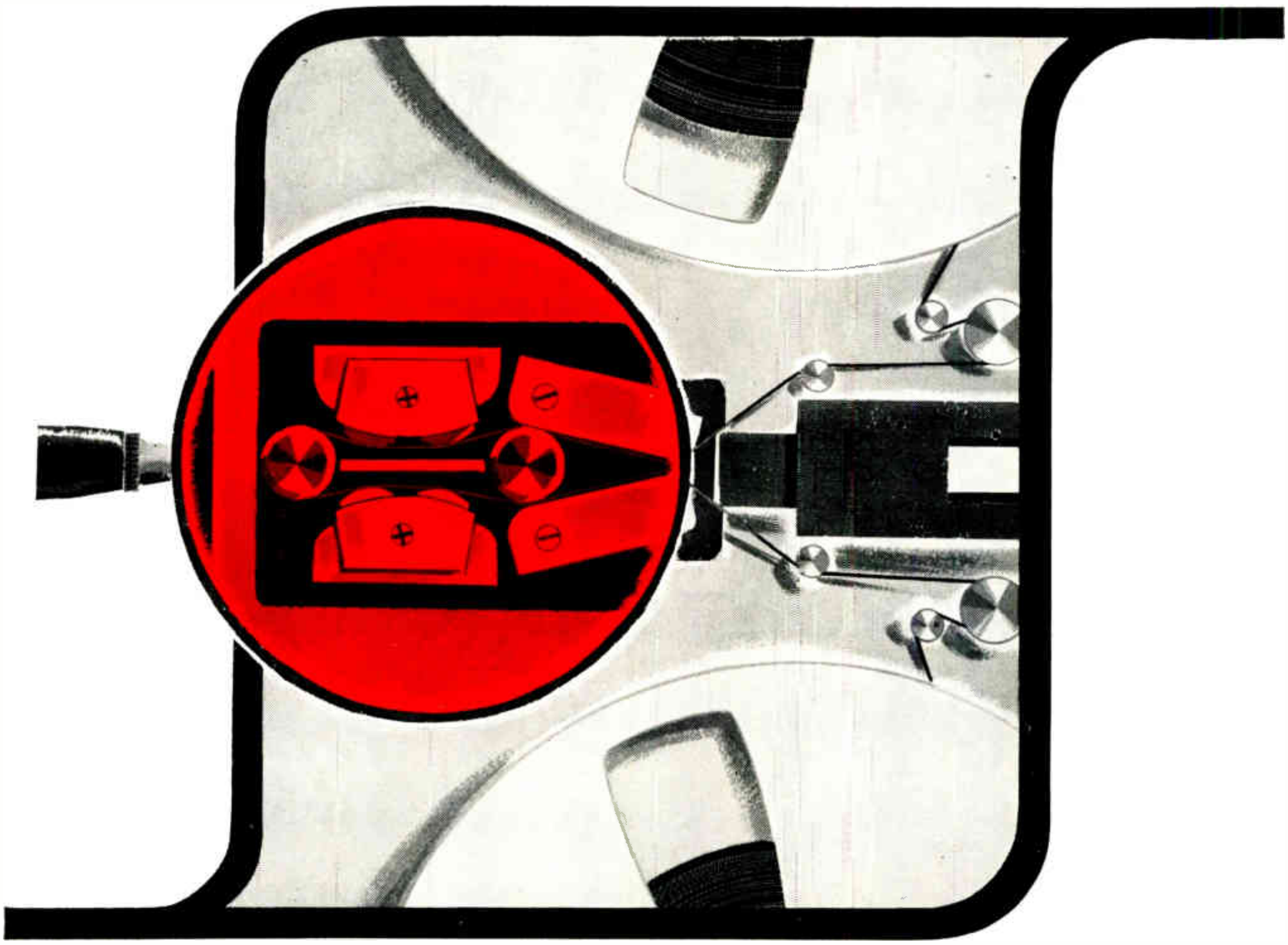
Circle 605 on Inquiry Card

Optical Scanner Units

This 6-page, multi-colored brochure describes a selected data page reader—an optical scanning machine capable of selecting and reading specified data from a business document and converting the information into business machine language for computer processing. Farrington Electronics, Inc., Alexandria, Va.

Circle 606 on Inquiry Card

First as a matter of record...SCOTCH® BRAND Instrumentation Tapes



HOT SPOT CONQUERED! Heavy duty tapes defy head heat, outlast ordinary tapes 15 times!

Hot spot for today's instrumentation tape is the localized head-heat buildup generated by higher and higher tape speeds and tensions. With ordinary tape, this heat can separate oxides from backing, deprive you of accurately recorded signal. Not so with "SCOTCH" BRAND Heavy Duty Instrumentation Tapes! They withstand temperatures from –40°F to as high as 250°F!

The heat-resisting formulation of high-potency oxides and binder minimizes rub-off, assures tapes that last at least 15 times longer than ordinary tapes—*frequently longer!* Conductivity, approximately 1000 times greater than that of ordinary tapes, drains off dust-attracting static charges. Exclusive Silicone lubrication protects against head wear, extends tape life.

16 different "SCOTCH" Heavy Duty Tapes, in 3 series, are now offered, including constructions with polyester backings of .65, 1 and 1.5 mils, coating thicknesses of .18, .43 and .65 mils. *"400" series* features excellent high and low frequency resolution. *"500" series* affords extra smoothness for extreme high frequency resolution. *"900" series* (only tapes recommended for Mincom CM-100 and CMP-100 Recorder/Reproducers) provides ultra-smooth oxide surfaces for critical short wavelength requirements.

Whatever your requirements for instrumentation tapes—standard, high output, high resolution, sandwich or heavy duty—call the nearby 3M representative. Or write Magnetic Products Division, Dept. MBR-82, 3M Company, St. Paul 1, Minn.

Magnetic Products Division 3M COMPANY

CONHEX SUB-MINIATURE R. F. CONNECTORS

Designed and manufactured to meet the industry's demand for a better connector. Real gold-plated, not just flashed. Maximum impedance match, minimum VSWR. Available in Crimp-On or Clamp-On designs.

SCREW-ON
Clamp-On

SNAP-ON
Clamp-On, Crimp-On

PRESS-FIT® TEFLON TERMINALS

Sealectro and only Sealectro makes Press-Fit terminals. Ultra-quality provides optimum reliability and assembly ease. Available in all standard EIA colors.

SUBMINIATURE STANDOFFS
Teflon bushings in diameters from .148" to .218". Choice of lugs, including turrets.

SUBMINIATURE FEEDTHRUS
For connections through chassis or casing. Choice of lug designs including hollow-tube.

MINIATURE STAND-OFFS
For components and assemblies stressing higher voltages. Wide choice of lugs and turret designs.

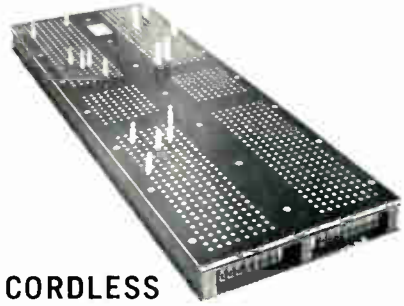
MINIATURE FEEDTHRUS
For handling voltages up to 4000 VDC. Wide choice of bushing diameters and lengths.

SEALECTRO COMPONENTS OFFER PROVEN RELIABILITY IN ALL INDUSTRIAL AND MILITARY APPLICATIONS

PRESS-FIT® TEST JACKS AND PLUGS

Male and female. Ideal for test instrument probes, jumper plugs and multiple pin plugs. Test jacks for printed circuitry.

SEALECTOBOARD



CORDLESS PROGRAM BOARDS

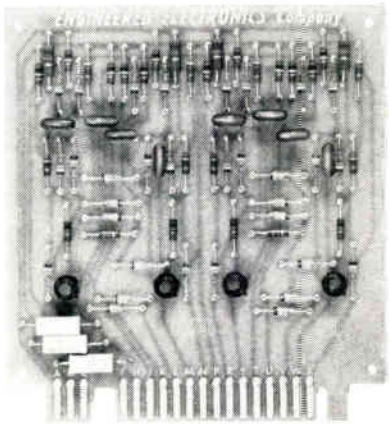
The revolutionary program board. Simplifies multi-channel switching. Provides complete connections with insertion of single pin. No cord clutter. Accessories include component holders for inserting diodes, resistors, or other components at any circuit point. Available in any X- and Y- configuration. Standard Proto-Kits including board, shorting pins and component holders available from distributors.

DELTIME MAGNETOSTRICTIVE DELAY LINES

Longer delay times utilizing the magnetostrictive principle for maximum stability and mechanical ruggedness. Delay times up to 10 milliseconds at repetition rate of 655 KC with return-to-zero, or 5 millisecond delay at 1 MC with return-to-zero. Suitable for data storage. Completely humidity and magnetically shielded. Many standard fixed and variable models available.

WRITE FOR CATALOGS . . . STATING PRODUCT INTEREST

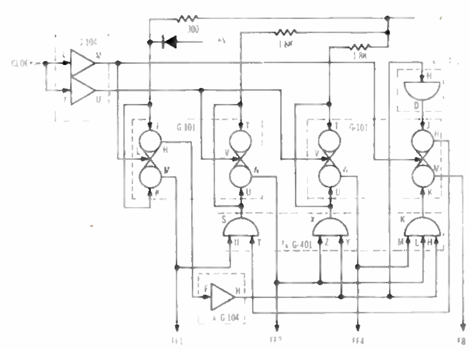
Sealectro CORPORATION
139 HOYT STREET • MAMARONECK, N. Y.

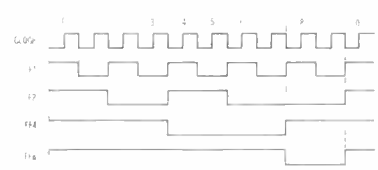


EECo G-SERIES CIRCUIT APPLICATIONS

10-$\frac{Mc}{s}$ SYNCHRONOUS $\frac{N}{10}$ COUNTER

Error-free synchronous N/10 counting at clock speeds up to 10 Mpps is normally a costly operation in terms of the electronics involved. The EECo circuit shown here, however, is an economical one in spite of its high reliability, because it employs low-cost EECo G-Series extended service digital circuit modules. ■ This 10-Mc synchronous N/10 counter uses a 1-2-4-8 code. It is made up of four G-Series circuit cards.





*PAT. APPLIED FOR

G-SERIES FEATURES

The G-Series is a complete family of high-quality, low-cost extended service digital circuits on cards. Units are designed for either synchronous or non-synchronous applications and feature standard input impedances, compatible standard signal levels, conservative electrical specifications, repairability, and keying for error-free insertion. In addition, they offer the unique feature of integral protection against power supply shorting damages.* Units in frequency sub-groups lower than 10 Mc will be available shortly.

The circuit illustrated is typical of the many practical applications of EECo G-Series extended-service digital circuit modules. We stand ready to furnish circuit modules and application data to meet the needs of your specific problems. Write, wire, or phone today.

ENGINEERED ELECTRONICS Company ®

ENGINEERED ELECTRONICS Company

1441 East Chestnut Avenue • Santa Ana, California
Kimberly 7-5651 Cable Address: ENGELEX

Tech Data

for Engineers

Silicon Logic Modules

This 8-page, 3-color brochure describing a line of silicon logic modules is available from Packard Bell Computer Corp., 1905 Armacost Ave., Los Angeles 25, Calif. Covering 13 circuit modules, the brochure gives general descriptions and operating characteristics which include operation over a temp. range from −55 to 100°C at a freq. of 1MC.

Circle 548 on Inquiry Card

Tape Readers

Short-form catalog illustrating and describing a line of OMNI-DATA electrostatic paper-tape recorders, chopped-reflected-light tape readers, and high-performance tape reelers is available from Omnitronics, Inc., sub. of Borg-Warner Corp., 511 N. Broad St., Phila. 23, Pa.

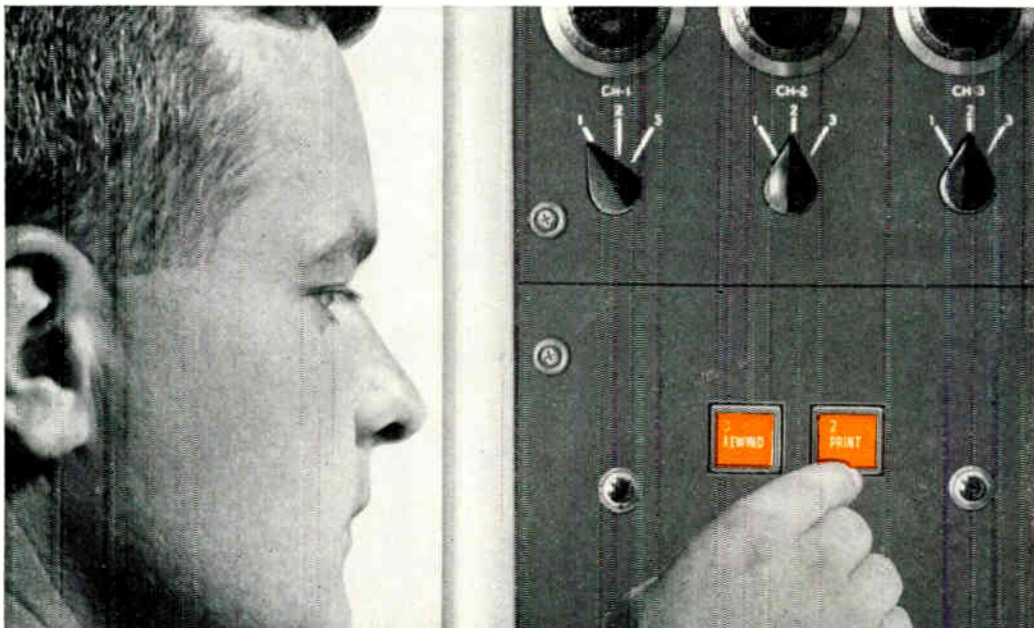
Circle 549 on Inquiry Card

Delay Lines

Tech data is available on the line of variable, audio, lumped constant, distributed constant, and subminiature lumped constant delay lines. Information is also included on magnetostrictive delay lines, networks and filters. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 550 on Inquiry Card

How to reduce panel space by more than 90%



The Cue Switch is a rear projection readout with a pushbutton viewing screen. When depressed, the viewing screen closes a momentary contact switch to control external circuits. Twelve messages (words, numbers, symbols) can be displayed individually or in combination. Message indicated can use one bulb for the word, one for the mode number, and one for the color leaving nine more for other mode numbers and commands.

with I·E·E *Cue* INDICATOR SWITCHES

Twelve individual messages that can be read out singly or in combination are combined with a push-button viewing screen on the Cue Switch to reduce panel space requirements to one square inch—a reduction of 90% or better!

Used with a stepping switch, the Cue Switch can initiate sequential command functions while indicating the mode of operation. It can be used to interrogate circuits and then read out conditions.

Where an operator must follow a check list, the Cue Switch can read out "WAIT FOR WARMUP," "OK TO PROCEED," or other instructions. For computer applications, the Cue Switch can be used as a mode of operation indicator while enabling the operator to start and stop the operation. For elevator applications, the Cue Switch can be used to call for the elevator car, then indicate the floor location of the car as it moves.

The electrical and mechanical simplicity and the quality construction of IEE Cue Indicator Switches provide a high degree of reliability. Economical pricing (single units $55) gives you a switch/readout combination adaptable to a wide range of practical applications.

Human Factors Considerations
IEE Cue Indicator Switches give you optimum control discernability by having instructions or commands appear on the face of the switch to be depressed—all characters are displayed on the same plane with 170° viewing angle—de-energized characters are not visible—minimum panel area is required for legible display.

Call your nearest IEE sales engineering representative for additional information and demonstration.

Specifications

DIMENSIONS: (overall) 2 inches high; 1 inch wide; 4 inches (with standard terminal assembly), 4.75 inches (with quick-disconnect terminal assembly). Push-button viewing screen 1" square.

WEIGHT: 5 ounces.

STANDARD CHARACTERS AVAILABLE: 0 through 9, "on" and "off;" other words, symbols and characters also available.

COLOR OF CHARACTERS AVAILABLE: White, Amber, Yellow, Red, Blue, Green. Special colors available on request.

CHARACTER SIZE: ⅝" high standard single numeral. Other sizes available from ⅛" to ⅝". Maximum size of letters, words, symbols should fit within a ¾" diameter maximum circumscribed circle.

VARIATIONS PERMIT IDENTICAL FRONT PANEL APPEARANCE: Switch and 12-message display, switch only, display only, switch-pilot light.

SWITCHES: 2 PDT mom. cont., 2 PDT alt. act.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.
5528 Vineland Avenue
North Hollywood, California
Phone: TR 7-1144

2

Automation

(Continued from page I-4)

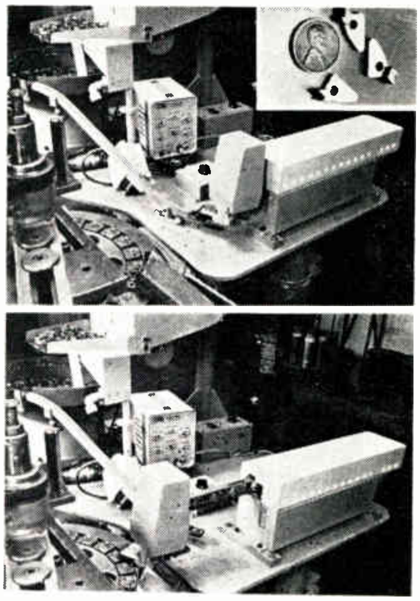
Naturally, his work is reviewed. When custom engineering is in agreement that this is the best solution, the time estimate is returned to marketing where it is converted into a dollar estimate. At USI, this is a fixed estimate, i.e., it is the complete price that the system, as specified, will be delivered and installed for, come what may. This quote then goes to the prospective customer through the field man.

If the customer decides upon automation and places the order, the job is assigned to the same project engineer that made the original estimate. If he is too heavily scheduled to handle the job, another engineer may be assigned. After an engineering briefing, the alternate engineer is usually in a position to carry through the original engineer's concept.

The project engineer is responsible for the job, or the equipment, until it is finally accepted by the customer.

To properly install, maintain, and advise on future modifications, a well-trained service force is also necessary. So that these service

Fig. 3: A set of fingers on the transfer machine picks up typewriter part (inset) from gravity feed chute, conveys it horizontally, and precisely places it into a close tolerance nest. Controller, segmented feeder bowl, and supply hopper are seen in the background. Note the level sensor.



personnel will be thoroughly oriented on the intricacies of any sophisticated systems which are being supplied, they are brought into the plant during manufacture of such systems. Members of this force have direct communication with the members of the customs engineering department.

Other Aspects

Now let's touch on a few of the other aspects in which a potential customer might be interested. Even with a relatively inexpensive "off the shelf" item, what about the obsolescence factor if the manufacturer should change the design of the item he wishes to handle. At USI, this is taken into consideration. In most simple automation jobs, only two pieces of equipment are involved: A segmented vibratory bowl feeder, Fig. 1, and a transfer machine called a TransfeRobot 200, Fig. 3.

The segmented bowl is probably the greatest contribution to freedom from obsolsecence. As seen in the illustration, a section of the outside rail of the bowl—about one third of the circumference, is detachable. It is this part *only*, in the feed system, that would have to be replaced if the handled item design was changed. Of course, there would probably have to be a change in the pick-up that handles the item being transferred—this is also only a minor change. A wide variety of mechanical, pneumatic, magnetic. and other accessory "fingers" are available.

These transfer machines can pick-up, turn over, insert, shuttle. or rotate with precision. They can also be used to combine, assemble, weld, stake, rivet, mark, oil, hold together, glue, and scores of other uses.

The above holds true for systems also—though other parameters may have to be considered and altered.

That's the automation story—sure it can mean considerable machinery; but, it can also mean inexpensive relief from monotony—usually doing a superior job.

The author wishes to express his thanks to H. E. Hayne and E. Miduch of U. S. Industries, Inc., Automation Div., for their assistance in preparing this article.

* * *

Tech Data

for Engineers

Card Reader

Tech data is available on the Speedreader 2000 a system using photosensing. It reads cards at speeds from 400 to 3000 cards/min. Speedreader 2000 reads any number of columns in cards of either the Remington Rand or IBM type. Hopper capacities are 4000 cards. Uptime Corp., 175 Commerce St., Broomfield, Colo.

Circle 557 on Inquiry Card

Delay Lines

Bel Fuse Inc., 198 Van Vorst St., Jersey City, N. J., has data available on Nanalines®, new nanosec. delay lines for use with high speed circuitry. Lines are available with time delays of 5 to 100 nsec; rise-time for a 100 nsec delay line is 9 nsec.

Circle 558 on Inquiry Card

Disc Files

A 12-page catalog titled, "Modular Mass Memory," covers the Bryant Series 400 disc files, with capacities from 30 million to 720 million bits. General information and specs. are provided on the files which are available with from 1 to 24 discs. Bryant Computer Products, div. Ex-Cell-O Corp., 852 Ladd Rd., Walled Lake, Mich.

Circle 559 on Inquiry Card

Computer Brochure

This 6-page 2-color brochure describes the Digital Data Processor (DDP-19), designed for real time applications, data acquisition and reduction, and scientific problem solving. DDP-19 has a 19-bit word, core memory with 5MC cycle and 3MC access times. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.

Circle 560 on Inquiry Card

Intercom

Fisher Berkley Corporation, 1475 Powell St., Emeryville 8, Calif., has available a 30 page manual on their Ektacom® and Bennett® intercom equipment. Complete specs. show how to obtain max. flexibility. Diagrams and schematics are included.

Circle 561 on Inquiry Card

Magnetic Tape Heads

Photographs, dimensional drawings and complete specs. cover 10 different types of Magnetic Heads and Drum Systems. Magne-Head Div., General Instrument Corp., 3216 West El Segundo Blvd., Hawthorne, Calif.

Circle 562 on Inquiry Card

Tape Adapter

Tech. data describing the EECO 754 Magnetic Tape Adapter which gives the IBM 1401 Computer the capability of reading and writing magnetic tape in GE/ERMA or GE 210 format, is available from the Electronic Engineering Co. of California, Box 58, Santa Ana, Calif.

Circle 563 on Inquiry Card

MAKE THIS DIRECTORY PART OF YOUR PERMANENT REFERENCE FILE . . .

HAVE YOU MOVED?

Don't forget to notify the ELECTRONIC INDUSTRIES Circulation Department, 56th and Chestnut Sts., Philadelphia 39, Pennsylvania. And, PLEASE TELL US THE COMPLETE FORMER ADDRESS.

If possible, please attach wrapper imprint to your change of address notice. For your new location give us complete details. Such as: Company name, your title, and primary product produced at new location.

Please cooperate. Failure to give us all information will only delay your address change.

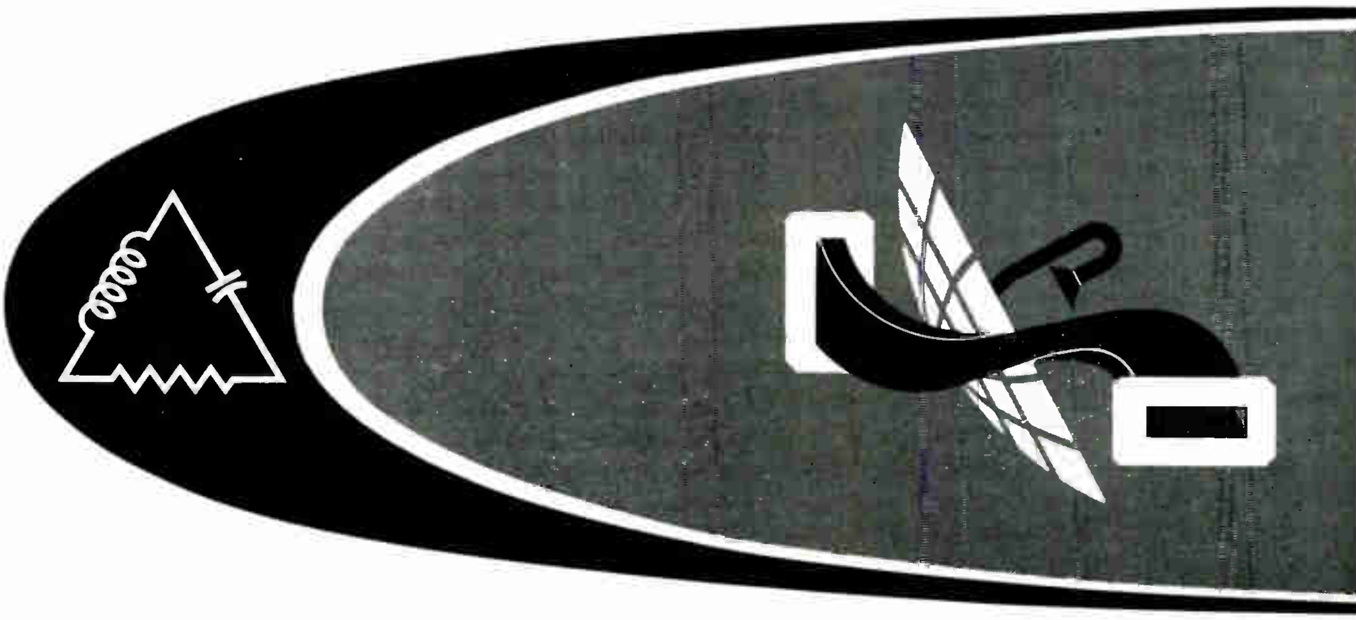
If possible, notify us at least four weeks in advance of any change.

ELECTRONIC INDUSTRIES

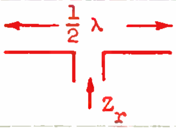
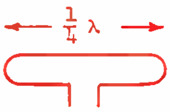
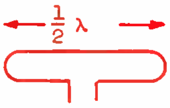
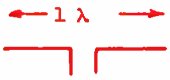
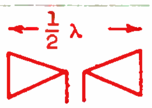
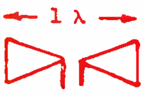
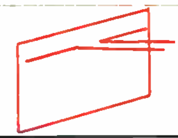
Circulation Department, 56th and Chestnut Sts., Philadelphia 39, Pa.

Section J

Microwave



Typical Antennas-Horizontal Polarization

Type	Configuration	Z_r ohms	ΔB %	Gain (db) above: Isotrope	Gain (db) above: Dipole
Small Dipole		—	—	1.74	−0.4
½ λ Dipole /Thick Tube L/D = 276		60	34	2.14	0 Reference Dipole
½ λ Dipole /Thick Tube L/D = 51	Similar to above	49	55	2.14	0
½ λ Dipole Cylinder L/D = 10	Similar to above	37	100	2.14	0
¼ λ Folded Dipole		6000 (resistive) 260 (av. surge Z)	5	1.64	−0.5
½ λ Folded Dipole		300	45	2.14	0
1 λ Dipole Cylinder		150	130	3.64	1.5
½ λ Biconical		72	100	2.14	0
1 λ Biconical		350	200	2.14	0
Crossed Dipoles or Turnstile/ (1 stack)		150	50	−0.86	−3
Turnstile 2 stack ½ λ / separation	Similar to above except stacked	—	—	2.14	0
Super Turnstile /or Batwing 1 Sections 3 Sections 6 Sections 12 Sections		— — — —	— — — —	2.14 7 10.14 13	0 4.8 8 10.9
4 Bay Helical		—	—	15.14	13
½ λ Dipole and Reflecting/ Sheet		150	20	7.14	5

Microwave Antennas

Antenna design is generally conceded to be for the specialists. However, equipment and system designers must have some knowledge of antennas. As an aid, we present some basic information about antennas in graphical form.

WHILE antenna design is generally left for the specialists, a knowledge of general types of antennas is necessary for any engineer concerned with electromagnetic radiations.

Here we present basic information about most of the more common antenna types in tabular form. The general classes of antennas listed in the tables are the dipole, array and aperture types.

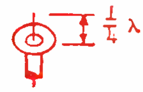
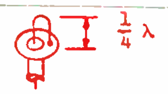
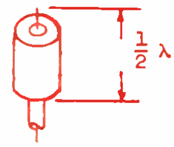
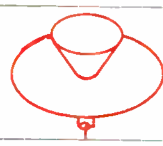
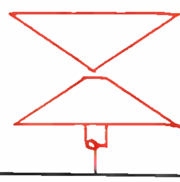
Antenna gain is usually expressed as x db's above an isotropic or dipole antenna. A half-wave dipole antenna is most commonly used as the standard to compare antenna gain. One reason is that such an antenna can be built and used as the standard while a true isotrope cannot. Also, an isotropic radiator of coherent waves does not exist[1] because it cannot satisfy Maxwell's equations. However, the properties of such an imaginary antenna are easily visualized, and the concept of an isotropic radiator is often found useful in the analysis of antenna systems. Hence, antenna gain is often listed in db's above an isotrope.

When selecting an antenna, five parameters must be considered: impedance (Z_r), bandwidth (ΔB), polarization, gain, and pattern. The equipment and its application will, to a great extent, determine or set the limits for these parameters.

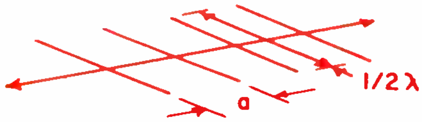
The chart material used here was supplied by O. M. Salati, Asst. Prof., Moore School of E. E., University of Pennsylvania and Mr. David F. Bowman, Manager Microwave Engineering, I-T-E Circuit Breaker Co.

1. Frederick E. Terman, "Electronic and Radio Engineering," 4th edition, *McGraw-Hill*, page 871.

Typical Antennas-Vertical Polarization

Type	Configuration	Z_r ohms	Δ B %	Gain (db) above Isotrope	Gain (db) above Dipole
¼ λ Dipole		28	40	2.14	0
Folded Unipole		150	45	2.14	0
½ λ Coaxial Dipole		50	16	2.14	0
Biconical Coaxial Dipole		72	200	2.14	0
Disk-cone		—	—	2.14	0
Biconical Horn		150	25	14.14	12

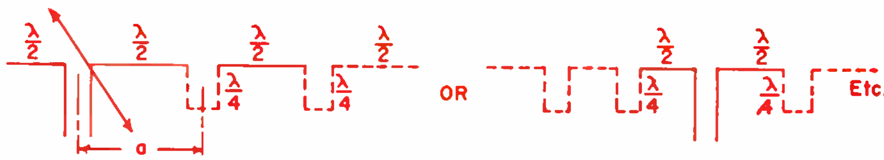
End Fire Array



Currents out of Phase

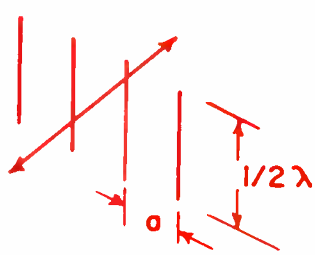
a	Gain, db above dipole
Theoretical Gain of Two End Fire ½ λ Elements for Various Spacings "a"	
⅝	1.7
½	2.2
⅜	3.0
¼	3.8
1/20	4.1
⅛	4.3

Collinear Array (Radiation-Bidirectional)



Spacing "a" between centers of adjacent ½ λ elements	Number of ½ λ elements in array versus gain in db above a reference Dipole: 2	3	4	5	6
a = ½ λ	1.8	3.3	4.5	5.3	6.2
a = ¾ λ	3.2	4.8	6.0	7.0	7.8

Broad Side Array



Currents in Phase

Theoretical Gain of Broadside ½ λ elements at different spacings "a".

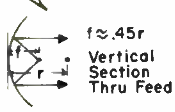
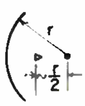
Spacing in wavelengths "a"	Gain, db above dipole
⅝	4.8
¾	4.6
½	4.0
⅜	2.4
¼	1.0
⅛	0.3

Theoretical Gain of Broadside ½ λ elements for different numbers of elements.

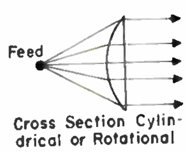
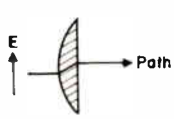
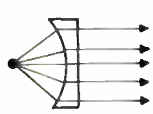
Number of elements	Gain, db above dipole
2	4.0
3	5.5
4	7.0
5	8.0
6	9.0

Microwave Antennas *(Concluded)*

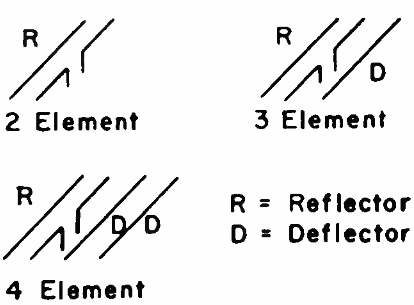
APERTURE TYPE ANTENNAS I

Reflector Focussing	Sketch	Primary Uses	Secondary Uses	Special Forms	Advantages	Disadvantages
Paraboloidal reflector and point source feed		Pencil beam 10 db or more gain	Fan beam	Offset reflector	Simplicity, low weight	Blockage unless offset. Dish reflection unless offset
Cylindrical parabolic reflector and line source feed		Fan beam	Pencil beam	1. Offset reflector 2. Parallel plates to form pillbox	Flexibility in controlling aspect ratio of fan-beam widths	Blockage unless offset. Dish reflection unless offset
Corner reflector and dipole feed		Pencil beam 10 to 14 db gain, half-wave dipole as feed	Element in multi-element array		Very high aperture efficiency in arrays	
Cassigrain and Schwarzschild systems		Monopulse and scanning pencil beams			Beam scan by feed movement	High sidelobe level occurs without extensive avoidance procedures
Toroidal reflector and scanning feed		Wide angle scanning in one plane	Multiple simultaneous beams by use of multiple feed elements		Beam scan by feed movement	Low efficiency of reflector area utilization
				Phase-corrected line source feed		Low efficiency of reflector area utilization
Spherical reflector and scanning feed		Wide angle scanning both planes				

APERTURE TYPE ANTENNAS II

Lens Focussing	Sketch	Possible Lens Media	Advantages	Disadvantages
Delay lens $n > 1$		Natural dielectrics: polystyrene polyethylene glass, ceramics fiber glass dielectric foams, etc.	No aperture blocking; any polarization possible; wide bandwidth; scanning of beam by feed movement; little reaction on feed	Weight
		Artificial dielectrics: metal discs, strips, spheres; dielectric spheres; dielectric plates with voids		
		Path-length medium: parallel conducting plates perpendicular to "E" field and corrugated or slanted for delay	No aperture blocking; wide bandwidth	Single polarization
Advance lens $n < 1$		Metal-plate waveguide Metal-rod medium		Single polarization narrow bandwidth (2 to 10%)
		Parallel conducting objects parallel to "E" field to increase phase velocity		

Parasitic Arrays



Number of Elements	Gain, db above dipole	Front to Back Ratio, db
2	4 to 5	10 to 15
3	6 to 7	15 to 25
4	7 to 9	20 to 30
5	9	—

Standard Waveguide Characteristics

STANDARD WAVEGUIDE CHARACTERISTICS

BAND	A-N TYPE	MATES WITH FLANGE Cover	MATES WITH FLANGE Choke	MATE-RIAL	INTERNAL DIMENSIONS	RECOMMENDED OPERATING RANGE TE_{10} MODE Frequency kmc/sec	Wavelength Air cm	Wavelength Guide cm	Wavelength Guide in	CUTOFF Freq. kmc	CUTOFF Wave-length cm	CALC ATTEN db/100 ft. Low Freq.	CALC ATTEN db/100 ft. High Freq.	CALC MAX cw Power Megawatts Low Freq.	CALC MAX cw Power Megawatts High Freq.
L	RG 69/U RG 103/U	UG-417A/U UG-417A/U	UG-417A/U UG-417A/U	Brass Alum.	6.500x3.250	1.12- 1.70	26.766-17.634	45.706-20.857	17.994-8.212	.908	33.020	.424 .269	.284 .178	11.9	17.2
	RG 104/U RG 105/U	UG-435A/U UG-437A/U	UG-435A/U UG-437A/U	Brass Alum.	4.300x2.150	1.70- 2.60	17.634-11.530	29.878-13.575	11.763-5.344	1.372	21.844	.788 .501	.516 .330	5.2	7.5
	RG 112/U RG 113/U	UG-553/U UG-554/U	UG-553/U UG-554/U	Brass Alum.	3.400x1.700	2.20- 3.30	13.626- 9.084	22.175-10.681	8.730-4.205	1.736	17.272	.877 .751	.572 .492	3.5	4.7
S	RG 48/U RG 75/U	UG-53/U UG-584/U	UG-54A/U UG-585/U	Brass Alum.	2.840x1.340	2.60- 3.95	11.530- 7.589	19.181- 8.924	7.552-3.513	2.078	14.427	1.48 .940	1.01 .641	2.2	3.2
C	RG 49/U RG 95/U	UG-149A/U UG-407/U	UG-148B/U UG-406A/U	Brass Alum.	1.872x0.872	3.95- 5.85	7.589- 5.124	12.594- 6.083	4.958-2.395	3.152	9.510	2.79 1.77	1.93 1.22	1.4	2.0
G	RG 50/U RG 106/U	UG-344/U UG-441/U	UG-343A/U UG-440A/U	Brass Alum.	1.372x0.622	5.85- 8.20	5.124- 3.656	7.560- 4.294	2.976-1.691	4.301	6.970	3.85 2.45	3.08 1.94	.56	.71
H	RG 51/U RG 68/U	UG-51/U UG-138/U	UG-52A/U UG-137A/U	Brass Alum.	1.122x0.497	7.05-10.00	4.252- 2.998	6.385- 3.525	2.514-1.388	5.259	5.700	5.51 3.50	4.31 2.74	.35	.46
X	RG 52/U RG 67/U	UG-39/U UG-135/U	UG-40A/U UG-136A/U	Brass Alum.	0.900x0.400	8.20-12.40	3.656- 2.418	6.088- 2.848	2.397-1.121	6.557	4.572	8.64 5.49	6.02 3.83	.20	.29
U	RG 91/U RG 107/U	UG-419/U UG-419/U	UG-541/U UG-541/U	Brass Silver	0.622x0.311	12.40-18.00	2.418- 1.665	3.754- 1.960	1.478- .772	9.487	3.160	12.8 6.14	11.2 5.36	.12	.16
K	RG 53/U RG 121/U RG 66/U	UG-595/U UG-597/U UG-595/U	UG-596/U UG-598/U UG-596/U	Brass Alum. Silver	0.420x0.170	18.00-26.50	1.665- 1.131	2.664- 1.334	1.049- .525	14.048	2.134	27.7 17.6 13.3	19.8 12.6 9.50	.043	.058
V	RG 96/U	UG-599/U	UG-600/U	Silver	0.280x0.140	26.50-40.00	1.131- .749	1.866- .882	.735- .347	21.075	1.422	21.9	15.0	.022	.031
	RG 97/U	UG-383/U	UG-383/U	Silver	0.224x0.112	33.00-50.00	.909- .600	1.508- .705	.549- .278	26.342	1.138	31.0	20.9	.014	.020
	RG 98/U	UG-385/U	UG-385/U	Silver	0.148x0.074	50.00-75.00	.600- .400	.994- .472	.391- .186	39.864	.752	52.9	39.1	.0063	.0090
	RG 99/U	UG-387/U	UG-387/U	Silver	0.122x0.061	60.00-90.00	.500- .333	.844- .395	.332- .156	48.351	.620	93.3	52.2	.0042	.0063

Courtesy of Sperry Microwave Electronics Co., Div. of Sperry Rand Corp.

The Hall effect is not new—it has been around for many years. However, it now has some interesting applications in the microwave field. Here is how the Hall effect theory was applied to the design of a microwave power meter.

By ANTHONY D. RUGARI
Rome Air Development Center
Air Force Systems Command
USAF, Griffiss A.F.B., N.Y.

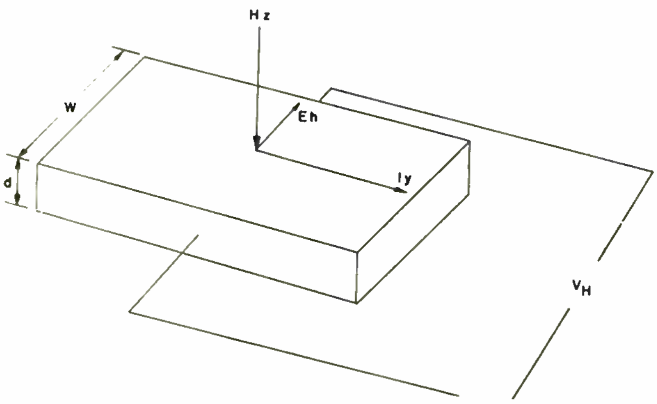
For Microwaves . . .

A Hall Effect Power Meter

IT is a well-known fact that the Hall effect phenomenon is suitable for the measurement of microwave power. Professor Barlow and co-workers, University College, London, have published numerous papers describing the application of the Hall effect in germanium to microwave power measurement. The dc voltages which resulted were relatively small in magnitude. The results obtained here, with the intermetallic compounds, are approximately two orders of magnitude better. This, therefore, enhances the realizability of a microwave power meter using the Hall effect phenomenon.

A model of a waveguide containing a Hall crystal is examined to determine the extraneous effects which exist along with the Hall effect phenomenon and the influence which these effects have on the magnitude of the dc Hall voltage.

Fig. 1: Hall crystal representation is shown by sketch.



As a result, the design of a Hall effect power meter capable of accurately measuring from 1 to 250 watts of CW power at S-band frequencies is described.

Hall Effect Theory

An expression for the Hall voltage, resulting when a magnetic field is applied perpendicular to the direction of current flow in a current-carrying conductor, can be derived using basic electromagnetic theory. Consider the vector quantities shown in the Hall crystal representation of Fig. 1. A Lorentzian Force, F, is exerted on the current carriers by the magnetic field, Hz,

$$\vec{F} = e\,\vec{v} \times \vec{B} \tag{1}$$

where

v is the velocity of the current carriers

B is the magnetic induction, and

e is the electronic charge.

Since $\vec{v}$ and $\vec{B}$ are mutually perpendicular,

$$F = \bar{n}\, e\, v_y\, Bz, \tag{2}$$

where

$\bar{n}$ defines the direction perpendicular to the $y\,z$ plane. An alternate expression for the force F can be written as

$$\vec{F} = e\,\vec{E}_H, \tag{3}$$

where

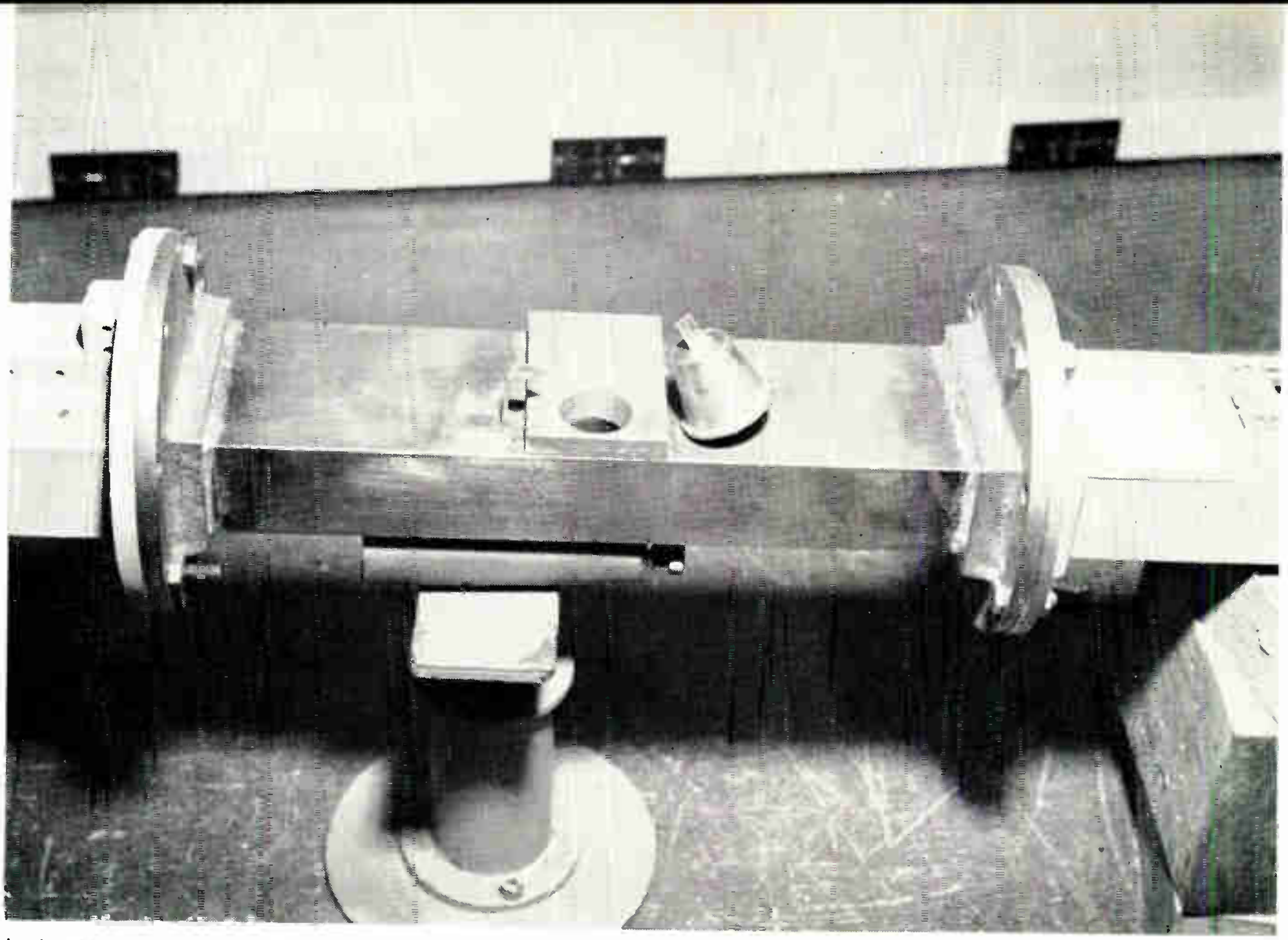
E_H is the Hall electric field, $E_H = v_y\, Bz$. (4)

The current density, Jy, is given by the following expressions:

$$Jy = e\, v_y\, n. \tag{5}$$

where

$$n \text{ is the number of } \frac{\text{carriers}}{\text{cm}^3},\ Jy = \frac{Iy}{wd} \tag{6}$$



A microwave power meter designed for S-band frequencies uses an indium arsenide phosphide Hall crystal.

and

Iy is the current flow in the y direction.

$$\frac{Iy}{wd} = e\, v_y\, n. \qquad (7)$$

Substituting for v_y in Eq. 4,

$$E_H = \frac{Iy}{wd}\,\frac{1}{en}\,Bz. \qquad (8)$$

By definition, the Hall constant, R_H is

$$R_H \cong \frac{\mu}{\sigma} \qquad (9)$$

where

μ is the carrier mobility or $\dfrac{\text{drift velocity}}{\text{electric field}}\ \dfrac{\text{cm}^2}{\text{v-sec}}$,

σ is the conductivity of the conductor, and $\sigma = n\, e\, \mu$. (10)

Therefore,

$$R_H = \frac{1}{en} \qquad (11)$$

and

$$E_H = R_H\,\frac{Iy}{wd}\,Bz. \qquad (12)$$

Since

$$E_H = \frac{V_H}{w}, \qquad (13)$$

then

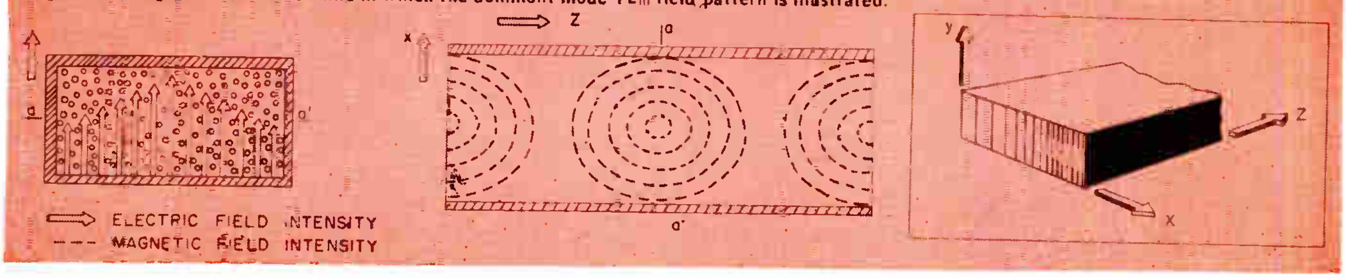
$$V_H = \frac{R_H}{d}\,Iy\,Bz. \qquad (14)$$

A review of the preceding equations indicates that the Hall voltage is optimized when:

the conductor has a low carrier concentration, hence, a semiconductor; the conductor has high carrier mobility; and the conductor is very thin, that is, d is made small.

The direction of E_H, and, therefore, the polarity of V_H, is dependent upon the direction of the current and magnetic field vectors. A reversal or a 180° change in either Iy or Bz, but not both, will cause a 180°

Fig. 2: A waveguide transmission line in which the dominant mode TE_{10} field pattern is illustrated.



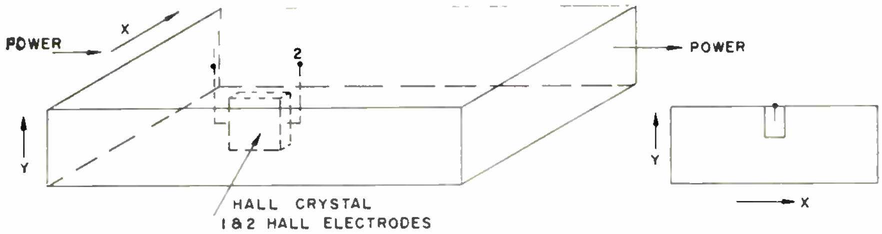


Fig. 4: A waveguide transmission line with a Hall crystal positioned inside of it.

change in the direction of E_H and thus a reversal in the polarity of V_H.

Researchers have shown that the dc properties of mobility are not appreciably changed at frequencies exceeding those of the microwave band. Therefore, Eq. 14 may be written in terms of a sinusoidal varying $\bar{E}$ and $\bar{H}$ field where the current flow in the conductor is proportional to $\bar{E}$ and the magnetic induction is proportional to $\bar{H}$.

$$V_H = \frac{K\,Ey\,Hz}{2}\left[\cos\Delta\phi - \cos\left(2\,\omega t + \phi_1\right)\right] \qquad (15)$$

where

K is a constant determined by the Hall crystal properties and also the propagation medium parameters,

$\Delta\phi$ is the phase difference between Ey and Hz, and

ϕ_1 is the phase angle of the resulting ac term.

It is seen that a dc component and an ac component result. The magnitude of the dc component is dependent upon the phase difference between Ey and Hz, and is a maximum when the two quantities are in electrical phase. This dc term was measured and is discussed here.

Waveguide Field Configuration

In considering a waveguide transmission line in which the dominant mode, TE_{10}, is prevalent, the field pattern is as shown in Fig. 2. The electric and magnetic fields are mutually perpendicular. The electric field has a y component only, which is an electrical phase with the x component of the magnetic field. The magnetic field has a z component also which is 90° out of electrical phase with the electric field. Since Eq. 15 indicates a dependency of the Hall voltage on the electrical phase difference between E and H, it is evident that the positioning of the crystal in the waveguide is of extreme importance.

Figure 3

Semiconductor Properties

	Energy Gap ev	(μ) Mobility (300° K) CM²/V — Sec Electron	Hole	Hall Constant (R_H)
Si	1.1	1200	500	$\sim 10^3$
Ge	0.68	3800	1900	$\sim 10^3$
In As	0.35	23,000	200	120
In As P	—	35,000	—	200
In Sb	0.18	60,000	1200	200

$$V_H \simeq \frac{\mu}{\sigma}\,\frac{IB}{d} \qquad R \simeq \frac{\mu}{\sigma}$$

Semiconductor Material Properties

It was pointed out in a preceding review[8] of the Hall effect equations that the Hall voltage is directly proportional to mobility. Observation indicates the Hall constant rather than mobility is the more important parameter. This would be true only if there were a constant current source supplying the current bias to the conductor and an unlimited power dissipation capability of the conductor. Since this is obviously not true, it can be easily shown that the resistivity term in the Hall voltage equation cancels out and, therefore, mobility is of primary importance.

$$V_H \simeq \frac{\mu}{\sigma}\,\frac{IB}{d} \simeq \mu\,p\,\frac{IB}{d} \qquad (16)$$

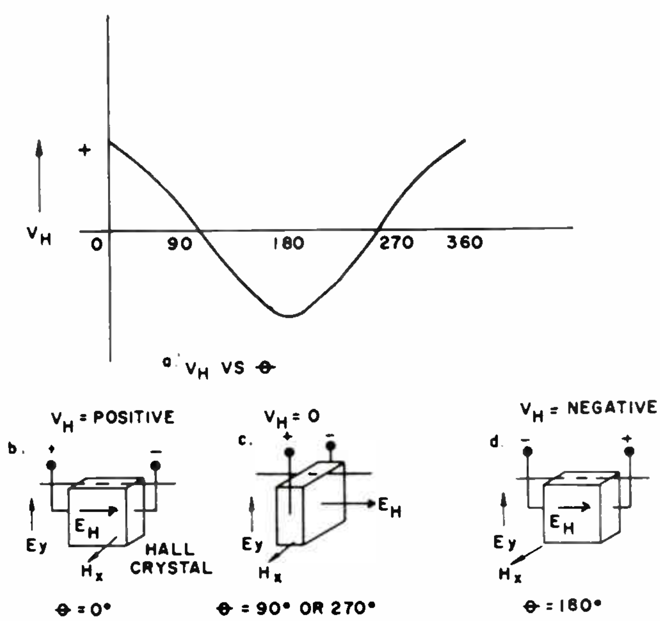
$$V_H \simeq \mu\,\frac{EB}{d}\,. \qquad (17)$$

The properties of Si and Ge are compared with those of several of the intermetallic compounds in Fig. 3. It is seen that indium antimonide, In Sb, has the largest majority carrier mobility with In As P, In As, Ge and Si following in descending order. The electron mobility of the intermetallics is approximately one to two orders of magnitude larger than that of Ge. Indium antimonide has a poor temperature coefficient and, therefore, was not used in our experiments.

DC Effects in a Waveguide

A waveguide transmission line in which a Hall crystal has been positioned, Fig. 4, is now examined. The

Fig. 5: Pictorial and graphical representation of Hall voltage.



dc output voltage present at the Hall electrodes may consist of the following components.

$$V_O = V_H + V_E + V_R + V_{TH} \quad (18)$$

where

V_O is the dc output voltage,
V_H is the dc Hall voltage,
V_E is the dc voltage due to the Ettingshausen effect,
V_R is the rectification voltage, and
V_{TH} is the thermal component.

Since we are interested only in the Hall voltage component, let us examine each of the above components as the crystal is rotated 360° about a symmetrical axis in the xz plane. The 0° reference is chosen for the crystal position as shown in Fig. 4. The direction of rotation is counterclockwise.

The conditions which define the presence of a Hall voltage are that the direction of the current bias in the crystal, the direction of the magnetic flux density and the direction of the Hall electric field are all mutually perpendicular. The direction of the Hall electric field, in our model, is defined by the position of the Hall electrodes. It is possible that a Hall electric field exists and also that $V_H = 0$. if the Hall electrodes are placed such that relative to the Hall electric field, they lie in an equipotential line. This condition is present in our model when $\theta = 90°$ and 270°. At $\theta = 0°$, the Hall voltage is a maximum. At $\theta = 180°$. the Hall voltage is again maximum; however, its polarity is opposite to the polarity at V_H at $\theta = 0°$. A pictorial and graphical representation of V_H vs. θ is shown in Fig. 5.

The Ettingshausen effect describes the appearance of a thermal gradient mutually perpendicular to the direction of a longitudinal electric current and a transverse magnetic field

$$\frac{dT}{dy} = -A_E B_z J_y. \quad (19)$$

The Ettingshausen coefficient has been measured for indium arsenide and found to be small in comparison with the Hall coefficient. A rough approximation indicated that the dc component contributed by this effect was many orders of magnitude smaller than the expected dc Hall voltage. Therefore, this effect is neglected and further discussion omitted.

The presence of a dc rectification voltage is due to the non-ohmic properties of the Hall electrodes and the non-symmetrical placement of the Hall contacts. The magnitude of this component is directly proportional to the residual output of the crystal and thus to the current bias. A graphical representation of Vr vs. θ is shown in Fig. 6.

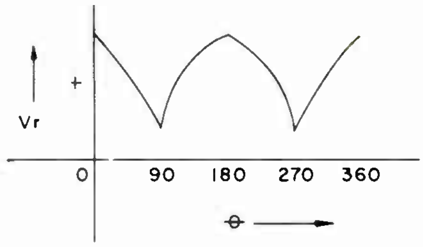


Fig. 6: A graphical representation of V_r vs. θ (rectification voltage).

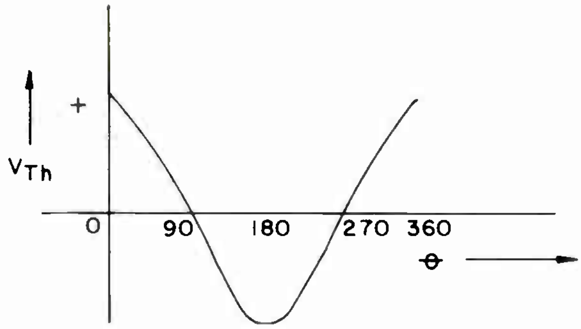


Fig. 7: V_{TH} versus θ (thermal voltage) is shown graphically.

There are 3 significant conditions which will cause a thermal gradient in the Hall crystal, in the direction of E_H, and result in a dc voltage as defined by one of the thermoelectric effects. These are as follows: Excessive current bias; Uneven heating of the Hall crystal due to disturbances in the transmission line caused by the *transmission line components;* Uneven heating of the Hall crystal due to disturbances in the transmission line caused by the *Hall crystal itself.*

The thermal gradient due to excessive current bias was experimentally determined to be negligible for excessively large currents approaching crystal burnout. For the purpose of this analysis the thermal gradients due to disturbances caused by the transmission line components and the crystal itself may be treated simultaneously. The assumption is made that the thermal voltage has the same polarity as the Hall voltage at $\theta = 0°$. Then at $\theta = 90°$ and $\theta = 270°$. this component should be at a minimum and approaching zero. At $\theta = 180°$, the direction of the thermal gradient has been reversed and, therefore. the thermal voltage has a polarity opposite to its polarity at $\theta = 0°$ (see Fig. 7).

Since the rectification voltage is always of one polarity, it can easily be isolated from the sum of the Hall voltage and thermal voltage. This is accomplished by comparing the positive maximum dc output voltage with the negative maximum dc output voltage, which are 180° apart as shown in Eq. 20.

$$V_H + V_{th} = + \frac{V_O - (-V_O)}{2}. \quad (20)$$

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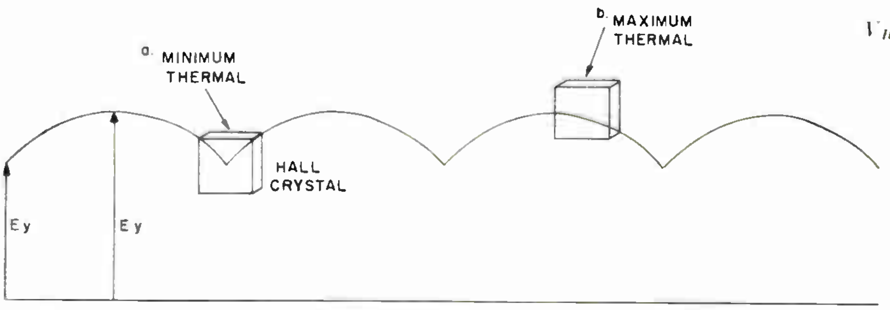

Fig. 8: Hall crystal positioning in a waveguide's standing wave field.

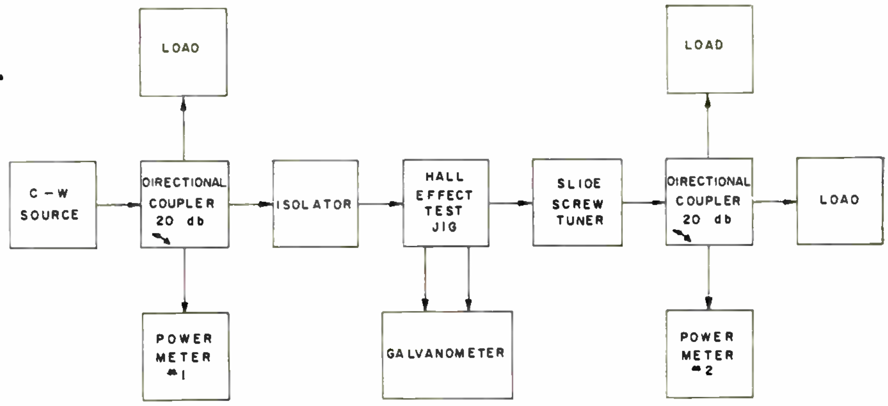

Fig. 9: The test setup shown was used for measuring the thermal emf of crystal.

If the rectification voltage is large compared to $V_H + V_{TH}$, it will shift the negative maximum $(-Vo)$ such that it will appear as a positive voltage.

The remaining problem is to isolate the Hall voltage from the thermal voltage. An examination of the properties of the two quantities indicates that there are 3 parameters which are sufficiently different and may allow isolation of either component:

Rise time: A true Hall voltage should have a very fast rise and decay time when the power is pulsed on and off at a fast rate. The rise and decay time of any thermal component will be slow.

Phase dependency: The magnitude of the Hall voltage is dependent upon the phase difference between the current flow in the Hall crystal and the incident magnetic flux. The thermal voltage has no phase dependency.

Thermal voltage: The thermal voltage is derived from a thermal gradient due primarily to the electric field in the transmission line. It is independent of the magnetic flux. The Hall voltage depends upon the cross product of E and H.

Knowing that the thermal voltage is primarily caused by the E field, it is possible to negate the effects of disturbances in the transmission line due to transmission line components by proper placement of the Hall crystal (Fig. 8). In position 8a, the thermal voltage should be essentially zero and in the 8b position, the thermal voltage should be a maximum. It is much more complicated to isolate the complex disturbances caused by the crystal. One possible means of accomplishing this is to plate the ends of the crystal with a material having a conductivity much higher than the conductivity of the crystal. The disturbances will still be present; however, they will have no effect on the crystal which will not see the disturbances. The crystal should be positioned to minimize transmission line disturbances to insure maximum power transfer to the load. The following experiment was performed to determine the relative magnitudes of the Hall and thermal voltages in a transmission line as a function of VSWR and Power.

Analysis of Thermal vs. Hall Voltage

An experimental analysis of the thermal component using the rise time method was not feasible because of the small magnitudes of dc output voltages which are obtainable from the Hall crystal in this applica-

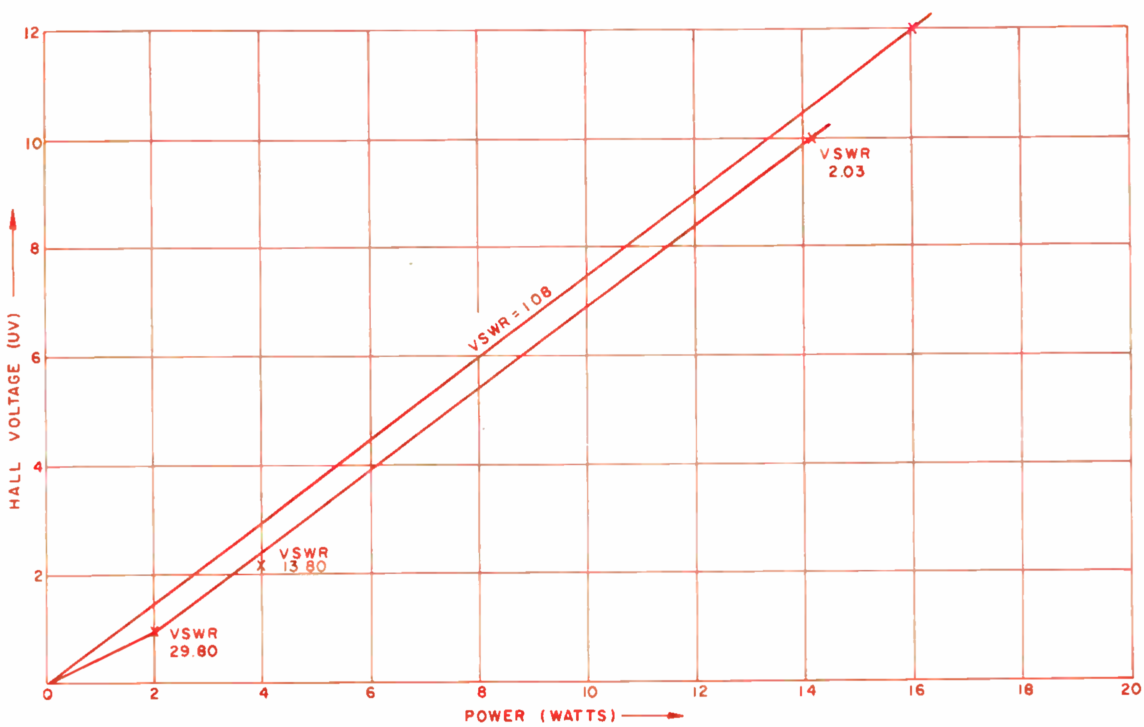

Fig. 10: Shown is a graph of power vs. Hall voltage. Note that readings are proportional to power and not to VSWR.

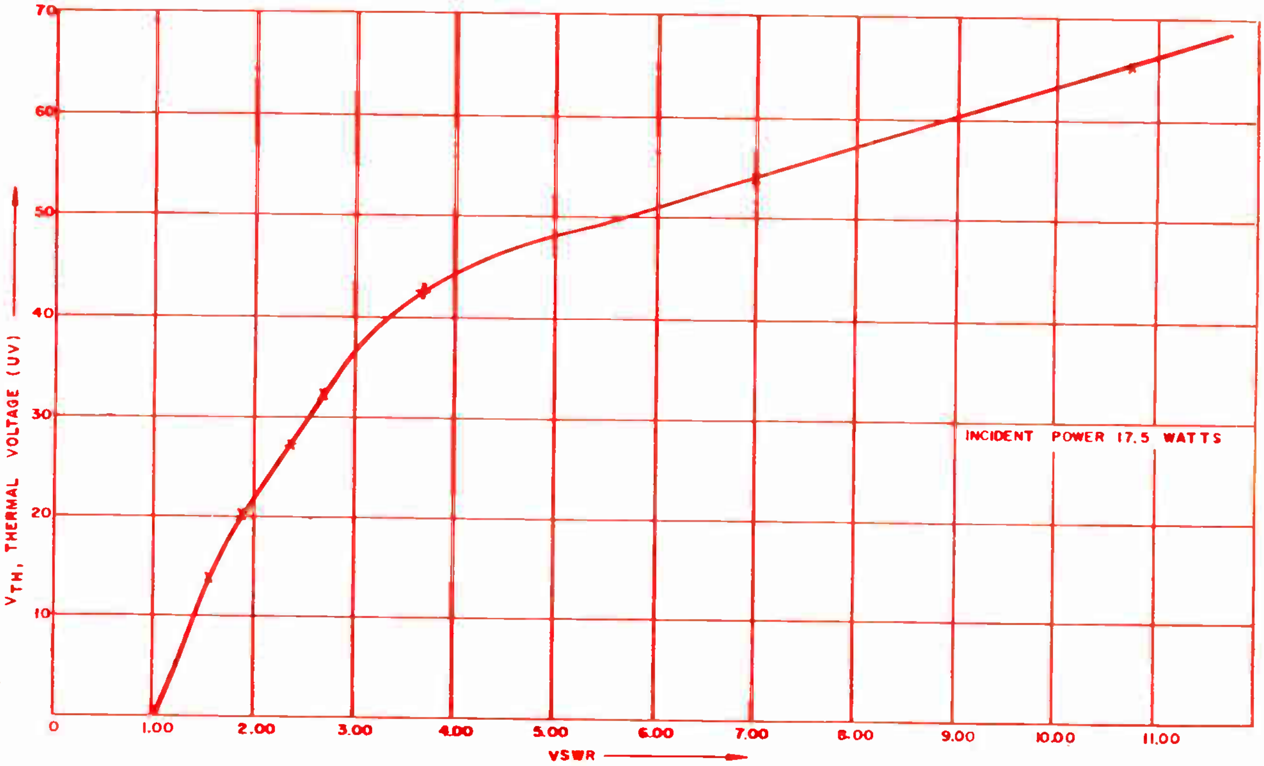

Fig. 11: Graph of VSWR versus thermal voltage. The thermal component is about 2 μv for a VSWR of 1.08.

tion. A phase shifter was built which would allow a change in the phase of the current bias in the crystal with respect to the incident magnetic flux. The results reported in RADC-TN-60-164, may be construed to be somewhat ambiguous and, therefore, a third method was used to isolate V_H from V_{TH}.

This method required the insertion of known standing waves in the transmission line. The Hall crystal was positioned for maximum and then for minimum thermal effects. Another requirement was that the mismatch caused by the crystal was small compared to other mismatches. Some interesting conclusions resulted from observing the dc output voltage, *Vo*, for a series of known standing waves.

The test setup of Fig. 9 was used to perform this experiment. The standing wave was introduced in the transmission line by insertion of the probe associated with the slide screw tuner. Also, the tuner allowed the positioning of the standing wave for maximum and minimum heating of the crystal. After the standing wave was so positioned, the incident and reflected power was calculated from the readings of the two power meters. The VSWR was then calculated.

The assumption was made that the thermal voltage would be caused solely by mismatches in the transmission line and, therefore, for an ideal transmission line, VSWR = 1.00, the thermal voltage is equal to zero.

The crystal was placed in the transmission line such that theoretically a dc Hall voltage should be observed and also such that it caused minimum disturbance in the transmission line. The following initial measurements were then performed.

a. VSWR of the transmission line *minus* the crystal is equal to 1.06.

b. VSWR of the transmission line *plus* the crystal is equal to 1.08.

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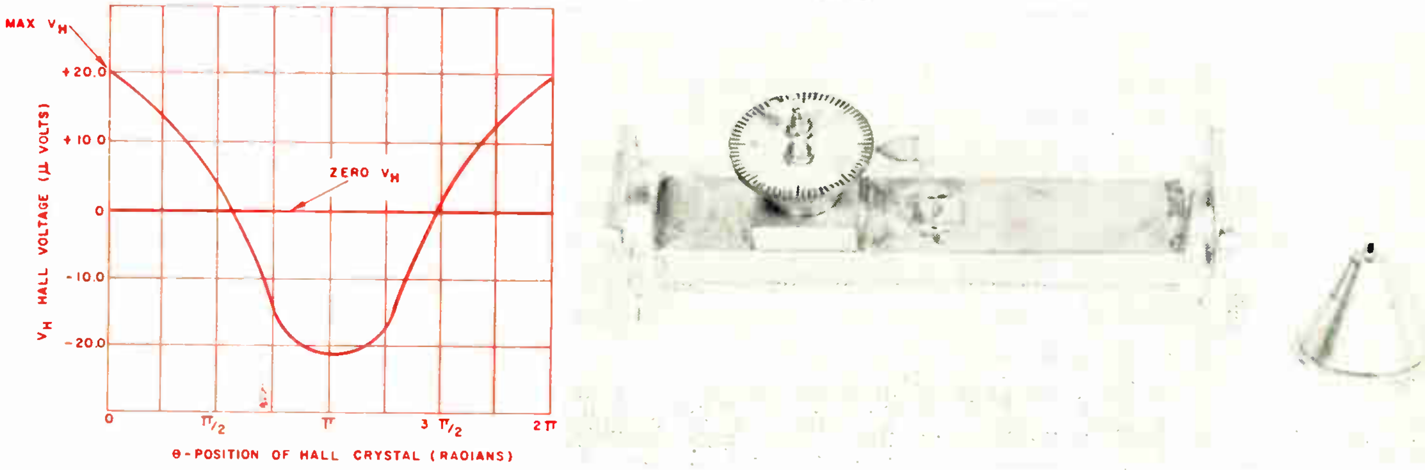
Fig. 12: An indium arsenide crystal was placed in the waveguide shown. A plot of v_H vs. the angle of rotation, θ was made.



The dc output voltage was then observed for several standing waves when the crystal was positioned for minimum thermal effects. This allowed isolation of the disturbance caused by the transmission line components but not by the crystal. The readings are plotted in Fig. 10. It would be expected that if these voltages were due to a thermal effect, they would increase proportionally with increasing VSWR. It is seen that they do not increase proportional to increasing VSWR but are proportional to power. The readings were then compared to the readings of dc voltage vs. power for a transmission line having a VSWR of 1.08.

It is concluded that the dc voltage readings recorded when the crystal is positioned for minimum thermal effect are Hall voltage readings, the error caused by the Hall crystal disturbance is included. Also, the readings recorded for a fixed VSWR of 1.08 are primarily Hall voltage readings with a somewhat larger error caused by a disturbance or VSWR of 1.08.

The next problem was to determine the effect of large disturbances on the dc output voltage reading. The Hall crystal was positioned for maximum heating effects. The dc output voltage was recorded for several known standing waves. The readings thus recorded contained both thermal and Hall voltage components. They were corrected in accordance with the previous discussion and recorded. A graph of V_{TH} vs. VSWR is shown in Fig. 11. It is seen that the thermal component is approximately 2 μv. for a VSWR of 1.08 and an incident power of 17.5 watts.

The thermal component is approximately an order of magnitude less than the Hall component for small VSWR of 1.10 or less. The error increases proportionally for larger mismatches. However, if the mismatch is known and is truly a standing wave, then the Hall crystal can be positioned such that the disturbance will not affect the Hall voltage reading and the forward power can be accurately measured. If the disturbance is caused by the crystal, other means must be taken to minimize the thermal voltage.

X-Band Hall Voltage Measurements

An indium arsenide, In As, crystal was placed in a waveguide transmission line as shown in Fig. 12. The crystal was mounted on a conical-shaped base to allow 360° rotation of the crystal in the waveguide. The insertion depth of the crystal was kept at a minimum in order to keep the disturbances, caused by the crystal, down to a minimum. The size of the active crystal was small in comparison to the waveguide cross section. A plot of the dc Hall voltage, v_H vs. the angle of rotation, θ, was made when the transmission line was propagating 50 mw average of pulsed power at a frequency of 9050 MC. A maximum of +20 microvolts was measured at $\theta = 0°$, and at $\theta = 180°$ (effective power reversal) the dc Hall voltage changed polarity and was −20 μv. At $\theta = 90°$ and 270°, the Hall voltage was 0, as predicted. Thus for this particular sample and insertion depth, a sensitivity of 0.40 μv./mw. of power was obtained.

Microwave Power Meter

The parameters which must be considered in the design of a Hall effect power meter may be categorized as follows:

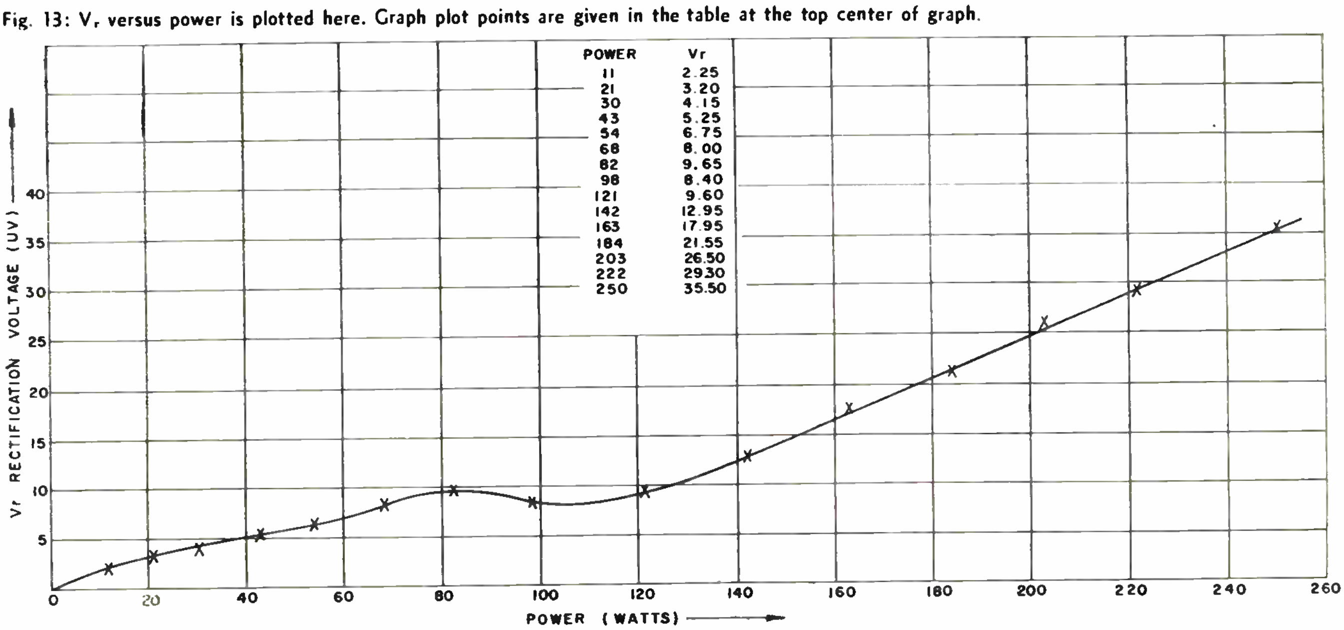
a. Electric and magnetic field configuration in the transmission line.
b. Semiconductor material properties.
c. Hall crystal position in the transmission line.
d. Disturbances caused by the transmission line components.

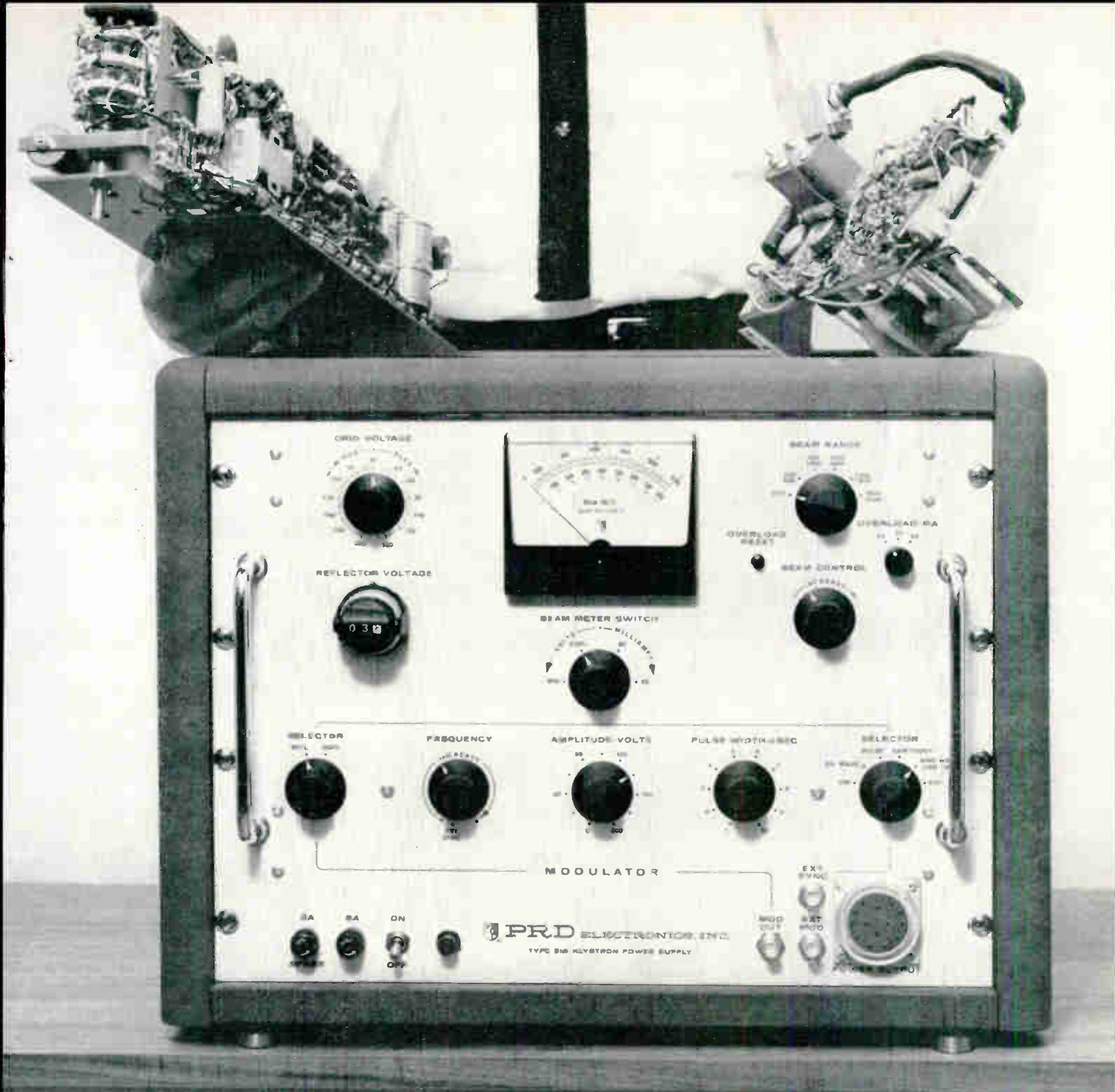
These parameters have all been discussed in this report.

A microwave power meter was designed at S-band frequencies using an indium arsenide phosphide Hall crystal. The crystal was placed in the waveguide section at a position close to the side walls of the waveguide. The VSWR of the transmission line, minus the

(*Continued on page* J-16)

Fig. 13: V_r versus power is plotted here. Graph plot points are given in the table at the top center of graph.





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NEW 200 TO 2200 VOLT PRD KLYSTRON POWER SUPPLY FEATURES RUGGED MODULAR CONSTRUCTION

The versatile new PRD 815 Klystron Power Supply has four separate supplies for beam, reflector, grid, and heater. Further, it features unusually rugged construction, in which each supply is a separate plug-in module, easily accessible. A floating modulator system allows switching from CW to square wave or pulse without altering the output frequency. Beam supply ranges from 200 to 2200 volts, reflector (with digital readout) from 0 to 1000 volts, thus a wide range of tubes (including TWT's) can be accepted. Sawtooth, sine, square wave and pulse, plus external modulation, are built in. 19″ width fits standard rack. Price $1195. Send for data!

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Power Meter *(Concluded)*

crystal, was measured as 1.06. The additional disturbance of the Hall crystal increased the VSWR to 1.08. The crystal was also positioned for minimum thermal effects due to the transmission line VSWR of 1.06. The ends of the crystal were lined with tinfoil to minimize the thermal effects due to the crystal disturbance.

The maximum negative and positive Hall voltages were found to occur at $\theta = 75°$ and $255°$, respectively. A definite rectification component was noticed due to the non-ohmic properties of the Hall electrodes. A plot of Vr vs. power is shown in Fig. 13 and a plot of the Hall voltage vs. power is shown in Fig. 14. The power readings were measured with a Hewlett-Packard Calorimeter Power Meter, having an accuracy of $\pm 5\%$.

It is seen that a dc Hall voltage of 0.733 microvolts corresponds to 1 watt of power. The stability of the power meter was checked over a period of 8 hours and no noticeable drift was detected.

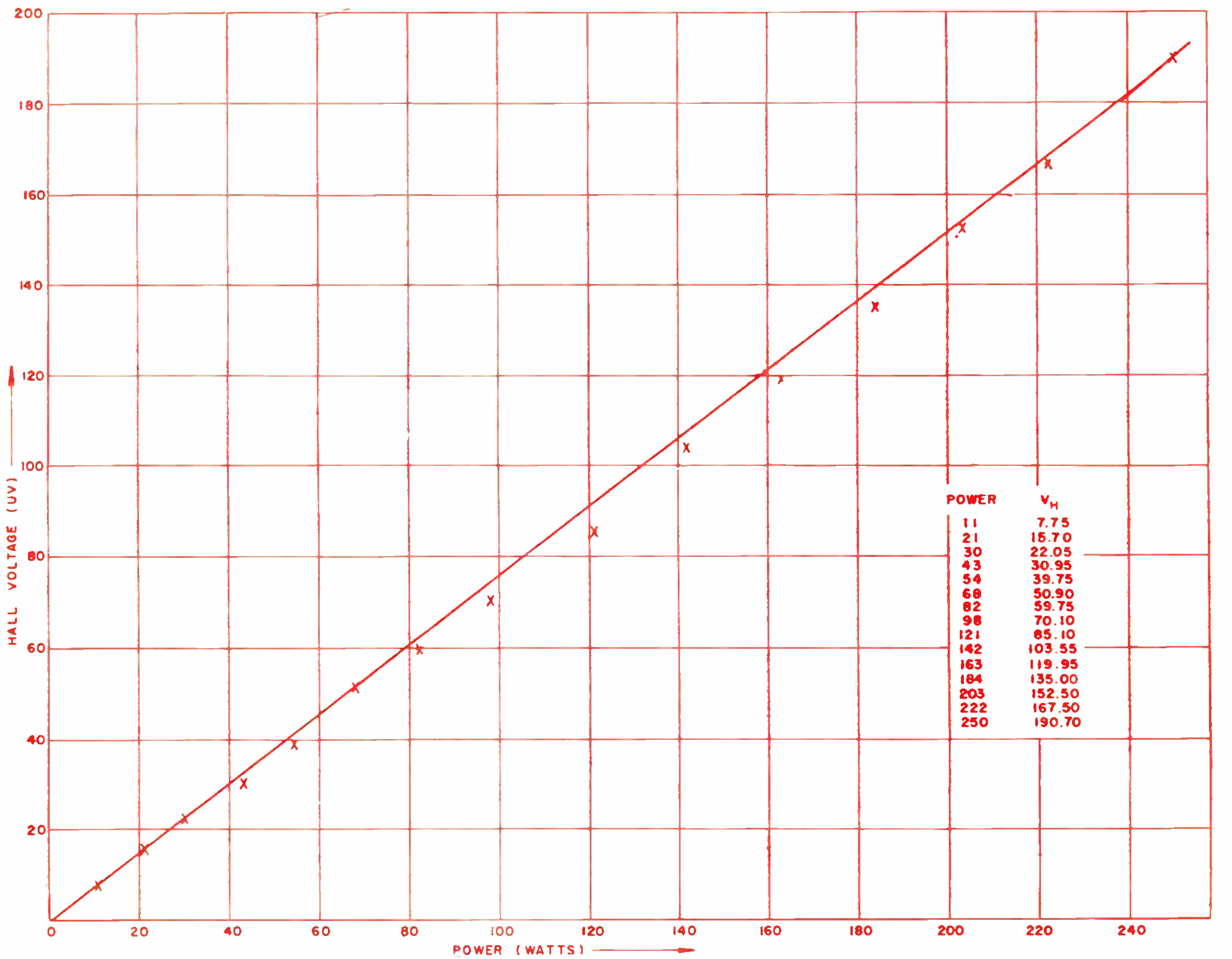
Conclusions

Microwave power measurement techniques are constantly being investigated. An explanation for this arises from the fact that existing microwave power measurement techniques consider only one parameter of power, that is, they consider only the electric field intensity. This may readily result in measurement errors and limitations, for example, when the VSWR is reasonably high, measurement errors result and special precautions are required. The Hall effect allows a true power measurement in that both the electric field and the magnetic field must be present before a dc Hall voltage is obtained, therefore, the results of this study are believed to be of extreme significance to microwave power measuring instrumentation.

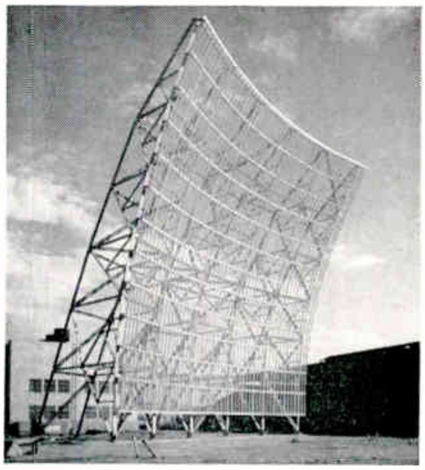
References

1. Barlow, H. M., and Kotoka, S., *The Hall Effect and Its Application to Power Measurements at 10 G c/s*, Proc. IRE B105, 55 (1958).
2. Barlow, H. M., and Stephenson, C. N., *Power Measurement at 4 G c/s by the Application of the Hall Effect in a Semiconductor*. Proc. IRE B106, 27 (1959).
3. Barlow, H. M., *Hall Effect and its Application to Microwave Power Measurement*, Proc. IRE 46-1411 (1958).
4. Hambleton, S. E., and Gartner, W. W., *Microwave Hall Effect in Germanium and Silicon at 70 KMC*, USASRDL, Fort Monmouth, N. J.
5. Dekker, *Solid State Physics*, page 360, Prentice-Hall, Inc.
6. *Reference Data for Radio Engineers*, Fourth Edition, Federal Telephone & Telegraph Co.
7. Schelkunoff, *Electromagnetic Waves*, D. Van Nostrand Company, Inc.
8. Rugari, A. A., *Measurement of Hall Voltages at Microwave Frequencies*, RADC TN-60-164, Sept. 1960.

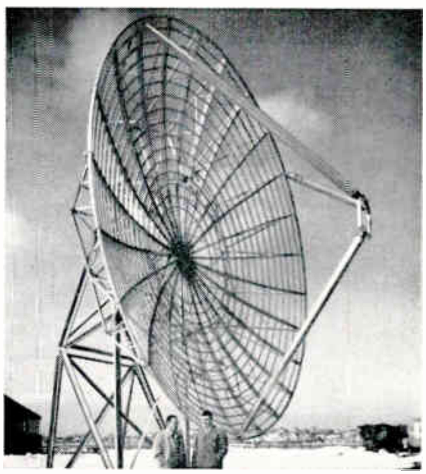
Fig. 14: Hall voltage versus power is plotted. The power levels used are the same ones used in the graph of Fig. 13.



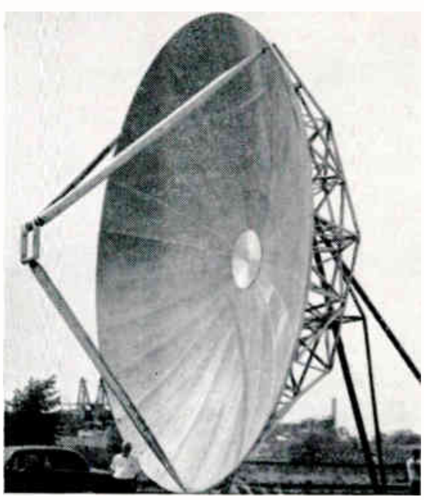
A complete line of antennas and antenna components



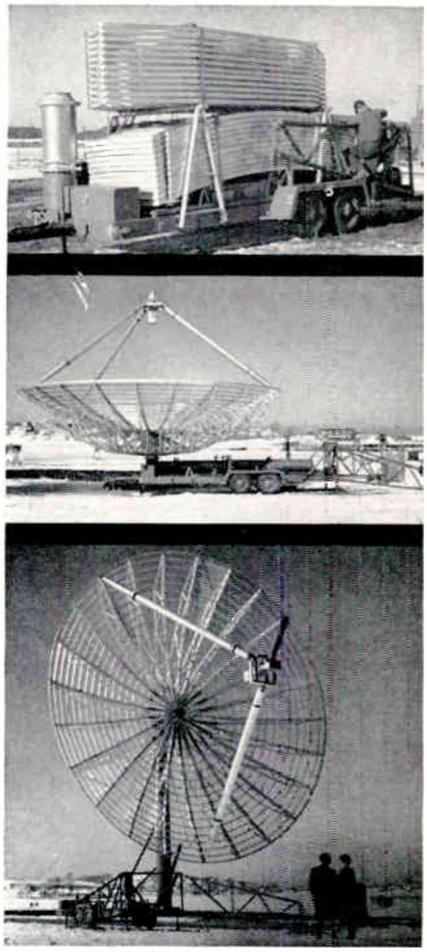
60-foot ground mounted tropospheric antenna. It's an offset paraboloid design, is fabricated of galvanized steel, and features maximum interchangeability and standardization of the various members.



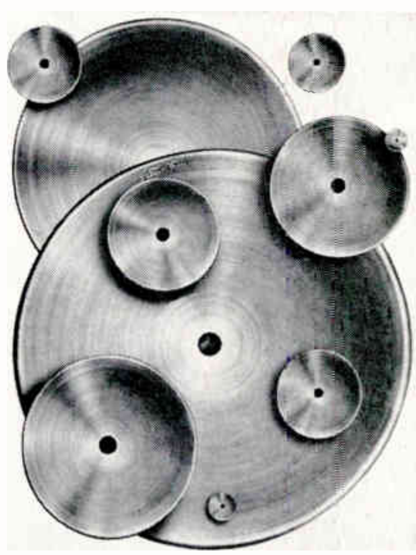
This is a 30-foot, mesh surface paraboloid (Model 101) which was designed for wide use in the fields of radio astronomy, tropospheric scatter propagation, tracking, and experimental test installations. The mount was also designed by ASI, and features azimuth and elevation adjustments at the foot plates where they can be easily reached.



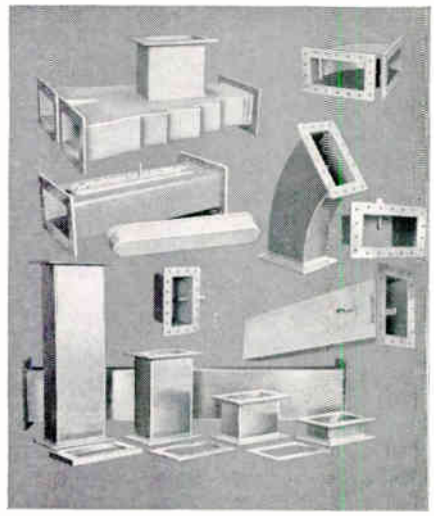
This is the most accurate production antenna of comparable size ever built. It's a 30-foot, solid surface dish (Model 103) and boasts a static surface tolerance of ± 0.045 center 15′ diameter, and ± 0.080 outside 15′ diameter. It can be used at frequencies above 10,000 mc, and is rugged enough to withstand 150 mph wind with 4″ of ice. Special models are available with a surface tolerance of ± 0.020 RMS.



This 30-foot mobile scatter antenna (Model 111) is a completely self contained unit mounted on a steel flat bed trailer. It is easy to assemble, and can be erected by a winch or a hydraulic lifting device. When in transit, all surface panels, hardware, feed supports, guys, etc. nest compactly on the top of the trailer and can be tightly secured in order to withstand transport over rough terrain. The pictures show (1) the antenna completely packed and ready for transit, (2) assembled but not erected, (3) completely erected.



ASI has available as part of their complete antenna service, a wide range of spun parabolic reflectors. This method of metal forming eliminates the use of expensive tools thereby reducing costs and manufacturing time.



ASI's complete line of RF components for many different bands includes straight sections, bends, hybrids, slide screw tuners, dummy loads, transitions, stub tuners, diplexers and feed horns. They are all designed to handle high power with low VSWR, and all flange surfaces are machined after welding to assure excellent electrical contact.

ASI has a complete catalog available that contains specifications on their antennas and antenna components. Also available are a facilities booklet that gives background information about the people and capabilities, and a 20-page booklet of wavelength tables from WR 430 through WR 2300.

For the answers to problems in the design, fabrication, and installation of antennas, antenna components, or complete antenna systems in the fields of scatter communications, missile tracking, space tracking, radar and surveillance, radio astronomy and special antenna projects . . . ASK ASI

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Ka-Band Fixed Frequency Magnetron SYLVANIA M-4064

FEATURES: **125KW peak power over 34.7 to 35 Gc. • Less than 9-lb. weight • Wide pulse width and duty cycle ranges • Improved starting stability • Improved drift characteristics • Rugged, reliable, proven design.**

Sylvania M-4064 provides an unusually broad range of pulse widths—from 40 nsec to 1 μsec, and duty cycles – from .00007 to .0008. (Investigation indicates that pulse widths of less than 40 nsec., peak power to 140KW, are practicable.)

First proposed in 1959, Sylvania M-4064 has been the object of intensive refinement and testing. New techniques for improved cathode and anode processing, outgassing of parts and exhaust procedures have increased tube efficiency, life expectancy (not more than 20% power drop-off during life) and pulse stability over life. M-4064 can exceed vibration specs of 20g to 2000 cps, shock of 50g in 3 planes over 11 msec, and 1000-hour life tests at 1.0 μsec.

If your application demands heavyweight performance from a bantamweight magnetron, ask your Sylvania Sales Engineer about the advantages of Sylvania M-4064.

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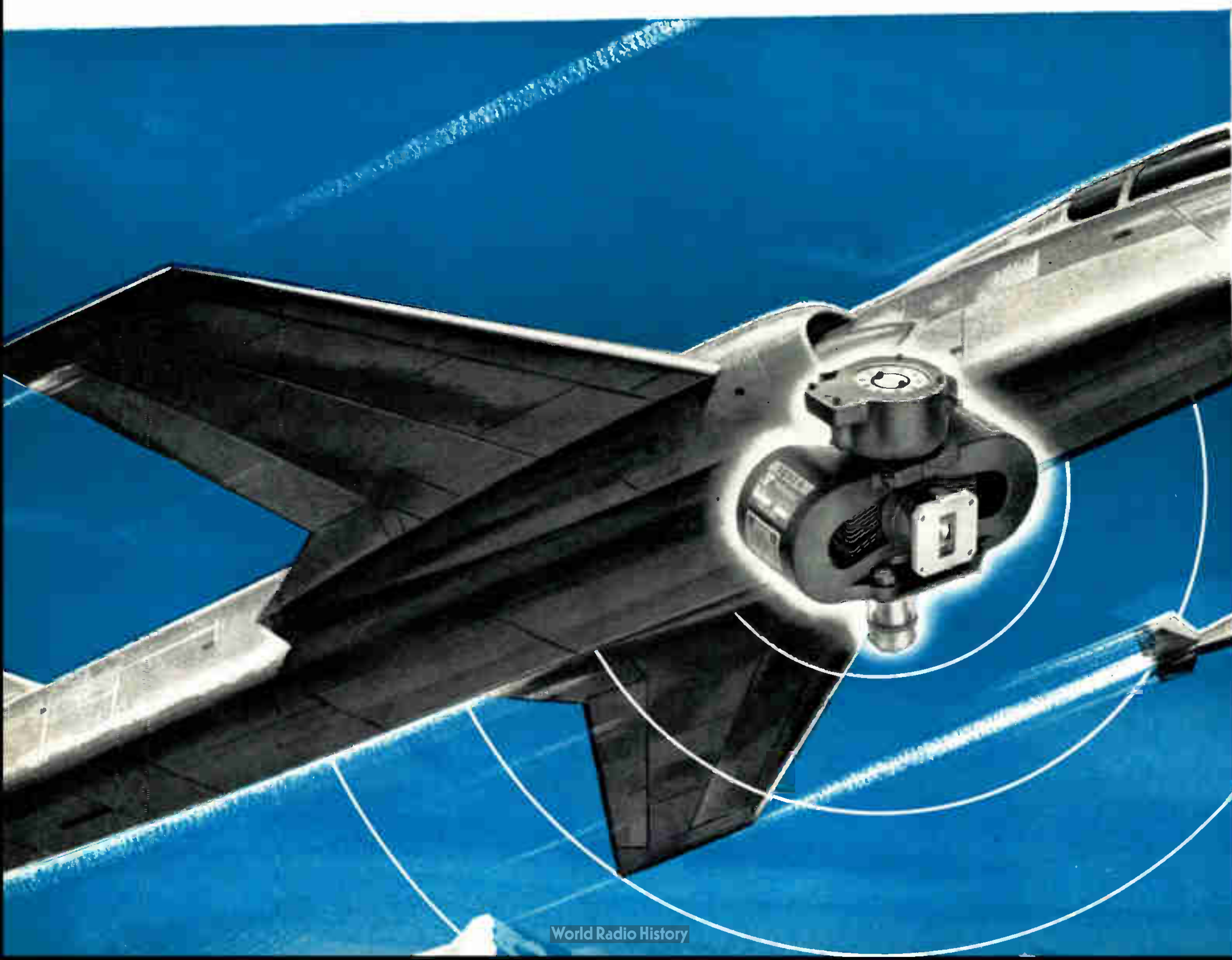

Ka-Band Crystal Protector

Sylvania TR-4271 is an integral cavity, compact transmit-receive tube. TR-4271 offers outstanding, field-proven performance in the frequency range of 33.814 Gc. to 35.906 Gc. It operates exceptionally well at short pulse widths and is designed for crystal protection at incident peak powers at or above 1 watt. Max. spike leakage energy—.02 ergs; max. leakage power—10 μw; max. recovery time at an ignitor current of 150 μamps — 2 μsec.

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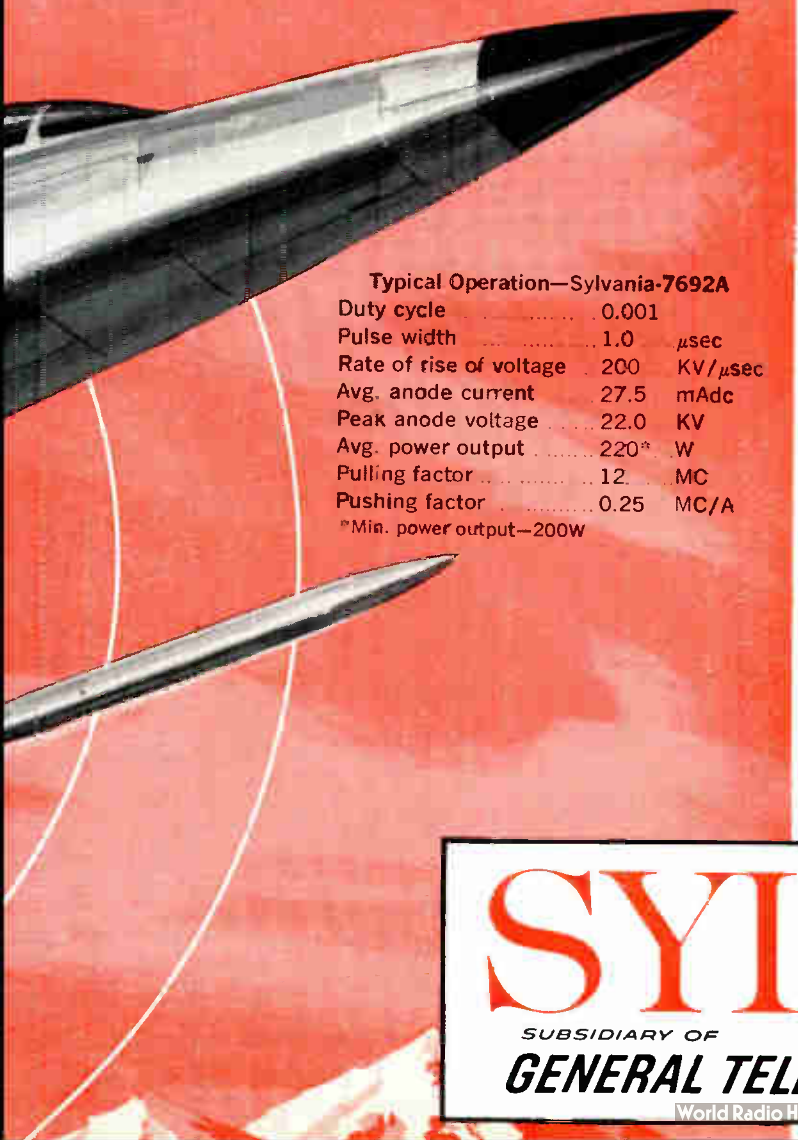
weight! Enhance reliability!



Typical Operation—Sylvania-7692A

Duty cycle	0.001	
Pulse width	1.0	μsec
Rate of rise of voltage	200	KV/μsec
Avg. anode current	27.5	mAdc
Peak anode voltage	22.0	KV
Avg. power output	220*	W
Pulling factor	12.	MC
Pushing factor	0.25	MC/A

*Min. power output—200W

X-Band Tunable Magnetron SYLVANIA-7692A

FEATURES: 220KW peak power over 8550 to 9650MC. Lightweight 12-lb. package • Superior tuner design • Linear tuning • Reduced jitter • Improved memory behavior • Mechanical simplicity/ruggedness • Low pushing figure • Compatible with MIL-E-5272A environments.

Sylvania-7692A is readily adaptable to either hand or servo tuning methods. It features Sylvania inductive post tuning which utilizes fewer moving parts—e.g., single tuning head, only one vacuum-barrier bellows—thereby enhancing reliability. Short "free length" of the tuner posts—only 0.20"—eliminates possibility of mechanical and electrical resonances. Tuner post guide ring assures precise post alignment, serves as an effective electrical and thermal ground for the tuning post structure.

Improved starting characteristics of 7692A provide exceptional pulse memory behavior: instantaneous switching from 0.25 to 2.5 μsec. pulse widths causes less than 0.5% missing pulses; fixed pulse stability under adverse conditions of voltage pulse rise time and pulse width is better than 0.1%. Jitter characteristics, too, are improved — less than 200KC in frequency and 10 nsec. in time.

Your Sylvania Sales Engineer has full info on the many other advantages of Sylvania-7692A, such as typical field life of 1000 hours, safety margin on window "suck-in," stability under vibration. Ask him.

For technical data on a specific type, write Microwave Device Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, N. Y.

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SYLVANIA

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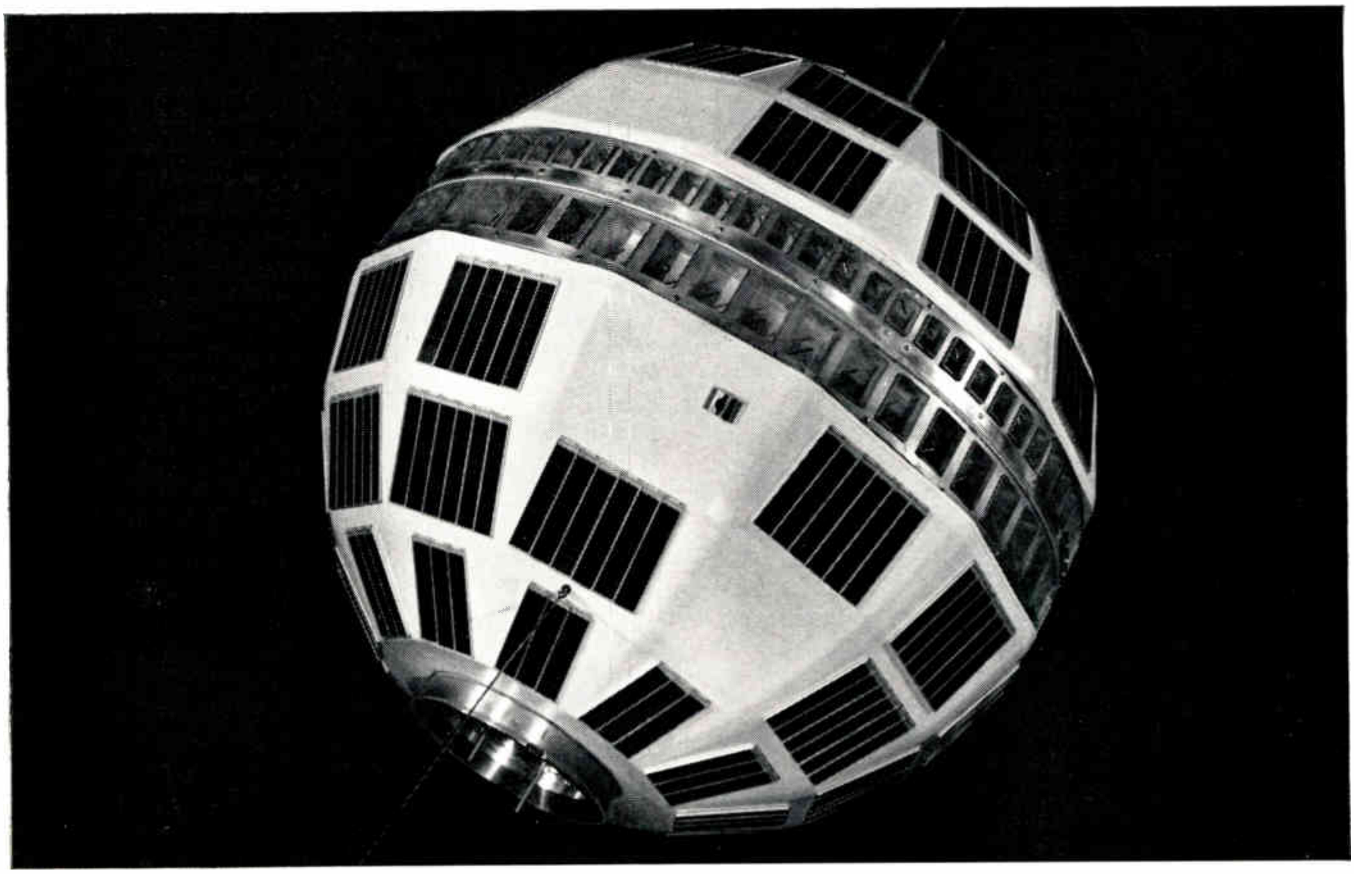
GENERAL SYSTEM

☐ Telstar orbits with FXR Products



Model of Telstar experimental communications satellite. The dual row of slotted antennas can be seen around the equator of the sphere. Patches of solar cells on the shell convert sunlight into electricity to provide power.

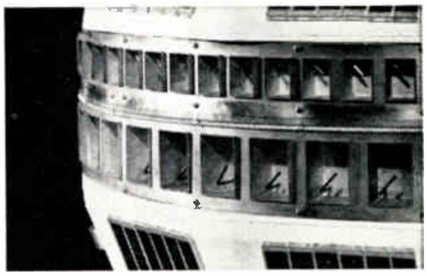
Telstar orbits with FXR products

Project Telstar—the first privately financed space effort—is a Bell System communications experiment, carried out in cooperation with N.A.S.A. Telstar will test the use of broadband repeater satellites for overseas communications. The program will also check out tracking techniques and ground equipment. Intercontinental telephone and TV trials will be conducted. Telemetry data on radiation and numerous conditions in the space environment will be gathered, too. The vehicle is a step toward continuous global communications with microwave radio.

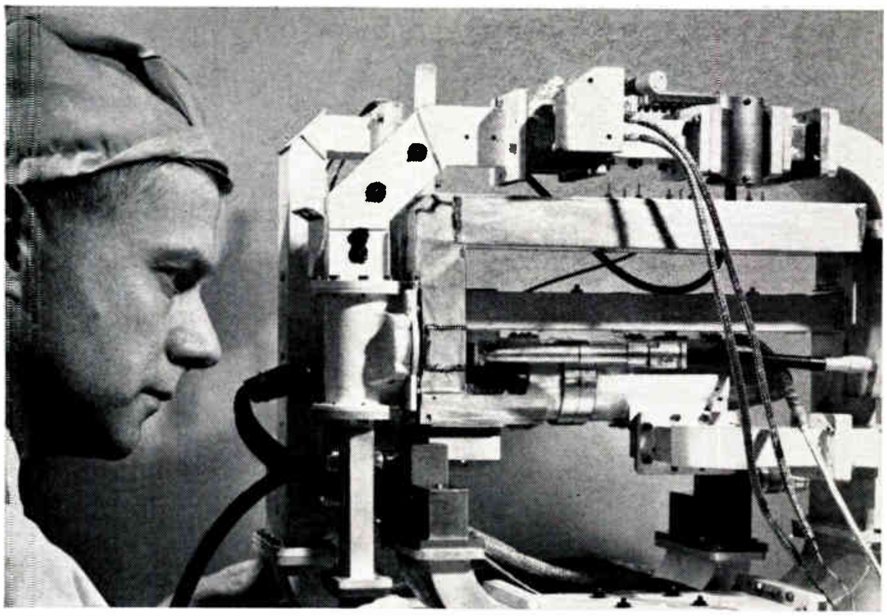
When Telstar orbits the earth FXR products will go with it. ■

Antenna probes specially made for relay sphere

The waist of the relay satellite has a double row of antennas for transmitting and receiving microwave signals. The probes within the antenna slots—120 of them—were custom produced by FXR to Bell Telephone Laboratories design. They consist of long and short probes tooled from beryllium with Tellon insulators. ■



Section of satellite shows equatorial antenna slots. Upper row transmits, lower row receives microwave signals.



The waveguide "plumbing" is shown undergoing tests before final assembly of satellite. Microwaves are received, amplified, and transmitted back to the ground in Telstar.

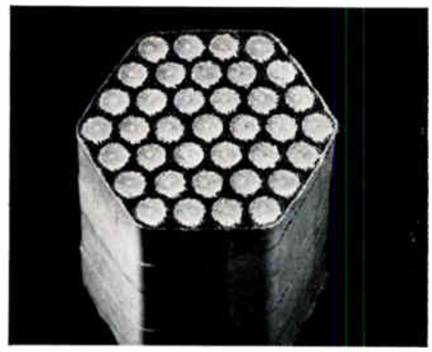
FXR waveguides in satellite

FXR fabricated 13 of 20 waveguide-type pieces in the satellite. These waveguides—"straights" and "bends"—were precision fabricated of lightweight magnesium to exacting Bell Telephone Laboratories specifications. Some of the components are used to filter signals from the crowded spectrum. FXR is a major supplier of waveguides and waveguide components for systems application: custom or standards of aluminum, brass, copper, coin silver or magnesium.

Amphenol cable used at tracking station

Antenna at the Andover tracking station was erected this winter. Cable is shown being carried during construction.

At the giant Andover, Maine, tracking station, 37 lengths of Amphenol RG 11 A/U coaxial cable measuring a total of over 28 miles, connect the tracking horn with the control building. RG 11 A/U is a copper braid coaxial cable with a non-contaminating jacket of polyvinyl chloride and polyethylene core. It's a standard FXR cable made to rigid specifications that meet or surpass military requirements.



Cross-section of RG 11 A/U cable that connects antenna horn to transmitting equipment. Thirty-seven lengths—a total of 28 miles—of this standard FXR cable were used.

FXR is your single source of Amphenol cable and wire, microwave test equipment and subsystems, FXR waveguide switches, DK coaxial switches, Amphenol and ipc coaxial connectors. ■

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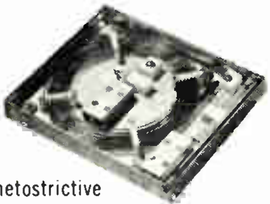
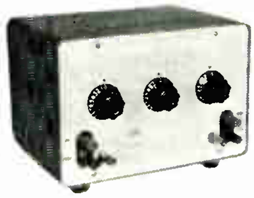


Magnetostrictive Delay Lines



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Ranges from 10 to 10,000 μsec; Frequency 200 KC to 1 MC R.Z.; per MIL specs upon request. Efficiently designed for optimum size, temperature, coefficient, and signal to noise.

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Series 200 Push-button Decade Delays. Ranges: 0-5.075 to 0-50.1 μsec. Rise time .20 to 2.0 μsec. Impedance 1000 ohms.

Series 400 Continuously Variable Delays. Ranges: 0-.10 μsec to 0-.70 μsec. Rise time .03 to .095 μsec. Impedances 100 to 1500 ohms.

Series 500 Continuously Variable Video Delays. Ranges: 0.9 μsec to 0-15 μsec. Impedances 1000 to 56 ohms. Rise time .2 to 3.0 μsec.

Series 600 Variable Delay Lines. Ranges: 0-2.0 μsec to 0-15 μsec. Impedances 100 and 1000 ohms. Rise times .17 to .90 μsec. 60 step switch provides resolution to 1/120 of total delay.

Series 700 Miniature Variable Delay Networks. Ranges: .125 μsec to 1.50 μsec. Impedances 1500 to 93 ohms. Pulse attenuation — 1.0db (max.) all units. Rise time .03 to .30 μsec.

Series 800 Miniature Trimmer Delay Line. Ranges: 0-50 to 0-250 μsec. Resolution less than 1 μsec. Designed for printed board mounting. Size only: .75"w x .35"h x 2.25" and 4.0"

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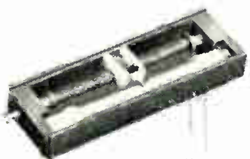

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Better than 35-1 Delay/rise ratio in a 3½ cubic inch package. Typical design model 37-74: Delay time 2.5 μsec. Attenuation — less than 2 db. Rise time: less than .075 μsec.

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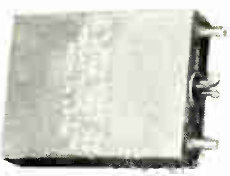
In only 6 cubic inches. Delay time 20.3±.1 μsec. Rise time 0.45 μsec max. Impedance 470 ohms. Attenuation 4 db. Also model 52-77 for 24.65 μsec in 9 cubic inches.



Miniature Delay Line Series 37-74

Audio Delay Lines

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Low pass and high pass filters with f_c from 1.5 to 300 KC; Attenuation of 40 db at and beyond 2.5 X f_c for low pass and 40 db at and below .4 X f_c for high pass. Insertion loss less than 2 db. Temperature —20°C to +85°C. Size only ¾" x ¾" x 1⅛".

CUSTOM FILTERS

Exacting phase characteristics can be met for low, high, and bandpass filters in small case sizes, and at very competitive prices.

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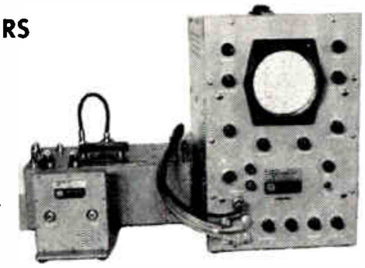
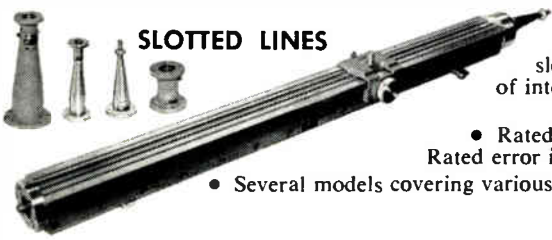
AUTOMATIC IMPEDANCE PLOTTERS



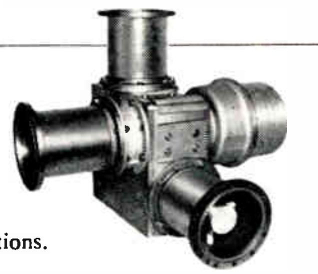
- Measure and plot rf impedance or transfer characteristic as a continuous function of frequency from 0.1 to 1700 mc.
- Impedance versus frequency curve is automatically plotted as it would be seen at any point desired.
- Entirely self-contained, except for use of an external oscillator.

SLOTTED LINES



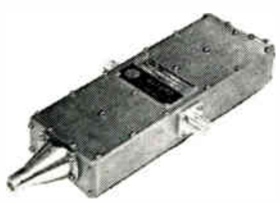
- High-precision universal slotted lines with a wide variety of interchangeable tapered reducers and tunable probes.
- Rated residual SWR is under 1.010. Rated error in detected signal under 1.005.
- Several models covering various bands from 37.5 to 4,000 mc.

COAXIAL SWITCHES



- For use in rigid 3⅛" and 6⅛" coaxial transmission line.
- Low SWR.
- Motor-driven or manually operated.
- Very high peak power models for radar applications.

INSTRUMENT HYBRIDS



- Inherent high isolation independent of frequency. Rated residual unbalance from 40 to 60 db.
- Wide range of frequency bands from 45 mc to 3600 mc for use with all transmission line sizes from Type N to 6⅛".
- Constant coupling in both magnitude and phase over the frequency range, with equal loads.

INSTRUMENT LOADS

- Excellent stability and low reflection. Suitable as secondary standards.
- SWR of Type N termination under 1.02, 0-1100 mc.
- Available in nearly all rigid and flexible coaxial transmission line sizes.
- Models for use at liquid nitrogen temperatures.

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35 Mulholland Street
Toronto, Canada
RU 7-0991

Canada (Ottawa Area)
Electrodesign
428 Rideau St., Suite 100-A
Ottawa, Canada
SH 9-6837

LOW NOISE TWT EXTENDS RADAR RANGE

A limitation on the effective range of a radar equipment is the noise level in the receiver: the limiting range is reached when signal to noise ratio approaches unity. The signal to noise ratio in the equipment cannot be better than that in the first stage, therefore the use of a low noise amplifying tube in that stage is of paramount importance.

STC offers two tubes of eminently suitable design for use in S-band:

Type W9/2E for broadband coverage with a gain of 40 dB and noise factor of about 8·5 dB. It is intended for operation over the whole frequency range 2·5 to 4·1 Gc/s with fixed voltages. An aluminium foil mount is available with coaxial r.f. connectors.

Type W10/3E for narrow band operation with about 23 dB gain and 6·8 dB noise factor with the grid voltages set for optimum noise factor at the appropriate centre frequency.

W10/3E has a frequency range 2·7 to 3·3 Gc/s in solenoid circuit 495—LVA—003 with waveguide r.f. connectors or frequency range 2·8 to 3·8 Gc/s in solenoid circuit 495—LVA—006 with coaxial r.f. connectors.

W9/2E

W10/3E mount
495-LVA-006S

NEW BACKWARD WAVE OSCILLATORS

The new K- and Q-Band backward-wave oscillators in the STC range incorporate a d.c. isolator in the output waveguide to permit operation with grounded cathode as well as grounded output terminal. These oscillators are tuned purely by variation of the line (slow wave structure) voltage which may now be positive to ground. Two grids are provided for amplitude modulation: grid 2 set positive relative to cathode and grid 1 at zero, or negative with a superimposed modulating signal requiring only low energy.

∗ *SPECIAL ANNOUNCEMENT:*
Improvements to the K-band oscillator have more than doubled its original output power at the upper frequencies.

Type Y333/1E

ABRIDGED DATA

Band	Valve Code	Freq. Range (Gc/s)	Line Voltage (V)	Output Power (mW)
K	Y322/1E	18–26·5	650–3000	30 to 200
Q	Y333/1E	26·5–40	700–3200	10 to 80

For Data Sheets write to:

Standard Telephones and Cables Limited

VALVE DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON · ENGLAND

USA enquiries for price and delivery to ITT Components Division, P.O. Box 412, Clifton, N.J.

ITT

62/18MS

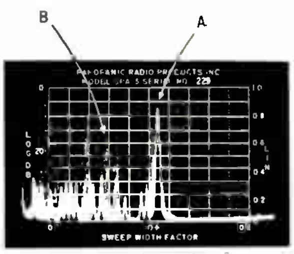
1kc to 25mc
FREQUENCY RANGE

up to 3mc
SWEEP WIDTH

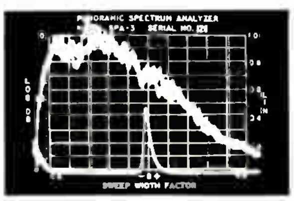
2μv
USABLE SENSITIVITY

MORE CAPABILITIES for MORE APPLICATIONS

PANORAMIC MODEL SPA-3/25 SPECTRUM ANALYZER



Analysis of multiplexed voice communications circuit pinpoints high channel level (A) due to "singing" or oscillations. Adjacent channels at 4 kc intervals, some voice modulated, are also seen. Voice peaks (B) show up clearly. 40 db log scale.



Noise spectrum analysis using internal video smoothing filter displays average noise level versus frequency in easily appreciated form. Internal marker pips are 500 kc apart.

HIGHLIGHT SPECIFICATIONS

Frequency Range 1 kc—25 mc (usable to 200 cps) (SPA-3 to 15 mc)

Sweep Width Adjustable, calibrated from 0 to 3 mc

Center Frequency Adjustable, calibrated from 0 to 23.5 mc.

Markers Crystal controlled, 500 kc and harmonics to 25 mc.

Resolution I-F bandwidth adjustable, 200 cps thru 20 kc

Sweep Rate 1 to 60 sweep/sec. continuously adjustable Sweep operated synchronized to power line, or non-synchronized.

Amplitude Scales Linear, 40 db Log and Power

Sensitivity 20 μv to 2 v full scale. Min. discernible level = 2 μv

Attenuator 100 db calibrated

Response Flatness ±15% or ±1.5 db up to 23.5 mc

Input Impedence 72 ohms. (50 ohms optional. High impedence probe PRB-1, optional)

dependable CERTIFIED SPECIFICATIONS for accurate data

Wide frequency coverage to 25 mc, scanning width to 3 mc and sensitivity to 2μv plus many other exceptional performance characteristics enable the SPA-3/25 to provide accurate graphic measurement of virtually all types of signals: CW, AM, FM, pulsed, and noise. Its versatility and convenience for a multitude of applications have resulted in widespread acceptance.

The calibrated sweep width and center frequency controls are readily adjusted to select broadband scans or high resolution "zoomed in" analyses. Resolution capability is 200 cps. Crystal controlled markers check the frequency calibrations. The high persistence 5" CRT readout includes 3 selectable calibrated level scales: linear, 40 db log, and power. An adjustable smoothing filter facilitates single line noise density plotting. *(See screen photo at lower left)* Scanning rate is adjustable from 1 to 60 cps.

For applications requiring measurement only up to 15 mc, specify Model SPA-3. It includes all the outstanding features of the Model SPA-3/25. A companion Sweep Frequency Generator, Model G-6 is used with the SPA-3/25, SPA-3 for single line response plotting to 15 mc. With the G-6, testing and alignment of filters, I-F's, and other networks are performed in a fraction of the time required for manual tuning methods.

Comprehensive technical bulletins are available on SPA-3/25, SPA-3, G-6, and other Panoramic instruments used from 0.5 cps to 44 kmc.

Panoramic electronics, inc.

Panoramic Electronics, Inc. • 540 South Fulton Avenue, Mount Vernon, N. Y. Phone: (914) OWens 9-4600
Formerly Panoramic Radio Products, Inc.
TWX: MT-V N.Y.—5229 • Cables: Panoramic, Mount Vernon, New York.

Circle 238 on Inquiry Card

POWER

HIGH POWER VARACTORS

Questions — to be read in anxious voice by Frequency Multiplier Designers

Answers — to be read by a top-notch Manufacturer of Varactor Diodes

Q Are there any varactors that can be hit with real power yet?

A Yes! The new MA-4050 and MA-4060 series of power varactors can be driven with as much as 20 watts at VHF-UHF in frequency multiplier circuits.

Q Are efficiencies good with these varactors?

A Yes! Typical efficiencies when driven in the 100 megacycle region are — 70-80%-doubling • 50-70%-tripling • 40-50%-quadrupling.

Q Can performance be improved at frequencies above the VHF-UHF range?

A Yes! Because of the higher power now available at VHF-UHF frequencies, overall multiplier system output power will be improved.

Q Can present reversible cartridge varactors handle these newly available power levels?

A Yes! The new MA-785 Varactor Mount permits reversible cartridge varactors to be operated at maximum power levels in any application. The MA-785 units, made of high conductivity copper, approach the thermal effectiveness of an infinite heat sink (95%).

Q Is there anything else I should know?

A Yes! The transistor-style packages have dual diodes with common cathode mounted for use in push-pull circuits and hexagonal stud-mounted packages have single diodes • Both packages provide optimum heat transfer • Individual zero bias junction capacitances of 20 to 40 picofarads (minimum) are available (MA-4050B, 4060B and MA-4050A, 4060A respectively) • Breakdown voltage exceeds 80V and series resistance measured at 500 Mc is less than 3 ohms.

Q Are these varactors available?

A Yes! Now, from your nearest Microwave Associates Distributor or from the factory directly. The varactor mounts are also available. Prices are attractive.

Q What if I need more power?

A It's probably already available. These varactors can handle all the power practically available from UHF transistors. If you want more power . . . just ask!

RECOMMENDED VARACTORS

These recommendations are based on Microwave Associates' considerable experience in designing, building and testing varactors and varactor multipliers. As improved technologies permit, our recommendations will be modified. Contact the factory for the latest information.

DRIVE FREQ. (Mc)	DRIVE POWER (WATTS)				
	20	10	5	2.5	1
30-60	**MA-4050A *MA-4060A	**MA-4050A *MA-4060A	*MA-4060A MA-4347G	*MA-4060B MA-4347F	MA-4346F
60-120	**MA-4050A *MA-4060A	**MA-4050B *MA-4060A	*MA-4060B MA-4347F	MA-4347E	MA-4346E
120-240	**MA-4050B	**MA-4060B MA-4347F	MA-4347E	MA-4347D	MA-4346E
240-480		MA-4346F	MA-4347D	MA-4347C	MA-4346D
480-960		MA-4346E	MA-4346D	MA-4346C	MA-4346C

*Stud mounting
**Stud mounting, two junctions for parallel or push-pull circuits
All others, in MA-785 heat sink mount, or equivalent.

MICROWAVE ASSOCIATES, INC.

United Kingdom Sales: Microwave and Semiconductor Devices, Ltd. Skimpot Trading Estate, Luton, Bedfordshire, England
Other Export Sales: Microwave International Corp. 36 W. 44th Street, N.Y.C., N.Y., U.S.A. Cable: Microken

BURLINGTON, MASSACHUSETTS • WESTERN UNION FAX
TWX: BURLINGTON, MASS. 942 • BROWNING 2-3000

Tech Data

for Engineers

Microwave Catalog

This 12-page, 2-color brochure covers microwave antennas ranging from 400MC. thru 12.7GC. with the design data and tables showing gain, beamwidth, side lobe characteristics, etc. A section is included on design and manufacturing facilities. Bulletin 620, Mark Products Co., 5439 W. Fargo Ave., Skokie, Ill.

Circle 564 on Inquiry Card

Power Splitter

Tech data is available from Astrolab Inc., 120 Morris Ave., Springfield, N. J., on their Power Splitter with freq. range at 250 to 4000MC. Characteristic impedance, 50Ω; VSWR is 1.15 to 1.0 max.; Power is 300w average; Insertion loss is 0.2db.

Circle 565 on Inquiry Card

Microwave Oscillators

Catalog 62-A from Trak Microwave Corp., 5006 N. Coolidge Ave., Tampa, Fla., gives illustrations, specs, and performance curves on miniature microwave oscillators, amplifiers and harmonic generators.

Circle 566 on Inquiry Card

Microwave Amplifiers

Wave Particle Div., Paradynamics, Inc., 10 Stepar Place, Huntington Sta., L. I., N. Y., is offering tech. data on electronically swept microwave signal sources (BWO & VTM) microwave levelers, millimeter wave length signal sources, TWT amplifiers, and universal TWT power supplies.

Circle 567 on Inquiry Card

Microwave Isolator

Tech data including photographs, descriptions, applications, specs., and typical performance characteristics charts on an X-band wide-temp. range load isolator; C-band communications microwave isolator; UHF three-port circulator; and a C-band miniature Y-circular is available from Solid State Systems Div., Motorola, Inc., 3102 N. 56th St., P. O. Box 5409, Phoenix 10, Ariz.

Circle 568 on Inquiry Card

Microwave Information Kit

Andrew Corp., P. O. Box 807, Chicago 42, Ill., is offering an antenna system information kit for microwave engineers. Included are catalogs on Heliax flexible air dielectric cable, microwave antennas and accessories, rigid coaxial transmission lines, hubloc antennas, microwave log periodic antennas covering 300 to 3000 mc, and a tech. bulletin entitled, "Performance Aspects of Dish Radomes" plus a parabolic antenna system computer and transmission line and waveguide selector. The parabolic antenna system computer is for calculating parabolic antenna radiation, characteristics, performance of passive repeaters, free space and tropospheric forward scatter, propagation attenuations and thermo noise and equivalent noise in.

Circle 569 on Inquiry Card

Circle 242 on Inquiry Card

Tech Data

for Engineers

Microwave Catalog

A 32-page catalog of microwave instrumentation is available from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. This catalog deals only with the generation, transmission, and measurement of microwave phenomena. For convenience in use, the contents have been arranged by freq. range, rather than by model number. Photographs, specs, and a section on microwave measuring techniques is included.

Circle 570 on Inquiry Card

Ferrite Components

Rantec Corp., Calabasas, Calif., is offering tech data on their coaxial ferrite junction devices. Information is included on coaxial 4-port circulator, coaxial isolators, coaxial 3-port circulators, and coaxial switches, modulators and variable attenuators.

Circle 571 on Inquiry Card

Microwave Components

Melabs, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif., is offering a condensed catalog and product summary No. 861 describing their line of microwave instrumentation and special products and microwave components. Included are electronically tuned signal generators, a crystal video receiver, electronically tuned superhet receiver, low noise TWT amplifiers, parametric amplifiers, masers, telemetry receivers, antennas, satellite r-f checkout systems, band separation filters, diode switches or modulators, and isolators.

Circle 572 on Inquiry Card

Test Equipment

Waveline Inc., Caldwell, N. J., is offering an improved and expanded catalog on Microwave Test Equipment containing information on over 1000 precision instruments of a standard product line covering from 2.60 to 90.0GC. Complete technical information, descriptions, photographs, and price list are included.

Circle 573 on Inquiry Card

Waveguide Bends

This 44-page, 2-color catalog, BE61, describes in detail more than 170 models covering EIA waveguide sizes from WR28 to WR650. The catalog includes VSWR curves on many of the models described. Engineering information, including a discussion of Bend theory, waveguide reference and termination dimensions with tolerances, as well as illustrations of the various styles available, is included. Microwave Development Laboratories, Inc., 15 Stratmore Rd., Natick Industrial Centre, Natick, Mass.

Circle 574 on Inquiry Card

Traveling Wave Tubes

Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif., is offering a catalog which covers their line of backward wave amplifiers, forward wave amplifiers, backward wave oscillators, and special purpose tubes.

Circle 575 on Inquiry Card

Tech Data

for Engineers

Microwave Reference

Contains 111 pages, 2-color, of well illustrated microwave test equipment and reference information. Test equipment (60-pages) includes: direct reading freq. meters; slotted lines and probes; detector-mixer mounts, terminations; adapters; SWR indicator; receivers; and swept oscillators. Reference data (51-pages) contains: freq. impedance, power and attenuation measurement data; standard waveguide characteristics; conversion tables; tables of constants; information on klystron power supplies and basic microwave symbols and equations. Diagrams, charts, schematics, and photographs through-out. Sperry Microwave Electronics Co., Clearwater, Fla.

Circle 576 on Inquiry Card

Microwave Components

A 16-page condensed catalog of microwave components and a description of development and production facilities is available from Airtron, a div. of Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J. Included are photographs and specs. of representative ferrite devices, rigid waveguide components, rigid and flexible waveguide, and solid state materials and devices.

Circle 577 on Inquiry Card

Antenna

Ground plane antenna Model 10-2 has a freq. range from 70 to 300 MC. Constructed of corrosion resistant materials throughout and suited to severe environmental applications. Plas-Tron Corp., 815 S.W. Viewmont Drive, Portland 1, Ore.

Circle 578 on Inquiry Card

Wavelength Tables

Antenna Systems, Inc., Hingham, Mass., offers wavelength tables from waveguide size WR-430 to WR-2300. These computer-calculated tables of constants for rectangular waveguide, give lengths in free space and waveguide sizes in both centimeters and inches. They also give the ratio of the guide wavelength to the free space wavelength and vice versa for purposes of scaling as well as the cutoff wavelength and cutoff freq. of the guide.

Circle 579 on Inquiry Card

Microwave Components

Budd Stanley Co., Inc., 175 Eileen Way, Syosset, L. I., N. Y., is offering a 205-page catalog on their line of microwave test instruments and components. Some products listed include fixed waveguide attenuators, variable calibrated flap attenuators, precision multi-hole directional couplers, series Tees, standards gain horns, standard reflection waveguide terminations, shorting waveguide switches, E and H plane waveguide bends and coaxial slotted lines. Descriptions, photographs, outline drawings, electrical and mechanical specs and applicable military specs plus a section on basic principles of microwaves are included.

Circle 580 on Inquiry Card

Tech Data

for Engineers

Instruments/Components

"Instruments and Components" Catalog SJ-61, describes a line of r-f instruments and coaxial components. It includes characteristics, dimensions and prices of slotted lines, tapered reducers, adapters, and instrument loads. Also included is information on calibrated mismatches, impedance-matching tuners and networks, transmission-line hybrids, line stretchers, and variable calibrated attenuators. The 34-page catalog is available from Alford Mfg. Co., 299 Atlantic Ave., Boston, Mass.

Circle 581 on Inquiry Card

Microwave Antennas

Telerad, Div. of The Lionel Corp., Route 69-202, Flemington, N. J., is offering a 42-page catalog on microwave products covering coaxial transmission line equipment, antennas, waveguide, accessories, components and systems. Photographs, schematics, cut-aways, specs and engineering data are included.

Circle 582 on Inquiry Card

Thin Films

Metavac, Inc., 45-68 162nd St., Flushing 58, N. Y., is offering a comprehensive 10-page brochure describing their high vacuum thin film technology products. The brochure is divided into 2 sections. One describes evaporated thin film products having microwave applications; the other illustrates various precision coated products for optical and infrared uses. Some of the products included are: resistance elements for coaxial and waveguide attenuators, microwave resistance cards, thin metal film resistors, lenses, domes, and coatings for lasers. Specs., illustrations, outline drawings, and transmission data are included.

Circle 583 on Inquiry Card

Microwave Components

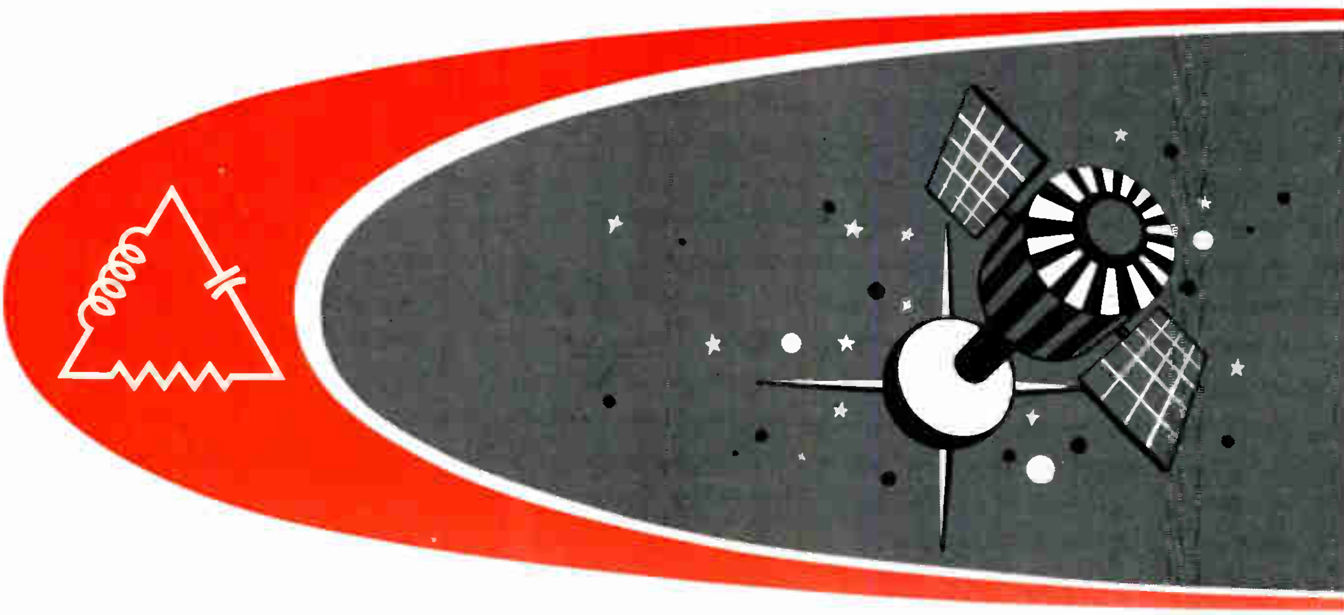
This 10-page, 2-color brochure covers the following components: high power waveguide isolator; harmonic filter covering from 5.925-6.425GC; broadband waveguide isolators; coaxial isolators; waveguide switches; waveguide assemblies including a microwave bridge, a pressurized assembly and a "Tee"—isolated duplexer; waveguide Y-T circulators; coaxial isolators with type "N" connectors; and ferrite microwave components and sub-assemblies including slide screw tuner, adjustable isolators and mechanical variable attenuators. Caswell Electronics Corp., 414 Queens Lane, San Jose 12, Calif.

Circle 585 on Inquiry Card

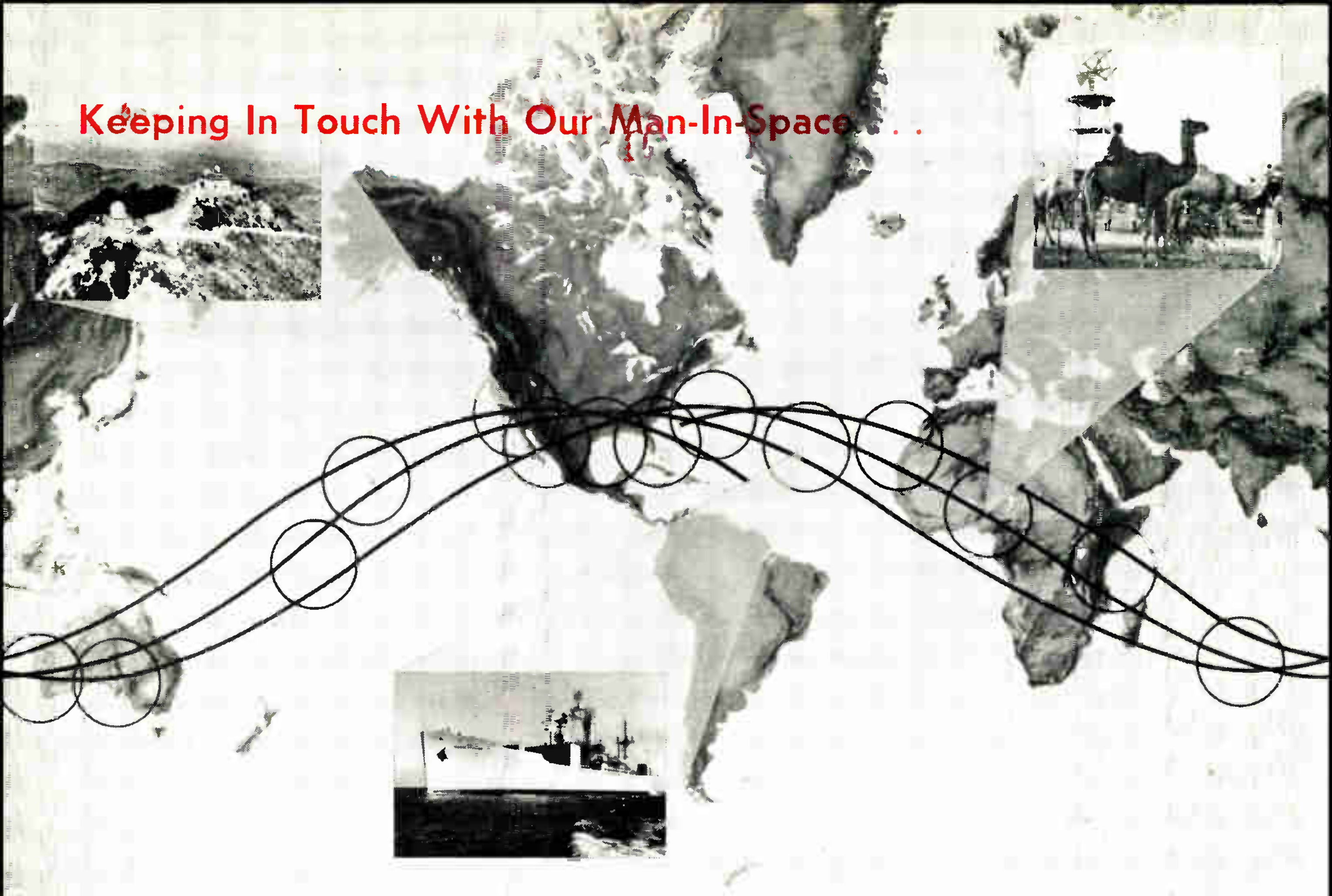
ADS OF INTEREST IN OTHER SECTIONS dealing with "Microwave"

Section K

Space Electronics



Keeping In Touch With Our Man-In-Space . . .



(Photos courtesy of Burns and Roe, Inc., U. S. Navy and NASA)

Mercury Control: "5, 4, 3, 2, 1, zero, liftoff."
Astronaut: "It is a little bumpy along about here."
Mercury Control: "You have a go of at least 7 orbits."
Astronaut: ". . . all systems are O. K."
Mercury Control (later): ". . . . recommend you fly-by-wire."
Astronaut: "Roger, am remaining fly-by-wire."

PROVIDING voice communications between Earth and Project Mercury's man-in-space has cost the U. S. thousands of man-hours and around $75 million dollars.

The vast, complex, ground communications network, which keeps our Earth-orbiting astronaut in almost continual contact, covers around 60,000 miles of the Earth's surface. All told, about 140,000 circuit miles interconnect the 16 tracking and communications sites to Goddard Space Flight Center, Greenbelt, Md., and Mercury Control Center at Cape Canaveral, Fla.

Land lines, submarine cables, and point-to-point radio (both microwave and HF) link radio, teletype and computer equipments together. Only proven circuits, tested and tried radio paths, etc., are used. Every media of communication used was selected only after study of data collected by NBS (National Bureau of Standards) over the past 25 years. All circuits are duplicated, or stand-by circuits are available in case of emergency. Every piece of equipment has at least one "double" and sometimes more than one.

Telephone, teletypewriter and high-speed data (1,000 bits/sec.) information are carried on the network in "real-time." Transmission time for a message, from one site to any other site, is a little over 1 second. There are about 35,000 miles of voice channels interconnecting 13 sites. Around 96,400 circuit miles of teletype channels connect all the sites (radar data comes from 13 sites). Some 5,500 circuit miles of high-speed data lines run between Goddard Space Flight Center (GSFC) and Cape Canaveral.

Project Mercury is a proving ground—a basis—for our advanced space missions. Because of this fact, its Ground Communications and Tracking Network was only designed for a moderately long lifetime of from 3 to 4 years. More sophisticated and sensitive networks are even now being installed around the world.

Where existing facilities for Mercury's Network were available, NASA used them. Where they weren't, NASA constructed new sites. Where land sites were impossible, ships were used. Every effort was made to keep the astronaut in continual contact. The Mercury Network does just this.

Electronic Industries feels fortunate in being able to provide these first technical details on Project Mercury Communications. We are indebted to Mr. George A. Cassels, Communications Branch, Goddard Space Flight Center, Greenbelt, Md., for his gracious effort and technical assistance.

To keep in continuous contact with an Earth-orbiting capsule was NASA's unique problem. A world-girdling, ultra-reliable network of teletype, radio and high-speed data systems was the solution.

PROJECT MERCURY's World-Wide Communications Net

By LOUIS S. GOMOLAK
Assistant Editor
ELECTRONIC INDUSTRIES

The network was too large and complicated for any one company to take on alone. A 5-company team is responsible for this vast, vital, network. Western Electric Co. is prime range contractor and is responsible for technical management of the 18 tracking and telemetry stations in the net. International Business Machines Corp. (IBM) supplied computers, computer programming and simulation displays. Bell Telephone Laboratories is the systems engineering contractor, responsible for communications and control displays. Burns and Roe, Inc., has logistic support, site construction and site facility responsibilities. Bendix Aviation installed radar, ground-air communications, telemetry and site display equipments.

The network's first successful test was in September of '61 with the monitoring of an unmanned, single orbit, capsule. In November of '61, it successfully monitored the MA-5 (ENOS, the chimp) in a 2-orbit flight. February 20, 1962, put the network to its sternest and most vital test. The Ground Communications Network came through with flying colors. To quote NASA officials, "Tracking and telemetry were beautiful."

The Network's Keystone

Goddard Space Flight Center (GSFC) is the keystone in this communications network. All information passes through GSFC. The only exception is data on the life-support equipment. Goddard is the keystone because of economy; it costs less to link all the sites to one message center than to interconnect the sites to each other.

Radar data, telemetered capsule instrument readings, voice exchanges between site and spaceman—all pass through GSFC. The radar data is digested in Goddard's dual IBM 7090 computers and forwarded to the sites and Mercury Control Center (MCC) at the Cape. Through a complex switching arrangement, voice contacts with the capsule are spread around the world. All of this is done almost instantly.

Just how *is* this done? What actually happens when the capsule comes "in view" of a site? What happens before and after the capsule's arrival? How are transmission interference problems avoided or dealt with? What is some of the equipment and how does it operate? *(Continued on following page)*

GODDARD SPACE FLIGHT CENTER

Airview of the keystone in Project Mercury's Ground Communications and Tracking Network. From left to right: Research Projects Bldg.; Space Projects Bldg.; Central Flight Control and Range Tracking Bldg. Latter holds computers, switching center and the network communications facilities.

(Photo courtesy of NASA)

Mercury Network *(Continued)*

The Mercury Network can be divided into 4 systems or operations. These are: Inward Teletype System; Outward Teletype System; and the Computing and Tracking Operations. The first we'll take a look at will be the Inward Teletype System—data from the sites of Goddard and Mercury Control.

Inward Teletype System

All teletype messages from the sites are funneled to Goddard. Simultaneously: messages pour in from the site the capsule has just left; the site with capsule "in view"; and the site about to acquire the capsule. To avoid mass confusion, each message is assigned an address or Call Directing Code (CDC). These codes tell the automatic switching and relay equipment where to send the incoming message. The CDC also tells the priority of the message.

A capsule, traveling at 17,500 mph, has approximately 6 minutes "in view" time at any one site. But, during this 6 minutes the capsule is also being monitored by adjacent sites. Message traffic will pour in from all these sites. This much traffic could make for delay or for adjacent site transmission interference, with the "in view" site's messages. To avoid this, the circuits incoming to Goddard are divided into 2 groups. (There are at least 2 circuits between GSFC and any site, for simultaneous sending and receiving). One group contains 9 circuits, the other has 8. Of this total of 17, five circuits are part-time and 3 are shared by 2 or more sites.

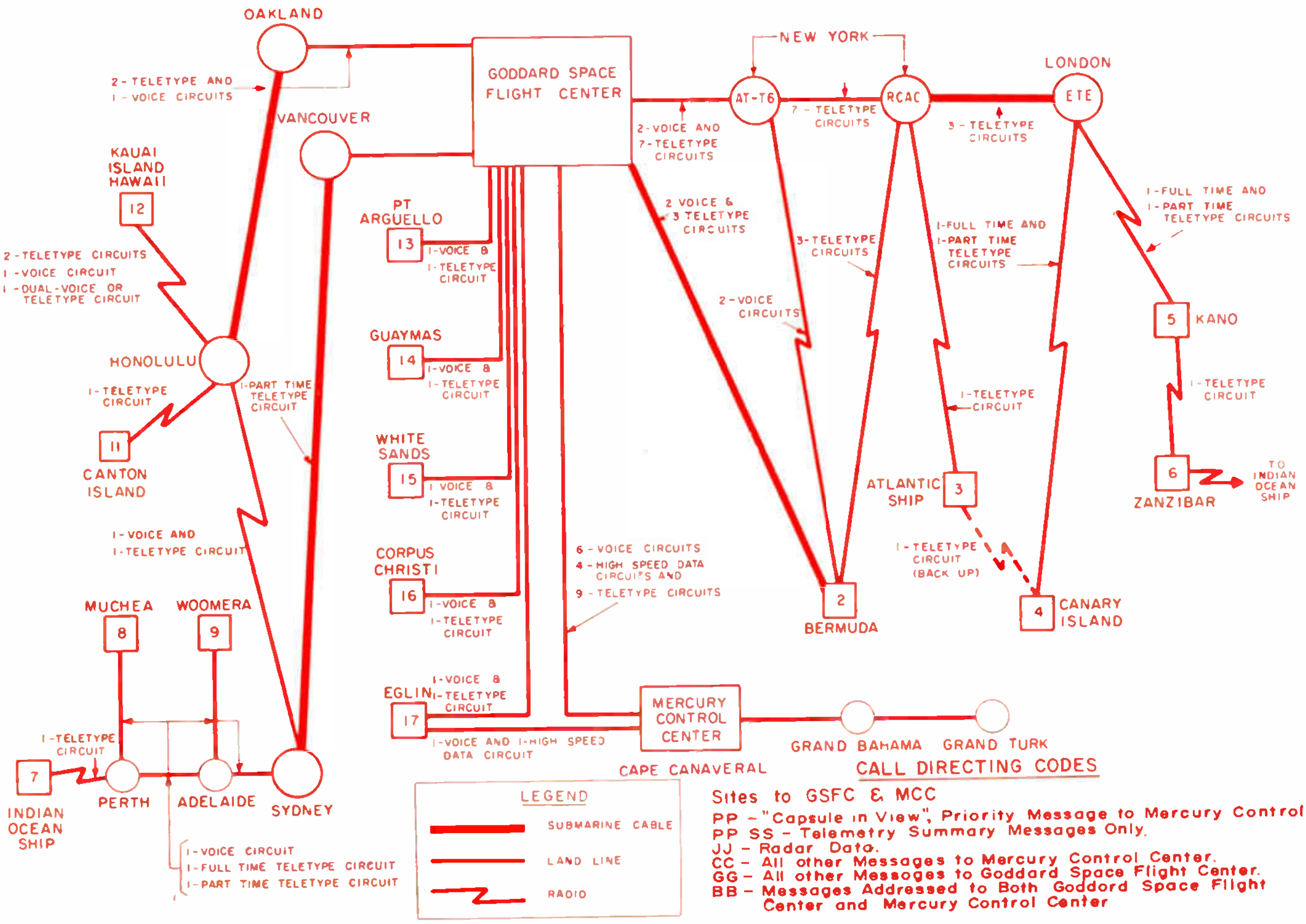
These shared and part-time circuits are interesting. The part-timers are used only when mission conditions exist (either in test or actual mission time). They help out with the traffic on the shared circuits. These part-time circuits allow adjacent sites to "leap-frog" data to GSFC. An example here will probably be helpful.

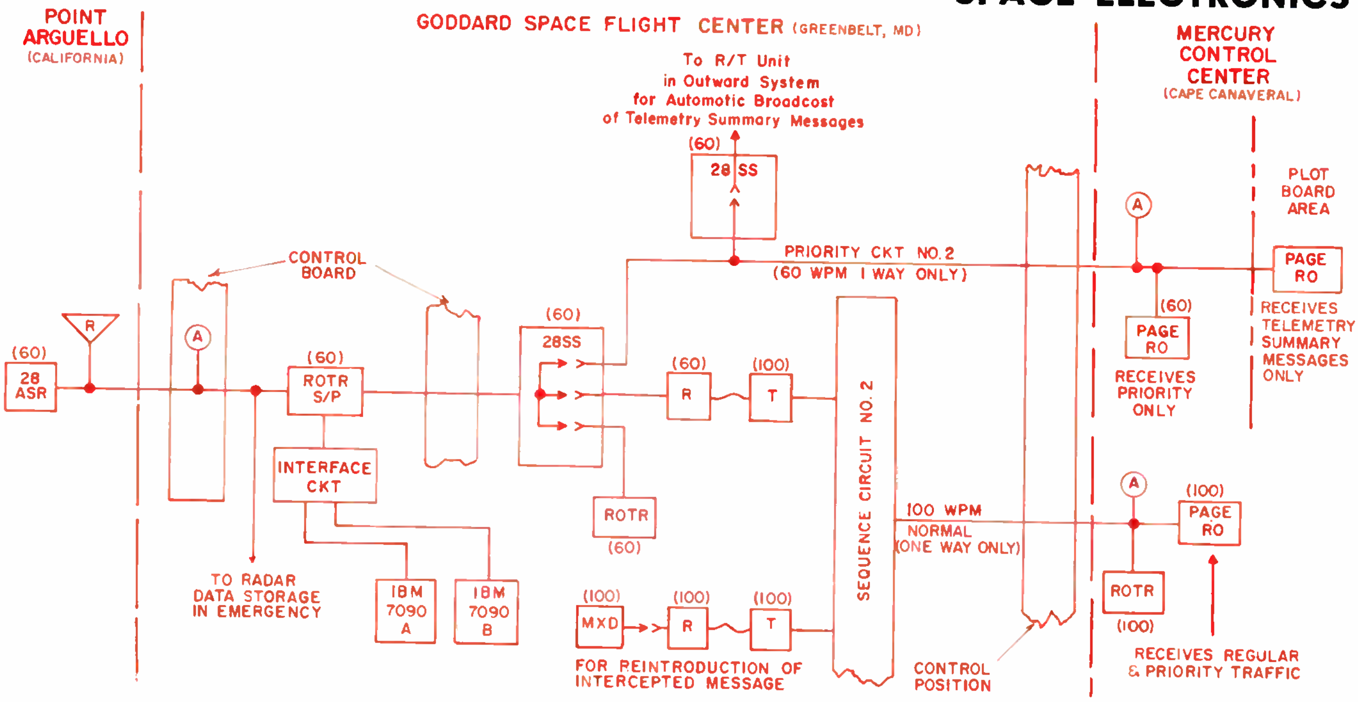
The Indian Ocean Ship (IOS), Muchea (MUC) and Woomera (WOM), Australia, and Canton Island (CTN) all share the same full-time circuit to Goddard. The following is what happens when the part-time circuit is added. The capsule has just left IOS, is over MUC, and is approaching WOM and CTN. The ship uses the full-time circuit to finish sending the large amount of data it has to forward. Muchea is using the part-time circuit for its information. By the time the capsule is near Woomera, the ship has finished transmitting and WOM takes up the full-time circuit. When Muchea finishes with its data, the capsule is just approaching Canton Island. CTN now picks up the part-time circuit Muchea was using. All this information is received at Goddard without delay or adjacent site interference.

Let's look at what happens when a message is received at GSFC. Where does it go? What happens if

NETWORK FACILITIES

Breakdown of the 140,000 circuit miles, stretching over some 60,000 miles of the Earth's surface. Land lines, submarine cables and radio are used to connect the world-wide sites to the Goddard Space Flight Center and the Mercury Control Center. *(Diagram courtesy of NASA)*





1-WAY TELETYPE—FEEDING DATA INTO GODDARD SFC

Typical layout for teletype circuit from a site to Goddard Space Flight Center and Mercury Control Center. Radar and telemetry messages, from Pt. Arguello, come into the ROTR S/P (receiving machine). Radar converted to digital form and sent to computers. Priority and regular traffic goes to 28SS (switching unit). Priority traffic chooses both Priority Ckt. No. 2 and Sequence Ckt. No. 2 for reliability. Messages for GSFC and MCC are recorded in the ROTR Unit (recording unit at GSFC) for post flight analysis. Messages are received at MCC on 2 separate units for reliability in case one circuit fails. Nearly 100 items pass from the sites to GSFC and MCC.

the wrong CDC or no CDC has been assigned? Is all incoming information treated the same?

One thing should be pointed out before we proceed. The Mercury Ground Communications Network is a *fully-automatic* communications network, with manual capabilities in case of emergency. Everything being as it should, a message can be sent anywhere in the world-wide network in a little over a second, without manual handling at any time.

A typical message path is from Pt. Arguello, Calif., to Goddard and Mercury Control. This example, with slight modification, will fit all other sites in the net.

Pt. Arguello's long range radar "picks-up" the capsule as it comes "in view." The 28ASR and the Radar Digital Data Converter send nearly 100 items of information, at 60 WPM teletype speed, to GSFC. These items include: radar data; telemetered capsule environment, instrument readings and equipment checks.

At Goddard, the ROTR S/P "sees" the CDC of "JJ" (radar data) and "blinds-off" the other equipment on the inward line. The receiving machine converts the serial (punched) data to parallel (digital) form and sends it on to the computers. The computers digest the data and generate 37 different pieces of information, which are then sent to Mercury Control. In case something goes wrong with the ROTR S/P, and Goddard's spare ROTR S/P's are in use, the radar data

Inward Teletype System Equipment Symbols

(60) = 60 wpm teletype.
(100) = 100 wpm teletype.
28ASR = Automatic Sending and Receiving Teletypewriter.
R = Radar digital data to teletype form converter.
A = Open Circuit Alarm.
ROTR S/P = Receiving Only Typing Reperforator—Serial to Parallel. Receives incoming signals from line, forwards non-radar data to 28SS unit, converts serial (punched) radar data into parallel (digital) form and sends to computers.
Interface Ckts. = feed both IBM 7090 computers simultaneously with radar data from ROTR S/P.
28SS = 28-type Station Selector Unit.
ROTR = Receiving Only Typing Reperforator. Automatically copies incoming messages.
MXD = Tape Transmitter Gate of Multi-Gate Unit. Tape transmitter for manual relay of intercepted messages.
R∼T = Reperforator-Transmitter Unit (R/T). Takes 60 wpm data, changes it to 100 wpm and automatically forwards messages to Mercury Control.
Priority Ckt. No. 2 = Priority circuit for Group 2 sites. Messages with "PP" code automatically choose this line to Mercury Control.
Sequency Circuit No. 2 = Delivers both regular and priority messages, at 100 wpm, to Mercury Control from Group 2 sites. "PP" messages automatically choose this line also, for reliability.
Page RO = Page message Receiving Only Unit.

Outward Teletype System Equipment Symbols

Trans Start = Transmitter Start Unit. "Poll" all line transmitters for traffic-to-go and also for "up" or "down" status.
PB = Push Button Unit. When button is pushed on this unit, it automatically assigns a CDC and sends the message to an R/T Unit. One on each 28ASR and LBXD.
28 ASR = Automatic Sending and Receiving Machine.
LBXD = Gate of 28-type Multiple Tansmitter. One in each Group, at Goddard, for transmitting taped messages to the sites.
MXD = Tape Transmitter Gate of Multi-Gate Unit. For manual transmission of messages to sites. (By-passes automatic equipment, for use in emergencies.)
28 DIST = Converts digital (parallel) radar data to punched (serial) form and forwards acquisition and other radar messages to R/T Units. Two at computer outputs and 2 as stand-bys.
ROTR = Receiving Only Typing Reperforator. For intercepting messages for manual relay from an MXD unit.
RO = Receiving Only. Receives 60 wpm teletype messages.
RO MON = Receiving Only Monitor. Monitors all messages and in case of equipment malfunction can store messages and prevent their loss.
R∼T = Reperforator-Transmitter Unit. Changes 100 wpm messages to 60 wpm and forwards messages to sites. Will also store messages if outgoing line is being used.
R-T Control = Reperforator-Transmitter Control Ckt. Switches message to the desired line's R/T Unit.

will not be lost. Connected electrically ahead of the receiving equipment is emergency equipment which will store incoming radar data till the computers are back in "up" status.

The ROTR S/P also "sees" other CDC's. These include "PP" (priority) and "CC" (Mercury Control). These messages will go straight through Goddard to MCC. Depending on the CDC, the 28 Station Selector equipment does a number of things, simultaneously. These are: send "PP" data directly to Mercury Control over Priority Circuit No. 2, and also to an R/T unit; send "CC" data directly to an R/T unit; record all incoming messages in the ROTR unit tied to this circuit. When Pt. Arguello sends a Telemetry Summary Message, it is automatically sent to Mercury Control and also to a Summary Broadcast transmitter in Goddard's Outward Teletype System, for transmission to all the sites. At Mercury Control, these messages are shown on the main plot board.

Messages sent to the R/T unit are converted into 100 WPM form and sent to MCC. The equipment that handles these R/T units does a number of simultaneous acts and deserves a closer look.

The equipment associated with Sequence Ckt. No. 2, prevents stations from monopolizing circuit time and aids in "line-sharing." This sequence equipment: places a demand for an outgoing line as soon as the ROTR S/P "sees" the CDC; it starts an R/T unit if the outgoing line is idle; if the line is in use, the sequencer equipment will start the R/T unit as soon as the line is free; if more than one R/T unit has tape, the equipment allows each unit a turn to send one message until any backlog is cleared up.

In case of equipment breakdown or messages with an erroneous CDC or no CDC, Goddard will intercept. These messages will then be manually reinserted into the network with the MXD unit.

All equipment at Goddard is in duplication. The lines from GSFC to MCC are also duplicated (2 Priority Circuits and 2 Sequence Circuits). Priority messages follow duplicate paths. Any message with a CDC of "PP" will automatically select Priority Circuit No. 2 and Sequency Circuit No. 2 (if the site is in group 1, it will be PC No. 1 and SC No. 1).

Outward Teletype System

Let's follow messages from Mercury Control and Goddard to Pt. Arguello. Again, this circuit is representative of the other 16 outward circuits from MCC and GSFC to the sites.

Messages originating at MCC and GSFC are taped. The tape is inserted into the 28ASR (MCC) or the LBXD (GSFC). In the case of Mercury Control, the operator pushes a button on the push button unit. A CDC is automatically assigned and the message is on its way, over 100 WPM lines to GSFC. If the circuit (at Goddard) Mercury Control wants is free, the message automatically goes to an R/T unit, is converted to 60 WPM teletype form and transmitted to Pt. Arguello. If, for some reason, Goddard is using the line, MCC's message is stored in the R/T unit till the line is free. Then it is automatically forwarded.

At Goddard the message goes from the LBXD to the R/T unit and is forwarded. Messages also come to the R/T units from the 7090's. The 7090's are constantly generating capsule acquisition messages. These contain azimuth, range, elevation angle and the time at which the capsule should come "in view." The messages are transmitted to the sites concerned, 3 times, about 20 minutes apart. From the computers the message goes to the 28 DIST. The 28 DIST converts the digital (parallel) data into punched (serial) form and sends it to an R/T unit.

In case of an open circuit, down equipment or other malfunctions, an alarm is sounded. Goddard intercepts any messages, or diverts them to "up" equipment. If intercepted, the messages are then manually forwarded to the sites by the MXD units. Also, if there is an erroneous CDC assigned, Goddard intercepts and manually (MXD) forwards the message.

If Mercury Control wants to emergency broadcast to all sites, it throws a switch and has exclusive use of all outgoing circuits. The emergency message path is from the transmitter (at MCC) linked to Group 1 circuits (at Goddard) through an automatic switch to Group 2 circuits.

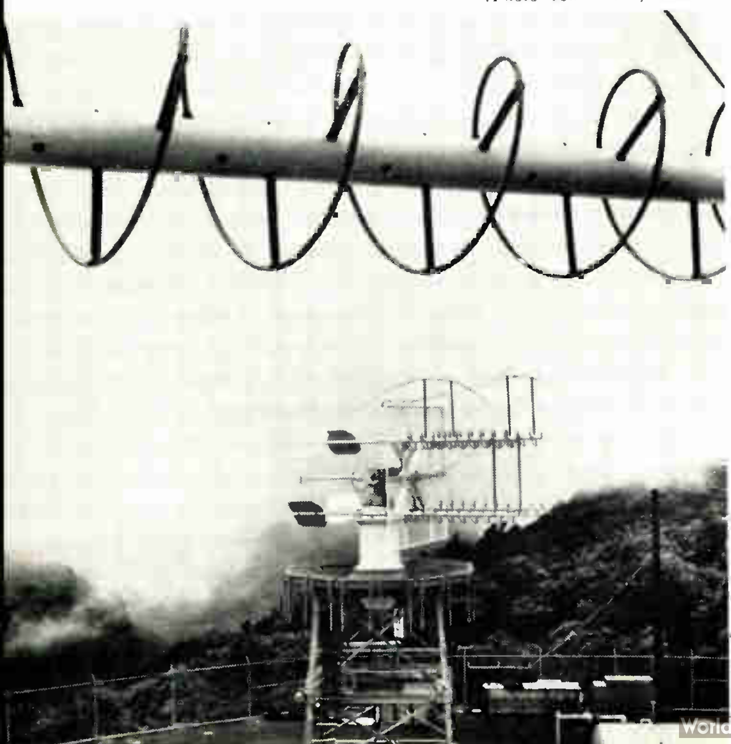
As with the Inward System, there are a total of 17 outgoing circuits. Five of these are part-time and 3 are shared. The part-time circuits allow simultaneous transmission to adjacent sites or to more than one receiving unit at the same site, without transmission delay or interference.

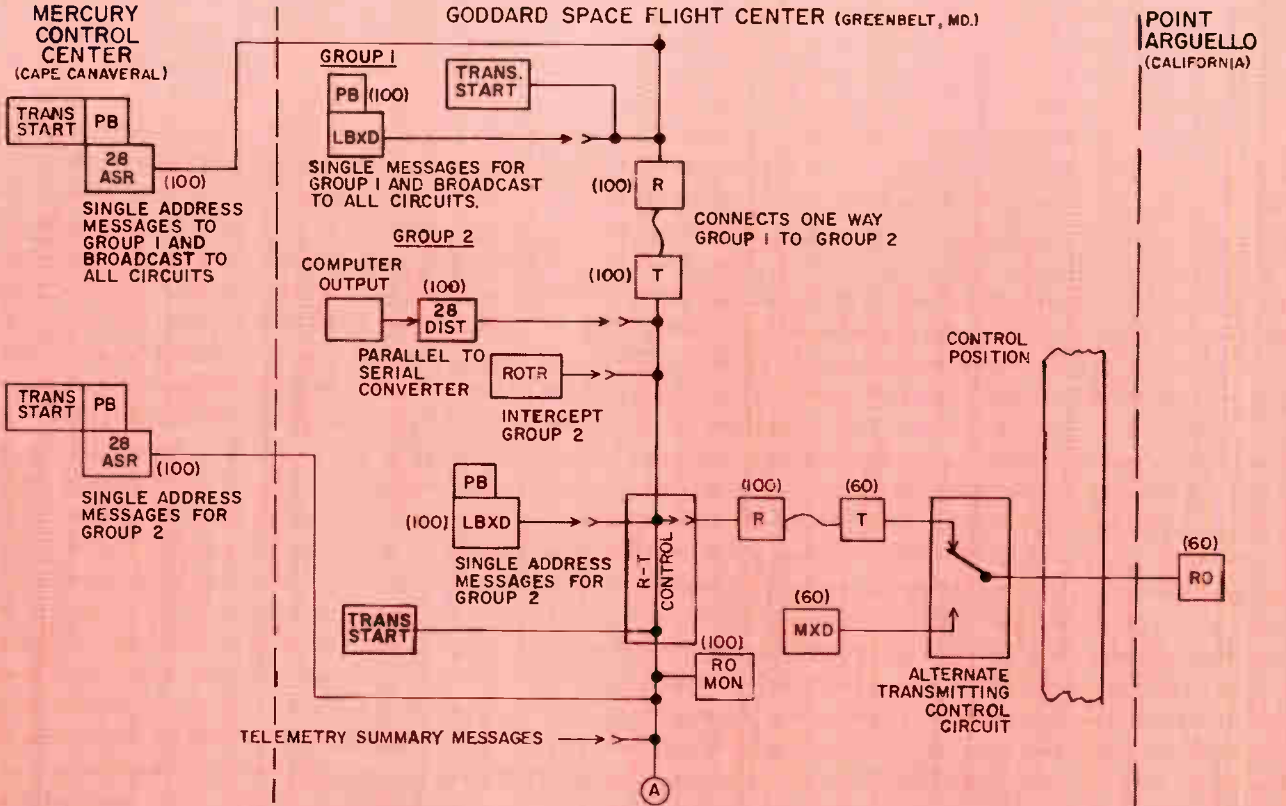
One of the most important pieces of equipment in the Outward System is the Trans Start Unit. Both MCC and GSFC have these units connected to their tape sending equipment. The Trans Start Unit continuously and automatically "polls" all transmitter stations for "up/down" status and any "traffic-to-go." A Transmitter Start Code (TSC) is sent to each sending station in a pre-determined pattern. If the transmitter has no message to send, it replies with a "V"

HAWAIIAN QUAD-HELIX

Quad-helix telemetry antenna at Kauai, Hawaii. One of 18 tracking and communications sites in the Mercury Network, Kauai is one of six network sites with command control equipment.

(Photo courtesy of NASA)





1-WAY TELETYPE SYSTEM—FEEDING DATA TO THE SITES

Typical layout for teletype circuit from GSFC to the sites. Messages are taped and put into the 28ASR (MCC) or the LBXD (GSFC) transmitting machines. A button is pushed on the PB (Push Button) unit, a site address is assigned and the message is automatically forwarded. Computer output data (acquisition messages, etc.) enter the 28DIST and are converted from digital to punched form. Then they go to an R-T Control Ckt. (Reperforator-Transmitter), and on to an R/T unit to be forwarded to the site. Trans Start Unit "polls" all transmitters for "up/down" status and traffic-to-go, and will also automatically start any transmitting station loaded with tape for transmission. MXD (transmitter) is for manual relay transmission, and for use in case of equipment malfunction.

(no-traffic) signal. The Trans Start Unit then automatically "polls" the next transmitter.

If the transmitter has a message to send, the Trans Start Unit automatically starts the machine and the message is forwarded. The procedure for transmitting follows. The transmitter first sends the CDC. It then stops and waits for a "V" (invitation to transmit) signal from the selected line's R/T unit. When the transmitter gets this "V," a second CDC is sent, followed by an end-of-address code and the message text. When the message text ends, the transmitter pauses 2 seconds and then sends an end-of-message code. The code: automatically switches the R/T unit back to a waiting condition; and starts the Trans Start Unit "polling" again.

During the "polling," lights at the Control Position indicate which station is sending. The Position also has keys for: stopping the "polling"; skip "polling" certain transmitters if desired.

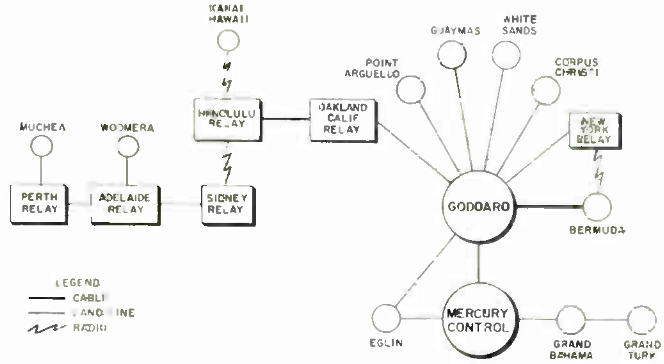
To sum-up the Outward System. GSFC and MCC push a button, a CDC is assigned and the message sent. GSFC neither delays nor stores any message unless the circuits are being used or equipment is down. There is no message loss from "down" gear or erroneous CDC's; GSFC will intercept and manually relay the message. Goddard can intentionally intercept outgoing messages if there is trouble at site receiving equipment or a line is open. GSFC and MCC can broadcast to all sites simultaneously, by pushing a single button and transmitting the message once. In an emergency, MCC can throw a switch and have exclusive control of all out-going circuits.

Voice Network

Mercury Control at the Cape has an indication that the Freedom 7's heat and re-entry shield is loose. MCC checks with astronaut, through Hawaii, and finds he has no such indication. The Mercury Flight Controllers decide to be safe and leave the retro-package on the capsule, until it is over Texas during re-entry. This information is passed to Pt. Arguello over Mercury's Voice Communications Network. Controllers

MERCURY'S VOICE NETWORK

Layout of Project Mercury's Voice Network. SCAMA (Switching Conferencing and Monitoring Arrangement), located at Goddard, controls hook-up between any 2 or all of the net's sites.



Mercury Network *(Continued)*

at the Cape hear Arguello's Flight Controller give the instructions to the astronaut. An emergency has been met successfully.

Project Mercury's Voice Network was designed primarily for just such occasions. The command control sites (able to control capsule maneuvers, retro-firing, etc.), are linked to the Goddard Space Flight Center. There are 6 command sites: Mercury Control, Bermuda; Muchea, Australia; Pt. Arguelo; and Guaymas, Mexico. Also, 10 of the tracking sites: MCC; Bermuda; Muchea; Woomera; Kauai, Hawaii; Pt. Arguello; Guaymas; White Sands, N. Mex.; Corpus Christi, Tex.; and Eglin, Fla., are connected to GSFC.

In Goddard is the Switching, Conferencing and Monitoring Arrangement (SCAMA). This is the switching center for the voice network. Here, any 2 or all of the sites on the net can be linked together for a number of purposes. These include: actual missions; practice missions; during actual missions—monitoring the astronaut's voice communications and for pass-off of capsule radar contact; and general and administrative conferences.

The network contains about 35,000 miles of voice channels, for nearly continuous 2-way voice contact with the astronaut. Two frequency ranges are used: 1 channel between 15 and 30 MC and 3 channels between 200 and 300 MC. Four-wire circuits are used throughout the net (2 wires in each direction). This 4-wire technique keeps distortion to a minimum, allows for good volume levels and has a high-degree of reliability. Land lines, overseas radio links, submarine cable and microwave relay are used. All of this is necessary because some of the sites are half-way around the world, Muchea and Woomera, Australia for example. The submarine cable to Hawaii, via Oakland, Calif., was chosen for reliability and ease of transmission. The East-West paths have had a poor radio performance history, and there isn't any room in this vital, life and death, network for "drop-outs" or "fading."

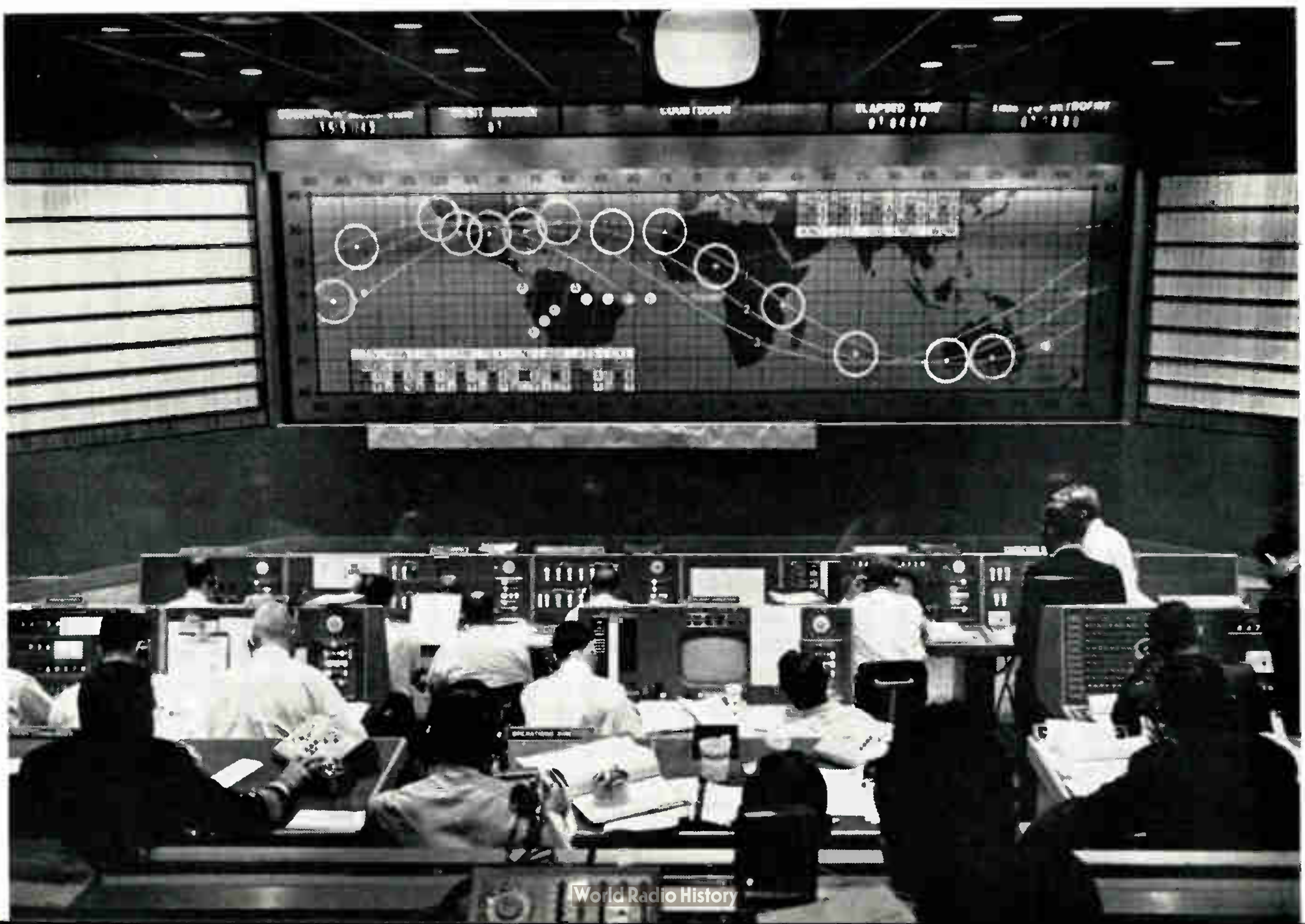
During missions the voice network sites are linked into one loop. All of these sites can monitor network traffic, but only those having a need to talk are allowed to. The SCAMA operator, at GSFC, controls this "talk-access-capability." Each site is allowed to talk, in turn, as the capsule comes "in view." Each site's Flight Controller is then able to talk directly with the Flight Controller at the Cape.

If conditions are right, the whole network is able to monitor transmissions between the astronaut and the "in view" site.

With several radio links, the net has a problem with atmospheric and storm noise. The radio link from Australia to Honolulu is especially susceptible. To counteract this interference, when Kauai, Hawaii, has the capsule "in view," special measures are taken. Honolulu, during Kauai transmission time, has a switch, which it throws and opens the transmission circuit from Sidney. Even though transmission is

MERCURY CONTROL CENTER AT THE CAPE

Mercury Control personnel during the first orbit of the Friendship 7. Man next to naval officer (Recovery Commander) is the Operations Director. Directly in front of him are the Mercury Flight Directors. Capsule is just leaving Australia. *(Photo courtesy of NASA)*



stopped, Woomera and Muchea are still able to listen in on the net's traffic.

The mission network hook-up has several important reasons-for-being. The net's 4 main purposes follow. 1. MCC gets "real-time" information on the capsule. This lets Mercury Control counteract emergencies as they are in progress. 2. If for some reason the capsule must be brought out of orbit in a hurry, MCC can immediately direct (much faster than by teletype) the nearest command site (to the capsule) to change the settings for retro-firing. 3. With all the network sites monitoring the astronaut-Earth communications, the sites are ready at any instant to begin action in an emergency. 4. More exact radar tracking is possible. When 2 sites, say Pt. Arguello and Guaymas, have overlapping radar and command transmitter coverage, the voice net allows them to pass-off the capsule without loss of coverage or mix-up of signals. Pt. Arguello tells Guaymas the exact moment it ceases transmitting. Guaymas begins its own transmitting the next second. This avoids simultaneous transmission of command and radar beacon signals from both sites, causing capsule equipment to damage itself. The SCAMA operator (at Goddard) connects just the sites concerned (using telephone-switchboard-type cord circuits) together.

The telephone lines used in the continental limits portion of the network are leased from U. S. common carriers. Outside of the continental limits, a combination of leased (from foreign carriers) and constructed radio and wire circuits are used.

Computing and Tracking Operations

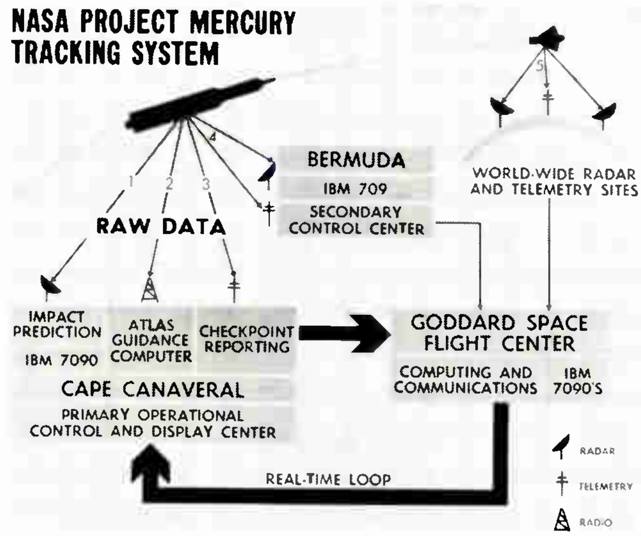
The final part of the Mercury Ground Communications and Tracking Network we'll look at will be the Computing and Tracking Operations.

The tracking system uses 2 types of radars—Verlort and the AN/FPS-16. Tracking procedure for a site having both types, has the Verlort "pick-up" the capsule as soon as possible. Verlort data is manually switched (at the site) for teletype transmission. As the capsule "closes" with the site, the switch is thrown to the FPS-16. When the capsule moves out of '16 range, the switch is thrown back to the Verlort system.

Except for continual coverage of the first minutes of flight, radar data is sent back to Goddard in samples taken every 6 seconds. The radar data, plus the Greenwich Mean Time, is put into tape form and forwarded to GSFC's 7090's. The computers take the data, digest it and other incoming and preset information and forward to Mercury Control some 37 items vital to the flight. These items are sped over high-speed data (1,000 bits/sec.) lines, and used to run wall maps, plot boards and display devices.

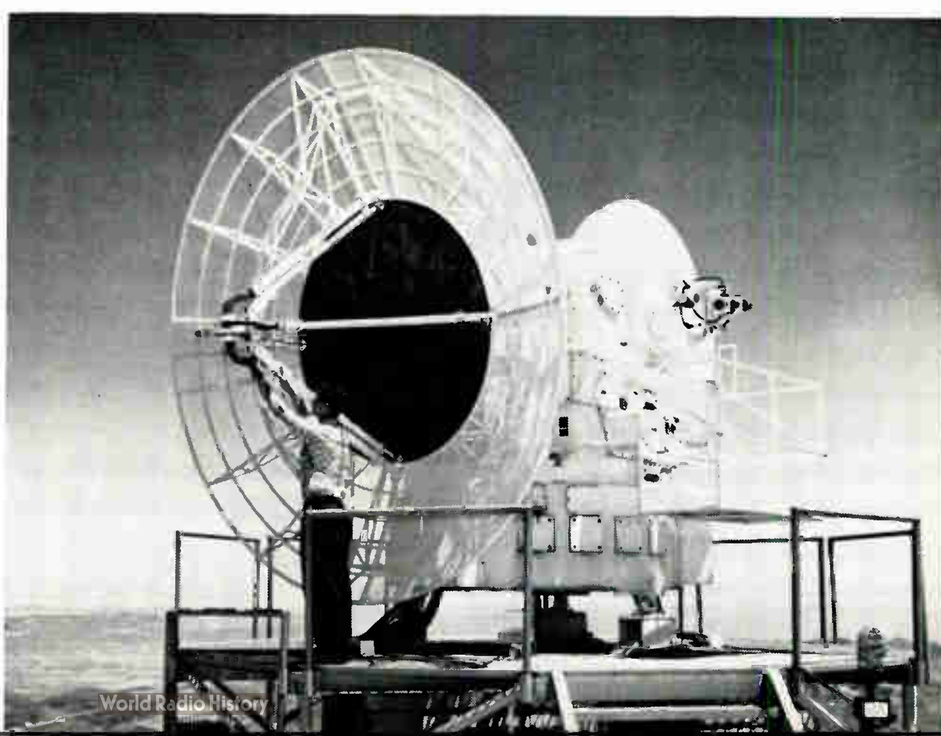
The computers also generate display information that is sent to the sites and that runs display equipment at Goddard itself.

Mercury Control Center has a wide variety of equipment. Included are 14 control consoles, 36 computer operated displays, and units for recording and displaying almost 100 capsule telemetered items of information. (*Continued on Following Page*)



TRACKING PROCEDURE *(Diagram courtesy of IBM)*

Radar data (1) automatically converted into computer language and sent to the IBM 7090 at the Cape. Guidance data (2) from vehicle radioed to Atlas Guidance Computer at Burroughs-General Electric Complex at Cape. Telemetry data (3) from vehicle reports mission check points, lift-off, booster separation, etc. Radars and telemetry equipment (4) at Bermuda feed IBM 709 at BDA to help determine if an acceptable orbit is being achieved. Network tracking and telemetry stations (5) send data back to Goddard, helping to establish capsule's exact orbit.



LONG RANGE RADAR

Pt. Arguello's long range precision tracking radar. Called the Verlort, it is atop Mount Tranquillon, 2,200 feet above sea level. Tracking procedure has the Verlort "pick-up" the capsule as soon as it is "in view." When the capsule closes with the site, the tracking is switched to the AN/FPS-16 (short range radar). When the capsule is out of '16 range, tracking is switched back to the Verlort. Radar "skin tracks" the Mercury Spacecraft to determine roll, pitch and yaw.

(Official U. S. Navy photo)

Mercury Network *(Concluded)*

Goddard display equipment includes 2 plot boards, each driven by 4 Digital-to-Analog Converter channels. These X vs. Y plots can be made to show for example, capsule heights vs. flight path angle.

Computing Operations

Reliability in Project Mercury's Computing Operations, as in the other parts of the Ground Communications and Tracking Network, is by duplication. Goddard uses 2 IBM 7090's in parallel.

GSFC's computers have been programmed: 1. To recognize where data is coming from. 2. To determine what kind of data it is (radar, telemetry, or manually inserted). 3. To assess the reasonableness of the new data as compared to programs already stored in the computer's memory. 4. To shift automatically from one computational method to another as the mission dictates (from launch to orbital to re-entry calculations). 5. To take raw data, digest it, and deliver results—simultaneously and continuously. 6. To accept up to 32 interruptions, one on top of the other (incoming and outgoing data, manual interrogations, timing information), and then on a priority basis, to go back and pick-up where it left off. 7. To digest all incoming data into output for display purposes and also send capsule acquisition messages to the sites.

Goddard's computers are not the only ones in the network. Bermuda and the Cape also have them. The Cape's Impact Predictor is an IBM 7090 and is used to predict where the rocket would land if its power cut-off during climb to orbit altitude. Another computer at the Cape is in the Burroughs-General Electric Complex. This special purpose computer is part of the guidance system of the Mercury launch vehicle. It receives radar, plus telemetry, data from the vehicle itself.

Bermuda has an IBM 709 computer, which when combined with BDA's radar data, gives Bermuda its own data on the capsula, and aids the Flight Controllers at the Cape in deciding if the capsule should be inserted into orbit, or if the mission should be aborted.

GODDARD COMPUTING ROOM

Main computing room at Goddard Space Flight Center. Over 37 vital items of information are produced here and forwarded to Mercury Control for display. Large objects in center are the X-Y Plot Boards. Over 5,000 miles of high-speed data lines connect Goddard to the computers at Cape Canaveral, Fla. *(Photo courtesy of NASA)*

There are about 5,500 circuit miles of high-speed data lines between Goddard and Cape Canaveral. This circuit mileage is in the form of 4 separate data lines. Two come from the Burroughs-General Electric special purpose computer. The other two come from the Impact Predictor 7090.

Three of the major computer program systems are: Launch; "Where the capsule will be"; and "Where the capsule is now."

Launch computations (from liftoff till the capsule is out of the Cape's range) have 2 phases—normal and abort. The normal covers: liftoff to tower separation (safety tower); tower separation to capsule separation; and post capsule separation. During this phase, a continuous prediction of time for retro-fire and impact point is computed and displayed in case the mission must be aborted.

If Mercury Control decides an abort is necessary, the radar data is converted to vector point and velocity. The time for retro-fire and the impact point are computed, displayed and the capsule is brought back to Earth.

The orbiting phase contains the "Where the capsule is going to be" and "Where the capsule is now" programs, which are run simultaneously. The former is properly called the Orbit Prediction Macro-System. It develops an output table of predicted positions and corresponding velocities of the capsule flight. A set of pre-planned orbital parameters are manually fed into the computers and aid in solving the solutions determining the capsule orbit.

The latter, or "Where the capsule is now," program, is called the Differential Correction Macro-System. It determines the instantaneous orbit parameters. A variety of facts are involved here. Included are: edited radar observations; the orbit prediction table (from preceding paragraph); and the pre-planned orbit parameters. The pre-planned orbit is corrected and this information is displayed as instantaneous orbit elements. The same orbit differential correction process is also used to predict capsule re-entry trajectory and landing point. As a hint of computational accuracy, Mercury Control's radio and television comments stated, "On the basis of his present flight trajectory, we estimate he (Lt. Col. John H. Glenn, Jr.) will land about a mile from a destroyer (USS Noa) associated with the USS Randolph at the end of the third orbit." He actually landed about 5 miles away.

Conclusion

Project Mercury's Ground Communications and Tracking Network is vast and complex, yet extremely reliable. We have tried to give as accurate and detailed an account as space permitted. Reliability, which is literally a matter of life and death, is attained in a high degree. Duplication of equipment, circuits and systems is extensively used. Most of the Network is automated. Project Mercury's Ground Communications and Tracking Network, as our first tracking and communications network, is truly a shining example of American know-how and effort.

We wish to thank the Western Electric Co., International Business Machines Corp., Bell Telephone Laboratories, Burns and Roe, Inc., and especially NASA's Goddard Space Flight Center for information made available to us.

* * *

New Tech Data for Engineers

Space Technology

"General Electric Valley Forge Space Technology Center," an 8-page pamphlet describes the main features of this first large space center in the United States built by private industry. Designated PIB-58, the pamphlet is illustrated with facility photos and drawings. Information includes general description, a list of facilities and details of the Space Environment Simulation Laboratory. General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Phila. 1, Pa.

Circle 693 on Inquiry Card

Microwave Components

Short Form Catalog, No. SF 202 describes coaxial attenuators, balanced mixers, hybrid power dividers, directional couplers, coaxial hybrid tees, and coaxial phase shifters. Included are photographs and specifications. Merrimac Research and Development, Inc., 517 Lyons Ave., Irvington 11, N. J.

Circle 694 on Inquiry Card

Log-Periodic Antenna

Performance details and applications are described in tech. data on a vertically polarized monopole log-periodic antenna for ionosphere sounder systems. G/A Model 726-4/64 offers low and constant VSWR, 10db gain and low take-off angle. Granger Associates, 974 Commercial St., Palo Alto, Calif.

Circle 695 on Inquiry Card

UHF Bandpass Filters

Melpar, Inc., Special Products Div., Sub. of Westinghouse Air Brake Co., 3000 Arlington Blvd., Falls Church, Va., is offering tech data on their line of uhf bandpass filters featuring center freqs. of 400 to 1500 mc; bandwidths of 5 to 20% and signal rejection greater than 20 db at one bandwidth from filter center freq.

Circle 696 on Inquiry Card

FM Instruments

Condensed catalog is available from Electro - Mechanical Research, Inc., Sarasota, Florida, describing their line of FM instruments and accessories for airborne telemetering. Descriptions and condensed specs. on FM subcarrier oscillators, FM mixers and amplifiers, and VHF power amplifiers and telemetry transmitters are included.

Circle 697 on Inquiry Card

Telemetry Systems

Acton Laboratories, Inc., 533 Main St., Acton, Mass., is offering a general catalog which describes their phase measuring and phase standards equipment, precision dial drives, mechanical products, and Rotoflex® Commutators. The commutator designed for rocket and satellite telemetry systems has a noise level guaranteed less than 10mv.

Circle 698 on Inquiry Card

Antenna Towers

Tech data is available on the Trylon Type 2400H tower for microwave communications. Also included is information on special towers for military uses, prefabricated cables and guys, and towers for VHF-UHF point-to-point communications. Wind Turbine Co., West Chester, Pa.

Circle 699 on Inquiry Card

Microwave Absorbers

Electronautics Corp., Maynard, Mass., has available data sheet #6-9000-1 describing Hi-Pow, a newly developed microwave absorbing material for use in high power terminations, dummy loads and as high temp., high vacuum attenuators. Attenuation at X-band varies from 30db/in. to 200db/in.

Circle 700 on Inquiry Card

Rotary Joint Design

Sage Laboratories, Inc., 3 Huron Dr., E. Natick Industrial Park, Natick, Mass., is offering 3 new tech. discussions entitled, "Microwave Crystal Diodes," "Noise Figure & Sensitivity of Mixers & Video Detectors" and "Rotary Joint Design." The discussions include outline drawings, schematics, diagrams, and characteristic charts.

Circle 286 on Inquiry Card

Compensated Crossbars

Tech. Bulletin No. 60-301, 4 pages, 2 colors, entitled "Wide Band Compensated Crossbars," will be of interest to engineers working in radar, telemetry, communications, video, and data processing. The illustrated bulletin discusses the inter-related problems of frequency-response fidelity, crosstalk, and impedance match, and the way in which they are compounded in signal-switching systems as the freq. spectrum widens to 30MC. James Cunningham Son & Co., Inc., Honeoye Falls, N. Y.

Circle 287 on Inquiry Card

Reflector Antennas

WDL-TR-1500 entitled, "Reflector Antennas for Radio and Radar Astronomy," is available from Philco Corp., Western Development Labs., 3875 Fabian Way, Palo Alto, Calif. The 91 page booklet is the result of a world-wide survey of electro-mechanical data on reflector type radio telescopes. Data is tabulated according to country and operating radio observatory, for each antenna in order of increasing physical cross-sectional area above ten square meters. An extensive list of references is included.

Circle 288 on Inquiry Card

Multiplex System

A 4-page tech. bulletin on the Type LD Telephone Multiplex System for radio is offered by Farinon Electric, 935 Washington St., San Carlos, Calif. Included is data on equipment operation, electrical and mechanical design detail and options.

Circle 289 on Inquiry Card

Slotted Lines

Complete specs. are provided for various types of waveguide, components, test components and special products. Included in the catalog are slotted line and matched loads, slide tuners, high power pressurizable phase shifters, movable tunable terminations, multihole tuners and precision traveling detectors. This 22-page catalog is available from Electronic Specialty Co., Technicraft Div., 116 Waterbury Rd., Thomaston, Conn.

Circle 290 on Inquiry Card

Microwave Test Equipment

California Technical Industries, Div. of Textron, Inc., 1421 Old County Rd., Belmont, Calif., is offering a 22-page catalog on microwave test equipment which features VSWR measuring systems, magnetron r-f supplies, variable polarization antennas and automatic radome beamship measuring system.

Circle 291 on Inquiry Card

Telemetry

Applied Electronics Corp. of New Jersey, Metuchen, N. J., has tech. data available on their solid state telemetry equipment. Featured is PCM digital telemetry systems, PDM multicoders completely transistorized, PAM, Model MAH-3 series of pulse amplitude modulation multicoders, solid state commutators, and dc amplifiers.

Circle 292 on Inquiry Card

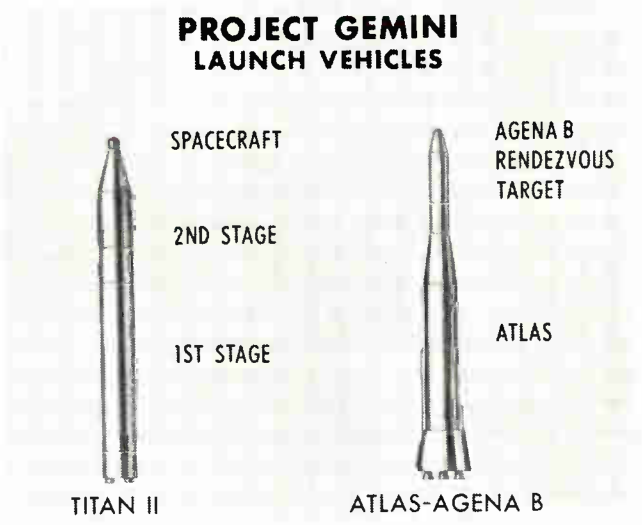
Future Space Satellites and Missions

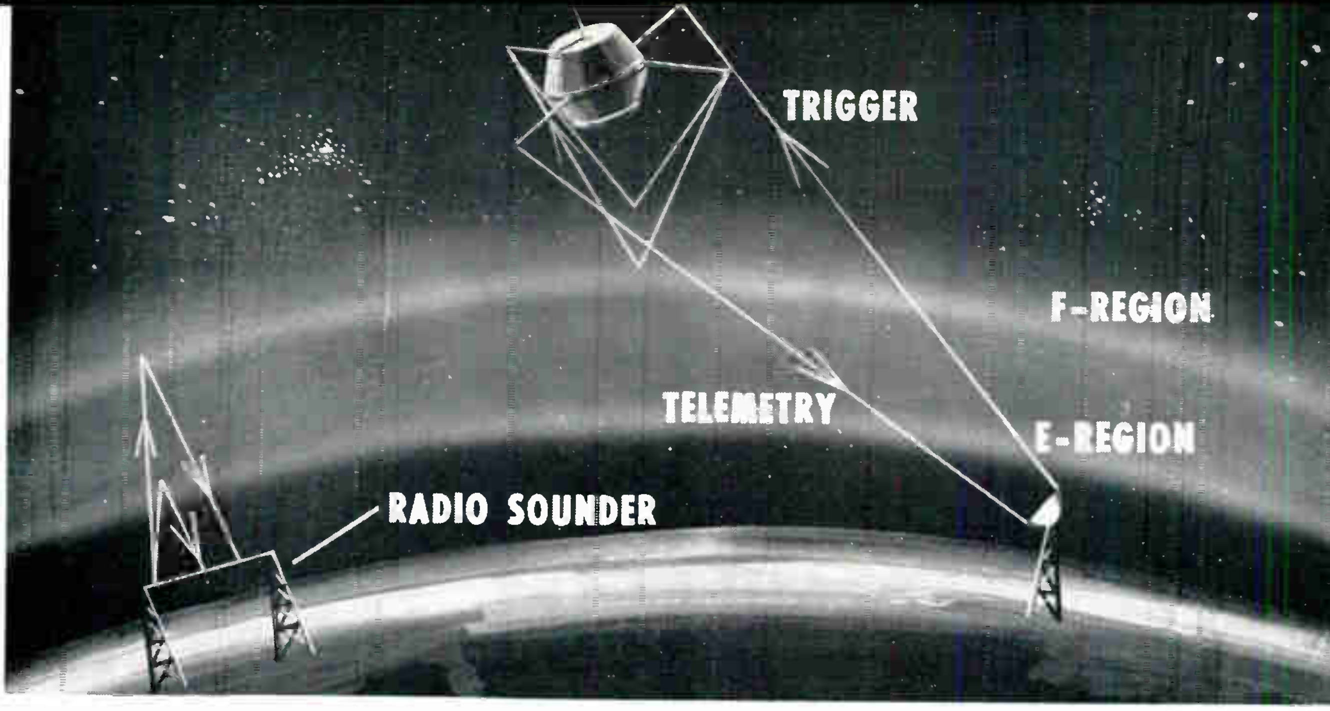
- Saturn
- Topside Sounder
- OAO
- Nimbus
- Gemini
- Mariner
- Relay
- Surveyor
- Syncom
- OGO

(Photo courtesy of NASA)

SATURN
C-1 version at liftoff, Oct. 27, 1961. Upper 2 stages were dummy loads. Thrust: 1.3 million lbs. Nine more shots scheduled. C-2 version (3 to 4 million lbs. thrust) for circumlunar mission about 1966. Nova (12 to 20 million lbs. thrust) is scheduled for Apollo launching and lunar landing before 1970.

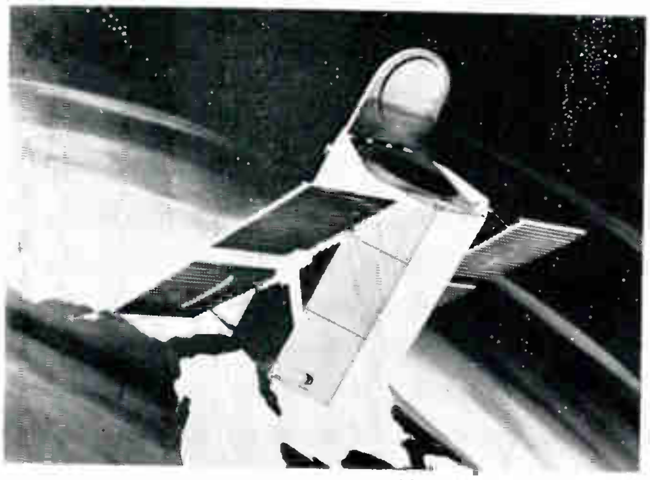
(Photo courtesy of NASA)





(Photo courtesy of NASA)

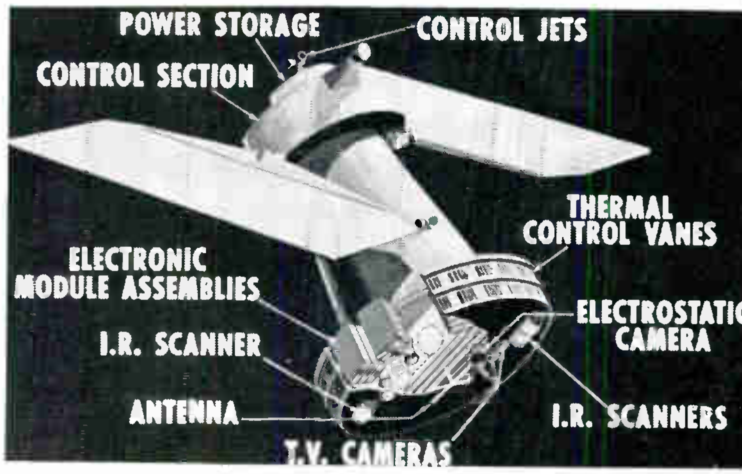
TOPSIDE SOUNDER (S-48): NASA's scientific satellite is scheduled for launching in the 3rd quarter of 1962. It will measure ionospheric electron density above the peak ionization of the F-2 layer, which will be 252.9 to 463 5 kilometers.



(Photo courtesy of Grumman)

OAO

NASA's Orbiting Astronomical Observatory is scheduled for laurch in late '63 or early '64. Carrying 1,000 lbs. of equipment, it will measure cosmic phenomena (24 hour orbit).

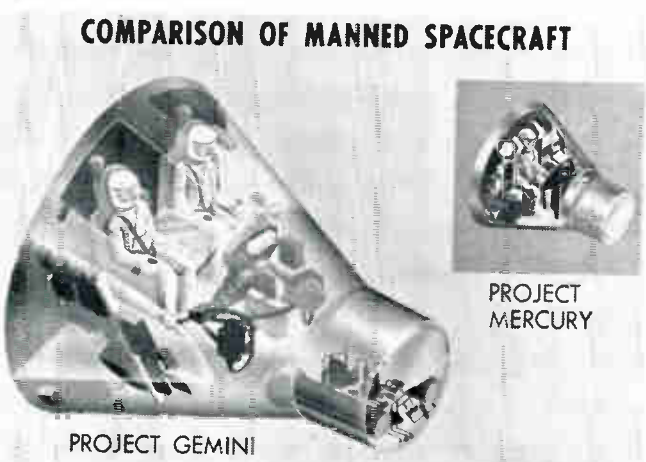


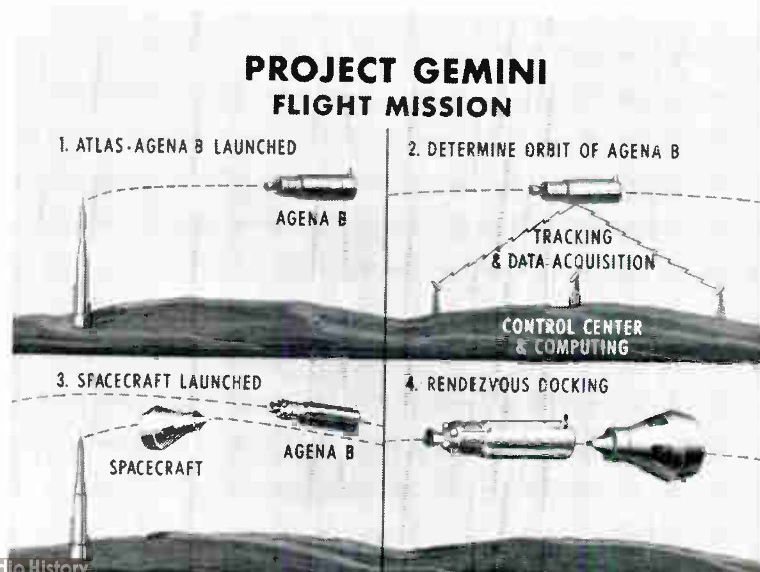
(Photo courtesy of NASA)

NIMBUS

Scheduled for a late 1962 launch. NASA's Meteorological satellite is follow-on to the highly successful Tiros Series. Will carry advanced TV cameras and radiation detectors.

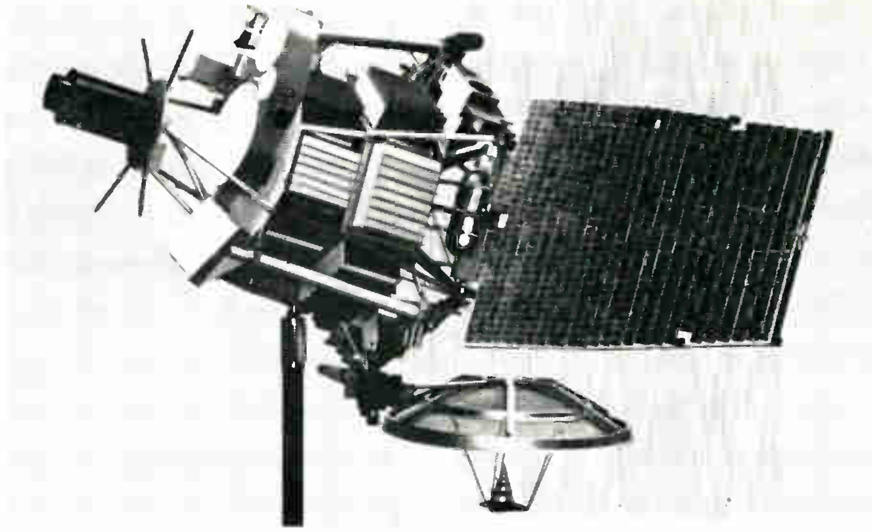
GEMINI: Two-man spacecraft will have around 50% more volume and weigh about two to three times as much as its predecessor Mercury. Unmanned flights are scheduled for possible launchings in 1963 or 1964. Saturn may be used in later flights.





. . . Satellites and Missions

(Continued)



MARINER

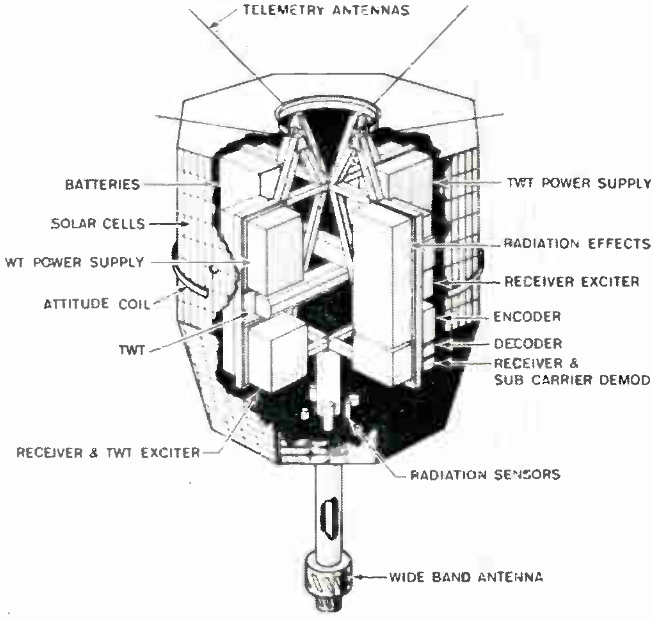
NASA's Deep Space Probe will be sent to Venus later this year. It is designed to scan the planet for temperature distribution; find out what the atmosphere is made of; and measure any planetary magnetic fields that may be present.

(Photo courtesy of NASA)

RELAY

This active repeater communications satellite will carry 2 communications transponders able to receive and transmit television, 2-way telephone and other wide-band data. Planned to receive on 1725mc and re-transmit on 4170mc. Will also conduct experiments in radiation effects on components.

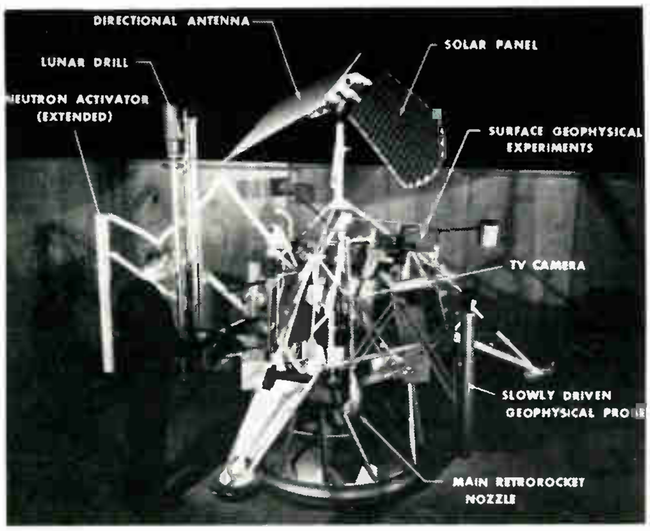
(Photo courtesy of NASA)



SURVEYOR

Lunar Survey Craft for soft land (6 mph) on the moon. Launch: 1963. Will analyze moon surface materials and radio results back. Carries 4 TV cameras for detailed observations.

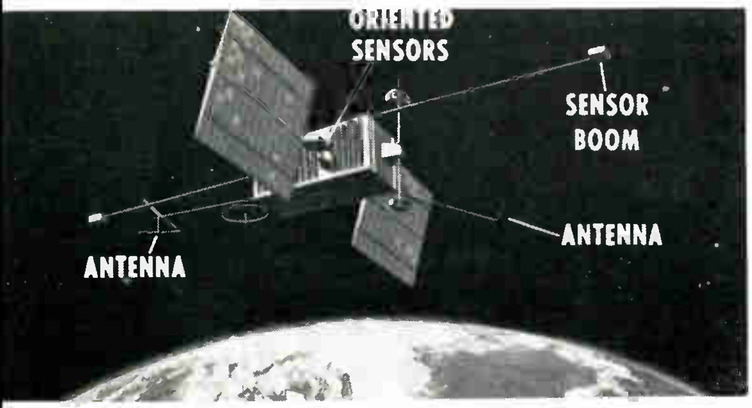
(Photo courtesy of NASA)



OGO

NASA's Orbiting Geophysical Observatory is in developmental status. Will be first standardized satellite—carrying up to 50 experiment instruments in a stock structure.

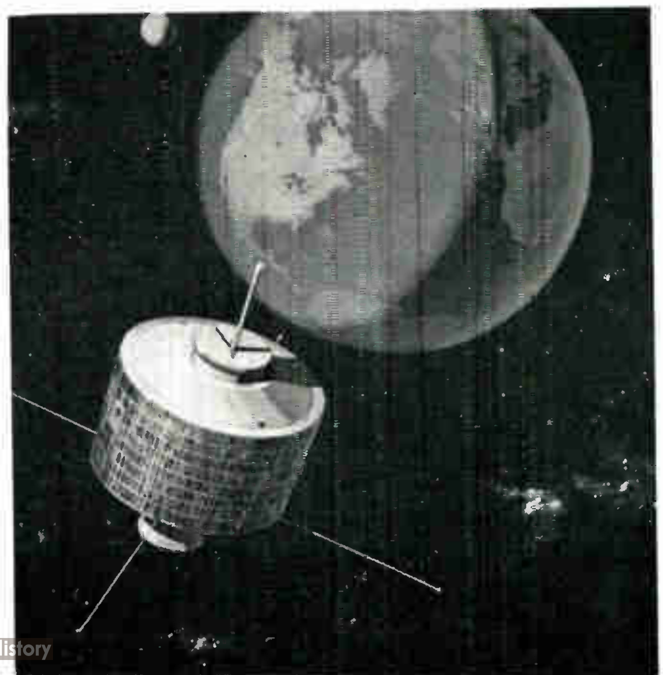
(Photo courtesy of NASA)



SYNCOM

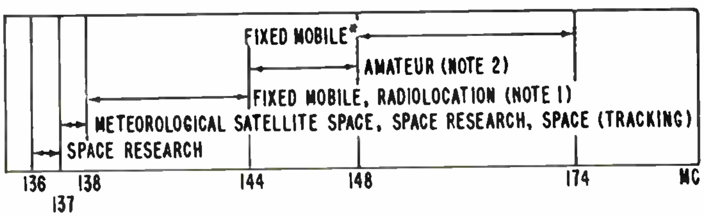
In a 22,300 mile, near synchronous orbit, this communications satellite will relay telephone and telegraph signals. The Mk. II version will make possible 1,200 2-way telephone calls simultaneously. NASA has scheduled launching for late in 1962.

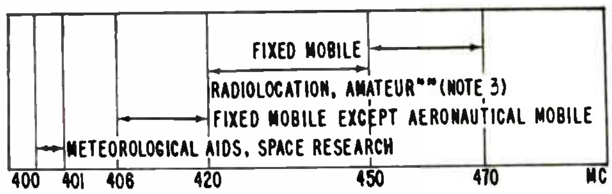
(Photo courtesy of Hughes)

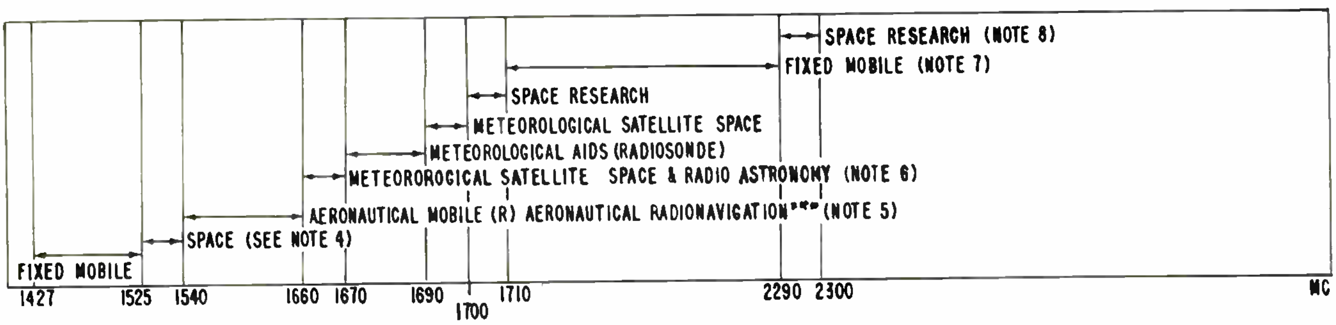


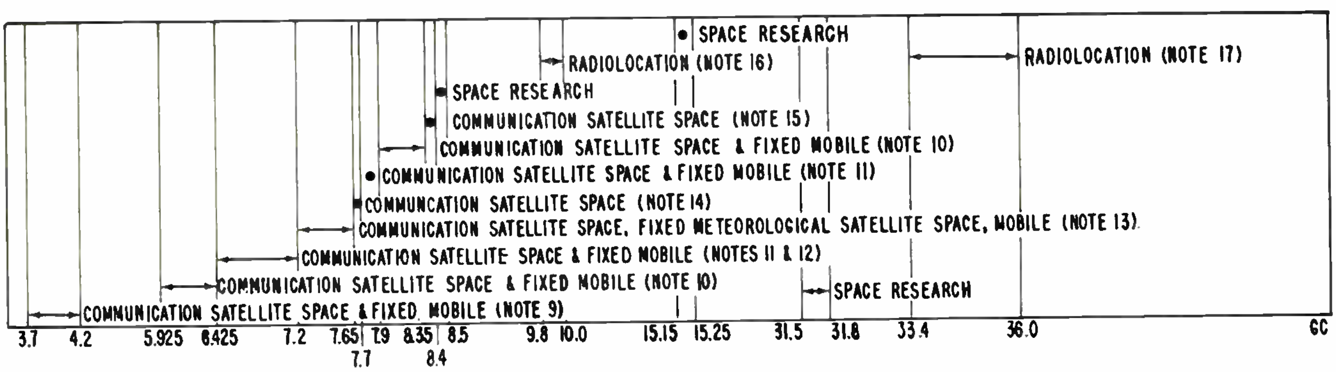
Preliminary Views of U.S.A. . . . Space

Extract from Federal Communications Commission Docket No. 13552 (Enclosure 1 to Doc. 5713/6-4.9.1.) Section 8. Conclusions—The U. S. A. has concluded that, in order to: a. Accommodate aerospacecraft, b. Accommodate meteorological satellites, c. Augment the Space and Earth-Space (space research) bands contained in the Geneva Radio Regulations, and d. Provide frequency allocations in the immediate future for the reliable exchange, via communication satellite relay, of high-capacity information between points on the earth's surface, including ships, aircraft and aerospacecraft, the Table of Frequency Allocations should be amended as follows:









NOTES

1. Permitted service.
2. The frequencies 144.0 and 148.0MC, with a maximum bandwidth of 20KC, may be used for satellite command purposes subject to agreement between administrations concerned and those whose services, operating in accordance with the Table, may be affected.

* 287, footnote as contained in Geneva Radio Regulations.
** 317, 318, footnote as contained in Geneva Radio Regulations.
*** 341, footnote as contained in Geneva Radio Regulations but with the limits of the appropriate band changed to read: 1540-1660MC.

3. The frequencies 420.0 and 450.0MC, with a maximum bandwidth of 25KC, may be used for satellite command purposes subject to agreement between administrations concerned and those whose services, operating in accordance with the Table, may be affected.
4. In the band 1525-1535MC, telemetry only; in the band 1535-1540MC, command only.
5. The use of the band 1540-1660MC by the aeronautical mobile (R) service is limited to radiocommunications along civil routes for flights utilizing space radiocommunication techniques and which may be operating in the space environment.
In the band 1600-1660MC the aeronautical radionavigation services will be protected from harmful interference from the aeronautical mobile (R) service for an unspecified period of time.
6. The radio astronomy service is authorized to use the band 1664.4 - 1668.4MC. The radio astronomy service shall be protected from harmful interference from services operating in other bands only to the extent that those services are protected from each other.
7. The band 2110-2120MC may be used for command of spacecraft engaged in deep space research, subject to agreement between administrations concerned and those whose services, operating in accordance with the Table, may be affected.
8. For deep space research only.
9. For transmission only by communication satellite stations whose field strength at the earth's surface is below that which will cause harmful interference to stations in the fixed and mobile services.
10. For transmission only by earth stations, subject to agreement between administrations affected.
11. Transmission by earth stations in this band is subject to agreement between administrations affected. When used for communication satellite stations, the field strength at the earth's surface shall be below that which will cause harmful interference to stations in the fixed and mobile services.
12. The band 7.12-7.13GC may be used for command of spacecraft subject to agreement between administrations affected.
13. For transmission only by communication satellite and meteorological satellite stations whose field strength at

Frequency Allocations

the earth's surface is below that which will cause harmful interference to stations in the fixed and mobile services.

Meteorological satellite stations share 100MC of this band.

14. For transmission only by communication satellite stations.

15. For transmission only by earth stations.

16. The band 9.9-10.0GC may be used for satellite weather radar for precipitation detection.

17. Satellite weather radar for cloud detection share 100MC of this band.

APPENDIX 1*

GUIDE FOR USE OF THE 1959 I.T.U. SPACE AND EARTH-SPACE RESEARCH BANDS

BAND, MC	PRIMARY USE	REASON	SECONDARY USE
10.003–10.005	Ionosphere research.	Marked propagation effect; can be used world-wide with standard receivers and antennas.	Ultra-range telemetry, low altitude satellite.
136–137	Tracking in center-third of the band; telemetering in the other two-thirds.	Replaces the IGY 108 MC; minimum noise area for tube receivers. World-wide tracking net is available.	Ionospheric measurements in association with the above band. Narrow band telemetering.
183.1–184.1	No planned use.		
400–401	Telemetering; low scan rate TV for geophysical and astronomical satellites; navigation satellites.	Conventional transistors are practical.	Deep space research with very large antennas.
1427–1429	Telemetering; narrow-band TV; deep space; development of precision minitrack.	Excellent for deep space with very large antennas. Very low propagation effects.	
1700–1710	Wide-band TV for meteorological satellites.	For meteorological and data transmission where wide-band is needed; likewise for radio-relay.	Planet radar.
2290–2300	Primary telemetering and tracking band for deep space research.	Nearly the ideal frequency area for 85 foot parabolic reflector antennas. Very low cosmic noise.	"Double-doppler" cross-band velocity measurements.
BAND, GC			
5.25–5.255	No planned use.		
8.4–8.5	Communication satellite research—earth-to-earth relay experiments. Deep space probes.	The 100 MC bandwidth here permits wide-band communications relay.	Space navigation application; planet radar; meteorology (with 15.15 and 31.5 GC bands).
15.15–15.25	Space relay.	High directivity.	Meteorology (used with 8.4 and 31.5 GC bands).
31.5–31.8	Space relay; re-entry telemetering.	High directivity—small antennas. Penetration of plasma layer.	Meteorology (used with 8.4 and 15.15 GC bands).

* Appendix 1 summarizes the present use of the 1959 OARC Space Research Bands. Appendix 2 shows recommended augmentation of Appendix 1.

APPENDIX 2b

PROPOSED NEW INTERNATIONAL SPACE RESEARCH BANDS

IN ITU BANDS	NEED	REMARKS
137–174 MC	Two frequencies for earth-to-space satellite command purposes. One should be at 144 MC and the other at 148 MC, each 20 KC bandwidth.	The selection of these band-edge frequencies, 144 and 148 MC, would produce the minimum impact on existing services—a "command" is usually a single pulse of less than one second duration—adjacent services will not be aware of its presence.
406–470 MC	Two frequencies for earth-to-space satellite command purposes. One should be at 420 MC and the other at 450 MC. The bandwidth should be 25 KC.	The selection of these band-edge frequencies, 420 and 450 MC, should produce a minimum impact on the existing services, reasoning as above.
1435–1660 MC	The band 1525–1540 MC for space use, for both telemetering and command purposes.	The too-narrow band 1427–1429 MC should be deleted. The band 1525–1535 MC would be used for space-to-earth telemetering, and the band 1535–1540 MC for earth-to-space services, such as command, interrogation and control of the space vehicle.
1700–2300 MC	The band 2110–2120 MC for deep space command, footnote status.	Suggested footnote: The band 2110–2120 MC may be used for earth-to-space-probe command purposes subject to agreement between administrations concerned and affected. This band would be paired with the 2290–2300 MC deep-space research band for command purposes.
5.925–8.4 GC	A command band 7.12–7.13 GC for command of research satellites using the 8.4–8.5 GC space research band, footnote status.	Suggested footnote: The band 7.12–7.13 GC may be used for command of spacecraft subject to agreement between administrations concerned and affected. This band is paired with the 8.4–8.5 GC space research band for command, interrogation and control purposes.

Tech Data

for Engineers

Microwave Components

Specs. and uses are detailed in tech data from the Instrument Div., LFE Electronics Inc., Dept. 1079, 714 Beacon St., Boston 15, Mass., on precision microwave instruments and components. Information is included on their Series 814A and 816L ultra-stable microwave oscillators; Series 820XLK crystal locked klystron oscillators; and Model 240 disturbance waveform analyzer.

Circle 293 on Inquiry Card

Traveling Wave Tubes

Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif., is offering tech data on their traveling wave tubes. Characteristic charts, complete electrical specs, and photographs are included on low noise tubes, medium power tubes, low power tubes, and Serrodyne and special purpose tubes.

Circle 294 on Inquiry Card

Microwave Accessories

Antlab, Inc., 6330 Proprietors Rd., Worthington, Ohio, has a 1962 short form catalog including antenna pattern recorders, microwave receivers, boresight systems, antenna pattern integrators, radome mounts and fork-controlled oscillators. Schematics, photographs, outline drawings and specs. are included.

Circle 295 on Inquiry Card

Digital Computers

This 12-page tech bulletin contains information on the SDS 900 Series digital computers. The high speed, low cost computers are solid state, single address, ferrite core memory machines for general-purpose scientific and special-purpose systems integration. Scientific Data Systems, Inc., 1542 15th St., Santa Monica, Calif.

Circle 296 on Inquiry Card

Shunt Tees

Tech. data is available from Aircom Inc., 48 Cummington St., Boston 15, Mass. on their line of series and shunt tees, hybrid tees, precision bends, coax-waveguide adapters, straight sections, twists, and waveguide stands.

Circle 297 on Inquiry Card

Recording Paper

This 8-page illustrated booklet describes Alfax Type "A2" electrosensitive recording paper for commercial facsimile, industrial and scientific data recording purposes. Photos, graphs and tables explain the advantages and characteristics of the recording paper which is for slow and medium speed recording uses. Alfax Paper & Engineering Co., Alden Research Center, Westboro, Mass.

Circle 298 on Inquiry Card

From Avco...

traffic cop for today's crowded skyways

It delivers up to 120 landings per hour, even under instrument conditions . . . handles 24 aircraft in the terminal area at a time . . . provides continuous surveillance of every plane in its 90-mile control radius.

It's Avco's Air Traffic Control Central—the AN/GSN-11—developed by Avco's Electronics and Ordnance Division. The GSN-11 is designed to make more efficient use of limited air space at busy terminals—increase landing safety. It automatically guides a plane's pilot from point of identification to landing position. It computes air speed and capability, wind direction, and all other arriving traffic—then selects the simplest, most economical flight path to a safe landing.

Now on test at the National Aviation Flight Experimental Center near Atlantic City, the GSN-11 is being tried out with planes ranging from high-speed jet interceptors to slow single-engine types. Upon completion of these tests by the USAF and the FAA, Avco will be able to offer the most advanced air traffic control equipment in existence today.

For complete information on Avco's Air Traffic Control Central, write: Director of Marketing, Electronics and Ordnance Division, Avco Corp., Cincinnati 41, Ohio.

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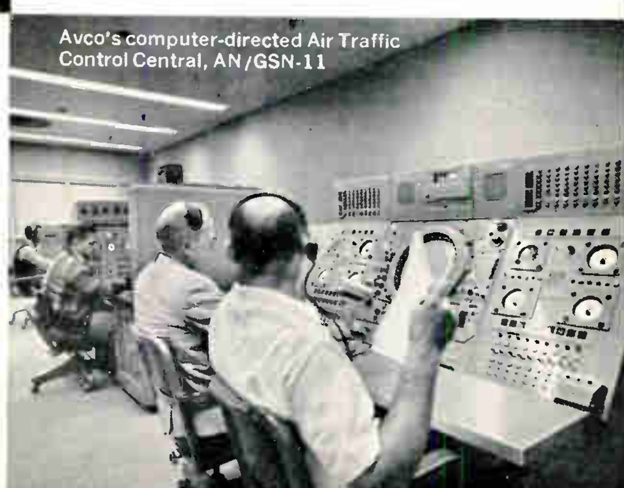

Avco's computer-directed Air Traffic Control Central, AN/GSN-11

Circle 250 on Inquiry Card

Wanted:

ASTRONAUT

with 3 years' experience making lunar orbits.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

For Sale:

MERCURY CAPSULE SWITCHES

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

Wanted:

GEOLOGIST

CONTROLS COMPANY OF AMERICA
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Wanted:

25 POUNDS LUNAR DUST

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

Wanted:

ROBOT

with 28 volt electrical system

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

This advertisement is an explanation. *Number 14 in a series.*

WHY

Control Switch Division has been running these unusual advertisements

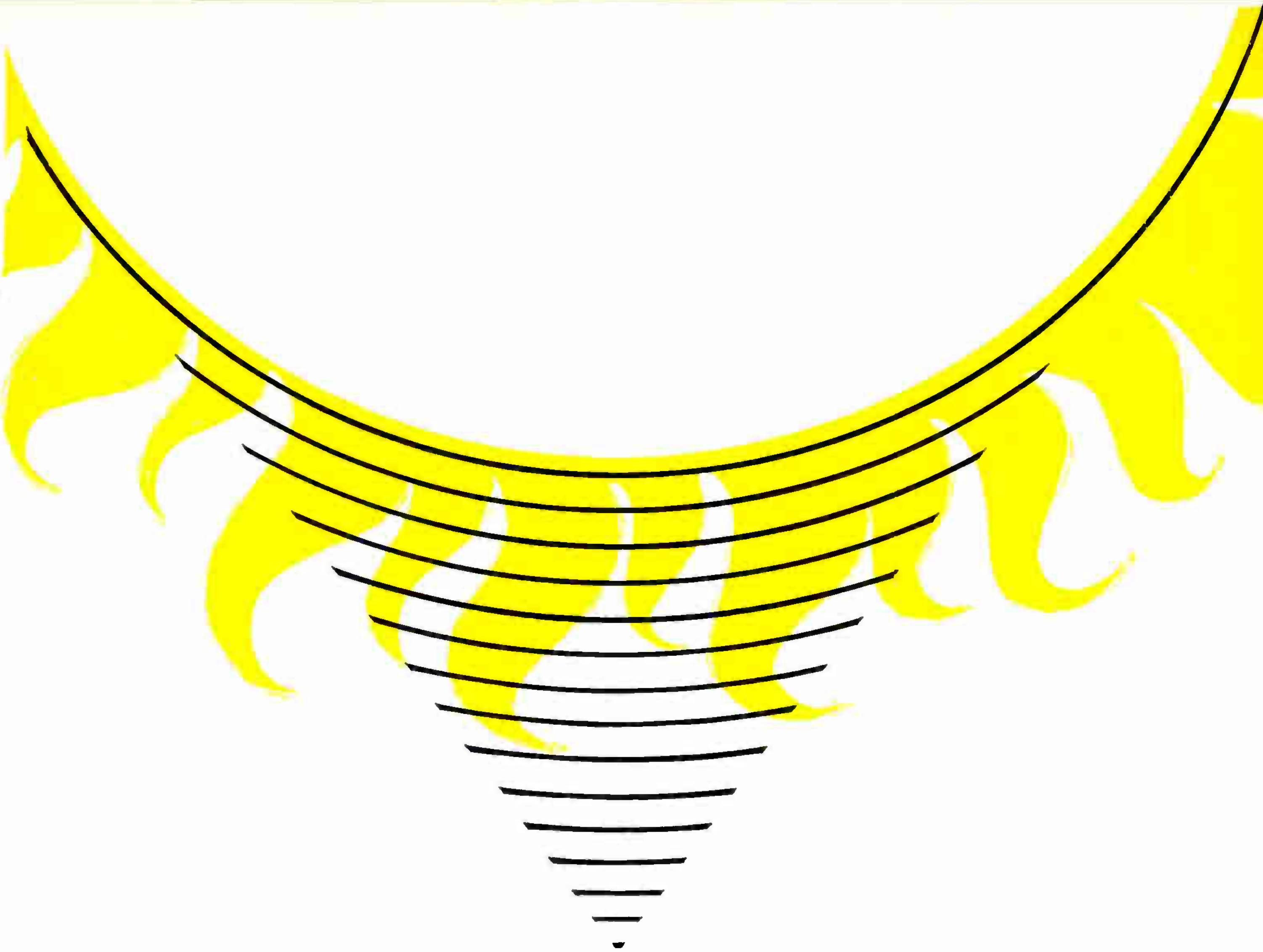
The 1961 Defense Dept. procurement and renegotiation law appears to prohibit technical product advertising as an allowable normal business expense for prime and sub-contractors. Only Help-Wanted, Critical Materials, and Surplus Goods ads are allowed. Our series of ads follow the "letter-of-the-law", as a dramatic protest to the disallowing of technical product advertising, which is so vital to keeping Engineers up-to-date on current developments. Our objective is to alert industry to the dangers of this law which we believe is inconsistent with the normal operation of Free Enterprise, and a dangerous precedent. What is your opinion?

Free full-size reprints of this series of ads, suitable for framing, are available on request.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

Circle 252 on Inquiry Card

Manufacturers of the Electrosnap and Hetherington full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.



CAPTURING SOLAR STORMS WITH RADAR...

new data for man's exploration of space

Using the world's most powerful VHF radar system, MIT Lincoln Laboratory Solar Radar Site near El Campo, Texas is gathering new data on the sun's corona; measuring the origin and intensity of violent coronal activity which ejects high energy particles into the solar system . . . a serious hazard to space travel.

Heart of the radar is a 500,000 watt VHF transmitter designed and built by Continental Electronics, specialists in super power transmitters. Operating at frequencies near 38 megacycles per second with a continuous output power of 500,000 watts, this transmitter is ten times more powerful than the largest commercial broadcast transmitter in the United States.

Increasing our scientific knowledge of the factors affecting space travel, the El Campo project is jointly sponsored by the U. S. Army, Navy, and Air Force.

Partial view of the transmitter, console and control panel for the radar system.

Continental Electronics

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4212 S. BUCKNER BLVD. • EV 1-7161 • LTV SUBSIDIARY OF LING-TEMCO-VOUGHT, INC.

Designers and Builders of the World's Most Powerful Radio Transmitters

Circle 249 on Inquiry Card

SPECIAL PURPOSE TUBES

OA2	.80	4-65A	10.00	25Z6WGT	1.50	725A	10.00	5751WA	2.00
OA2WA	2.00	4-125A	20.00	26Z5W	1.50	726A	5.00	5763	1.75
OA3	.85	4-250A	32.50	FG-27A	20.00	726B	5.00	5777	150.00
OB2	.60	4-400A	30.00	28D7W	3.50	726C	8.50	5778	150.00
OB2WA	2.00	4-1000A	80.00	FG-32	10.00	NL-760	20.00	5783	2.25
OB3	.70	4AP10	10.00	35T	10.00	802	7.50	5784	2.50
OC3	.50	4B31	12.50	35TG	2.50	803	3.50	5797	2.50
OD3	.30	4C35	15.00	FP-54	100.00	804	15.00	5796	10.00
C1A	8.50	4CX250B	30.00	FG-57	10.00	805	7.50	5800/VX-41	7.50
1AD4	1.50	4CX1000A	125.00	RK-60/1641	1.50	807	1.50	5803/VX-55	5.00
1B24	7.50	4D32	15.00	HY-69	3.00	807W	2.00	5814A	1.35
1B24A	12.50	4E27A	27.50	BL-75	3.00	808	2.50	5829	1.00
1B35A	3.00	4J32	100.00	75TL	17.50	809	5.00	5826	50.00
1B63A	10.00	4J34	100.00	TG-77	7.50	810	15.00	5837	50.00
1C/3B22	5.00	4J50	100.00	HF-100	10.00	811	2.50	5840	2.50
C1K	7.50	4J52A	100.00	100TH	12.00	811A	4.00	5845	6.00
1P21	32.50	4PR60A	50.00	100TL	12.00	812A	4.75	5852	5.00
1P22	8.00	4X150A	13.50	FG-105	25.00	813	12.50	5876	8.50
1P25	10.00	4X150D	15.00	F-123A	5.00	814	3.50	5879	1.15
1P28	15.00	4X150G	25.00	FG-172	25.00	815	5.00	5881 6L6WGB	2.00
1Z2	1.50	4X250B	20.00	211	2.50	816	2.25	5886	4.00
2-01C	12.50	4X250F	30.00	212E	25.00	826	3.50	5893	12.50
2AP1A	8.50	5BP1A	9.50	FG-235	50.00	828	12.50	5894	18.85
2B23	20.00	5C22	17.50	242C	10.00	829B	10.00	5915	1.00
2BP1	10.00	5CP1A	9.50	244A	3.50	832	2.50	5931/5U4WG	2.00
2C36	22.50	5CP7A	9.50	245A	3.50	832A	7.50	5933/807W	2.50
2C39A	9.75	5D21	7.50	249B	10.00	833A	37.50	5948/1754	100.00
2C39B	15.00	5J26	50.00	249C	5.00	836	2.50	5949/1907	50.00
2C40	7.50	5JP1	7.50	250R	10.00	837	1.00	5963	1.00
2C42	3.00	5LP1	7.50	250TH	25.00	838	1.00	5964	.85
2C43	7.50	5R4GY	1.25	251A	50.00	842	7.50	5965	.85
2C46	5.00	5R4WGA	4.00	254A	3.50	845	7.50	5975	2.50
2C50	4.00	5R4WGB	6.00	FG-258A	100.00	849	75.00	5976	50.00
2C51	1.50	5R4WGY	2.00	259A	3.50	851	50.00	5992	5.00
2C52	1.50	5RP1A	9.50	262B	3.50	866A	1.90	5993	5.00
2C53	7.50	5Y3WGT	1.25	267B	5.00	869B	50.00	6005/6AQ5W	1.50
2D21	.50	5Y3WGTB	2.50	271A	12.50	872A	5.00	6012	4.00
2D21W	1.00	6AC7W	.50	274A	3.50	884	1.25	6021A	2.00
2E24	2.25	6AC7WA	2.00	283A	3.50	885	.85	6032	10.00
2E26	2.50	6AG5WA	1.50	287A	3.50	889RA	150.00	6045	1.15
2E30	3.50	6AG7Y	1.00	QK-288	250.00	891R	200.00	6072	1.50
2J42	75.00	6AK5W	1.25	HF-300	35.00	913	9.50	6073	1.50
2J51	50.00	6AK5 (WE)	.75	300B	5.00	920	2.50	6074	1.75
2J55	90.00	6AL5W	.60	304TH	35.00	927	1.50	6080	3.35
2K22	25.00	6AN5	1.75	304TL	35.00	931A	3.50	6080WA	5.00
2K25	8.50	6AN5WA	3.50	307A	.50	1000T	80.00	6080WB	10.00
2K26	35.00	6AQ5W	1.00	310A	3.50	R1130B	10.00	6082	3.35
2K28	25.00	6AR6	.75	311A	3.50	1500T	150.00	6087/5Y3WGTB	2.50
2K29	25.00	6AS6W	1.00	313C	1.50	1614	2.75	6101/6J6WA	1.50
2K30	50.00	6AS7G	2.50	323A	6.00	1620	4.00	6106	1.50
2K33A	200.00	6AU6WA	1.25	328A	3.50	1624	1.00	6115/QK351	50.00
2K34	75.00	6B4G	3.35	329A	4.50	1625	.50	6130/3C45	6.50
2K35	200.00	6BA6W	.75	336A	2.50	1635	2.00	6136/6AU6WA	1.25
2K39	150.00	6BE6W	1.50	337A	3.50	1846	50.00	6146	3.00
2K41	50.00	6BF7W	2.00	347A	1.00	1855	250.00	6159	3.50
2K42	125.00	6BH6W	2.75	348A	4.50	2050	1.25	6161	35.00
2K43	200.00	6BL6	20.00	349A	3.50	ZB-3200	100.00	6186/6AG5WA	1.50
2K44	125.00	6BM6	25.00	350A	3.50	5516	7.50	6189/12AU7WA	1.50
2K45	20.00	6BM6A	30.00	350B	2.50	5528/C6L	3.50	6197	1.75
2K47	150.00	6C4W	2.50	352A	8.50	5545	20.00	6201/12AT7WA	1.85
2K48	50.00	6C4WA	1.00	354A	12.50	5550	30.00	6202/6X4WA	1.50
2K50	175.00	6C21	17.50	355A	12.50	5552/FG235	50.00	6211	.75
2K54	10.00	6D4	1.50	371B	2.50	5553/FG258	100.00	6216	3.00
2K55	15.00	6F4	3.50	388A	2.00	5557/FG17	5.00	6236	125.00
2K56	50.00	C6J	10.00	393A	5.00	5558/FG32	10.00	6248	250.00
2P21	40.00	C6J/A	15.00	394A	3.00	5559/FG57	10.00	6263	9.00
2X2A	1.25	C6J/K	20.00	395A	2.25	5560/FG95	25.00	6265/6BH6W	2.75
3A5	.75	6J4	1.75	396A/2C51	1.50	5561/FG104	50.00	6299	37.50
3AP1	3.50	6J4WA	2.50	398A/5603	3.00	5586	150.00	6316/BL800A	100.00
3B4	2.50	6J6W	.60	401A/5590	1.00	5608A	6.00	6322/BL25	12.50
3B24W	3.00	6J6WA	1.00	403B/5591	3.00	5636	2.25	6336	8.75
3B24WA	5.00	6K4	2.00	404A/5847	7.50	5642	2.25	6336A	12.75
3B25	2.50	6L6GAY	.75	407A	3.75	5643	3.00	6344/QK235	500.00
3B26	2.25	6L6WGA	1.50	408A/6028	2.75	5647	3.50	6350	1.25
3B28	3.00	6L6WGB	2.00	409A/6AS6	1.00	5651	1.00	6352	7.50
3B29	5.00	6Q5G	2.50	GL-414	90.00	5654/6AK5W	1.50	6385	10.00
3BP1A	7.50	6SJ7WGT	1.25	410R	75.00	5656	5.00	6390	125.00
3C22	15.00	6SK7W	.75	416B/6280	20.00	5663	1.00	6394	12.75
3C23	4.00	6SK7WA	2.00	417A/5842	9.50	5665/C16J	35.00	6438	5.00
3C24/24G	7.50	6SL7WGT	1.00	418A	9.50	5667	125.00	6442	30.00
3C33	7.50	6SN7W	.50	420A/5755	5.00	5670	1.00	6463	1.00
3C45	3.50	6SN7WGT	1.00	421A/5998	7.50	5672	1.35	6485	1.50
3CX100A5	15.00	6SN7WGTA	2.50	429A	6.50	5675	10.00	6517/QK358	500.00
3D21A	5.00	6SU7GTY	.85	GL-434A	10.00	5678	1.25	6533	7.50
3D22	8.00	6V6GTY	1.00	450TH	40.00	5686	2.25	6542	5.75
3DP1A	5.00	6X4W	.75	450TL	40.00	5687	1.50	6550	3.00
3E29	7.50	6X4WA	1.50	578	5.00	5691	5.00	6807	20.00
3GP1	2.50	6X5WGT	1.00	KU-610	5.00	5692	3.50	6883	3.50
C3J	7.50	SRL7H	100.00	NL-623	10.00	5693	3.50	7034/4X150A	15.00
C3J/A	9.50	7AK7	2.50	631-P1	5.00	5696	1.00	7044	1.50
3J21	35.00	7MP7	22.50	673	15.00	5718	1.50	7580	35.00
3J31	100.00	10KP7	15.00	676	30.00	5720/FG33	17.50	8002R	25.00
3JP1	5.00	12AT7WA	1.50	677	40.00	5721	100.00	8005	10.00
3K21	125.00	12AU7WA	1.50	701A	5.00	5725/6AS6W	1.50	8008	7.75
3K22	125.00	12AX7W	1.35	703A	1.50	5726/6AL5W	.75	8013A	5.00
3K27	150.00	12AY7	1.00	707B	2.50	5727/2D21W	1.25	8014A	30.00
3K30	100.00	C16J	25.00	715C	15.00	5728/FG67	10.00	8020	4.50
3KP1	9.75	FG-17	5.00	719A	12.50	5749/6BA6W	1.00	8025A	7.50
3RP1	7.50	HK-24	5.00	721B	5.00	5750/6BE6W	1.50	9003	2.00
3WP1	12.50	25T	10.00	723A/B	3.50	5751/12AX7W	1.35	9005	3.50

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916-685-9582

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Min. order $10

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SUPPLIERS OF ELECTRON TUBES SINCE 1932

Tech Data

for Engineers

Silver Brazing

Brazing News #86, available from Handy & Harman, 850 Third Ave., New York 22, N. Y., contains information on a method for joining copper and copper alloys by silver brazing them.

Circle 299 on Inquiry Card

Mask Washers

A brochure giving information on 2 agitation type spray painting mask washers and 6 modules of high pressure spray washers is available from Conforming Matrix Corp., 839 New York Ave., Toledo 11, Ohio.

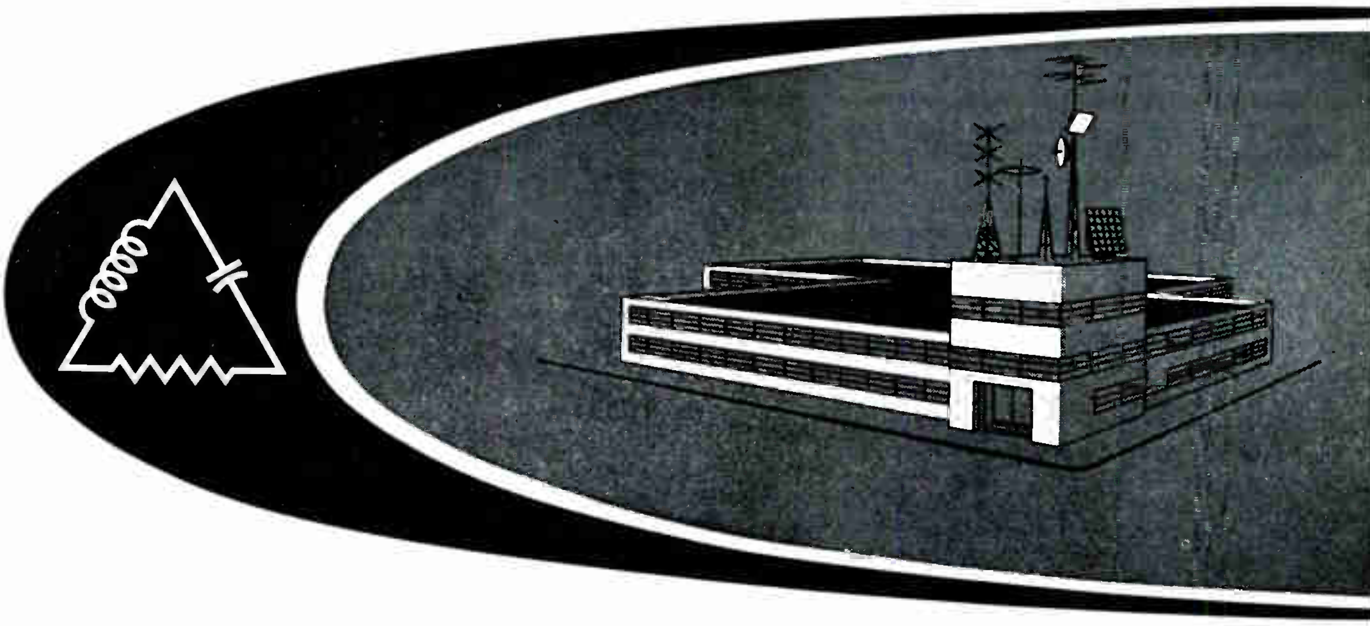
Circle 300 on Inquiry Card

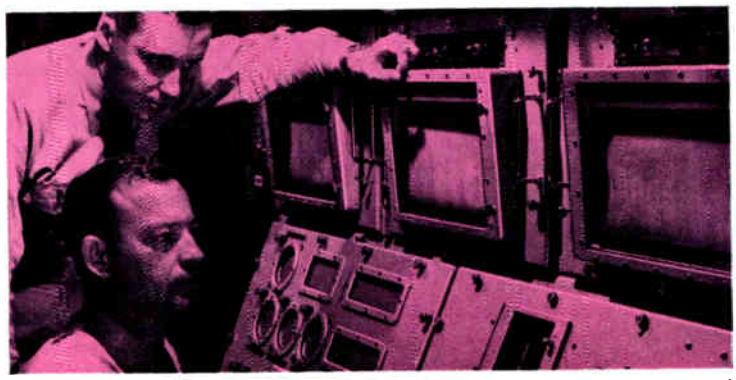
EQUIPMENT, MATERIALS, PARTS & COMPONENTS

Circle 257 on Inquiry Card

Section L

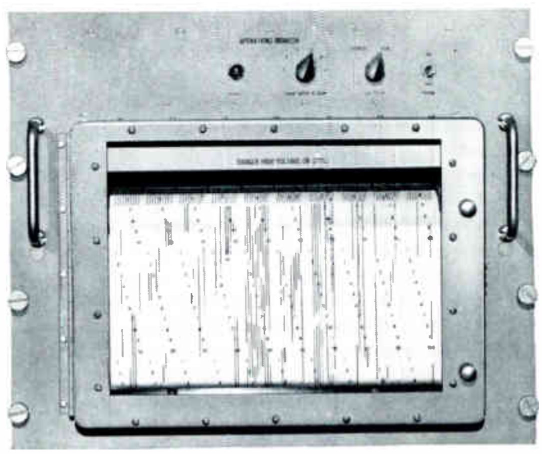
Manufacturers & Products

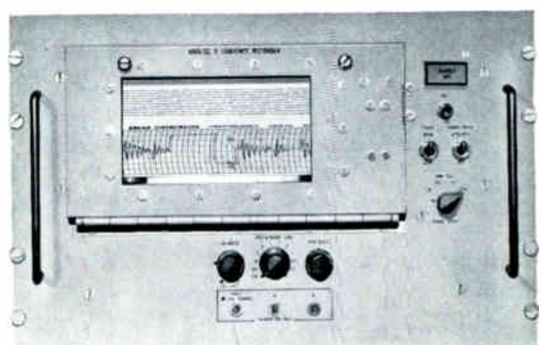




Training Console for POLARIS Navigation Control

in recording reliability means nothing





. . . without the dimension of time. Performing to standards month after month, year after year, is the *true* measure of reliability. It is, in fact, the true measure of Brush Recording Systems that have documented much of the information from vehicles and satellites since the beginning of the space age. That's why Brush is able to design Recording Systems that *originally* meet MIL specs . . . Analog Recorders . . . 120 channel Operations Monitors and the combination AN/SEQ Recorder that simultaneously records both analog data and sequential events. Vital components in every *standard* Brush system conform to these rigid requirements: pen motors, transmissions, circuit boards, hardware and wiring. This capability and experience is unmatched in the industry. Before prototype design becomes a problem—write Brush for complete details.

brush INSTRUMENTS

DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

1962 **ELECTRONIC INDUSTRIES** DIRECTORY

ALPHABETICAL LISTING OF MANUFACTURERS

A listing of the names and addresses of manufacturers in the electronic and allied industries. All the information in this listing and in the product listing section has been supplied by the manufacturers.

A A METAL PRODUCTS INC
154 ELLIOT ST BRATTLEBORO VT
AAA WIRE WORKS INC
45 FOX ST NEW HAVEN CONN
ABALON PRECISION MFG CORP
540 CASANOVA ST NEW YORK 59 N Y
ABACUS INC
1718 TWENTY FIRST SANTA MONICA CALIF
ABBEON INCORPORATED
179-15 JAMAICA AVE JAMAICA 32 N Y
ABBOTT SCREW & MFG CO
6525 N CLARK ST CHICAGO 26 ILL
ABC FAIRCO INC
543 MONTEREY PASS RD MONTEREY PK CALIF
ABESTE CORP
49 ACKERMAN ST BLOOMFIELD N J
ABRAMS INSTRUMENT CORP
606 E SHIAWASSEE ST LANSING 1 MICH
ABTRONICS INC
64 S P ST LIVERMORE CALIF
ACCESSORY CONTROLS EQUIPMENT
805 BLOOMFIELD AVE WINDSOR CONN
ACCESSORY PROD CO DIV OF TEXTRON INC
616 WHITTIER BLVD WHITTIER CALIF
ACCURACY INC
4 GORDON ST WALTHAM 54 MASS
ACCURATE ELECTRONICS CO
2005 BLUE ISLAND AVE CHICAGO 8 ILL
ACCURATE ELECTRONICS CORP
169 S ABBE RD SE ELYRIA OHIO
ACCURATE INSTRUMENT CO
2418 ALABAMA AVE HOUSTON 6 TEXAS
ACCURATE MFG CO
44 HEPWORTH PL GARFIELD N J
ACCURATE SPECIALTIES CO INC
345 LODI ST HACKENSACK N J
ACCURATE SPRING MFG CO
3811 W LAKE ST CHICAGO 24 ILL
ACDC ELECTRONICS INC
2979 N ONTARIO ST BURBANK CALIF
ACE COIL & ELECTRONICS CO
914 LINCOLN HWY METUCHEN N J
ACE DRILL BUSHING CO INC
5407 FOUNTAIN AVE LOS ANG CALIF
ACE ELECTRIC MFG CO
1458 SHAKESPEARE AVE NEW YORK 52 N Y
ACE ELECTRONICS ASSOC
99 DOVER ST SOMERVILLE MASS
AC ELECTRONICS INC
11725 MISSISSIPPI AVE LOS ANG CALIF
ACE ENGG & MACHINE CO INC
TOMILSON RD HUNTINGDON VALLEY PENNA
ACE PLASTIC CO
91-30 VAN WYCK EXPWY JAMAICA 35 N Y
ACE SPRING MFG CO
146 32ND ST BROOKLYN N Y
ACE SYCAMORE INC
SYCAMORE ILL
ACETO CHEMICAL CO INC
40 40 LAWRENCE ST FLUSHING N Y
ACF ELECTRONICS DIV
RIVERDALE MD
ACF ELECTRONICS DIV ACF INDUSTRIES INC
11 PARK PL PARAMUS N J
ACHESON COLLOIDS CO
1951 WASHINGTON AVE PORT HURON MICH
ACKERMAN ENGRAVERS
43 22 LONG ISLAND CITY N Y
ACKERMAN-GOULD CO INC
10 NEIL COURT PO BOX 188 OCEANSIDE LI N Y
ACME BATTERY CORP
200 HENRY ST STAMFORD CONN
ACME BRASS FOUNDRY CO OF S A INC
716 WYOMING ST SAN ANTONIO 3 TEXAS
ACME ELECTRIC CORP
WATER ST CUBA N Y
ACME ELECTRIC HEATING CORP
99 READING ST BOSTON MASS
ACME INDUSTRIAL CO
200-222 N LAFLIN ST CHICAGO 7 ILL
ACME MFG & GASKET CO
738 N 41 ST PHILA PA
ACME MODEL ENGG CO
6224 15TH AVE BROOKLYN 19 NY
ACME NEWPORT STEEL CO
NEWPORT KY
ACME WIRE CO
1255 DIXWELL AVE NEW HAVEN 14 CONN

ACOPIAN TECHNICAL CO
927 SPRUCE ST EASTON PA
ACOUSTICA ASSOCIATES
10400 AVIATION BLVD LOS ANGELES 45 CALIF
ACOUSTIC RESEARCH INC
24 THORNDIKE ST CAMBRIDGE MASS
AC RAY ELECTRONICS INC
910 N 20 AVE HOLLYWOOD FLA
ACRO DIV ROBERT SHAW FULTON CONTROL CO
2040 E MAIN ST COLUMBUS OHIO
ACRO ELECTRONIC PRODUCTS CO
119 ST MIHIEL DR RIVERSIDE N J
ACROMAG INC
15360 TELEGRAPH RD DETROIT MICH
ACROMARK CO
309 MORRELL ST ELIZABETH NJ
ACRO PRODUCTS CO
369 SHURS LANE PHILADELPHIA 28 PA
ACRO TOOL & DIE WORKS
4554 BROADWAY CHICAGO ILL
ACRO WELDER MFG CO
1719 W ST PAUL AVE MILWAUKEE WISC
AC SPARK PLUG ELECT DIV
1925 KENILWORTH PL MILWAUKEE WISC
ACTAN ELECTRONICS INC ENGRG MFG & DEV CORP
130 COUNTY COURTHOUSE RD NEW HYDE PARK NY
ACTIONCRAFT PRODUCTS
2 YENNICOCK AVE PORT WASHINGTON N Y
ACTON LAB
1180 RAYMOND BLVD NEWARK N J
A C TRANSFORMER CORP
89 MADISON ST NEWARK 5 N J
ADAGE INC
292 MAIN ST CAMBRIDGE MASS
ADAM METAL SUPPLY INC
463 48TH AVE LONG ISLAND CITY N Y
ADAMS & WESTLAKE CO
1025 N MICHIGAN ELKHART IND
ADAMS ELECTRONICS INC
16 CHARLES ST BANGOR MICH
ADAMS RITE MFG CO
540 W CHEVY CHASE DR GLENDALE 4 CALIF
ADAMS RUSSELL CO INC
200 SIXTH ST CAMBRIDGE MASS
ADC PRODUCTS DV OF MAGNETIC CONTROLS
6405 CAMBRIDGE ST MINN MINN
ADCON DIV WAYNE-GEORGE CORP
322NEEDHAM STREET NEWTON 64 MASS
ADCRAFTERS CO
325 W HURON ST CHICAGO ILL
ADDRESSOGRAPH MULTIGRAPH CORP
1200 BABBITT RD CLEVELAND OHIO
ADEL PRECISION PROD DV GENERAL METALS CORP
1444 WASHINGTON AVE HUNTINGTON W VA
ADEPT INDUSTRIES INC
1636 W HUNTING PARK AVE PHILA 40 PA
ADHESIVE PRODUCTS CORP
1660 BOONE AVE NEW YORK 60 N Y
ADLER ELECTRONICS INC
1 LEFEVRE LANE N ROCHELLE N Y
ADMIRAL CORP
3800 W CORTLAND ST CHICAGO ILL
ADVANCE CARBON & ELECTRIC MFG CO
2505 MARIPOSA ST SAN FRANCISCO 10 CALIF
ADVANCE ELECTRONICS CO
8510 NORTH END AVE OAK PARK 37 MICH
ADVANCE GEAR & MACHINE CORP
5851 HOLMES AVE LOS ANG CALIF
ADVANCE GLOVE MFG CO
901 W LAFAYETTE BLVD DETROIT 26 MICH
ADVANCE INSTRUMENT CORP
1709 F ST BELMAR N J
ADVANCE ROSS ELECT CORP
2538 PETERSON AVE CHICAGO 45 ILL
ADVANCE ROSS ELECT CORP
860 WASHINGTON ST BURLINGTON IOWA
ADVANCE ROSS ELECT CORP
1010 W MADISON WASHINGTON IOWA
ADVANCE TECHNOLOGY LABS DIV AMER STANDARD
369 WHISMAN RD MT VIEW CALIF
ADVANCED ELECTRONICS INC
94 SILAS DEANE HWY ROCKY HILL CONN
ADVANCED ELECTRONICS MFG CORP
2025 PONTIUS AVE LOS ANGELES 25 CALIF
ADVANCED ELECT CORP
2 COMMERCIAL ST HICKSVILLE LI N Y
ADVANCED INSTRUMENTS
45 KENNETH ST NEWTON HIGHLANDS 61 MASS

ADVANCED MEASUREMENT INST INC
109 DOVER ST SOMMERVILLE MASS
ADVANCED STRUCTURES
5159 BALTIMORE DR LAMESA CALIF
ADVANCED TECHNOLOGY INC
SANTA BARBARA CALIF
ADVANCED VACUUM PRODUCTS INC
430 FAIRFIELD AVE STAMFORD CONN
AD-YU ELECTRONICS LAB INC
249 TERHUNE AVE PASSAIC N J
AERCOIL INC
2207 SUMMIT AVE UNION CITY N J
AERMOTER CO
2500 W ROOSEVELT RD CHICAGO ILL
AERODEX INC
PO BOX 123 MIAMI 48 FLA
AERO ELECTRONICS CORP
1729 W 134 ST GARDENA CALIF
AEROFLEX CORP DIV AEROFLEX LAB
48 25 36TH ST LONG ISLAND CITY N Y
AEROJET GENERAL CORP
ATLANTIC DIVISION FREDERICK MD
AEROJET GENERAL CORP ASTRONICS DIV
6352 N IRWINDALE AVE AZUSA CALIF
AEROLAB DEVELOPMENT CO SEMICONDUCTOR SYSTEMS
330 W HOLLY ST PASADENA CALIF
AEROLITE ELECTRONICS CORP
2207SUMMIT AVE UNION CITY NJ
AEROLUX LIGHT CORP
653 11 AVE NEW YORK 36 N Y
AERO MECHANISMS INC
7750 BURNET AVE VAN NUYS CALIF
AERONAUTICAL COMM EQUIP CO
3090 S W 37 AVE MIAMI FLA
AERONAUTICAL ELECTRONICS INC
P O BOX 6527 RALEIGH N C
AERONAUTICAL & INST DV ROBERTSHAW FULTON CO
SANTA ANA FREEWAY-EUCLID AVE ANAHEIM CALIF
AERONCA MFG CORP
MIDDLETOWN OHIO
AERONCA MFG CORP AEROSPACE DIV
BOX 536 BALTIMORE MD
AERONUTRONIC SYSTEMS INC
FORD ROAD NEWPORT BEACH CALIF
AEROQUIP CORP
300 S EAST AVE JACKSON MICH
AERO RESEARCH INSTRUMENT CO
315 N ABERDEEN ST CHICAGO 7 ILL
AERO SERVICE CORP
210 E CORTLAND ST PHILA PENNA
AEROSONIC MARINE INC
PO BOX 569 CLEARWATER FLA
AEROSPACE ELECTRONICS INC
PO BOX 48-495 MIAMI FLA
AEROTRONIC ASSOCIATES INC
BOX 367 CONTOOCOOK N H
AEROVOC CORP
740 BELLEVILLE AVE N BEDFORD MASS
AEROVOX CANADA LTD
1551 BARTON ST HAMILTON ONTARIO CANADA
AEROVOX CORP HIQ DIVISION
MYRTLE BEACH SC
AEROVOX PACIFIC
1100 CHESTNUT ST BURBANK CALIF
AETNA FELT CO
204 CENTRE ST NEW YORK 13 NY
AETNA SUPPLY INC
15 N HICKORY ST ARLINGTON HTS ILL
AFFILIATED PHOTOGRAPHIC CO
21 W 45 ST NEW YORK 36 N Y
AFFILIATED SCREW PROD CO
3800 WESLEY TERR SCHILLER PK ILL
A G A DIV ELASTIC STOP NUT CORP
1027 NEWARK AVE ELIZABETH 3 N J
AIDIN AUTOMATION INC
1613 E NEW YORK AVE BROOKLYN 12 N Y
AIDS DEVEL CO
16560 ELDERDALE RD CLEVELAND OHIO
AINSLIE CORP
531 POND ST BRAINTREE MASS
AIRBORNE ACCESSORIES CORP
1414 CHESTNUT AVE HILLSIDE 5 N J
AIRBORNE ELECT CO
6813 TROOST AVE N HOLLYWOOD CALIF
AIRBORNE INSTRS LAB DIV CUTLER HAMMER INC
COMAC ROAD DEER PARK LI N Y
AIRCOM INC
48 CUMMINGTON ST BOSTON 15 MASS

ELECTRONIC MANUFACTURERS—A TO Z

AIRCONDUCTORS
367 E ALONDRA GARDENA CALIF
AIRCRAFT & ELECT SPEC
22 GREEN ST BROWNSBURG IND
AIRCRAFT ARMAMENTS INC
INDUSTRY LANE COCKEYSVILLE MD
AIRCRAFT FITTING CO
701 FEDERAL HWY DANIA FLA
AIRCRAFT INSTRUMENTS CO
304 KING OF PRUSSIA RD RADNOR PENNA
AIRCRAFT RADIO CORP
BOONTON N J
AIRDESIGN CORP
BOX 987 NORRISTOWN PA
AIR ELECTRONICS CO
7250 HINDS AVE N HOLLYWOOD CALIF
AIRESEARCH MFG CO ARIZONA DIV GARRETT CORP
402 S 36TH ST PHOENIX ARIZ
AIREX CORP
TIBBETTS RD BOX 1517 ROCHESTER N H
AIR FILTER CORP
4554 W WOOLWORTH AVE MILWAUKEE WISC
AIRFLYTE ELECTRONICS CO
535 AVENUE A BAYONNE N J
AIRGUIDE INSTRUMENT CO
2210 WABANSIA AVE CHICAGO ILL
AIR MARINE MOTORS INC
2221 BARRY AVE LOS ANG CALIF
AIR MARINE MOTORS
369 BAYVIEW AVE AMITYVILLE L I N Y
AIRMATIC VALVE INC
7314 ASSOCIATE AVE CLEVELAND 9 OHIO
AIRMATICS SYSTEMS CORP
441 MARKET ST SADDLE BROOK NJ
AIR MAZE DIV ROCKWELL STANDARD CORP
25000 MILES RD CLEVELAND OHIO
AIR O TRONICS ENG CO
MORRISVILLE N Y
AIRPAX ELECT INC SEMINOLE DIV
FORT LAUDERDALE FLA
AIRPAX ELECTRONICS INC
CAMBRIDGE MD
AIRPAX ELECTRONICS INC
2550 E FOOTHILL BLVD PASADENA CALIF
AIRPAX PRODUCTS CO
JACKTOWN RD CAMBRIDGE MD
AIR REDUCTION SALES CO REDUCTION CO
150 E 42 ST NEW YORK N Y
AIR-SHIELDS INC
HATBORO PENNA
AIRTEC INC
139 E 1ST AVE ROSELLE N J
AIR TRANSPORT MFG CO
1114 N SYCAMORE AVE LOS ANGELES CALIF
AIRTRON A DIV OF LITTON INDUST
200 E HANOVER AVE MORRIS PLAINS N J
AIRTRON CANADA LTD
349 CARLAW AVE TORONTO 8 ONT CANADA
AIRTRONICS INC
5221 RIVER RD BETHESDA MD
AIRTRONICS INTL CORP
6900WEST RD BOX 8576 FT LAUDERDALE FLA
AIRTRONIX DEVELOPMENT CORP
4902 CHURCH AVE BROOKLYN 3 N Y
A & J MFG CO
4214 ARTESIA FULLERTON CALIF
AJAX CONDENSER CO
932 WRIGHTWOOD AVE CHICAGO ILL
AJAX ELECTROTHERMIC CORP
AJAX PARK TRENTON N J
A K MFG CO INC
410 S HAGER AVE BARRINGTON ILL
AKRON METALLIC GASKET CO
150 N UNION ST AKRON OHIO
ALAC INC
365 W ARDEN ST GLENDALE 3 CALIF
ALADDIN ELECTRONICS DIV ALADDIN INDUSTRIES
703 MURFREESBORO RD NASHVILLE 10 TENN
A L A INDUSTRIES INC
151 CROTONA AVE HARRISON N Y
ALAN WOOD STEEL CO
CONSHOHOCKEN PA
ALCAR INSTRUMENTS INC
411 ROBBINS AVE TRENTON N J
ALCO ELECTRONIC PRODUCTS INC
3 WOLCOTT AVE LAWRENCE MASS
ALCON METAL PRODUCTS INC
1750 N KIMBALL AVE CHICAGO ILL
ALCONOX INC
853 BROADWAY NEW YORK N Y
ALDEN ELECTRONIC & IMPULSE
P O BOX 125 WESTBORO MASS
ALDEN PRODUCTS CO
12359 N MAIN ST BROCKTON 64 MASS
ALDEN SYSTEMS CO
117 N MAIN ST BROCKTON MASS
ALDSHIR MANUFACTURING CO INC
111 LAKE AVE TUCKAHOE N Y
ALECTRIC MFG CO
7842 39TH AVE KENOSHA WISC
ALERT PRODUCTS INC
728 MARKET ST CAMDEN N J
ALERT SUPPLY CO
7343 PARAMOUNT BLVD PICO RIVERA CALIF
ALEXANDRIA DIV AMF
1025 ROYAL ST ALEXANDRIA VA
ALFAX PAPER & ENG CO INC
BOX 125 WESTBORO MASS
ALFORD MFG CO
299 ATLANTIC AVE BOSTON 10 MASS
ALFRED ELECTRONICS
3176 PORTER DRIVE STANFORD INDUST PARK
PALO ALTO CALIF
ALITE DIV U S STONEWARE CO
BOX 119 ORRVILLE OHIO
ALKALINE BATTERY DIV
212 DURHAM AVE METUCHEN N J

ALL AMERICAN ENGG CO
BOX 1247 WILMINGTON DEL
ALL AMERICAN TOOL & MFG CO
8027 LAWNDALE AVE SKOKIE ILL
ALLARD INSTRUMENT CORP
146 E 2ST MINEOLA N Y
ALL CHANNEL PRODUCTS CORP
JERSEY SHORE PENNA
ALLEGANY INSTRUMENT CO
1091 WILLS MOUNTAIN CUMBERLAND MD
ALLEGHENY ELECTRONICS CHEMICALS CO
20 LEAR ST BRADFORD PA
ALLEGHENY ELECTRONIC CHEMICALS CO
LEWIS RUN PENNA
ALLEGHENY PLASTICS INC
ROUTE 51 THORN RN RD CORAPOLIS PENNA
ALLEN AVIONICS INC
255 E 2ND ST MINEOLA N Y
ALLEN-BRADLEY CO
136 W GREENFIELD AVE MILWAUKEE 4 WISC
ALLEN BUSINESS MACHINE INC
333 COMMERCE S W GRAND RAPIDS MICH
ALLEN ELECTRIC & EQUIPMENT CO
2101-2117 N PITCHER ST KALAMAZOO MICH
ALLEN ELECTRONIC CORP
937 INDUSTRIAL AVE PALO ALTO CALIF
ALLEN ELECTRONICS CORP
92 BRANCH ST PONTIAC MICH
ALLEN MFG CO
BLOOMFIELD CONN
ALLEN TOOL CORP
308 MALTBIE ST SYRACUSE NY
ALLIED ALLEGRI MACHINE CO INC
141 RIVER RD NUTLEY 10 N J
ALLIED CHEMICAL DIV GENERAL CHEM CORP
40 RECTOR ST NEW YORK 6 NY
ALLIED CONTROL CO
2 EAST END AVE NEW YORK 21 N Y
ALLIED CONTROL CO INC
PLANSVILLE CONN
ALLIED CONTROL CO INC
WAUREGAN CONN
ALLIED DECALS INC
20700 MILES AVE CLEVELAND OHIO
ALLIED ELECTRONIC EQUIP CO
868 SAN MATEO AVE SAN BRUNO CALIF
ALLIED RESEARCH & ENG CO
6916 SANTA MONICA BLVD HOLLYWOOD CALIF
ALLIED WITAN CO
BOX 8725 12500 BELLAIRE RD CLEVE OHIO
ALLIES PRODUCTS CORP
P O BOX 188 KENDALL BRANCH MIAMI FLA
ALLIS CHALMERS
COLUMBUS & PREBLE AVES PITTSBURGH PA
ALLIS CHALMERS
1126 S 70TH ST WEST ALLIS WISC
ALLIS CO LOUIS
427 E STEWART ST MILWAUKEE 1 WISC
ALLISON LABS INC
11301 E OCEAN AVE LA HABRA CALIF
ALLMETAL SCREW PRODUCTS CO INC/WEST COAST DV
5822 W WASHINGTON BLVD CULVER CITY CALIF
ALLMETAL SCREW PRODUCTS CO
821 STEWART AVE GARDEN CITY NY
ALLOY BELLOWS INC
18125 ROSELAND RD CLEVELAND 12 OHIO
ALLOY METAL WIRE WORKS
PROSPECT PARK PENNA
ALLOY METALSMITHS INC
88 COMMERCE RD CEDAR GROVE NJ
ALLOYD ELECTRONICS CORP
35 CAMBRIDGE PKWAY CAMBRIDGE MASS
ALLOYS UNLIMITED INC
21 01 43RD AVE LONG ISLAND CITY N Y
ALLOYS UNLIMITED INC
26 32 SKILLMAN AVE L IS CITY N Y
ALL PRODUCTS CO COMMUNICATION PROD DIV
BOX 520 MINERAL WELLS TEX
ALL STAINLESS INC
40 RUGG RD ALLSTON MASS
ALL STAR PRODUCTS INC
SQUIRE AVE DEFIANCE OHIO
ALL-STATE WELDING ALLOYS CO
249 FERRIS AVE WHITE PLAINS N Y
ALL TRONICS INC
45 BOND ST WESTBURY L I N Y
ALL WEATHER ANTENNA MFG CO INC
350 S EGG HARBOR HAMMONTON NJ
ALLYN INC WELCH
SKANEATELES FALLS N Y
ALMOR DEVELOPMENT CO INC
2021 W 17TH ST LONG BEACH CALIF
ALNOR INST CO DV OF ILL TESTING LABS INC
420 N LASALLE ST CHICAGO ILL
ALONGE PRODUCTS INC
163 W 23RD ST NEW YORK N Y
ALPAR MFG CORP
220 DEMETER ST PALO ALTO CALIF
ALPHA CORP
820 ARAPAHO RD RICHARDSON TEXAS
ALPHA METALS INC
56 WATER ST JERSEY CITY 4 N J
ALPHA MOLYKOTE CORP
65 HARVARD AVE STAMFORD CONN
ALPHA WIRE CORP
200 VARICK ST NEW YORK N Y
ALPHADUCT WIRE & CABLE CO
25 VAN DYKE AVE NEW BRUNSWICK N J
ALPINE ELECTRIC COMPONENTS INC
WATERBURY CONN
ALPITEC INC
49 GLEASON AVE STAMFORD CONN
ALSOP ENGRG CORP
MILLDALE CONN
ALTEC LANSING CORP
1515 S MANCHESTER AVE ANAHEIM CALIF
ALTHOR PRODUCTS
2301 BENSON AVE BROOKLYN N Y

ALTO FONIC TAPE SERVICE INC
211 LAMBERT ST PALO ALTO CALIF
ALTO SCIENTIFIC CO
855 COMMERCIAL ST PALO ALTO CALIF
ALUMINUM ALLOYS CORP
6650 W WALTEN DETROIT MICH
ALUMINUM CO OF AMERICA
1501 ALCOA BLDG PITTSBURGH 19 PA
ALUMINUM CO OF AMER REA MAGNET WIRE CO
CONCORD RD LAFAYETTE IND
ALVA ALLEN INDUSTRIES
35 & 13 JCT CLINTON MO
ALWAC COMPUTER DIV EL-TRONICS INC
13040 S CERISE HAWTHORNE CALIF
AMATON ELECTRONIC HARDWARE CO INC
88 DRAKE AVE NEW ROCHELLE N Y
AMBROID CO
BOX 30 WEYMOUTH 88 MASS
AMCHEM PRODUCTS INC
AMBLER PENNA
AMCO ENG CO
7333 W AINSLIE ST CHICAGO ILL
AMECO DIV ANTENNAVISION INC
2449 W OSBORN RD PHOENIX ARIZ
AMELCO INC
2040 COLO AVE SANTA MONICA CALIF
AMERAC INC
DUNHAM RD BEVERLY MASS
AMERICAN AIR FILTER CO
215 CENTRAL AVE LOUISVILLE KY
AMERICAN AIRFRAME CORP
721 W 25TH ST HIALEAH FLA
AMERICAN ALUMINUM CO
230 SHEFFIELD ST MOUNTAINSIDE N J
AMERICAN ASTRO-SYSTEMS
2112 CHICO AVE EL MONTE CALIF
AMERICAN AVIONICS INC
2028-2032 STONER AVE LOS ANGELES 25 CALIF
AMERICAN BOSCH CORP
ROOSEVELT FIELD GARDEN CITY N Y
AMERICAN BOSCH ARMA CORP
5000 PARKSIDE PHILA PA
AMERICAN BRASS CO
414 MEADOW ST WATERBURY CONN
AMERICAN BRAKE SHOE CO RAYMOND ATCHLEY DIV
2339 COTNER AVE LOS ANG CALIF
AMER CHAIN & CABLE BRISTOL CO
127 BRISTOL ST WATERBURY CONN
AMERICAN CHAIN & CABLE DATA MASTERS CORP
85 HAZEL ST GLEN COVE NY
AMER CHAIN & CABLE WILSON MECH INST DIV
929 CONNECTICUT AVE BRIDGEPORT CONN
AMERICAN CONCERTONE
9449 W JEFFERSON BLVD CULVER CITY CALIF
AMERICAN CYANAMID CO FORMICA DIVISION
CINCINNATI OHIO
AMERICAN CYSTOSCOPE MAKERS INC
8 PELHAM PKY PELHAM MANOR N Y
AMERICAN DECALCOMANIA CO
636 11TH AVE NEW YORK 36 N Y
AMERICAN DECALCOMANIA CO
310 LAKESIDE CLEVELAND OHIO
AMERICAN DISTRICT TELEGRAPH CO
20 BRIDEWELL PLACE CLIFTON N J
AMERICAN ELECTRIC CABLE CO
181 APPLETON ST HOLYOKE MASS
AMERICAN ELECTRONICS CO
178 HERRICKS RD MINEOLA L I N Y
AMERICAN ELECT INC INSTRUMENT
9503 JEFFERSON BLVD CULVER CITY CALIF
CULVER CITY CALIF
AMERICAN ELECTRONICS INC
2112 CHICO AVE EL MONTE CALIF
AMERICAN ELECTRONICS INC
4811 TELEGRAPH RD LOS ANGELES 22 CALIF
AMERICAN ELECT INC TALLER & COOPER DIV
75 FRONT ST BROOKLYN N Y
AMERICAN ELECT LABS INC
RICHARDSON RD COLMAR PENNA
AMERICAN ELECTRONICS CO
2801 37TH AVE NE MINN MINN
AMERICAN ELECTRICAL HEATER CO
6110 CASS AVE DETROIT MICH
AMERICAN ELECT LABS MICROWAVE & PHASING
P O BOX 552 LANSDALE PA
AMERICAN ELECTRONICS INC
1596 E ROSS AVE FULLERTON CALIF
AMERICAN ELECTRIC SWITCH DIV
CLARK CONTROLLER CO MINERVA OHIO
AMERICAN ELITE INC
48-50 34TH ST LONG ISLAND CITY 1 N Y
AMERICAN EMBLEM CO
4 GENESEE ST NEW HARTFORD NY
AMERICAN FELDMUEHLE CORP
11 W 42ND ST NEW YORK 36 N Y
AMERICAN GELOSO ELECT INC
251 FOURTH AVE NEW YORK N Y
AMERICAN GYRO DIV TAMAR ELECT INC
9320 LINCOLN BLVD LOS ANG CALIF
AMER HYDROMATH CORP
24 20 JACKSON AVE L I CITY N Y
AMERICAN INSTRUMENT CO
8050 GEORGIA AVE SILVER SPRINGS MD
AMERICAN INSULATOR CORP
NEW FREEDOM PA
AMER LATEX FIBRE CORP
500 N BROADWAY LAWRENCE MASS
AMERICAN LAUBSCHER CORP
250 W 57TH ST NEW YORK 19 NY
AMERICAN LAVA CORP SUBS MINN MINING MFG
CHEROKEE BLVD & MFRS RD CHATTANOOGA 5 TENN
AMERICAN LIGHT ALLOYS INC
1265 MCBRIDE AVE LITTLE FALLS NJ
AMERICAN MACH & FOUNDRY CO
261 MADISON AVE NEW YORK N Y
AMER MACH & FOUNDRY
BOX 187 STA F BUFFALO N Y

AMER MACH & FOUNDRY POTTER & BRUMFIELD DIV
MARION KY
AMERICAN MAGNETICS CORP
P O BOX 98 CARTERVILLE ILL
AMERICAN MEASUREMENT & CONTROL INC
240 CALVARY ST WALTHAM 54 MASS
AMERICAN MERCANTILE CO INC
33 W 42ND ST NEW YORK 36 N Y
AMERICAN METAL CLIMAX INC
61 BROADWAY NEW YORK 6 N Y
AMERICAN MICROPHONE CO DIV G C ELECT CO
400 S WYMAN AVE ROCKFORD ILL
AMERICAN MICROPHONE CO
400 S WYMAN AVE ROCKFORD ILL
AMERICAN MICROWAVE & TV CORP
1369 INDUSTRIAL RD SAN CARLOS CALIF
AMERICAN MISSILE PROD CO INC
15233 GREVILLEA AVE LAWNDALE CALIF
AMERICAN MONARCH CORP
2801 37TH AVE N E MINNEAPOLIS 18 MINN
AMERICAN NUCLEAR SERVICE CORP
61 BROADWAY NEW YORK 6 NY
AMERICAN OPTICAL CO INSTRUMENT DIV
BOX A BUFFALO 15 N Y
AMERICAN OPTICAL
1 MARLBORO ST KEENE NH
AMERICAN PERFIT CRYSTAL CORP
653 11 AVE NEW YORK 36 N Y
AMERICAN PRINTED CIRCUITS CO
104 FORREST ST METUCHEN N J
AMERICAN PRODUCTS MFG CO
8127 33 ORLEANDER ST NEW ORLENAS LA
AMERICAN RADAR COMPONENTS INC
415 E MAIN ST DENVILLE N J
AMERICAN RECTIFIER CORP
95 LAFAYETTE ST NEW YORK 13 N Y
AMERICAN RESEARCH CORP
ROUTE 6 FARMINGTON CONN
AMERICAN RESEARCH & MFG CORP
920 HALPINE AVE ROCKVILLE MD
AMERICAN SEALANTS CO
705 N MOUNTAIN RD HARTFORD CONN
AMERICAN SEMICONDUCTOR CORP
3940 N KILPATRICK AVE CHICAGO 41 ILLINOIS
AMERICAN SILVER CO
3607 PRINCE ST FLUSHING 54 N Y
AMERICAN SOLDER & FLUX CO
19 & WILLARD STS PHILADELPHIA 40 PA
AMERICAN SOUND PROD INC
4753 4TH AVE S MINNEAPOLIS MINN
AMER SPEEDLIGHT CORP
6301 METROPOLITAN AVE MIDDLE VILLAGE NY
AMERICAN STANDARD AD TECH LAB
369 WHISMAN RD MOUNTAIN VIEW CALIF
AMERICAN STANDARD CONTROL DIV
5900 TRUMBULL AVE DETROIT MICH
AMERICAN STANDARD CONTROL DV
100 ROCKWOOD ST ROCHESTER N Y
AMERICAN STANDARD CORP
5900 TRUMBULL AVE DETROIT 8 MICH
AMERICAN STERILIZER SCIENTIFIC & IND DEPT
ERIE PENNA
AMERICAN SUPER TEMPERATURES WIRES INC
DIV OF HAVEG INDUST
32 W CANAL ST WINOOSKI VT
AMERICAN TELEVISION & RADIO CO
300 E 4TH ST ST PAUL 1 MINN
AMERICAN TELEVISION & RADIO CO
ST PAUL MINN
AMERICAN THERMO ELECTRIC CO
1023 N FULLER AVE LOS ANGELES 46 CALIF
AMERICAN TIME PROD INC
61-20 WOODSIDE AVE WOODSIDE 77 LI NY
AMERICAN TOWER CO
RFD 2 BOX 29 SHELBY OHIO
AMERICAN TRANSFORMER DIV RADIO ENG LABS
29 01 BORDEN AVE L I CITY N Y
AMERICAN TUBE BENDING CO
5 LAWRENCE ST NEW HAVEN CONN
AMERLINE CORP
2727 W CHICAGO AVE CHICAGO ILL
AMERSIL QUARTZ DIV ENGELHARD INDUST INC
685 RAMSEY AVE HILLASIDE NJ
B C AMES CO
131 LEXINGTON ST WALTHAM MASS
AMGLO CORP
4333 RAVENSWOOD AVE CHICAGO 13 ILL
AMI INC
1500 UNION AVE GRAND RAPIDS 2 MICH
AMP INC CAPITRON DIV
155 PARK AVE ELIZABETHTOWN PA
AMP INCORPORATED
EISENHOWER BLVD HARRISBURG PENNA
AMPEREX ELECTRONICS CORP
SLATERVILLE R I
AMPEREX ELECTRONIC CORP
230 DUFFY AVE HICKSVILLE N Y
AMPERITE CO
561 BROADWAY NEW YORK 12 N Y
AMPEX AUDIO/SUB AMPEX CORP
1020 KIFER RD SUNNYVALE CALIF
AMPEX CORP
934 CHARTER ST REDWOOD CITY CALIF
AMPEX MAGNETIC DIV
BOX 190 OPELIKA ALA
AMPEX MAGNETIC TAPE PRODUCTS
OPELIKA ALA
AMPEX PROFESSIONAL PROD CO
BOX 500 REDWOOD CITY CALIF
AMPHENOL CANADA LTD
349 CARLAW AVE TORONTO ONT CANADA
AMPHENOL CONNECTOR
1830 S 54TH AVE CHICAGO 50 ILL
AMPHENOL WESTERN DIV
9201 INDEPENDENCE AVE CHATSWORTH CALIF
AMPLIFIER CORP OF AMER
398 BROADWAY NEW YORK N Y

AMPLITEL INC
342 W 40 ST NEW YORK 18 N Y
AMPLIVOX LTD ABBEY MFG EST MT PLSNT
WEMBLEY MIDDLESEX ENGLAND
AMTEL AMERICAN MICROWAVE & TELEVISION
1369 INDUSTRIAL RD SAN CARLOS CALIF
AMTHOR TESTING INST CO
45 53 VAN SINDEREN AVE BROOKLYN N Y
AMTRON CORP
17 FELTON ST WALTHAM 54 MASS
AMY ACEVES & KING
11 W 42 ST NEW YORK N Y
ANACONDA ALUMINUM CO
BOX 1654 LOUISVILLE KY
ANACONDA ALUMINUM CO
20-21 WAGARAW RD FAIRLAWN NJ
ANACONDA WIRE & CABLE CO
25 BROADWAY NEW YORK 4 N Y
ANACONDA WIRE & CABLE
RIVER ST HASTINGS-ON-HUDSON NY
ANADEX INSTRUMENT S INC
14734 ARMINTA ST BOX 472 VAN NUYS CALIF
ANALAB INSTRUMENT CORP
30 CANFIELD RD CEDAR GROVE N J
ANALOGUE CONTROLS INC
200 FRANK RO HICKSVILLE N Y
ANALYTIC SYSTEMS CO DIV RESCH INST CORP
980 N FAIR OAKS AVE PASADENA CALIF
ANALYTICAL MEASUREMENTS INC
585 MAIN ST CHATHAM N J
ANATRAN DIV OF ENDEVCO CORP
45 W UNION ST PASADENA CALIF
ANCHOR ALLOYS INC
966 MEEKER AVE BROOKLYN N Y
ELECTRONIC SPECIALTY CO ANCHOR METALS DIV
HURST TEXAS
ANCHOR METALS DIV D S KENNEDY & CO
ANNISTON ALA
ANCHOR PLASTICS CO
3636 36ST LONG ISLAND CITY N Y
ANCHOR SPEC MFG CO
300 HOLLISTER RO TETERBORO N J
ANCO INSTR DIV AMER NAME PLANE & MFG CO
4254 W ARTHINGTON ST CHICAGO ILL
ANDERS ELECTRONICS INC
30 BROOK RD NEEDHAM HGTS MASS
ANDERSEN LAB INC
501 NEW PARK AVE W HARTFORD CONN
ANDERSON & SONS INC
NORTH ELM ST WESTFIELD MASS
ANDERSON AIRCRAFT CO
SPRING ST NORTH DIGHTON MASS
ANDERSON CONTROLS INC
9959 PACIFIC AVE FRANKLIN PARK ILL
ANDERSON CONTROLS INC
3906 ELM ST MCHENRY ILL
ANDERTON ELECTRONIC LAB
129 E 1800 ST BOUNTIFUL UTAH
ANDREA RADIO CORP
27 01 BRIDGE PLAZA N LONG ISLAND CITY N Y
ANDREW ANTENNA CORP
606 BEECH ST WHITBY ONTARIO CAN
ANDREW CALIF CORP
941 MARYLAND AVE CLAREMONT CALIF
ANDREW CORP
BOX 807 CHICAGO ILL
ANDREWS TOWER INC
1420 LAYTON AVE FORT WORTH TEXAS
ANDROMEDA INC
11151 VIERS MILL RD WHEATON MD
ANELEX CORP
150 CAUSEWAY ST BOSTON MASS
ANKO MFG CO
5025 N 124TH ST MILWAUKEE 18 WIS
ANNIS CO R B
1101 N DELWARE ST INDIANAPOLIS IND
ANSLEY MFG CO ARTHUR
NEW HOPE PA
ANSONIA WIRE & CABLE CO
111 MARTIN ST ASHTON R I
ANTARA CHEMICALS
DIV GENERAL ANILINE & FILM CORP
ANTARA CHEMICALS DIV GEN FILM CORP
435 HUDSON AVE NEW YORK N Y
ANTENNA & RADOME RESEARCH ASSOC
27 BOND ST WESTBURY N Y
ANTENNA CORP
21341 ROSCOE BLVD CANOGA PARK CALIF
ANTENNA DESIGNS INC
802 WASHINGTON ST BURLINGTON IOWA
ANTENNA PRODUCTS CO DIV OF ALL PROD CO
BOX 110 MINERAL WELLS TEXAS
ANTENNA SPECIALISTS CO
12435 EUCLID AVE CLEVELAND OHIO
ANTENNA SYSTEMS INC
HINGHAM INDUST CENTER HINGHAM MASS
ANTHONY & CO J L
115 BAKER ST PROVIDENCE R I
ANTI CORROSIVE METAL PRODUCTS INC
P O BOX 1894 ALBANY N Y
ANTI CORROSIVE METAL PRODUCTS CO
CASTLETON-ON-HUDSON N Y
ANTLAB INC
6330 PROPRIETORS RD WORTHINGTON OHIO
ANTON ELECTRONICS LABS
1226 FLUSHING AVE BROOKLYN 37 NY
ANTON MACHINE WORKS
1226 FLUSHING AVE BROOKLYN 37 N Y
ANTREX CORP
2001 W WILLOW ST CHICAGO 47 ILL
ANTRONIC CORP
2712 W MONTROSE AVE CHICAGO ILLINOIS
APAHOUSER CORP OF N E
1312 BOYLSTON ST BOSTON 15 MASS
APCO ACCESSORY PRODUCTS CO
616 W WHITTIER BLVD WHITTIER CALIF

APCO MOSSBERG CO
205 LAMB ST ATTLEBORO MASS
APEL CO SUB RAYTHEON CO
213 E GRAND AVE S SAN FRAN CALIF
APEX COATED FABRICS CO
12 E 22 ST NEW YORK 10 N Y
APEX COIL TRANSFORMER CORP
1919 S FAIRFIELD AVE CHICAGO 8 ILL
APEX MACHINE CO
14 13 118TH ST COLLEGE POINT 56 N Y
APEX WIRE CABLE CORP
237 37ST BROOKLYN N Y
A P M CORP
41 HONECK ST ENGLEWOOD N J
APPALACHIAN ELECTRONIC INSTRUMENTS INC
810 MONROE AVE RONEEVERTE W VA
APPARATUS DEVELOPMENT CO
115 MAIN ST WETHERSFIELD 9 CONN
APPLE FREQUENCY MEASURING SERVICE
409 UNION AVE BURLINGTON N C
APPLETON CO INC HARRY
136 SAN FERNANDO RD LOS ANG CALIF
APPLIED DEVELOPMENT CORP
12838 WEBER WAY HAWTHORNE CALIF
APPLIED DYNAMICS INC
ANN ARBOR MICH
APPLIED ELECTRONICS CO SUB
213 E GRAND AVE SAN FRANSOCSO CALIF
APPLIED MAGNETICS CORP
1407 NORMAN FIRESTONE RD SANTA BARB AIRPOT
GOLETA CALIFORNIA
APPLIED PHYSICS CORP
2724 S PECK RD MONROVIA CALIF
APPLIED RADIATION CORP
2404 N MAIN ST WALNUT CREEK CALIF
APPLIED RESEARCH INC
76 S BAYLES AVE PORT WASHINGTON NY
APPLIED RESEARCH LABS
3717 PARK PL GLENDALE CALIF
APPLIED TECHNOLOGY CORP
73 03 GRAND AVE MASPETH N Y
APW CO
72 MAIN ST ROCKAWAY N J
ARCAN EASTERN LTD
P O BOX 158 STA C HAMILTON ONT CANADA
ARCH GEAR INC
4336 E 10TH CT HIALEAH FLA
ARCH GEAR WORKS INC
97 HOLMES ST QUINCY MASS
ARCH INSTRUMENT CO
101 HOLMES ST N QUINCY MASS
ARCO ELECT INC
COMMUNITY DRIVE GREAT NECK N Y
ARCON ELECTRONICS DIV OF ARCON INDUST
BOX 31 3052 BURNEY PL LOS ALAMITOS CALIF
AR & DA ENGG CO
135 MAIN ST BELLEVILLE NJ
ARDE ASSOC ENGRG DIV
11 HILL ST NEWARK N J
ARDE PORTLAND INC
80 SECOND ST PORTLAND MAINE
ARDENTE ACOUSTIC LABS LTD
MINERVA RD LONDON N W 10 ENGLAND
ARENBERG ULTRASONIC LABORATORY INC
94 GREEN ST JAMAICA PLAIN 30 MASS
A R F PRODUCTS INC
7627 LAKE ST RIVER FOREST ILL
A R F PRODUCTS INC
P O BOX 57 RANTON N M
ARF PRODUCTS INC
GARDNER RD RATON N M
ARGONNE ELECT MFG CORP
111 JERICHO TPKE SYOSSET LI N Y
ARGOS PRODUCTS CO
301 MAINS ST GENOA ILL
ARIZONA GEAR MFG CO
3544 E FORT LOWELL TUCSON ARIZ
ARKAY INTERNATIONAL INC
88 06 VAN WYCK EXPSWAY RICHMOND HILL 18 NY
ARK ELECT CORP
624 DAVISVILLE RD WILLOW GROVE PA
ARK LES SWITCH CORP
51 WATER ST WATERTOWN MASS
ARLIN MFG CO
12 PERKINS ST P O BOX 296 LOWELL MASS
ARMCO STEEL CORP
703 CURTIS ST MIDDLETOWN OHIO
ARMEL ELECTRONICS INC
1601 75TH ST N BERGEN N J
ARMSTRONG CORK CO
LANCASTER PENNA
ARMSTRONG WHITWORTH EQUIP
HUCCLECOTE GLOUCESTER ENG
ARNHOLD CERAMICS INC
1 E 57TH ST NEW YORK 22 NY
ARNOLD ENG G CO
P O BOX G MARENGO ILL
ARNOLD ENGG CO REPATH PACIFIC DIV
1551 EAST ORANGETHORPE FULLERTON CALIF
ARNOLD MAGNETICS CORP
6050 W JEFFERSON BLVD LOS ANGELES 16 CALIF
ARNOUX CORP
11924 W WASHINGTON BLVD LOS ANGELES CALIF
ARRA RESEARCH ASSOCIATES
27 BOND ST WESTBURY N Y
ARROW MACHINIST & FABRICATORS
154 E 3RD ST MT VERNON N Y
ARROW RADIO CO
1829 DAVENPORT RD TORONTO ONTARIO CANADA
ARROWHEAD PRODUCTS
4411 KATELLA AVE LOS ALAMITOS CALIF
AR & T ELECTRONICS INC
LITTLE ROCK ARK
AR&T ELECTRONICS INC
1101 MCALMONT LITTLE ROCK ARK
ART DECORATING CO
4201 HUDSON BLVD N BERGEN N J

ELECTRONIC MANUFACTURERS—A TO Z

ART WIRE & STAMPING CO
227 HIGH ST NEWARK 2 N J
ARTISAN ELECTRONICS CORP
171 RIDGEDALE AVE MORRISTOWN N J
ARTISAN METAL WORKS CO
11400 MADISON AVE CLEVELAND 2 OHIO
ARTOS ENGG CO
2757 S 28TH ST MILWAUKEE WISC
ARTRONIC INSTRUMENT CO
11232 TRIANGLE LA SILVER SPRING MD
ARTRONICS INC
82 SANFORD ST HAMDEN CONN
ARTTED CO INC
367 WORTHINGTON ST SPRINGFIELD 3 MASS
ARVEY CORP
300 COMMUNIPAW AVE JERSEY CITY 4 N J
ARVIN INDUSTRIES INC
COLUMBUS IND
ASCOP DIV ELECTRO MECHANICAL RESCH INC
44 WALLACE RD PRINCETON N J
ASHEVILLE-SCHOONMAKER MICA CO
900 JEFFERSON AVE NEWPORT NEWS VA
ASHLAND ELECTRIC PRODUCTS INC
3202 QUEENS BLVD LONG ISLAND CITY 1 N Y
ASKANIA REGULATOR CO
240 E ONTARIO ST CHICAGO 11 ILL
ASQUITH CO S A
427 W CHEVY CHASE DR GLENDALE CALIF
ASSEMBLY PRODUCTS INC
75 WILSON MILLS RD CHESTERLAND OHIO
ASSOC AMER WINDING MACHINERY INC
750 ST ANNS AVE NEW YORK N Y
ASSOCIATED COMMODITY CORP
620 FIFTH AVE NEW YORK 20 N Y
ASSOCIATED ELECTRICAL INDUSTRIES LTD
155 CHARING CROSS RD LONDON W C 2 ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
CARHOLME RD LINCOLN ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
ELCT CNTRL SLS DPT NEW PKS LEICSTR ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
COMPUTER SLS DPT TRFFRD PK MNCHSTR ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
MILITARY RDR SLS DPT BLCKBD RD LEICSTR ENG
ASSOCIATED ENG & MFG CORP
210 STONEHOUSE RD GLEN RIDGE N J
ASSOCIATED ENG CORP
65 KENT ST BROOKLUNE MASS
ASSOCIATED MFG CO
4755 N ROCKWELL ST CHICAGO ILL
ASSOCIATED PRODUCTION CO
162 N CLINTON ST CHICAGO 6 ILL
ASSOCIATED RESEARCH INC
3787 W BELMONT AVE CHICAGO ILL
ASSOCIATED SPECIALTIES CO
1751 MAIN ST OREFIELD PA
ASSOC SPRING CORP
BRISTOL CONN
ASSOCIATED TESTING LABS
109 ROUTE 46 WAYNE N J
ASSOC TESTING LABS INC SOUTHEASTERN DIV
1112 SOLANA AVE WINTER PARK FLA
ASTATIC CORP
250 HARBOR ST CONNEAUT OHIO
ASTRA TECHNICAL INSTRUMENT CORP
9905 W JEFFERSON BLVD CULVER CITY CALIF
ASTRODATA INC
240 E PALAIS RD ANAHEIM CALIF
ASTROMATIC DIV CONTROL CO OF AMER
140 WASHINGTON ST EL SEGUNDO CALIF
ASTROMETRICS INC
1108 SANTA BARBARA ST SANTA BARBARA CALIF
ASTRON CORP
255 GRANT AVE E NEWARK N J
ASTRO SYSTEMS INC
220 E 23RD ST NEW YORK N Y
ASTROTHERM CORP
1625 BELLENFONTAINE ST INDIANAPOLIS IND
A T ELECTRONICS INC
BOX 1841 NEW HAVEN CONN
ATELIERS DE MONTAGES ELECT
77 RUE ST CHARLES PARIS 15 EME FRANCE
ATKINS & MERRILL INC
POST RD SOUTH SUDBURY MASS
ATKINSON LAB INC
7070 SANTA MONICA BLVD LOS ANGELES CALIF
ATKOMATIC VALVE CO INC
545 W ABBOTT ST INDIANAPOLIS 25 IND
ATLANTIC & PACIFIC WIRE & CABLE CO
137 GRAND ST NEW YORK NY
ATLANTIC RESEARCH CORP
SHIRLEY HWY AT EDSALL RD ALEXANDRIA VA
ATLANTIC TRANSFORMER CORP
30 HYNES AVE GROTON CONN
ATLANTIS ELECTRONICS CORP
1807 STRATFORD DR GARLAND TEXAS
ATLANTIS ELECTRONIC CORP
3326 BROADWAY GARLAND TEXAS
ATLAS COIL CORP
63 MAIN ST ANSONIA CONN
ATLAS CONNECTORS CORP
43 RIVER RD N ARLINGTON N J
ATLAS CONTROLS INC
9 ERIE DRIVE NATICK MASS
ATLAS ENG CO
10 CHENEY ST ROXBURY MASS
ATLAS MINERAL PRODUCTS CO
151 WALNUT ST MERTZTOWN PA
ATLAS OVERHEAD DOOR CO
MILL ST AT READING RR QUAKERTOWN PA
ATLAS POWDER CO
TAMAQUA PA
ATLAS SOUND CORP
1449 39 ST BROOKLYN 18 N Y
ATLAS TRANSFORMER CO
5975 FAIRMOUNT EXT SAN DIEGO CALIF
ATLEE CORP
2 LOWELL AVE WINCHESTER MASS

ATMO SEAL CO
3475 CARDIFF AVE CINCINNATI OHIO
ATOCON CORP
527 N UNION ST GALION OHIO
ATOHM ELECTRONICS
7648 SAN FERNANDO RD SUN VALLEY CALIF
ATOMIC ACESSORIES INC
811 W MERRICK RD VALLEY STREAM N Y
ATOMIC LABS INC
3086 CLAREMONT AVE BERLELEY CALIF
ATTLEBORO REFINING CO
36 UNION ST ATTLEBORO MASS
AUBURN INDUSTRIAL PARK
AUBURN MASS
AUBURN MFG CO
PEASE AVE & STACK ST MIDDLETOWN CONN
AUDAX INC
109 01 37TH AVE CORONA N Y
AUDEX CO
3968 XENWOOD AVE MPLS MINN
AUDIO ACCESSORIES
279 BROADWAY AMITYVILLE N Y
AUDIO CRAFTERS
1601 BLUFF ROAD MONTEBELLO CALIF
AUDIO DEVICES INC
444 MADISON AVE NEW YORK 22 N Y
AUDIO DEVICES INC RECTIFIER DIV
620 E DYER RD SANTA ANA CALIF
AUDIO ELECTRONICS
15858 35TH N E SEATTLE 55 WASH
AUDIO EQUIPMENT CO
75 HARBOR ROAD PORT WASHINGTON N Y
AUDIO EQUIPMENT
15749 WYOMING AVE DETROIT MICH
AUDIOGERSH CORP
514 BROADWAY NEW YORK 12 N Y
AUDIO INSTRUMENT CO
135 W 14 ST NEW YORK 11 N Y
AUDIO MFG CORP
100 RESEARCH DRIVE STAMFORD CONN
AUDIOMATION LABS
7230 CLINTON RD UPPER DARBY 14 PA
AUDIO PRECISION AIDS INC
SCARBOROUGH PK OSSINING N Y
AUDIOSEARS CORP
SHEPARD HILL RD ROXBURY NY
AUDIOTAPE CORP
25 PARKER AVE GLENBROOK CONN
AUDIOTEX MFG CO/DIV G C TEXTRON INC
400 S WYMAN ROCKFORD ILL
AUERBACH CORP
1634 ARCH ST PHILA PA
AUGAT BROS
33 PERRY AVE ATTLEBORO MASS
AULT MAGNETICS CO
3511 N E CLEVELAND MINN 18 MINN
AUREX CORP
315 W ADAMS ST CHICAGO 10 ILL
AUSTIN ELECTRONICS DIV AUSTIN CO
76 9TH AVE NEW YORK 11 NY
AUTH ELECTRIC CO
34 20 45 ST LONG ISLAND CITY N Y
AUTHORIZED MFRS SERVICE CO
919 WYCKOFF AVE BROOKLYN 27 N Y
AUTO-CONTROL LABORATORIES INC
5251 W IMPERIAL HWY LOS ANGELES 45 CALIF
AUTOCRAT ELECTRONICS CO
5024 ELM ST SKOKIE ILL
AUTO DATA
BOX 9146 SAN DIEGO CALIF
AUTOMATED CONTROLS
1815 MAGNOLIA ALDERWOOD MANOR WASH
AUTOMATIC COIL CO INC
76 E 2ND ST MINEOLA N Y
AUTOMATIC CONTROL CO
995 UNIVERSITY AVE ST PAUL 4 MINN
AUTOMATIC ELECTRIC CO
NORTHLAKE ILL
AUTOMATIC ELECTRIC LAB
NORTHLAKE ILL
AUTOMATIC METAL PROD CORP
323 BERRY ST BROOKLYN N Y
AUTOMATIC SWITCH CO
HANOVER RD FLORHAM PARK N J
AUTOMATIC TIMING & CONTROLS INC
KING OF PRUSSIA PENNA
AUTOMATION COMPONENTS INC
875 HICKORY ST PECKVILLE PA
AUTOMATION DEVICES INC
3125 BRANDES ST ERIE PENNA
AUTOMATION DYNAMICS CORP
255 COUNTY RD TENAFLY N J
AUTOMATION INC
212 WORCESTER ST WELLESLEY HILLS 82 MASS
AUTOMATION INSTS INC
401 E GREEN ST PASADENA CALIF
AUTOMATION IND INC MAGNETICS DIV
INDUSTRIAL PARK BOULDER COLORADO
AUTOMATION MANAGEMENT INC
25 BRIGHAM ST WESTBORO MASS
AUTONETICS DIV NORTH AMERICAN AVIATION INC
9150 E IMPERIAL HWY DOWNEY CALIF
AUTONETICS DIV NORTH AMERICAN AVIATION INC
LA PALMA ANAHEIM CALIF
AUTO PRODUCTS MFG
2735 OLIVE ST ST LOUIS MO
AUTOSCREW CO INC
216 W 18 ST NEW YORK 11 N Y
AUTO-SWAGE PRODUCTS INC
SHELTON CONN
AUTO TEST INC
600 S MICHIGAN AVE CHICAGO 5 ILL
AUTO TEST INC
411 W 8TH ST NEILLSVILLE WISC
AUTOTRON INC
3629 N VERMILION ST DANVILLE ILL
AUTOTRONICS INC
P O BOX 208 FLORISSANT MO

AUTRON ENG INC
1301 WILSHIRE BLVD LOS ANGELES 17 CALIF
AUTRONICS CORP
180 N VINEDO AVE PASADENA CALIF
AVCO CROSLEY DIV
BOX 116 EVENDALE OHIO
AVCO CORP ELECTRONICS & ORDNANCE DIV
2630 GLENDALE CINCINNATI 41 OHIO
AVCO LYCOMING DIV
550 S MIAN ST STRATFORD CONN
AVEY DIV MOTCH & MERRYWEATHER
25 E 3RD ST COVINGTON KY
AVIATION INSTRUMENT & GEAR
2051 W 9TH AVE HIALEAH FLA
AVIEL ELECTRONICS INC
1755 BERKELEY ST SANTA MONICA CALIF
AVION FOUNDRY CORP
PO BOX 397 TARPON SPRINGS FLA
AVIONICS LTD P O BOX 200
NIAGARA-ON-THE-LAKE ONTARIO CANADA
AVNET CORP
5877 RODEO RD LOS ANG CALIF
AVNET ELECTRONICS CORP OF N CALIF
1262 N LAWRENCE STATION RD SUNNYVALE CAL
AVNET ELECTRONICS CORP
70 STATE ST WESTBURY N Y
AVO LTD
80 SHOPE RD PORT WASH N Y
AVTRON MFG INC
10409 MEECH AVE CLEVELAND 5 OHIO
AXEL ELECTRONICS INC
134 20 JAMAICA JAMAICA N Y
AXLER ASSOCIATES INC
102-42 43 AVE NEW YORK 68 N Y

B

BABBITT CHEMICAL CO
BOX 457 MATTAPOISETT MASS
BABCOCK & WILCOX CO
TUBULAR PRODUCTS DIV BEAVER FALLS PA
BABCOCK & WILCOX BAILEY METER CO
2980 EUCLID AVE WILCLIFFE OHIO
BABCOCK & WILCOX DIAMOND POWER SPEC CORP
BOX 415 LANCASTER OHIO
BABCOCK ELECT CORP
1640 MONROVIA AVE COSTA MESA CALIF
BABCOCK RELAYS
1640 MONROVIA AVE COSTA MESA CALIF
BACH AURICON INC
6900 ROMAINE AVE HOLLYWOOD CALIF
BACH-SIMPSON LTD
1255 BRYDGES ST LONDON ONT CANADA
BACHE & CO SEMON
636 GREENWICH ST NEW YORK 14 N Y
BACON INDUSTRIES
192 PLEASANT ST WATERTOWN 72 MASS
BAER CO N S
1-11 MONTGOMERY ST HILLSIDE 5 N J
BAILEY METER COMPANY
1050 IVANHOE RD CLEVELAND 10 OHIO
BAILEY METER CO
29801 EUCLID AVE WICKLIFF OHIO
BAIRD ATOMIC INC
WALTHAM MASS
BAKER CHEMICAL CO J T
PHILLIPSBURG N J
BAKER CO
106 GRANITE ST BIDDEFORD ME
BALCO RESEARCH LABS CAPACITOR DIV
49-53 EDISON PL NEWARK 2 N J
BALCRANK INC MACHINE TOOL DIV
DISNEY ST CINCINNATI 9 OHIO
ELECTRONICS DIV BALDWIN HAMILTON CORP
WALTHAM MASS
BALDWIN MFG CO INC
140 HOMER ST WATERBURY CONN
BALDWIN PIANO CO
1801 GILBERT AVE CINCINNATI 2 OHIO
BALLANTINE LABS INC
BOONTON N J
BALLARD CO IRVING
407 SANSOME ST SAN FRAN CALIF
BALLASTRAN CORP
1701 N CALHOUN ST FT WAYNE IND
BALTEAU ELECTRIC CORP
NEW & MEADOW STS STAMFORD N Y
H S BANCROFT & CO
209 COOPER ST WESTMONT COLLINGSWOOD N J
BAR WORK MFG CO INC
1198 HIGHLAND AVE WATERBURY CONN
BAR-RAY PRODUCTS INC
209 25TH ST BROOKLYN 32 N Y
BARBER & HOWARD CO
EAST AVE WESTERLY R I
BARBER COLMAN CO AIRCRAFT & MISSILE PROD DIV
ROCKFORD ILL
BARBER COLMAN CO MOTORS & COMPONENTS DIV
ROCKFORD ILL
BARBER COLMAN CO ELECT COMPONENTS DIV
ROCKFORD ILL
BARBER LABS ALFRED W
32 44 FRANCIS LEWIS BLVD FLUSHING N Y
BARBER-COLMAN CO
1300 ROCK ST ROCKFORD ILL
BARBOUR STOCKWELL CO
205 BROADWAY CAMBRIDGE MASS
BARCO CHEMICAL PRODUCTS CO
701 S LASALLE ST CHICAGO ILL
BARDEN CORP
200 PARK AVE DANBURY CONN
BARFIELD INSTRUMENT CORP
4101 N W 29TH ST MIAMI FLA

BARIUM & CHEMICALS INC
WILLOUGHBY OHIO
BARIUM CHEMICALS INC
STEUBENVILLE OHIO
BARKER & WILLIAMSON INC
CANAL & BEAVER STS BRISTOL PENNA
BARKER PRODUCTS CO
WEST BRIDGEWATER MASS
BARKSDALE VALVES
5125 ALCOA AVE LOS ANGELES 58 CALIF
BARNES DEVELOPMENT CO
213 W BALTIMORE AVE LANSDOWNE PA
BARNES ENGINEERING CO
30 COMMERCE RD STAMFORD CONN
BARNES METAL PRODUCTS CO
4425 W 16ST CHICAGO ILL
BARNETT INST CO
430 COMMERCE ST CLARKSVILLE TENN
BARNETT INSTRUMENT CO
KRAFT ST CLARKSVILLE TENN
BARNEY CHENEY CO
EIGHTH AVE NORTH CASSADY COLUMBUS OHIO
BARNSTEAD STILL & DEMINERALIZER CO
331 LANESVILLE TERR BOSTON 31 MASS
BAR RAY PRODUCTS INC
211 25TH ST BROOKLYN N Y
BARRETT CO LEON J
P O BOX 378 WORCESTER 1 MASS
BARRETT ELECTRONICS CORP
630 DUNDEE RD NORTHBROOK ILL
BARRETT ELECT CORP WESTERN DIV
897 COMMERCIAL ST PALO ALTO CALIF
BARRETT VARNISH CO
1532 S 50TH COURT CICERO ILL
BARRY CONTROLS DV OF BARRY WRIGHT CORP
700 PLEASANT ST WATERTOWN MASS
BARRY ELECTRONICS CORP
512 BROADWAY NEW YORK N Y
BARTA GRIFFIN CO
PO BOX 808 72 COMMERCIAL ST WORCT MASS
BARTH ENGRG & MFG CO INC
48 ELM ST MERIDEN CONN
BARTON INSTRUMENT CORP
580 MONTERY PASS RD MONTEREY PK CALIF
BARWOOD ELECTRONICS INC
120 S MARYLAND AVE GLENDALE 5 CALIF
BAR WORK CO INC
1198 HIGHLAND AVE WATERBURY CONN
BASCH CO GEORGE
19 HANSE AVE FREEPORT L I N Y
PENN CONTROLS INC BASCO DIV
1007 S 12TH ST WATERTOWN WISC
BASIC & EXPERIMENTAL PHYSICS
BOX 689 FALMOUTH MASS
BASLER ELECTRIC CO
BOX 269 RT 143 HIGHLAND ILL
BASO DIV PENN CONTROLS INC
4000 W BURNHAM ST MILWAUKEE WISC
BASSETT INC REX
1314 N E 17 CT FT LAUDERDALE FLA
BAUSCH & LOMB INCORP
1762 BAUSCH ST ROCHESTER N Y
BAYLEY INSTRUMENT CO
PO BOX 538 DANVILLE CALIF
BAYLY
AJAX ONTARIO CANADA
BAY STATE ABRASIVE PRODUCTS CO
12 UNION ST WESTBORO MASS
BAYSIDE TIMERS
45-25 162 ST FLUSHING 58 N Y
B & B ELECTRONICS CORP
17360 S GRAMERCY PL GARDENA CALIF
B & C INSULATION PRODUCTS INC
LINCOLN HWY ISELIN N J
BEACH-RUSS CO
622 GRAYBAR BLDG NEW YORK 17 N Y
BEAD CHAIN MFG CO
110 MOUNTAIN GROVE ST BRIDGEPORT 5 CONN
BEAM INSTRUMENTS CORP
350 5TH AVE NEW YORK 1 N Y
BEAN & CO MORRIS
HYDE RD YELLOW SPRINGS OHIO
BEARING INSPECTION INC
3311 E GAGE AVE HUNTINGTON PK CAL
BEATTIE-COLEMAN INC
1000 N OLIVE ST ANAHEIM CALIF
W A BEAUCHAINE & SONS INC
P O BOX 127 LAKEPORT N H
BEAU ELECTRONICS INC
1066 WOLCOTT ROAD WATERBURY CONN
BEAVER GEAR WORKS INC
1025 PARMELEE ST ROCKFORD ILL
BEAZART ELECTRONICS CO
7459 DEERING CANOGA PARK CALIF
BECK CO HAROLD
3640 N 2 ST PHILA 40 PENNA
BECKER BROS CARBON CO
3450 S LARIME AVE CICERO ILL
BECKER DURHAM
EAST DURHAM N Y
BECKER ELECT MFG CORP
1091 ROCKAWAY AVE VALLEY STREAM N Y
BECKER ELECTRONICS MFG CORP
RTE 145 E DURHAM N Y
BECKLEY MFG CO
BECKLEY W VA
BECKMAN & WHITLEY
973 E SAN CARLOS AVE SAN CARLOS CALIF
BECKMAN INST INC
2500 HARBOR BLVD FULLERTON CALIF
BECKMAN INST INC BERKELEY DIV
2200 WRIGHT AVE RICHMOND CALIF
BECKS INC
298 E 5 ST ST PAUL MINN
BEE CHEMICAL CO
2700 E 170TH ST LANSING ILL
BEGEN CO M
1683 JERROLD ST SAN FRANCISCO 24 CALIF

BELDEN MFG CO
415 S KILPATRICK CHICAGO 44 ILL
BELDING CORTICELLI INDUST INC
1407 BROADWAY NEW YORK N Y
BELFAB CORP
MUNICIPAL AIRPORT DAYTONA BEACH FLA
BELFAB CORP
BOX 1881 DAYTONA BEACH FLA
BELFAB CORP
PO BOX 1446 DAYTONA BEACH FLA
BELFUSE INC
198 VAN VORST JERSEY CITY N J
BELL & HOWELL PHOTO PRODUCTS DIVISION
7100 MCCORMICK RD CHICAGO 45 ILL
BELL AIRCRAFT CORP
PO BOX 1 NIAGARA FALLS BLVD BUFFALO 5 N Y
BELL INC F W
1356 NORTON AVE COLUMBUS 12 OHIO
BELL SOUND DIV THOMPSON RAMO WOOLDRIDGE INC
555 MARION RD COLUMBUS 7 OHIO
BELLAIRE ELECTRONICS INC
62 WHITE ST RED BANK N J
BELLEVILLE HEXEM CORP
638 UNIVERSITY AVE LOS GATOS CALIF
BELLOWS VALVIAR
PO BOX 631 AKRON 9 OHIO
BELMET PRODUCTS INC
503 MORGAN AVE BROOKLYN 22 N Y
BELMONT SMELTING & REFINING WORKS
330 BELMONT AVE BROOKLYN 7 N Y
BELOCK INSTRUMENT CORP
111 01 14 AVE COLLEGE POINT N Y
BELTRONICS CORP
344 INTERSTATE RD ADDISON ILL
BELZ INDUSTRIES DIV EL TRONICS INC
89 UNION ST MINEOLA N Y
BENCHMASTER MFG CO
1835 W ROSECRANS AVE GARDENA CALIF
BENCO TELEVISION ASSOC LTD
27 TABER RD REXDALE ONT CANADA
BENDIX AVIATION CORP BENDIX PACIFIC DIV
11600 SHERMAN WAY N HOLLYWOOD CALIF
BENDIX AVIATION CORP
1104 FISHER BLDG DETROIT 2 MICH
BENDIX AVIATION CORP RED BANK DIV
RT 35 EATONTOWN N J
BENDIX AVIATION CORP/SCINTILLA DIV
DELAWARE AVE SIDNEY N Y
THE BENDIX CORP
3130 WASSON RD CONN OHIO
BENDIX COMPUTER DIV THE BENDIX CORP
5630 ARBOR VITAE LOS ANG CALIF
BENDIX CORP BENDIX RADIO DIV
BALTIMORE MD
BENDIX CORP SEMICONDUCTORS DIV
HOLMDEL N J
BENDIX CORP ECLIPSE PIONEER DIV
TETERBORO NJ
BENDIX CORP THE PIONEER CENTRAL DIV
2734 HICKORY GROVE RD DAVENPORT IOWA
BENDIX CORP THE FRIEZ INST DIV
BALTIMORE 4 MD
BENNETT LAB INC
1475 POWELL ST EMERYVILLE CALIF
BENNETT LABS INC
4224 HOLDEN ST EMERYVILLE CALIF
BENNETT MFG CO INC
RAILROAD ST ALDEN NY
BENSON LEHNER CORP
11930 W OLYMPIC BLVD LOS ANG CALIF
BENSON LEHNER G B LTD
WEST QUAY RD SOUTHHAMPTON ENG
BENTLEY HARRIS MFG CO
CONSHOHOCKEN PA
BERG MFG CORP
NEW CUMBERLAND PA
BERGEN LABS INC
60 SPRUCE ST PATERSON 1 N J
BERGEN WIRE ROPE CO
456 GREGG ST LODI N J
BERGER BROS CO
135 DERBY AVE NEW HAVEN CONN
BERGIN CARBIDE CO
67 HEPWORTH PL GARFIELD N J
BERKSHIRE LABS
11-35 KINGSFORD RD HANOVER NEW HAMPSHIRE
BERKSHIRE TRANSFORMER CORP
ROUTE 341 KENT CONN
BERMAN LABS
112 03 ROCKAWAY BLVD OZONE PK N Y
BERMITE POWDER
22216 W SOLEDAD CANYON RD SAUGUS CAL
BERNARD FRANKLIN CO INC
FRANKFORD & TORRESDALE AVE PHILA PA
BERNCO ENGINEERING CORP
2320 S TIBBS AVE INDIANAPOLIS 41 IND
BERYLLIUM CORP
P O BOX 1462 READING PENNA
BEST MFG CO
1333 WALNUT ST BOX 2126 KANSAS CITY 42 MO
BESTCRAFT PRODUCTS CO
626 BROADWAY NEW YORK 12 N Y
BETHLEHEM STEEL CO
BETHLEHEM PA
BETTER COIL & TRANSFORMER CORP
GOODLAND IND
BETTS & BETTS CORPORATION
POMPERAUG ROAD WOODBURY CONN
BEVA LABORATORY
185 FOURTH STREET TRENTON 9 NJ
BEVIN WILCOX LINE CO
95 SKINNER ST E HAMPTON CONN
B & F INSTRUMENTS INC
3644 N LAWRENCE ST PHILA PA
B G CORP THE
321 BROAD AVE RIDGEFIELD NJ

B & H INSTRUMENT CO INC
3479 W VICKERY BLDG FT WORTH TEXAS
BIDDLE CO JAMES G
1316 ARCH ST PHILADELPHIA 7 PA
B I F INDUSTRIES
345 HARRIS AVE PROVIDENCE R I
BIGGS CO CARL H
1547 FOURTEENTH ST SANTA MONICA CALIF
BIO-RAD LABS
32ND AND GRIFFIN AVE RICHMOND CALIF
BIOPHYSICAL INSTRUMENTS INC
20 HERMAN ST PHILA PA
BIOS LABS INC
17 W 60 ST NEW YORK N Y
BIRD & CO RICHARD H
1 SPRUCE ST WALTHAM 54 MASS
BIRD & SONS LTD SYDNEY S
FLEETS LANE POOLE DORSET ENG
BIRD ELECTRONIC CORP
30303 AURORA RD CLEVELAND 39 OHIO
BIRDAIR STRUCTURES INC
1800 BROADWAY BUFFALO 12 N Y
BIRMA MFG CO INC
254 RAND ST BUFFALO 7 N Y
BIRMINGHAM SOUND REPRODUCERS LTD
MONARCH WKS POWER LANE STAFFORDSHIRE ENG
BIRNBACH RADIO CO
145 HUDSON ST NEW YORK 13 N Y
THE BIRTCHER CORP INDUSTRIAL DIV
745 S MONTEREY PASS RD MONTEREY PK CALIF
BISCHOF DIE ENGRAVING
1405 16TH ST RACINE WISC
BISHOP & CO PLATINUM WORKS J
MALVERN PENNA
BISHOP MFG CORP
10 CANFIELD RD CEDAR GROVE NJ
BITTERMANN ELECTRIC CO
BARLOW ST CANAAN CONN
BIWAX CORP
3445 HOWARD ST SKOKIE ILL
B & K MFG CO
1801 W BELLE PLAINE AVE CHICAGO 13 ILL
BLACK & DECKER MFG CO
E PENNA AVE TOWSON 4 MD
BLACK & WEBSTER INC
570 PLEASANT ST WATERTOWN MASS
BLACK LIGHT EASTERN CORP
24 KINKEL ST WESTBURY N Y
BLACK LIGHT PRODUCTS INC
4868 N SHERIDAN RD CHICAGO ILL
BLACKBURN ELECTRONIC CORP
55 W 7 ST WYOMING PA
BLACKHAWK ENGINEERING CO
P O BOX 146 JANESVILLE WISC
BLACKSTONE CORP
1111 ALLEN ST JAMESTOWN N Y
BLACO MFG CO
6541 EUCLID AVE CLEVELAND OHIO
BLAINE ELECTRONICS INC
14757 KESWICK ST VAN NUYS CALIF
BLAW-KNOX CO/BLAW-KNOX EQUIP DIV
PITTSBURGH 38 PENNA
BLEHART CO L D
10 FISKE PL MT VERNON N Y
BLICKMAN INC
201 GREGORY AVE WEEHAWKEN N J
BLILEY ELECTRIC CO
UNION STATION BLDG ERIE PA
BLINN CO DELBERT
P O BOX 757 POMONA CALIF
BLISS ELECTRONIC CORP
BOX 366 SUSSEX NJ
BLOCK ASSOC
395 PUTNAM AVE CAMBRIDGE MASS
BLOCKSOM & CO
5TH CANAL ST MICHIGAN CITY IND
BLOOMINGDALE RUBBER CO
P O BOX 191 ABERDEEN MD
BLOWERS INC
12655 WESTERN AVE BLUE ISLAND ILL
BLUE M ELECTRIC CO
138 E CHATHAM ST BLUE ISLAND ILL
BODINE ELECTRIC CO
2500 BRADLEY PLACE CHICAGO ILL
BOEHME INC H O
915 BROADWAY NEW YORK 10 N Y
BOEING AIRPLANE CO
DEPT 8200 WICHITA 1 KANSAS
BOESCH MFG CO
45 RIVER ST DANBURY CONN
BOETSCH BROS
115 CEDAR ST N ROCHELL N Y
BOGART MFG CORP
315 SIEGEL ST BROOKLYN N Y
BOGUE ELECTRIC MFG CO
52 IOWA AVE PATERSON 3 NJ
BOLSEY RESEARCH & DEVELOPMENT
11 W 57TH ST NEW YORK 19 NY
BOLTA PRODUCTS DIV GENERAL TIRE & RUBBER CO
70 GARDEN ST LAWRENCE MASS
BOMAC LABS INC
SALEM RD BEVERLY MASS
BOMYTE CO
GREEN ST SILVERDALE PA
BON DE ELECTRONIC LABS INC
361 363 RANTOUL ST BEVERLY MASS
BONE ENGG CORP
701 BROADWAY GLENDALE CALIF
BONNY MFG CORP
146 MAIN ST MAYNARD MASS
BOOKER & WALLSTAD DIV THERMOTECH IND
3330 GORHAM AVE MINN MINN
BOONTON ELECTRONICS CORP
738 SPEEDWELL AVE MORRIS PLAINS N J
BOONTON RADIO CORP
INTERVALE RD BOONTON N J
BOOTH CO ARTHUR E
265 S ALEXANDRIA AVE LOS ANGELES 4 CALIF

ELECTRONIC MANUFACTURERS—A TO Z

BOOTS AIRCRAFT NUT CO
NEWTON TURNPIKE NORWALK CONN
THE BORDEN CO CHEMICAL DIV
1 CLARK ST NO ANDOVER MASS
BORDEN CHEMICAL CO DIV BORDEN CO
P O BOX 430 COMPTON CALIF
BORDEN CHEMICAL CO
5000 LANGDON ST BOX 9522 PHILA PA
BORG EQUIP DIV AMPHENOL BORG ELECT CORP
120 MAIN ST JANESVILLE WISC
BORG-WARNER CONTROLS
3300 NEWPORT BLVD BOX 1679 SANTA ANA CALIF
BOSCO ELECT INC
56 ROUTE 10 HANOVER N J
BOSTON AUTO GAGE CO
70 WEST ST PITTSFIELD MASS
BOSTON INSULATED WIRE & CABLE CO
65 BAY ST BOSTON MASS
BOULEVARD ELECTRONICS INC
1229 WASHINGTON BLVD CHICAGO ILL
BOULEVARD RECORDING STUDIOS INC
632 N DEARBORN ST CHICAGO ILL
BOURNS INC
6135 MAGNOLIA AVE RIVERSIDE CALIF
BOURNS LABS INC
118 HAYWARD AVE AMES IOWA
BOW SOLDER PRODUCTS CO
251 FREEMAN ST BROOKLYN N Y
BOWERS BATTERY & SPARK PLUG CO
P O BOX 1262 READING PA
BOWMAR INSTRUMENT CORP
8000 BLUFFTON RD FT WAYNE IND
BOZAK MFG CO R T
587 CONNECTICUT AVE S NORWALK CONN
BOY-MAR ELECTRICAL SERVICE CO
1271 MISSION ST SAN FRANCISCO 3 CALIF
B & R TOOL & DIE CO
947 INDUSTRIAL AVE PALO ALTO CALIF
BRACH MFG CORP DIV GEN BRONZE CORP
200 CENTRAL AVE NEWARK 3 N J
BRAD THOMPSON INDUST INC
83 810 TAMARISK ST INDIO CALIF
BRADFORD COMPONENTS INC
65 SOUTH AVE SALAMANCA N Y
BRADLEY SEMICONDUCTORS CORP
275 WELTON ST NEW HAVEN CONN
BRADY CO W H
727 W GLENDALE AVE MILWAUKEE 9 WISC
BRAILSFORD & CO
670 MILTON RD RYE N Y
BRAININ CORP C S
320 WASHINGTON ST MT VERNON N Y
BRAM METALLURGICAL-CHEMICAL CO
820 65 AVE PHILADELPHIA 26 PA
BRAND REX DIV AMER ENKA CORP
18120 S BROADWAY GARDENA CALIF
BRAND REX DIV AMER ENKA CORP
ROUTE 6 N WINDHAM CONN
BRAND REX DIV AMER ENKA CORP
HAYWARD RD W ACTON MASS
BRAND WILLIAM REX DIV AMERICAN ENKA CORP
NORTH WINDHAM CONN
BRANSON CORP
41 S JEFFERSON RD WHIPPANY N J
BRANSON INSTRUMENTS INC
37 BROWN HOUSE RD STAMFORD CONN
BRAUN KNECHT HEIMANN CO
601 ONEIL AVE BELMONT CALIF
BRAUN TOOL & INSTRUMENT CO INC
140 FIFTH AVE HAWTHORNE N J
BREEZE CORPS
700 LIBERTY AVE UNION NJ
BREON LABS
1520 EVERGREEN RD WILLIAMSPORT PA
BREVEL PRODUCTS CORP
601 W 26TH ST NEW YORK N Y
BREW & CO RICHARD D
90 AIRPORT RD CONCORD N H
BRIDGEPORT BRASS CO
30 GRAND ST BRIDGEPORT 2 CONN
BRIGHT RADIO LABS INC
222 E 2ND ST MINEOLA LI N Y
BRIGHT STAR BATTERY
CLIFTON N J
BRILMAYER LAB E W
330 FIFTH AVE PELHAM N Y
BRISTOL CO
P O BOX 1790 EI WATERBURY CONN
BRISTOL CO
2040 N HAWTHORNE MELROSE PARK ILL
BRISTOL CO
6800 E ACCO ST LOS ANGELES CALIF
BRISTOL MOTORS DIV VOCALINE CO AMERICA INC
OLD SAYBROOK CONN
BRITISH RADIO ELECTRONICS LTD
1833 JEFFERSON PL NW WASHINGTON DC
BRITISH ELECTRONIC SALES
OAKLAND GARDENS FLUSHING 64 N Y
BRITISH ELECTRONIC SALES CO INC
PAINTON DIV
BRITISH RADIO ELECTRONICS LTD
1833 JEFFERSON PL NW WASHINGTON D C
BROADWAY COIL CO
5638 BROADWAY CHICAGO 40 ILL
BRON-SHOE CO
269 E BROAD ST COLUMBUS 15 OHIO
BROOKLYN PAINT & VARNISH CO INC
50 JAY ST BROOKLYN 1 N Y
BROOKS & PERKINS INC
1950 W FORT ST DETROIT MICH
BROOKS RADIO & TV CORP
84 VESEY ST NEW YORK 7 N Y
BROOKS RESEARCH
499 WEST COMMERCIAL ST EAST ROCHESTER NY
BROOKS ROTAMETER CO
P O BOX 432 LANSDALE PA
BROWN & SHARPE MFG CO
235 PROMENADE ST PROVIDENCE R I
BROWN BROCKMEYER CO
1000 S SMITHVILLE RD DAYTON OHIO
BROWN ENG CO INC
1100 MERIDIAN ST HUNTSVILLE ALA
BROWN INC DAYTON T
1305 STRONG RD COPIAGUE N Y
BROWNING LABS INC
100 UNION AVE LACONIA N H
BRUBAKER ELECTRONICS INC
11800 OLYMPIC BLVD LOS ANG CALIF
BRUMBERGER CO
34 34TH ST BROOKLYN N Y
BRUNO NEW YORK INDUST CORP
460 W 34 ST NEW YORK 1 NY
BRUNSWICK INSTRUMENTS
P O BOX 813 NEW BRUNSWICK N J
BRUSH BERYLLIUM CO READING DIV
SHOEMAKERSVILLE PENNA
BRUSH BERYLLIUM CO
5209 EUCLID AVE CLEVELAND OHIO
BRUSH INSTRUMENTS
37TH & PERKINS CLEVELAND OHIO
BRYANT COMPUTER PRODUCTS DIV EX-CELLO CORP
850 LADD ROAD WALLED LAKE MICH
BRYS INSTRUMENT CO
7026 6TH AVE BROOKLYN N Y
BTU ENGG CORP
179 BEAR HILL RD WALTHAM 54 MASS
BUCHANAN ELECTRICAL PROD CORP
HILLSIDE N J
BUCK ENGG CO
37 MARCY ST FREEHOLD N J
BUCKBEE MEARS CO
245 E 6TH ST ST PAUL MINN
BUCKBEE MEARS CO TOMI BUILDING
4TH & ROSABEL ST ST PAUL MINN
BUCKEYE IRON & BRASS WORKS
324 E 3RD ST DAYTON OHIO
BUD RADIO INC
2118 E 55TH ST CLEVELAND 3 OHIO
BUDD ELECTRONICS A DIV OF THE BUDD CO
43 22 QUEENS ST LONG ISLAND CITY N Y
BUDD LEWYT ELECTRONICS INC
43-22 QUEENS ST LONG ISLAND CITY 1 N Y
BUDD STANLEY CO
175 EILEEN WAY SYOSSET N Y
BUDELMAN ELECTRONICS CORP
375 FAIRFIELD AVE STAMFORD CONN
BUDELMAN RADIO CORP
375 FAIRFIELD AVE STAMFORD CONN
BUFFALO INSTRUMENT CORP
1780 ELMWOOD AVE BUFFALO NY
H H BUGGIE DIV BURNDY CORP
P O BOX 817 TOLEDO OHIO
BUHL OPTICAL CO
1009 BEECH AVE PITTSBURGH 33 PA
BUILDING BLOCKS ELECTRONIC CO
2506 GERRITSEN AVE BROOKLYN 29 N Y
BULLARD
286 CANFIELD AVE BRIDGEPORT 9 CONN
BULOVA WATCH CO ELECT DIV
40 01 61 ST WOODSIDE N Y
BUNDY ELECTRONICS CORP
171 FABYAN PL NEWARK 12 N J
BUNNELL & CO J H
81 PROSPECT ST BROOKLYN 1 N Y
BURDICK CORP
635 PLUMB ST MILTON WISC
BUREAU OF ENGRAVING INC INDUST DIV
500 S 4TH ST MINN MINN
BUREAU OF ENGRAVING INC
219 NORTH 2ND ST MINNEAPOLIS 15 MINN
BURGESS BATTERY CO
FOOT OF EXCHANGE ST FREEPORT ILL
BURGESS BATTERY CO DIV SERVEL CANADA LTD
415 BUTTREY ST NIAGARA FALLS ONT CANADA
BURKE & JAMES INC
321 S WABASH AVE CHICAGO 4 ILL
BURKLYN CO
3429 GLENDALE BLVD LOS ANG CALIF
BURLING INSTRUMENT CO
16 RIVER RD CHATHAM N J
BURMAC ELECTRONICS CO
142 LONG BEACH RD ROCKVILLE CENTRE N Y
BURNDY CORP
MILFORD CONN
BURNDY-ESCON INC
NORWALK CONN
BURNDY CORP OMATON DIV
NORWALK CONN
BURNELL & CO INC
10 PELHAM PKWY PELHAM MANOR NY
BURNETT RADIO LAB W W L
4814 IDAHO ST SAN DIEGO 16 CALIF
BURNLEY BATTERY & MFG CO
103 CLAY ST NORTH EAST PA
BURNOX ESCON INC
NORWALK CONN
BURR BROWN RESEARCH CORP
BOX 6444 TUCSON ARIZ
BURROUGHS CORPORATION ELECTRD DATA DIVISION
460 SIERRA MADRE VILLA PASADENA CALIFORNIA
BURROUGHS CORP MILITARY ELCTRNC CMPTR DIV
14300 TIREMAN AVENUE DETROIT 28 MICHIGAN
BURROUGHS CORPORATION PLYMTH MFG & ENG DIV
41100 PLYMOUTH ROAD PLYMOUTH MICHIGAN
BURROUGHS CORP CONTROL INSTR DIV
67 35TH STREET BROOKLYN 32 NY
BURROUGHS CORP ELECTRONIC INSTRS DIV
1209 VINE STREET PHILADELPHIA 7 PA
BURTON INSTRUMENT DIVISION BURTON MFG CO
2520 COLORADO AVE SANTA MONICA CALIF
BUSH TRANSFORMER CORP
707 N ST ENDICOTT N Y
BUSHNELL ELECTRIC
345 HESS ST BUSHNELL ILL
BUSSMANN MFG CO DIV MCGRAW EDISON
UNIVERSITY AT JEFFERSON ST LOUIS MO
BUTCHER CO L H
3628 E OLYMPIC BLVD LOS ANG CALIF
B/W CONTROLLER CORP
2200 E MAPLE BIRMINGHAM MICH
B W MFG INC PHILLIPS RADIO DIV KOKOMO IND
321 S UNION ST KOKOMO IND
B-W MFGRS INC PHILLIPS RADIO DIV
721 N WEBSTER ST KOKOMO IND
BY-BUK CO
4314 W PICO BLVD LOS ANGELES 19 CALIF
BYREX CORP
50 HUNT ST NEWTON MASS
BYTREX CORP
50 HUNT ST NEWTON 58 MASS

C

CABLE & WIRE PRODUCTS CO
CHICAGO RD SWANTON OHIO
CABLE DESIGNS INC
66 RUSHMORE ST WESTBURY LI N Y
CABLE SPEC OF CONN
95 KITTS LANE NEWINGTON CONN
CABRAL MOTORS INC
51 VICTORY LANE LOS GATOS CALIF
CADDELL-BURNS MFG CO
40 E 2 ST MINEOLA N Y
CAIG LABS
46 STANWOOD RD NEW HYDE PARK N Y
CALBEST ELECTRONICS CO
4801 EXPOSITION BLVD LOS ANGELES 16 CALIF
CALCON MFG CO
100 OAKLAND AVE WASHINGTON PA
CALCOR SPACE FACILITY INC
1010 W PHILADELPHIA WHITTIER CAL
CALCULAGRAPH CORP INC
272 RIDGEDALE AVE BOX 72 HANOVER NJ
CALEDONIA ELECTRONICS & TRANSFORMER CORP
P O BOX 98 CALEDONIA N Y
CALEDONIA ELECTRONICS & TRANSFORMER CORP
MAPLE ST CALEDONIA N Y
CALIDYNE CO INC SUB LING-ALTEC ELECTRONICS
120 CROSS ST WINCHESTER MASS
CALIF MAGNETIC CONTROL CORP
11922 VALERIO ST HOLLYWOOD CALIF
CALIF TECHNICAL INDUST DIV TEXTRON INC
1421 OLD COUNTY RD BELMONT CALIF
CALIFONE CORP
5922 BOWCROFT ST LOS ANGELES 16 CALIF
CALIFORNIA COMPUTER PROD INC
8714 CLETA ST DOWNEY CALIF
CALIFORNIA RESISTOR CORP
1631 COLORADO AVE SANTA MONICA CALIF
CALIFORNIA CHASSIS CO
5445 E CENTURY BLVD LYNWOOD CALIF
CALLINS INDUSTRIES INC
P O BOX 356 GREENFIELD TENN
CALMAG DIV CALIF MAGNETIC CONT CORP
11922 VALERIO ST N HOLLYWOOD CALIF
CALTRON PRODUCTS CO
3518 PICO BLVD LOS ANG CALIF
CALVERT ELECTRONICS INC
536 BROADWAY NEW YORK N Y
CALVIDEO ELECTRONICS INC
18601 S SANTA FE AVE COMPTON CALIF
CAMBLOCK CORP SUB WALTHAM PREC INST
221 CRESCENT ST WALTHAM MASS
CAMBRIDGE FILTER CORP
738 ERIE BLVD E SYRACUSE 3 N Y
CAMBRIDGE INSTRUMENT CO INC
OSSINING NEW YORK
CAMBRIDGE PANELYTE MOLDED PLASTICS CO
WEST PIKE RD CAMBRIDGE OHIO
CAMBRIDGE PATTEN WORKS
55 FIRST ST CAMBRIDGE MASS
CAMBRIDGE THERMIONIC CORP
445 CONCORD AVE CAMBRIDGE MASS
CAMCAR SCREW & MFG CO DIV TEXTRON INC
600 18 AVE ROCKFORD ILL
CAMDALE PRECISION INC
28300 GROESBECK HWY ROSEVILLE MICH
CAMERA EQUIPMENT CO INC
315 W 43RD ST NEW YORK 36 N Y
CAMERA MART INC
1845 BROADWAY NEW YORK 23 N Y
CAMLOC FASTENER CORP
22 SPRING VALLEY RD PARAMUS N J
CAMPBELL INDUSTRIES INC
DOVER N H
CAMPBELL INDUSTRIES INC
NORTH AURORA ILL
CAMPBELL X RAY CORP
108 CUMMINGTON ST BOSTON MASS
CAMPRO CO
3131 ALLIANCE RD N E CANTON 1 OHIO
CANADAIR LTD
PO BOX 6087 MONTREAL P Q CANADA
CANADIAN APPLIED RESCH DV A V ROE CANADA LTD
BOX 4004 TERN A TORONTO ONT CANADA
CANADIAN ASTATIC LTD
2273 DANFARTH AVE TORONTO ONT CANADA
CANADIAN AVIA ELECTS
6214 COTE DE LIESSE RD ST LRNT QUE CANADA
CANADIAN CURTISS-WRIGHT LTD
OAKVILLE ONTARIO CANADA
CANADIAN CURTISS-WRIGHT LTD
1980 SHERBROOKE ST W MONTREAL QUE CANADA
CANADIAN MARCONI CO
2442 TRENTON AVE MONTREAL 16 CAN

CANADIAN RADIUM URANIUM DV CANRAD PRES IND
43 W SIXTEENTH ST NEW YORK N Y
CANADIAN RESEARCH INSTITUE
85 CURLEW DRIVE DON MILLS ONT
CANNON CO C F
SPRINGWATER N Y
CANNON ELECTRIC CO EASTERN DIV
PINGREE LEAVITT STS SALEM MASS
CANNON ELECT CANADA LTD
160 BARTLEY DR TORONTO ONT CANADA
CANNON ELECTRIC CO
3208 HUMBOLDT ST LOS ANGELES 31 CALIF
CANNON ELECTRIC CO
PINGREE & LEAVITT STS SALEM MASS
CANNON ELECTRIC CO
2801 AIRLINE PHOENIX ARIZ
CANOGA DIV UNDERWOOD CORP
15330 OXNARD ST VAN NUYS CALIF
CANOGA ELECT CORP
15330 OXNARD ST VAN NUYS CALIF
CANRAD PRECISION INDUSTRIES
10136 E RUSH ST EL MONTE CALIF
CAPCON INC
61 STANTON ST NEW YORK 2 N Y
CAPEHART CORP DYNAMIC ELECTRONICS DIV
87046 123TH ST RICHMOND HILL 18 LI NY
CAPITOL CITY MFG CO
857 KING AVE COLUMBUS OHIO
CAPITOL MACHINE CO
36 BALMFORTH AVE DANBURY CONN
CAPPS & CO
20 ADDISON PL VALLEY STREAM L I N Y
CAPTIVE SEAL CORP
121 CLINTON RD CALDWELL N J
CAPTRAN CORP
1910 N ELSTON AVE CHICAGO ILL
CARAD CORP
3381 JUNIPERO SERRA BLVD PALO ALTO CALIF
CARBOLINE CO
32 HANLEY IND CT ST LOUIS MO
CARBONNEAU INDUSTRIES INC
100 LEXINGTON AVE S W GRAND RAPIDS 4 MICH
ELECTRONICS DIV CARBORUNDUM CO
LATROBE PA
CARBORUNDUM CO THE REFRACTORIS DIV
LATROBE PA
CARBORUNDUM CO GLOBAR PLANT
P O BOX 339 NIAGARA FALLS N Y
CARDION ELECTRONICS INC
65 RUSHMORE ST WESTBURY NEW YORK
CARDOX DIV CHEMETRON CORP
MONEE ILL
CARDWELL CONDENSER CORP
30 E MONTAUK HYW LINDENHURST N Y
CAREY ELECTRONIC ENG
1887 CLIFTON AVE SPRINGFIELD OHIO
CARLETON AVIATION CO INC
EAST AURORA N Y
CARLING ELECTRIC INC
505 NEW PARK AVE W HARTFORD 10 CONN
CARLSTEDT RESEARCH INC
2501 E 68TH ST LONG BEACH CALIF
CARMA MANUFACTURING CO
1879 MULLIN AVE TORRANCE CALIF
CARMER INDUSTRIES
22 N 26TH ST KENILWORTH NJ
CARMODY CORP
2360 WEHRLE DR BUFFALO 21 N Y
CAROL ELECT CORP
315W STEPHEN MARTINSBURG W VA
CAROL CABLE DV CRESCENT CO INC
20 CENTRAL AVE PAWTUCKET R I
CAROL ELECT DIV WEECO INC
315 W STEPHEN ST MARTINSBURG W VA
CAROLINA INDUST PLASTICS DIV ESSEX WIRE CORP
MT AIRY S C
CAROLINA WELDS PLANT
900 N GEORGE ST GOLDSBORO N C
CARPENTER MFG CO INC
P O BOX 217 DEWITT N Y
CARPENTER STEEL CO
FRONT & BERN STS READING PA
CARPENTER STEEL CO ALLOY TUBE DIV
SPRINGFIELD RD UNION NJ
CARROLL PRESSED METAL INC
133 DEWEY ST WORCESTER MASS
CARRUTHERS & FERNANDEZ MFG CO
1501 COLORADO AV BX 1470 SANTA MONICA CAL
CARSON MFG CO INC
INDIANAPOLIS IND
CARSTEDT RESEARCH
2501 E 68TH ST LONG BEACH CALIF
CARTER MFG CORP
23 WASHINGTON ST HUDSON MASS
CARTER PARTS CO
3401 W MADISON ST SKOKIE ILL
CARTRISEAL CORP
3515 W TOUHY AVE LINCOLNWOOD ILL
CASCADE RESEARCH DIV
5245 SAN FERNANDO RD W LOS ANGELES CALIF
CASTLE ENGINEERING CO
SENECA CASTLE NEW YORK
CASWELL ELECTRONICS CORP
414 QUEENS LANE SAN JOSE CALIF
CATALIN CORP OF AMERICA
1 PARK AVE NEW YORK 16 N Y
CATHODEON LTD
CHURCH ST CAMBRIDGE ENGLAND
C B C ELECTRONICS CO
2601 N HOWARD ST PHILA PA
C & D BATTERIES DIV ELECTRIC AUTOLITE CO
ATTICA IND
C & D BATTERIES DIV ELECT AUTOLITE CO
PENNSBURG PENNA
COMPUDYNE CORP PROCESS CONTROL DIV
404 S WARMINSTER RD HATBORO PA
CEDAR ENG DIV CONTROL DATA CORP
5806 W 36TH ST ST LOUIS PK MINN

COMMUNICATION MEASUREMENTS LABS
350 LELAND AVE PLAINFIELD N J
CFETRONICS
PO BOX 32 ALGER MICH
CELANESE PLASTICS CO
744 BROAD ST NEWARK 2 N J
CELANESE PLASTICS CO DIV OF CELANESE CORP
180 MADISON AVE NEW YORK 16 N Y
CELCO CONSTANTINE ENG LABS CO
P O BOX 555 MAHWAH N J
CELCO CONSTANTINE ENG LAB CO PACIFIC DIV
1150 E 8TH ST UPLAND CALIF
C E M CO INC
24 SCHOOL ST DANIELSON CONN
CENTIMEG ELECTRONICS
312 IMPERIAL HWY EL SEGUNDO CALIF
CENTRALAB DIV GLOBE UNION
3450 HOPKINS MILWAUKEE WISC
CENTRALAB DIV GLOBE UNION INC
FORT DOOGE IOWA
CENTRALAB DIV GLOBE-UNION INC
900 E KEEGE AVE MILWAUKEE 1 WISC
CENTRALAB DIV GLOBE UNION
5150 N 32ND ST MILWAUKEE WISC
CENTRALAB DIV GLOBE UNION
3238 N BREMEN MILWAUKEE WISC
CENTRAL COIL CORP
857 N QUEENS AVE LINDENHURST N Y
CENTRAL DYNAMICS LTD
147 HYMUS BLVD PTE CLAIRE QUE CANADA
CENTRAL ELECTRONIC MFRS
2 RICHWOOD PL DENVILLE N J
CENTRAL ELECTRONICS INC
1247 W BELMONT AVE CHICAGO 13 ILL
CENTRAL PORCELAIN CO
511 RAILROAD ST COLUMBIANA OHIO
CENTRAL RESEARCH LABS
RED WING MINN
CENTRAL SCIENTIFIC CO OF CALIF
1040 MARTIN AVE SANTA CLARA CALIF
CENTRAL SCIENTIFIC CO OF CANADA LTD
146 KENOAL AVE TORONTO 4 ONT CANADA
CENTRAL SCIENTIFIC CO
1700 IRVING PARK RD CHICAGO ILL
CENTRAL TRANSFORMER CO
900 W JACKSON BLVD CHICAGO 7 ILL
CENTRAL TRANSFORMER CORP
ARCADIA FLA
CENTROL ENG CO
119 E LEXINGTON INDEPENDENCE MO
CENTURY COIL CORP
1522 N CLYBOURN AVE CHICAGO 10 ILL
CENTURY ELECT INST INC
1333N UTICA TULSA OKLA
CENTURY ELECT CO
1806 PINE ST ST LOUIS MO
CENTURY ELECT CO
111 ROOSEVELT AVE MINEOLA N Y
CENTURY LIGHTING INC
521 W 43 ST NEW YORK N Y
CENTURY LIGHTING INC
1477 N E 129TH ST N MIAMI FLA
CENTURY PLATING CO
229 FERRIS AVE WHITE PLAINS N Y
CENTURY PROJECTOR CORP
3202 QUEENS BLVD LONG ISLAND CITY N Y
CERAMASEAL INC
P O BOX 25 NEW LEBANON CENTER N Y
CERAMATRONICS INC
364 HIGHLAND AVE PASSAIC N J
CERAMICS INTERNATIONAL CORP
39 SIDING PLACE MAHWAH N J
CERBERUS AG WERK FLEKTRONENTECHNIK
MANNEDORF SWITZERLAND
RONSON METALS CORP CERIUM METALS & ALLOYS DI
45 MFRS PL NEWARK N J
CERRO SALES CORP
300 PARK AVE NEW YORK N Y
CERTIFIED RADIO LABS
5507 13 AVE BROOKLYN N Y
C E S ELECTRONIC PRODUCTS INC
5026 NEWPORT AVE SAN DIEGO CALIF
CETRON ELECTRONIC CORP
715 HAMILTON ST GENEVA ILL
CETRON ELECTRONIC CORP
ROLYN PLACE ARCADIA CALIF
CFI CORP
1 COTTAGE PLACE MINEOLA N Y
C&H SUPPLY
415 E BEACH INGLEWOOD CALIF
CHACE CO W M
1600 BEARD AVE DETROIT 9 MICH
CHADWICK-HELMUTH CO
472 E DUARTE RD MONROVIA CALIF
CHALCO ENGINEERING CORP
15126 S BROADWAY GARDENA CALIF
CHAMPION DEARMENT TOOL CO
S MAIN ST MEADVILLE PENNA
CHANNEL INDUSTRIES INC
427 OLIVE ST P O BOX 1408 SANTA BARB CALIF
CHANNEL MASTER CORP
ELLENVILLE N Y
CHARLESTON RUBBER CO
STARK INDUSTRIAL PARK CHARLESTON S C
CHASE BRASS & COPPER CO MILL DIV
236 GRAND ST WATERBURY CONN
CHASE MTLS SERV DIV CHASE BRASS & COPPER CO
236 GRAND ST WATERBURY 20 CONN
CHASSIS-TRAK CORP
7302 S LA CIENEGA BLVD INGLEWOOD CALIF
CHATHAM CONTROLS CORP
33 RIVER ST CHATHAM N J
CHATHAM ELECTRONICS DIV-TUNG-SOL ELECTRIC IN
630 W MT PLEASANT AVE LIVINGSTON N J
CHATILLON SONS JOHN
85 CLIFF ST NEW YORK N Y
CHEMALLOY ELECTRONICS CORP
GILLESPIE AIRPORT SANTEE CALIF

CHEMCUT DIV CENTRE CIRCUITS INC
BOX 799 STATE COLLEGE PA
CHEMICAL COMMERCE
123 SUSSEX AVE NEWARK N J
CHEMICAL DEVELOPMENT CORP
ENDICOTT ST DANVERS MASS
CHEMICAL ELECTRONIC ENG
PO BOX 203 MATAWAN NJ
CHEMIONICS INC
7834 BOTHELL WAY N E SEATTLE WASH
CHEMPLAST INC
3 CENTRAL AVE EAST NEWARK NJ
CHEMTRONIC CORP
2950 FOSTER DR NASHVILLE TENN
CHERRY ELECT PROD CORP
1650 DEERFIELD RD HIGHLAND PARK ILL
CHESAPEAKE INSTRUMENT CORP
SHADYSIDE MD
CHESTER CABLE CORP
CHESTER N Y
CHET ENGINEERING CO
8140 ORION VAN NUYS CALIF
CHICAGO AERIAL INDUSTRIES
BARRINGTON ILL
CHICAGO CONDENSER CORP
3255 W ARMITAGE AVE CHICAGO ILL
CHICAGO DYNAMIC INDUSTRIES INC
1725 DIVERSEY BLVD CHICAGO 14 ILL
CHICAGO ELECTRONIC ENGG CO
3223 W ARMITAGE AVE CHICAGO 47 ILL
CHICAGO GASKET CO
1271 W NORTH AVE CHICAGO 22 ILL
CHICAGO MINIATURE LAMP WORKS
4435 RAVENSWOOD AVE CHICAGO ILL
CHICAGO RIVET & MACHINE CO
950 S 25 AVE BELLWOOD ILL
CHICAGO SCREW CO
2701 WASHINGTON BLVD BELLWOOD ILL
CHICAGO TELEPHONE OF CALIF
1010 SYCAMORE AVE S PASADENA CALIF
CHICAGO TELEPHONE OF CALIF INC
105 PASADENA AVE BOX 269 S PASADENA CALIF
CHICAGO THRIFT ETCHING
1555 N SHEFFIELD AVE CHICAGO ILL
CHICOPEE MILLS
47 WORTH ST NEW YORK N Y
CHISHOLM INDUST LTD
ELECT AVE PORT MOODY B C CANADA
CHOMERICS INC
341 VASSAR ST CAMBRIDGE MASS
CHRISTIAN PRECISION MFG
12TH & FEDERAL STS CAMDEN N J
CHRISTIE ELECTRIC CORP
3410 W 67 ST LOS ANGELES 43 CALIF
CHROMALLOY CORP
WEST NYACK NY
CHRONO LOG CORP
2583 WEST CHESTER PIKE BROOMALL PENNA
CHRYSLER CORP MISSILE DIV
P O BOX 2628 DETROIT MICHIGAN
CHU ASSOCIATES
BOX 387 WHITCOMB AVE LITTLETON MASS
CINAUDAGRAPH INC
7334 N CLARK ST CHICAGO 26 ILL
CINCH MFG CO CINCH JONES DIV
1026 S HOMAN AVE CHICAGO ILL
CINCH MFG CORP
1026 S HOMAN AVE CHICAGO ILL
CINCINNATI CLEANING & FINISHING MACHINERY CO
SHARONVILLE OHIO
CINCINNATI CLEANING & FINISHING MACHINERY
1100 HAGEMAN ST CINNATI OHIO
CINCINNATI MILLING MACHINE CO
MARSBURG AVE CINNATI OHIO
CINCINNATI SHAPER CO
BOX 111 CINN OHIO
CINCINNATI SUB-ZERO PRODUCTS
3932 READING RD CINCINNATI 29 OHIO
CINCINNATI TIME RECORDER CO
1733 CENTRAL AVE CINCINNATI 14 OHIO
CINEMA ENGINEERING DIV AEROVOX CORP
1100 CHESTNUT ST BURBANK CALIF
CINEMATIC DEVELOPMENTS CO
P O BOX 151 MENA ARKANSAS
CIRCON COMPONENTS CORP
SANTA BARBARA MUNICIPAL AIRPORT
CIRCUIT INSTRUMENT DIV INTL RESISTANCE CO
2801 72ND ST N ST PETERSBURG FLA
CIRCUITDYNE CORP
480 MERMAID ST LAGUNA BCH CALIF
CIRCUITS INC
1445 TOLLAND TPK MANCHESTER CONN
CITY CHEMICAL CORP
132 W 22 ST NEW YORK N Y
CITY MARKING DEVICES CORP
69 MURRAY ST NEW YORK N Y
C-THRU RULER CO
827 WINDSOR ST HARTFORD CONN
C & K COMPONENTS INC
101-103 MORSE ST NEWTON 58 MASS
CLAIREX CORP
8 W 30ST NEW YORK N Y
CLARAGE FAN CO
KALAMAZOO MICH
C P CLARE & CO
3101 W PRATT BLVD CHICAGO 45 ILL
CLARE & CO P J
FAIRVIEW N C
CLARK CONTROLLER CO
1146 E 151 ST CLEVELAND OHIO
CLARK CONTROLLER CO
4755 E 49TH ST LOS ANGELES CALIF
CLARK CRYSTAL CO
2 FARM RD MARLBORO MASS
CLARK ELECTRONIC LABS
BOX 165 PALM SPRINGS CALIF
CLARKE H JOY CO
27003 KNICKERBOCKER RD BAY VILLAGE OHIO

CLARKSON LABORATORIES INC
1450 FERRY ST CAMDEN N J
CLAROSTAT MFG CO
WASHINGTON ST DOVER N H
CLARY CORP
408 JUNIPERO ST SAN GABRIEL CALIF
CLAUSS CUTLERY CO
223 PROSPECT ST FREMONT OHIO
CLEAR BEAM ANTENNA CORP
21341 ROSCOE BLVD CANOGA PARK CALIF
CLEARTONE REPRODUCTION CORP
23-14 122ND ST COLLEGE POINT N Y
CLEGG LABS DIV CLEGG INC
RT 53 MT TABOR N J
CLETRON INC
1974 E 61 ST CLEVELAND 30 OHIO
CLEVELAND CONTAINER CO
6201 BARBERTON AVE CLEVELAND 2 OHIO
CLEVELAND ELECTRONICS INC
1974 E 61ST ST CLEVELAND 3 OHIO
CLEVELAND FABRICATING CO
7424 BESSEMER AVE CLEVELAND OHIO
CLEVELAND GRAPHITE BRONZE DIV CLEVITE CORP
CALDWELL OHIO
CLEVELAND INSTRUMENT CO
6220 E SCHAAF RD CLEVELAND 31 OHIO
CLEVELAND METAL SPEC CO
1783 E 21 ST CLEVELAND OHIO
CLEVELAND METAL SPECIALTIES CO
15516 INDUSTRIAL PKWY CLEVELAND OHIO
CLEVELAND WELDS PLANT
1133 E 152 ST CLEVELAND OHIO
CLEVITE ELECT COMPONENTS DIV CLEVITE
232 FORBES RD BEDFORD OHIO
CLEVITE HARRIS PRODUCTS INC
6545 CARNEGIE AVE CLEVELAND 3 OHIO
CLEVITE HARRIS PRODS INC
LOCKWOOD RD MILAN OHIO
CLEVITE ORDNANCE DIV CLEVITE CORP
540 E 105TH ST CLEVELAND 8 OHIO
CLEVITE ORDANCE DIV CLEVITE CORP
232 FORBES RD BEDFORD OHIO
CLEVITE TRANSISTOR
200 SMITH ST WALTHAM MASS
CLIFTON PRECISION PRODUCTS CO INC
BROADWAY AT MARPLE CLIFTON HGTS PA
CLIFTON PRECISION
COLORADO SPRINGS COLO
CLIPPARD INSTRUMENT LAB
7390 COLERAIN AVE CINN OHIO
CLIPPARD INSTRUMENT INC
513 E WASH ST PARIS TENN
CLOUGH BRENGLE CO
6014 BROADWAY CHICAGO ILL
CLOVER INDUSTRIES INC
578-588 YOUNG ST TONAWANDA N Y
CLOWES CERAMICS CORP
3711 CALHOUN AVE CHATTANOOGA TENN
CLUM MFG CO
611 NATIONAL MILWAUKEE WISC
CLY DEL MFG CO INC
P O BOX 1367 WATERBURY 20 CONN
C M MFG & MACHINERY CO
103 DEWEY ST BLOOMFIELD NJ
CO ENGINEERING CO
P O BOX 194 BOONTON N J
CO-OPERATIVE INDUSTRIES INC
100 OAKDALE RD CHESTER N J
COAST COIL CO
5333 W WASHINGTON BLVD LOS ANGELES CALIF
COAST PRO-SEAL & MFG CO
2235 BEVERLY BLVD LOS ANGELES 57 CALIF
COAXIAL COMPONENTS CORP
391 LUDLOW ST STAMFORD CONN
COBEHN INC
PASSAIC AVE CALDWELL N J
COHAN EPNER CO
142 W 14 ST NEW YORK 11 N Y
COHN CORP SIGMUND
121 S COLUMBUS AVE MOUNT VERNON N Y
COHU ELECTRONICS INC KIN TEL DIV
5725KEARNY VILLA RD SAN DEIGO CALIF
COIL COMPANY OF AMERICA
212 WASHINGTON ST NORTHVALE N J
COIL ENG & MFG
MARKLE IND
COIL ENGG & MFG CO
ROANOKE IND
COIL WINDING EQUIP CO
RAILROAD PLAZA OYSTER BAY N Y
COILCRAFT INC
CARY ILL
COILS ELECTRONICS CO
2939 49 N 2ND ST PHILA 33 PENNA
COLBER CORP
26 BUFFINGTON ST IRVINGTON 11 N J
COLE RADIO WORKS
86 WESTVILLE AVE CALDWELL N J
COLEMAN CABLE & WIRE CO
1900 N RIVER RD RIVER GROVE ILL
COLEMAN ELECTRONICS INC
133 EAST 162ND ST GARDENA CALIF
COLEMAN INSTRUMENTS INC
42 MADISON ST MAYWOOD ILL
COLIN CAMPBELL CO INC
MIRY BROOK RD DANBURY CONN
COLLECTRON CORP
304 E 45TH ST NEW YORK 17 N Y
COLLINS CORP G L
2820 E HULLETT ST LONG BEACH CALIF
COLLINS ELECTRONICS INC
STEVENSVILLE MD
COLLINS RADIO CO
855 35 ST N E CEDAR RAPIDS IOWA
COLLINS RADIO CO
1930 HILINE DR DALLAS 7 TEXAS
COLLINS RADIO CO OF CANADA LTD
11 BERMONDSEY RD TORONTO ONT CAN
COLLINS RADIO CO
19700 SAN JOAQUIN RD NEW PORT BEACH CALIF
COLLINS RADIO TEXAS DIV
1200 ALMA RD RICHARDSON TEXAS
COLLINS RADIO CO
315 2ND AVE S E CEDAR RAPIDS IOWA
COLLYER INSULATED WIRE CO
249 ROOSEVELT AVE PAWTUCKET R I
COLMAN ELECTRONIC PRODUCTS INC
1017 N E 3RD AVE AMARILLO TEX
COLONIAL ALLOYS CO
RIDGE AVE & CRAWFORD STS
PHILADELPHIA 29 PA
COLORADO RESEARCH CORP
BROOMFIELD COLO
COLSON CORP
440 SOMERVILLE AVE SOMERVILLE 43 MASS
COLUMBIA ELECT MFG CO
4519 HAMILTON AVE CLEVELAND OHIO
COLUMBIA METAL BOX CO
260 E 143 ST NEW YORK 51 N Y
COLUMBIA PRODUCTS CO
6625 SHAKESPEARE RD COLUMBIA S C
COLUMBIA PROD CO
R F D 3 COLUMBIA S C
COLUMBIA RECORDS
799 7 AVE NEW YORK N Y
COLUMBIA RESEARCH LABS
MACDADE BLVD & BULLENS LA WOODLYN PA
COLUMBIA TAPE MILLS INC
BANK ST E GREENVILLE PA
COLUMBIA TECHNICAL CORP
24 30 BRKLYN QUEENS EXPWY WOODSIDE 77 N Y
COLUMBIA WIRE & SUPPLY CO
2850 IRVING PARK RD CHICAGO ILL
COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT
380 MADISON AVE NEW YORK 17 N Y
COLUMBIAN CARBON CO MAPICO IRON OXIDE
MONMOUTH JUNCTION N J
COLUMBIAN ROPE CO
AUBURN NY
COLUMBUS ELECTRONICS CORP
1000 SAW MILL RIVER RD YONKERS N Y
COLUMBUS PROCESS CO
2851 SOUTHEASTERN AVE COLUMBUS IND
COLUMN MACHINE CO
MOULTON ST GEORGETOWN MASS
COLVIN LABS INC
364 GLENWOOD AVE E ORANGE N J
COMAR ELECTRIC CO
3349 ADDISON ST CHICAGO 18 ILL
COMBINED ELECT INC
4616 W 26TH ST CHICAGO ILL
COMCO PLASTICS INC
9834 JAMAICA AVE RICHMOND HILL N Y
COMERFORD MFG CO
880 S ROSE PL ANAHEIM CALIF
COMMER PLASTICS & SUPPLY CO
630 BROADWAY NEW YORK N Y
COMMERCIAL PLASTICS CO
945 GEORGE ST CHICAGO ILL
COMMERCIAL RADIO SOUND CORP
652 1 AVE NEW YORK N Y
COMMERCIAL TELECAST NETWORKS INC
608 5TH AVE NEW YORK 20 N Y
COMET LTD
BERNE SWITZERLAND
COMMONWEALTH METAL CRAFTS
NORTH AVE & AMORY STS WAKEFIELD MASS
COMMUNICATIONS CO
300 GRECO AVE CORAL GABLES FLA
COMMUNICATION EQUIPMENT & ENGRG CO
5646 W RACE AVE CHICAGO 44 ILL
COMMUNICATIONS PRODICTS CO
MARLBORO N J
COMMUNITY ENGG CORP
BOX 824 STATE COLLEGE PA
COMPONENTS FOR RESEARCH INC
979 COMMERCIAL ST PALO ALTO CALIF
COMPONENTS SPEC INC
9 KEES PLACE MERRICK L I N Y
COMPACT CONTROLS CO INC
1633 N HALSTED ST CHICAGO 14 ILL
COMPONENTS CORP
106 MAIN ST DENVILLE N J
COMPTON CORP
778 PLEASANT ST BELMONT 79 MASS
COMPONENT RESEARCH CO INC
3019 S ORANGE DR LOS ANGELES 16 CALIF
COMPUTER CONTROL CO INC WESTERN DIV
2251 BARRY AVE LOS ANGELES CALIF
CAMPAGNIE GENERALE DE METROLOGIE
CHEMIN DE LA CROIX ROUGE BOX 30
ANNECY HAUTE SAVOIE FRANCE
COMMUNICATION ACCESSORIES CO
U S 50 HWY LEES SUMMIT MO
COMPUTER CONTROL CO INC EASTERN DIV
983 CONCORD ST FRAMINGHAM MASS
COMPUTER DIODE CORP
250 GARIBALDI AVE LODI NJ
COMPUTER ENGG ASSOC
1610 MAGNOLIA MONROVIA CALIF
COMPUTER ENGINEERING ASSOCIATES INC
350 N HALSTEAD PASADENA CALIF
COMPUTER EQUIPMENT CORP
11612 OLYMPIC BLVD LOS ANGELES CALIF
COMPUTER INSTRUMENTS CORP
92 MADISON AVE HEMPSTEAD N Y
COMPUTER MEASUREMENTS CO
12970 BRADLEY AVE SYLMAR CALIF
COMPUTER SYSTEMS INC
CULVER RD MONMOUTH JUNCTION N J
COMPUTING DEVICES OF CANADA LTD
P O BOX 508 OTTAWA ONTARIO CANADA
COM TRONICS INC
3409 VENICE BLVD LOS ANG CALIF
CON-ELCO
1711 S MOUNTAIN AVE MONROVIA CALIF
CONANT LABS
BOX 3997 BETHANY STA LINCOLN 5 NEBR
CONAP INC
184 6 E UNION ST ALLEGANY N Y
CONAX CORP
2300 WALDEN AVE BUFFALO N Y
CONCERTAPES INC
PO BOX 88 WILMETTE ILL
CONCO
300 GRECO CORAL GABLES FLA
CONDENSER PROD DIV NEW HAVEN CLOCK & WATCH C
BOX 1046 BROOKSVILLE FLA
CONDOR ELECTRONICS INC
620 ORVIS ST SAN JOSE CALIF
CONDUCTORLAB INC
GROTON MASS
CONFORMING MATRIX CORP
830 NEW YORK AVE TOLEDO 11 OHIO
CONLEY ELECTRONICS CORP
8225 CHRISTIANA AVE SKOKIE ILL
CONN LTD C G
555 E JACKSON BLVD ELKHART IND
CONN MARINE INSTRUMENT CO
ESSEX CONN
CONN VALLEY ENTERPRISES
P O BOX 188 ESSEX CONN
CONN-CRAFT CO
301 FAIRLAWN AVE WATERBURY 5 CONN
CONNECTICUT ELECTRONIC PROD
18 LAKE ST MERIDEN CONN
CONN HARD RUBBER CO
P O BOX 1911 NEW HAVEN 9 CONN
CONNECTICUT HARD RUBBER CO
407 EAST ST NEW HAVEN CONN
CONNECTOR CORPORATION OF AMERICA
12959 SHERMAN WAY N HOLLYWOOD CALIF
CONNECTOR CORP
6027 N KEYSTONE AVE CHICAGO 30 ILL
CONNOLLY & CO WALLACE E
PO BOX 295 MENLO PARK CALIF
CONNOR SPRING MFG CO
390L S BROADWAY PL LOS ANGELES 37 CALIF
CONOFLOW CORP
2100 ARCH ST PHILA PENNA
CONRAC INC
19217 E FOOTHILL BLVD GLENDORA CALIF
CONRAD & MOSER
2 BORDEN AVE LONG ISLAND CITY 1 N Y
CONRAD INC
141 JEFFERSON ST HOLLAND MICH
CONSOLIDATED AIRBORNE SYSTEMS INC
900 3RD AVE NEW HYDE PARK N Y
CONSOLIDATED AVIONICS CORP
800 SHAMES DR WESTBURY N Y
CONSOLIDATED CERAMICS & METALIZING CORP
FLEMINGTON N J
CONSOLIDATED CONTROLS CORP
4 DURANT AVE BETHEL CONN
CONSOLIDATED DIESEL ELECTRIC CORP
880 CANAL ST STAMFORD CONN
CONSOLIDATED ELECT CORP
360 SIERRA MADRE VILLA PASADENA CALIF
CONSOLIDATED ELECTRODYNAMICS CORP
1775 MT READ BLVD ROCHESTER N Y
CONSOLIDATED MINING SMELTING OF CANADA LTD
TRAIL BC CANADA
CONSOLIDATED MOLDED PRODUCTS CORP
309 CHERRY ST SCRANTON 2 PENNA
CONSOLIDATED REACTIVE METLS INC
115 HOYT ST MAMORONECK N Y
CONSOLIDATED RESISTANCE CO OF AMERICA
44 PROSPECT ST YONKERS 1 N Y
CONSOLIDATED VACUUM CORP
1775 MT READ BLVD ROCHESTER N Y
CONSOLIDATED WIRE & ASSOCIATED COS
1635 S CLINTON ST CHICAGO 16 ILL
CONSTANTA CO OF CANADA LTD
280 REGINA AVE MONTREAL CANADA
CONSTANTIN CO L L
ROUTE 46 LODI NJ
CONTACT INC
BOX 6 HUDSON N HAMPSHIRE
CONTACTS INC
1100 SILAS DEANE HWY WETHERSFIELD 9 CONN
CONTINENTAL CONNECTOR CORP
34-63 56 ST WOODSIDE 77 NY
CONTINENTAL DEVICE CORP
12515 CHADRON AVE HAWTHORNE CALIF
CONTINENTAL-DIAMOND FIBRE CORP
NEWARK DELA
CONTINENTAL ELECTRIC CO
325 FERRY ST NEWARK 5 N J
CONTINENTAL ELECTRONICS CORP
2724 LEONIS BLVD LOS ANGELES 58 CALIF
CONTINENTAL ELECTRONICS CORP
302 OAKLAND ST BROOKLYN 22 N Y
CONTINENTAL ELECTRONIC MFG CO
4212 S BUCKNER BLVD DALLAS TEXAS
CONTINENTAL ELECT CORP OF CALIF
LOS ANGELES CALIF
CONTINENTAL MFG INC
1612 CALIF ST OMAHA NEB
CONTINENTAL PRECISION PROD
1026 E 179TH ST NEW YORK N Y
CONTINENTAL SCREW CO
459 MT PLEASANT ST NEW BEDFORD MASS
CONTINENTAL TECHNICAL SERVICE INC
19 W FOURTH ST DAYTON OHIO
CONTINENTAL WIRE CORP
322 N CHERRY ST WALLINGFORD CONN
CONTINENTAL X RAY CORP
1536 N CLYBOURN AVE CHICAGO ILL
CONTINENTAL-WIRT ELECTRONICS CORP
5221 GREENE ST PHILA 44 PA
CONTROL CIRCUITS INC
66 MARLBOROUGH ST PORTLAND CONN
CONTROL CORP
718 CENTRAL AVE NE MINNEAPOLIS 14 MINN

CONTROL DATA CORP
MINNEAPOLIS MINN
CONTROL DATA CORP
501 PARK AVE MINN MINN
CONTROL DEVICES
925 S ETON BIRMINGHAM MICH
CONTROL DYNAMICS
7420 FULTON AVE N HOLLYWOOD CALIF
CONTROL ELECT CO INC
10 STEPAR PLACE HUNTINGTON STA N Y
CONTROLLED ATMOSPHERE ENCLOSURES MFG CO
1061 E 8 ST JACKSONVILLE FLA
JERVIS B WEBB CO CONTROL ENG CO DIV
8900 ROSELAWN OETROIT MICH
CONTROL INDICATING CORP
BRADLEY FIELD WINDSOR LOCKS CONN
CONTROL MFG CO
ST PAUL MINN
CONTROL PRODUCTS INC
280 RIDGEDALE AVE E HANOVER N J
CONTROL SWITCH DIV CONTROLS CO OF AMERICA
4218 W LAKE ST CHICAGO 24 ILL
CONTROL SWITCH DIV CONTROLS CO OF AMERICA
DELMAR DR FOLCROFT PA
CONTROL TECHNOLOGY CO
41 16 29ST L I C NEW YORK
CONTROLIFR CORP
DAVENPORT FLA
CONTROLLED ATMOSPHERE ENCLOSURES MFG CO
1061 E 8 ST JACKSONVILLE 6 FLA
CONTROLS CO OF AMER ELECTRON DV
811 W BROADWAY BOX 937 TEMPE ARIZ
CONTROLS CO OF AMER
2450 N 32 ST MILWAUKEE WISC
CONTROLS FOR RADIATION INC
130 ALEWIFE BROOK PKWY CAMBRIDGE 40 MASS
CONTRONICS IN
43 LFON ST BOSTON MASS
CONVAIR ASTRONAUTICS
BOX 1128 SAN DIEGO 17 CALIF
COOK BATTERIES
3850 OLIVE ST DENVER COLO
COOK CO FRANK R
3850 OLIVE ST OENVER 7 COLO
COOK CO KEN
9929 W SILVER SPRING RD MILWAUKEE 18 WISC
COOK ELECTRIC CO DATA STOR DIV
8100 N MONTICELLO AVE SKOKIE ILL
COOK ELECTRIC CO NUCLEDYNE DIV
3412 RIVER RD FRANKLIN PARK ILL
COOK ELECT CO WIRECOM DIV
2700 N SOUTHPORT AVE CHICAGO ILL
COOK RESEARCH LABS
P O BOX 696 MENLO PARK CALIF
COOK TECHNOLOGICAL CENTER DIV
6401 OAKTON ST MORTON GROVE ILL
COOPER CO D C
1467 S MICHIGAN AVE CHICAGO 5 ILL
CO-OPERATIVE INDUSTRIES INC
100 OAKDALE RD CHESTER NJ
COOPERTRONIX
939 INDUSTRIAL PALO ALTO CALIF
COORS PORCELAIN CO
600 9TH ST GOLDEN COLO
COPPER & SONS INC JOSEPH B
180 VARICK ST NEW YORK N Y
COPPUS ENGRG CORP
344 PARK AVE WORCHESTER MASS
COPYMATION INC
5650 N WESTERN AVE CHICAGO 45 ILL
CORBETT SCIENCE LABS F W
3115 VENICE BLVD LOS ANG CALIF
CORBIN CORP
76 PRIMROSE LA LEVITTOWN NJ
CORDO CHEMICAL CORP
34 SMITH ST NORWALK CONN
CORNELL-DUBILIER ELECTRIC CORP
4144 GLENCOE AVE VENICE CALIF
CORNELL-DUBILIER ELECTRONICS DIV
118 E JONES ST FUQUAY SPRINGS NC
CORNING GLASS WORKS
CORNING N Y
CORNING GLASS WORKS
BRADFORD PA
CORNING GLASS WORKS ELECTRICAL PRODUCTS DIV
HOUGHTON PARK CORNING NY
CORNISH WIRE CO
50 CHURCH ST NEW YORK 7 N Y
CORONA ENGG SERVICE
94 52 CORONA AVE LEMHURST N Y
CORRUGATED PAPER PRODUCTS
2233 UTICA AVE BROOKLYN 34 N Y
CORSON ELECTRIC MFG CORP
540 39 ST UNION CITY N J
COSMIC RADIATION LABS
1645 MONTAUK HWY BELLPORT N Y
COSMIC RADIO CORP
853 WHITTIER ST NEW YORK 59 N Y
COTO COIL CO
65 PAVILION AVE PROVIDENCE R I
COTTRELL PAPER CO INC
887PURCHASE ST FALL RIVER MASS
COUCH ORDNANCE INC
3 ARLINGTON ST N QUINCY MASS
COURTER PROD DIV MODEL ENGG & MFG INC
N LAKE ST BOYNE CITY MICH
COUSINO ELECT CORP
1941 FRANKLIN AVE TOLEDO OHIO
COVEL MFG CO
P OBOX 116 BENTON HARBOR MICH
COX & CO
115 E 23 ST NEW YORK 10 N Y
COX INSTRUMENTS DIV GEORGE C NANKERVIS CO
15300 FULLERTON AVE DETROIT MICH
CRAFT LABS
209 AYLIFFE AVE WESTFIELD N J
CRAIG SYSTEMS INC
360 MERRIMACK ST LAWRENCE MASS
CRAIG SYSTEMS INC
LAWRENCE MASS
CRAMER DIV GIANNINI CONTROLS CORP
CENTERBROOK CONN
CRANE PACKING CO
6400 OAKTON ST MORTON GROVE ILL
CRANE SYST & CONTROLS GROUP
HOOKSETT INDUST PARK MANCHESTER N H
CRESCENT CO
20 CENTRAL AVE PAWTUCKET R I
CRESCENT COMMUNICATIONS CORP
43 HEMPSTEAD ST N LONDON CONN
CRESCENT ENGG & RESEARCH CO
5440 N PECK RD EL MONTE CALIF
CRESENT FABRICATORS CORP
3951 60TH ST WOODSIDE 77 N Y
CRITTENDEN TRANSFORMER WORKS
13011 S SPRING ST LOS ANG CALIF
CRITTENDEN TRANSFORMER WORKS
1220 N ADEAU ST LOS ANG CALIF
CRONAME INC
6283 HOWARD ST CHICAGO ILL
CROSS CO H
3229 BERGENLINE AVE UNION CITY N J
CROUSE HINDS CO
BOX 131 SYRACUSE NY
CROVEN LTD
500 BEECH ST WHITBY ONT CANADA
CROWN CONTROLS CORP
40 44 S WASHINGTON NEW BREMEN OHIO
CROWN ENG DIV DATA TECH INC
3821 COMMERCIAL N E ALBUWERQUE NEW MEXICO
CRUCIBLE STEEL CO OF AMERICA
P O BOX 2518 PITTSBURGH 30 PENNA
CRYOGENICS INC
STAFFORD VA
CRYSTAL RESEARCH PRODUCTS
W MADSON & PROSPECT AVE DUMONT NJ
CRYSTALONICS INC
249 5TH ST CAMBRIDGE MASS
CRYSTALX-WESTLAKE CORP
W LENNI RD LENNI MILLS PA
CTS CORP
ELKHART IND
CTS INC
P O BOX 152 BERNE IND
CTS OF ASHEVILLE INC
MILLS GAP ROAD SKYLAND NORTH CAROLINA
CUBEX CO
3322 TONIA AVE ALTADENA CALIF
CUBIC CORP
5575 KEARNY VILLA RD SANDIEGO CALIF
CUMMINS CHICAGO CORP
4740 RAVENSWOOD CHICAGO ILL
CUMMINS PORTABLE TOOLS DIV JOHN OSTER MFG CO
5055 N LYDELL AVE MILWAUKEE 17 WISC
CUNNINGHAM & SONS JAMES
33 LITCHFIELD ST ROCHESTER N Y
CURRY ARTS
522 GREEN RIDGE ST SCRANTON PENNA
CURTIS DEVELOPMENT & MFG CO
3218 N 33 ST MILWAUKEE 16 WISC
CURTIS DEVELOPMENT & MFG CO
3276 N 33RD ST MILWAUKEE 16 WISC
ELECTRONICS DIV CURTISS WRIGHT
E PATERSON N J
CURTISS WRIGHT CORP
9733 COORS RD NW BX 10044 ALBUQUEREUE N M
CURTISS-WRIGHT CORP ELECTRONICS DIV
35 MARKET ST EAST PATERSON NJ
CURTISS-WRIGHT CORP WRIGHT AERONAUTICAL DIV
WOOD RIDGE NJ
CUSH CRAFT
621 HAYWARD ST MANCHESTER N H
CUSTOM COMPONENTS INC
P O BOX 248 CALDWELL N J
CUSTOM ELECT MFG CORP
5009 E ADMIRAL PLACE TULSA OKLA
CUSTOM GEAR CO
648 COLLEGE S BEND IND
CUSTOM PRODUCTS CORP
606 LINDLEY ST BRIDGEPORT CONN
CUSTOM SCIENTIFIC INSTRUMENTS INC
541 DEVON ST KEARNEY NJ
CUTLER HAMMER INC
436 W 12 ST MILWAUKEE WISC
CUTLER METAL PRODUCTS CD
1025 LINE ST CAMDEN N J
CYCLE EQUIPMENT CO
17480 SHELBURNE WAY LOS GATOS CALIF
CYCLE TRANSFORMER CORP
356 GLENWOOD AVE ORANGE N J

D

DACO INSTRUMENT CO
TILLARY & PRINCE STS BROOKLYN 1 N Y
DAGE ELECTRIC CO
67 N 2 ST BEECH GROVE IND
THOMPSON RAMO WOOLDRIDGE INC DAGE DIV
W 10 ST MICHIGAN CITY IND
DAHLSTROM METALLIC DOOR CO
BUFFALO 2 STS JAMESTOWN N Y
DAISLEY CO INC RAY
585 W HOFFMAN AVE LINDENHURST N Y
DAKOTA ENGG INC
4315-4317 SEPULVEDA BLVD CULVER CITY CALIF
DALE ELECTRONICS INC DIV OF LIONEL CORP
BOX 488 COLUMBUS NEBR
DALE ELECTRONICS INC SIOUX DV
DIV OF LIONEL CORP YANKTON S D
DALES CO FRANKLIN
185 E MILL ST AKRON OHIO
DALES MFG CO
WABASSO FLA
DA-LITE SCREEN CO
WARSAW IND
DALLONS LABS
120 KANSAS ST EL SEGUNDO CALIF
DALLONS SEMICONDUCTORS DIV DALLONS LABS INC
5066 SANTA MONICA BLVD LOS ANGELES 29 CAL
DALWELD CO INC
15 BERTEL AVE MT VERNON N Y
DAMON ENGINEERING INC
240 HIGHLAND AVE NEEDHAM HEIGHTS 94 MASS
DAMON RECORDING STUDIOS
117 W 14 ST KANSAS CITY 5 MO
DAMPP CHASER INC
BOX 1641 1404 SPARTANBURG HWY
HENDERSONVILLE N CAROLINA
DANIELS INC C R
DANIELS MO
DANLY MACHINE SPECIALITIES INC
2100 S LARAMIE AVE CHICAGO 50 ILL
DANLY MACHINE SPEC INC
2100 S 54TH AVE CICERO ILL
DANO ELEC CO
93 MAIN ST WINSTED CONN
DANTE ELECTRIC MFG CO
BANTAM CONN
DARCO IND INC
2151 ROSECRANS AVE EL SEGUNDO CALIF
DATA CONTROL SYSTEMS INC
E LIBERTY ST DANBURY CONN
DATA DISPLAY INC
1820 COMO AVE ST PAUL MINN
DATA INSTRUMENTS
12838 SATICOY N HOLLYWOOD CALIF
DATALOG DIVISION AIR LOGISTICS CORP
2415 AMSLER ST TORRANCE CALIF
DATA-MASTER CORPORATION THE
85 HAZEL ST GLEN COVE NY
DATA SYSTEMS DEPT
3501 HARBOR BLVD COSTA MESA CALIF
DATA TECHNOLOGY INC
3821 COMMERCIAL NE ALBUQUERQUE N MEX
DATAMETRICS INC
87 BEAVER ST WALTHAM MASS
DATASCAN INC
P O BOX 785 CLIFTON N J
DATEX CORP
1307 MYRTLE AVE MONROVIA CALIF
DATRAN DIV AUTO INDUST INC
3501 LOMITA BLVD TORRANCE CALIF
DATRAX DIV W W HENRY CO
4443 E SLAUSON AVE MAYWOOD CALIF
DAVEN CO
ROUTE 10 LIVINGSTON NJ
DAVIOOFF CHARLES
198 BROADWAY NEW YORK 38 NY
DAVIES MOLDING CO HARRY
1428 WELLS ST CHICAGO ILL
DAVIES SUPPLY & MFG CO
4160 MERAMEC ST ST LOUIS 16 MO
DAVIS & CO J W
9212 DENTON DR DALLAS TEXAS
DAVIS ELECTRIC CO
230 SPRING AVE CAPE GIRARDEAU MO
DAVISON CHEMICAL CO
ERWIN TENN
DAVISON CHEMICAL CO
BOX 488 POMPTON PLAINS N J
DAWE INSTRUMENTS LTD
WESTERN AVE LONDON ENG
DAWELD CO INC
13 BERTEL AVE MOUNT VERNON N Y
DAY-RAY PRODUCTS INC
1133 MISSION ST S PASADENA CALIF
DAYSTROM INC MILITARY ELECTRONICS DIV
ARCHBALD PENNA
DAYSTROM INC TRANSICOIL DIV
WORCESTER PA
DAYSTROM INC POTENTIOMETER DIV
ARCHBALD PENNA
DAYSTROM INC CONTROL SYSTEMS DIV
4455 MIRAMAR RD LAJOLLA CALIF
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV
614 FRELINGHUYSEN AVE NEWARK 12 N J
DAYSTROM TRANSISTOR CORP
WORCESTER PENNA
DAYSTROM WESTON INDUST DIV DAYSTROM INC
MANCHESTER RD POUGHKEEPSIE N Y
DAYTON AIRCRAFT PRODUCTS INC
812 NW 1ST AVE FORT LAUDERDALE FLA
DAYTON AVIATION RADIO & EQUIP CO
BOX 312 BUSINESS RT 25 TROY OHIO
DAYTRONIC CORP
223 227 JEFFERSON ST DAYTON OHIO
DBM RESEARCH CORP
P O BOX 521 COCOA BEACH FLA
DE AN CONTROLS INC
944 DORCHESTER AVE DORCHESTER MASS
DEARBORN ELECTRONIC LABS INC
P O BOX 3431 ORLANDO FLA
DEBELL & RICHARDSON INC
WATER ST HAZARDVILLE CONN
DECHERT DYNAMICS CORP
PALMYRA PENNA
DECIMETER PRODUCTS CO
STAR ROUTE BOX 67 LITTLETON COLO
DECKER CORP
45 MONUMENT RD BALA CYNWYD PENNA
DECO ELECTRONICS INC
1000 CONNECTICUT AVE N W WASHINGTON D C
DECOURSEY ENGG LAB
11828 W JEFFERSON BLVD CULVER CITY CALIF
DEE ELECTRIC CO
1708 BELMONT AVE CHICAGO ILL
DEFIANCE PRINTED CIRCUIT CORP
144 COMMERCIAL ST MALDEN MASS

DE FLOREZ CO
116 E 30 ST NEW YORK 16 N Y
DEITZ CO S J
9 E WESLEY ST S HACKENSACK NJ
DEJUR-AMSCO CORP ELECTRONICS DIV
45-01 NORTHERN BLVD LONG ISLAND CITY 1 N Y
DE LANDRI PRECISION ELEMENTS CO INC
39 SCHOOL ST YONKERS N Y
DEL ELECTRONICS CORP
521 HOMESTEAD AVE MT VERNON N Y
DELCO APPLIANCE DIV GMC
P O BOX 230 ROCHESTER 1 N Y
DELCO RADIO DIV GMC
700 FIRMIN ST KOKOMO IND
DELCO REMY DIV GENERAL MOTORS CORP
2401 COLUMBUS AVE ANDERSON IND
DELCON CORP
943 INDUSTRIAL AVE PALO ALTO CALIF
DELMAR ENG LAB
6901 IMPERIAL HWY LOS ANG CALIF
DELMHORST INSTRUMENT CO
601 CEDAR ST BOONTON N J
DELS TUMBLING SERVICE
282 N ROSEMARY DEARBORN 6 MICH
DELSEN CORP
719 W BROADWAY GLENDALE 4 CALIF
DELTA COILS INC
1128 MADISON AVE PATERSON N J
DELTA ELECT CO
MARION IND
DELTA F INC
113 E STATE ST GENEVA ILL
DELTA SEMICONDUCTORS
835 PRODUCTION PL NEWPORT BCH CALIF
DELTIME INC
608 FAYETTE AVE MAMORONECK N Y
DELTRON CO INC
14736 ARMINTA ST VAN NUYS CALIF
DELTRON INC
2905 N LEITHGOW ST PHILADELPHIA 33 PA
DELUXE COILS INC
HUNTINGTON IND
DEMENT LABS
1717 E 19TH AVE PORTLAND OREGON
DEMORNAY BONARDI CORP
780 S ARROYO PKWY PASADENA CALIF
DEMUTH GLASS WORKS INC
P O BOX 629 PARKERSBURGH W VA
DENNISON MFG CO
300 HOWARD ST FRAMINGHAM MASS
DENRAD MFG CO INC
309 W WOODARD ST DENISON TEXAS
DENSON ELECTRONICS CORP
PO BOX 122 ROCKVILLE CONN
DEPENDABLE PRINTED CIRCUIT CORP
827 BLACK OAK RIDGE WAYNE NJ
DERBY LUMINESCENTS LTD OF LONDON ENG
C/O UNITED MINERAL & CHEMICAL CORP
16 HUDSON ST NEW YORK 13 NY
DERINGER METALLURGICAL CORP
8131 MONTICELLO AVE SKOKIE ILL
DERO ELECTRONICS
10 WOODS AVE ROOSEVELT NY
A L DERY & SONS TOOL & DIE CO
MAIN ST PINE MEADOWS CONN
DESIGN TOOL CO
1055 STEWART AVE GARDEN CITY N Y
DESMOND STEPHAN MFG CO
BOX NO 30 URBANA OHIO
DESPATCH OVEN CO
619 S E 8 ST MINNEAPOLIS MINN
DESTRON CO
25914 CHALMETTE ROLLING HILLS EST CALIF
DE-TEC-TRONIC CORP
2512 N HALSTED ST CHICAGO 14 ILL
DETROIT HOIST & MACHINE CO
8201 MORROW ST DETROIT 11 MICH
DETROIT POWER SCREWDRIVER CO
2813 W FORT ST DETROIT MICH
DEUTSCH CO ELECTRONIC COMPONENTS DIV
MUNICIPAL AIRPORT BANNING CALIF
DEVCO ENGG INC
PIER LANE WEST CALDWELL N J
DEVELOPMENT ENGG CO
9 CROSS ST NORWALK CONN
DEVELOPMENT ELECT CORP
3340 W EL SEGUNDO BLVD HAWTHORNE CALIF
DEVICE DEVELOPMENT CORP
428 BOSTON POST RD WESTON MASS
DEVICE SEALS INC
7235 RADFORD AVE N HOLLYWOOD CALIF
DEV TEK INC
5720 PRECISION RD ORLANDO FLA
DEWALD RADIO MFG CORP
35 15 37TH AVE LONG ISLAND N Y
DEWEY & ALMY CHEMICAL CO
6050 W 51 ST CHICAGO ILL
DEWITT DEVELOPMENT CO
3008 W 127 ST BLUE ISLAND ILL
DI-ACRO CORPORATION
300 8TH AVE LAKE CITY MINN
DIAL PRODUCTS CO
19 COTTAGE ST BAYONNE N J
DIALIGHT CORP
60 STEWART AVE BROOKLYN 37 N Y
DIAMOND ANTENNA & MICROWAVE CORP
35 RIVER ST WINCHESTER MASS
DIAMOND CHAIN CO INC
402 KENTUCKY AVE IND IND
DIAMOND COILS INC
540 39 ST UNION CITY N J
DIAMOND POWER SPECIALTY CORP
BOX 415 LANCASTER OHIO
DIAMOND TOOL ENGG CO
108 MASSACHUSETTS AVE BOSTON 15 MASS
DIAMOND TOOL & HORSESHOE CO
4602 4706 GRAND AVE W DULUTH MINN

DIAMONITE PRODUCTS MFG CO
DIV U S CERAMIC TILE CO SHREVE OHIO
DI-AN CONTROLS INC
944 DORCHESTER AVENUE DORCHESTER MASS
DIAPHLEX DIV
2700 N SOUTHPORT CHICAGO 14 ILL
DIATRON INC
BOX 3426 BELLAIRE TEXAS
DICE CO J W
16 HIGHWOOD AVE ENGLEWOOD N J
DICKSON ELECTRONICS CORP
248 WELLS FARGO AVE SCOTTSDALE ARIZ
DICON CORP
P O BOX 177 PORT WASHINGTON N Y
DICTAPHONE CORP
730 THIRD AVE NEW YORK N Y
DICTAPHONE CORP
375 HOWARD AVE BRIDGEPORT CONN
DIE-FORM CIRCUITS INC
6045 W OGDEN AVE CHICAGO 50 ILL
DIEBEL DIE & MFG CO
6505 OAKTON ST MORTON GROVE ILL
DIEHL MFG CO
FINDERNE AVE SOMERVILLE N J
DIELECT INC
CORAL ST BOX 44 FORDS N J
DIELECTRIC MATERIAL CO
1811 W BRYN MAWR AVE CHICAGO ILL
DIELECTRIC PRODUCTS ENGG CO
RAYMOND ME
DIELECTRIC PRODUCTS ENGG CO
BRIDGETON ME
DIETZ CO HENRY G INC
12-16 ASTORIA BLVD LONG ISLAND CITY 2 N Y
DIETZ CO S J
9 E WESLEY ST HACKENSACK N J
DIETZ DESIGN INC
GRANDVIEW MO
DIGITAL DESIGN CORP
BOX 21 CLAY N Y
DIGITAL SYSTEMS INC
812 DODSWORTH AVE COVINA CALIF
DIGITECH INC
382 DANBURY RD WILTON CONN
DIGITECH INC
130 WATER ST S NORWALK CONN
DIGITOOL CORP
5300 BROADWAY RD HOUSTON TEXAS
DIGITRAN CO DIV OF ENDEVCO
660 S ARROYO PARKWAY PASADENA CALIF
DIGITRAN CO DIV ENDEVCO CORP
45 W UNION ST PASADENA CALIF
DIGITROL SYSTEMS INC
TYRELL RD MILLBROOK N Y
DIGITRONICS CORP
ALBERTSON AVE ALBERTSON L I N Y
DILECTRIX CORP
ALLEN BLVD & GRAND AVE FARMINGDALE LI N Y
DILL PRODUCTS INC
371 E MAIN ST NORRISTOWN PA
DILLON & CO INC W C
14610 KESWICK ST VAN NUYS CALIF
DIMCO-GRAY CO
207 E 6 ST DAYTON 2 OHIO
DINION COIL CO
CALEDONIA N Y
DIOTRON INC
3650 RICHMOND ST PHILA PENNA
DIRIGO COMPASS & INSTRUMENT CO
BOEING FIELD BOX 37 SEATTLE WASH
DIT-MCO INC ELECTRONICS DIV
911 BROADWAY KANSAS CITY MO
DI-TRAN CORPORATION
11307 HINDRY AVE LOS ANGELES 45 CALIF
DITTMORE FREIMUTH CORP
2517 E NORWICH ST MILWAUKEE WISC
DIXON CORP
BURNSIDE BRISTOL R I
DIXON CRUCIBLE CO JOSEPH
167 WAYNE ST JERSEY CITY 3 N J
DJECO DIV DJORDJEVIC ENGG CO
1933 N DAMEN CHICAGO 47 ILL
DJORDJEVIC ENG CO
1933 N DAMEN CHICAGO ILL
DKE ELECTRIC BASES CORP
27 WRIGHT ST NEWARK NJ
DMETER MFG CO
22 24 LARKIN PLAZA YONKERS N Y
THE DOALL CO
254 N LAUREL AVE DES PLAINES ILL
DOCKENDORFF & CO INC
606 LINDLEY ST BRIDGEPORT CONN
DOLIN METAL PRODUCTS INC
315 LEXINGTON AVE BROOKLYN N Y
DOLINKO & WILKENS INC
1907 SUMMIT AVE UNION CITY N J
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSCO
LITTELL RD HANOVER N J
DONGAN ELECTRIC MFG CO
2987 FRANKLIN ST DETROIT MICH
DON LAN ELECTRONICS CORP SUB QUANTATRON INC
2520 COLORADO AVE SANTA MONICA CAL
DONMAR PRODUCTS INC
P O BOX 8396 DENVER 10 COLO
DONNELLY MFG CO
580 WINTER ST WALTHAM MASS
DORE CO JOHN L
PO BOX 7772 HOUSTON 7 TEX
DORMEYER CORP
700 N KINGSBURY AVE CHICAGO ILL
DORMEYER INDUSTRIES
3418 MILWAUKEE AVE CHICAGO 41 ILL
DORMEYER INDUSTRIES
KENTLAND INDIANA
DORNE & MARGOLIN
29 N Y AVE WESTBURY N Y
DORSETT ELECTRONICS
119 W BOYD NORMAN OKLA

DOSS ELECTRONIC RES INC
820 BALTIMORE AVE KANSAS CITY MO
DOSSERT MFG CORP
249 HURDN ST BROOKLYN 22 N Y
DOTCO INC
HICKSVILLE OHIO
DOTY ACOUSTICAL ELECTRONIC LABS
TOBYHANNA PENNA
DOUBLE E PRODUCTS CO
208 STANDARD ST EL SEGUNDO CALIF
DOUGLAS MICROWAVE CO
252 E 3 ST MT VERNON N Y
DOUGLAS ROESCH COMMUNICATIONS
2727 SAN FERNANDO ROAD LOS ANGELES 65 CAL
DOW CORNING CORP
BOX 592 MIDLAND MICH
DOW KEY CO
P O BOP 711 THIEF RIVER FALLS MINN
DOW KEY CO INC
RT 3 59 THIEF RIVER FALLS MINN
DOWNING CRYSTAL CO
191 SHAFFER AVE WESTMINSTER MD
D & R PILOT PLANTS INC
WATER ST HAZARDVILLE CONN
DRAKE CO R L
540 RICHARD ST MIAMISBURG OHIO
DRAKE MFG CO
4626 N OLCOTT AVE CHICAGO ILL
DRAKENFELD & CO B F
45 PARK PL NEW YORK 7 N Y
DRESSEN BARNES CORP
250 N VINEDO AVE PASADENA CALIF
DRESSER ELECT SIE DIV
10201 WESTHEIMER RD HOUSTON TEXAS
DRESSER ELECTRIC CO
2705 WIGHT ST DETROIT 7 MICH
DRESSER ELECT HST DIV
555 N 5ST GARLAND TEXAS
DRESSER-IDECO CO
8909 S VERMONT AVE LOS ANGELES 44 CALIF
DREXEL DYNAMICS CORP
MAPLE AVE HORSHAM PA
DRICO INDUSTRIAL CORP
100 8TH ST PASSAIC N J
DRIVER CO WILBUR B
1875 MCCARTER HWY NEWARK 4 N J
DRIVER HARRIS CO
HARRISON N J
DRY SCREEN PROCESS INC
1016 MADISON AVE PITTSBURGH 12 PA
DRYOMATIC CORP
BOX 591 715 FAYETTE ST ALEXANDRIA VA
DU-CO CERAMICS CO
BOX 278 SAXONBURG PA
DUCOMMUN CO M
580 FIFTH AVE NEW YORK 36 N Y
DUDEK & CO R C
407 MAPLE DR BEVERLY HILLS CALIF
DUKANE CORP
ST CHARLES ILL
DUMONT AIRPLANE & MARINE INSTRUMENT INC
PO BOX 92 CLEARFIELD PENNA
DUMONT LABS INC ALLEN B
750 BLOOMFIELD AVE CLIFTON NJ
DUMORE CO
1300 17TH ST RACINE WISC
DUNCAN ELECT INC
3865 FAIRVIEW RD COSTA MESA CALIF
DUNHAM-BUSH INC
W HARTFORD CONN
DUNLEE CORP
1023 S PUSCHECK RD BELLWOOD ILL
DUNN ENG CORP
38 HENRY ST CAMBRIDGE MASS
DUNTON CO MW
7 GOFF ST PROVIDENCE R I
DUOTONE CO
LOCUST ST KEYPORT N J
DU PONT DE NEMOURS & CO E I
WILMINGTON 98 DEL
DURAKOOL INC
1010 N MAIN ST ELKHART IND
DURALITH CORP
1025 RACE ST PHILADELPHIA 7 PA
DURAMARK INC
P O BOX 231 PORT WASHINGTON N Y
DURAMIC PRODUCTS INC
426 COMMERCIAL AVE PALISADES PARK N J
DURANT MFG CO
15 THURBERS AVE PROVIDENCE 5 RI
DURANT MFG CO
12TH & CLARK STS WATERTOWN WISC
DURATRON CORP
154 W 14TH ST NEW YORK 11 NY
DUREZ PLASTIC DIV-HOOKER CHEMICAL CORP
1926 WALCK RD NORTH TONAWANDA N Y
DURO SPECIALTY CO
811 BOSTON ST LYNN MASS
DWYER ELECTRONICS CO
AIRPORT RD BOX 452 NASHUA N HAMPSHIRE
DWYER MFG CO F W
P O BOX 373 MICHIGAN CITY IND
DX RADIO PRODUCTS CO
2300 W ARMITAGE AVE CHICAGO 47 ILL
DYMEC DIV OF HEWLETT PACKARD CO
395 PAGE MILL RD PALO ALTO CALIF
DYMO CORP
1476 66TH ST EMERYVILLE CALIF
DYNA SONICS CORP
200 MICHAEL DRIVE SYOSSET N Y
DYNACOR INC
1010 WESTMORE AVE ROCKVILLE MD
DYNACOR INC
10431 METROPOLITAN AVE KENSINGTON MD
DYNA-EMPIRE INC
1075 STEWART AVE GARDEN CITY L I N Y
DYNAIR ELECTRONICS INC
7564 BROADWAY LEMON GROVE CALIF

DYNAMETRICS CORP
NORTHWEST INDUST PARK BURLINGTON MASS
DYNAMIC AIR ENGG INC
7412 MAIE AVE LOS ANGELES 1 CALIF
DYNAMIC CONTROLS CO
2225 MASSACHUSETTS AVE CAMBRIDGE MASS
DYNAMIC ELECTRONICS INC
87-46 123RD ST RICHMOND HILL N Y
DYNAMIC GEAR COM INC
175 DIXON AVE AMITYVILLE N Y
DYNAMIC INSTRUMENT CORP
59 NEW YORK AVE WESTBURY N Y
DYNAMIC MEASUREMENTS CO
DAVISVILLE & TERWOOD RD WILLOW GROVE PA
DYNAMICS INST CO
583 MONTEREY PASS RD MONTEREY PK CALIF
DYNAMU MAGNETRONICS CORP DIV MAICO ELECT INC
21 N 3 ST MINNEAPOLIS MINN
DYNAPAR CORP
437 E STEWART MILWAUKEE WISC
DYNASONICS CORPORATION
200 MICHAEL DRIVE SYOSSET NY
DYNATRONICS CABLE ENGG CORP
136 SAN FERNANDO RD LOS ANG CALIF
DYNATRONICS INC
P O BOX 2566 ORLANDO FLA
DYNAVOX CORP
40-50 21ST ST LONG ISLAND CITY I N Y
DYNEL INC
12923 S SPRING ST LOS ANG CALIF
DYTRONICS CO
BOX 3676 COLUMBUS OHIO
DYTRONICS INC DIV OF TAYLOR FIBOR
ROCHESTER 53 MICHIGAN
DZUS FASTENER CO
125 UNION ST WEST ISLIP N Y

E

EAGLE ELECTRIC MFG CO
2310 BRIDGE PLAZA SO LONG ISLAND CITY 1 NY
EAGLE ELECTRIC MFG CO INC
2814-18 W FULLERTON AVE CHICAGO 47 ILL
EAGLE SIGNAL CO DIV GAMEWELL CO
202 20 ST MOLINE ILL
EAGLE-PICHER CO AMERICAN BLDG
AMERICAN BLDG CINCINNATI 1 OHIO
EALING CORP
33 UNIVERSITY RD CAMBRIDGE MASS
EALTHAM PRECISION INST CO INC
47 51 33 ST LONG ISLAND CITY N Y
EASTERN AIR DEVICES
391 CENTRAL AVE DOVER N H
EASTERN CHEMICAL CORP
34 SPRING ST NEWARK N J
EASTERN ETCHING & MFG CO
GRAPE ST CHICOPEE MASS
EASTERN INDUSTRIES DIV OF LIFE INC
100 SKIFF ST HAMDEN CONN
EASTERN PRECISION RESISTOR CORP
116 MYRTLE AVE RICHMOND HILLS N Y
EASTERN ROLLING MILLS INC
1122 E 180TH ST NEW YORK N Y
EASTERN SMELTING & REFINING CORP
109 W BROOKLINE ST BOSTON 18 MASS
EASTERN SPECIALTY CO
3617 N 8 ST PHILA 40 PA
EASTERN TECHNICAL ASSOC INC
MAIN ST NORTH ACTION MASS
EASTMAN KODAK CO
343 STATE ST ROCHESTER 4 NY
EATON MFG CO DYNAMIC DIV
3122 14TH AVE KENOSHA WISC
EATON MFG CO RELIANCE DIV
25 CHARLES AVE SE MASSILLON OHIO
EBAUCHES A DEP SEMICONDUCTEURS
FAUBOURG HOPITAL NEUCHATEL SWITZERLAND
EBERLINE INSTRUMENT CORP
805 EARLY ST SANTA FE NEW MEXICO
EBERT ELECTRONICS CORP
212-76 JAMAICA AVE QUEENS VILLAGE 28 N Y
EBY CO H H
4700 GERMANTOWN AVE PHILADELPHIA 44 PA
EBY SALES CO
148-05 ARCHER AVE JAMAICA 35 NY
ECKEL CORP
155 FAWCETT ST CAMBRIDGE 38 MASS
ECKEL VALVE CO
1425 FIRST ST SAN FERNANDO CALIF
ECLIPSE ENG CO
226 S GLASGOW AVE INGLEWOOD CALIF
ECLIPSE-PIONEER DIV BENDIX CORP
TETERBORO N J
ECM CORP
8160 ORION AVE VAN NUYS CALIF
EDAL INDUSTRIES INC
64 FRANKLIN ST NEW HAVEN 11 CONN
EDCLIFF INSTRUMENTS
1711 S MOUNTAIN AVE MONROVIA CALIF
EDCO ENG & DEV CORP
2225 E FRANKLIN MINN MINN
EDER INSTRUMENT CO INC
2293 N CLYBOURN AVE CHICAGO ILL
EDERER ENGG CORP
2931 1ST AVE S SEATTLE WASH
EDGERTON GERMESHAUSEN & GRIER INC
BLDG 226 SANTA BARBARA AIRPORT GOLETA CAL
EDGERTON GERMESHAUSEN & GRIER INC
1622 S A ST PO BOX 1912 LAS VEGAS NEV
EDGERTON GERMESHAUSEN & GRIER
160 BROOKLINE AVE BOSTON MASS
EDISON INDUST THOMAS A INST DIV
45 LAKESIDE AVE W ORANGE N J
EDKO ELECTRONICS ENGG CO
397 BEDFORD AVE BROOKLYN 11 NY
E D L CO
BOX 2508 5929 DUNES HWY GARY IND
EDD CANADA LTD
BOX 97 CORNWALL ONT CANADA
EDO CORP
13 10 111 ST COLLEGE POINT L I N Y
EDP CORPORATION
3501 SO ORANGE BLOSSOM TRAIL ORLANDO FLA
EDROY PRODUCTS CO
480 LEXINGTON AVE NEW YORK N Y
EDUCATIONAL ELECTRONICS CO
1227 LOYOLA AVE CHICAGO 26 ILL
EDWIN BOHR ELECT
5880 DAYTON BLVD CHATTANOOGA TENN
EFCON INCORP SUB GENERAL INST
GARDEN CITY L I N Y
EGAN LABORATORY
107-56 113TH ST RICHMOND HILL 19 N Y
E H RESEARCH LAB INC
163 ADELINE ST OAKLAND CALIF
EIDSON ELECTRONIC CO
1902 N 3 ST TEMPLE TEXAS
EISLER ENGG CO
750 S 13 ST NEWARK 3 N J
EISLER TRANSFORMER CO INC
24 N SALEM ST DOVER N J
EISLER TRANSFORMER CO INC
16 N SALEM ST DOVER N J
EITEL-MC CULLOUGH INC
301 INDUSTRIAL WAY SAN CARLOS CALIF
EITEL-MCCULLOUGH INC
798 SAN MATEO AVE SAN BRUNO CALIF
ELASTIC STOP NUT CORP OF AMERICA
2330 VAUXHALL RO UNION N J
ELCO CORP
M ST BELOW ERIE AVE PHILA 24 PA
ELCO TOOL & SCREW CORP
1111 SAMUELSON RD ROCKFORD ILL
ELCOR INC
1225 W BROAD ST FALLS CHURCH VA
ELDEMA CORP
1805 BELCROFT AVE EL MONTE CALIF
ELDORADO ELECT CO
2821 10 ST BERKELEY CALIF
ELECT DIV OF GENERAL MOTORS CORP
1925 EAST KENILWORTH PLACE MILWAUKEE WISC
ELECT INSTRUMENT CO
33-00 NORTHERN BLVD LONG ISLAND CITY NY
ELECT MECHANICAL RES INC
SARASOTA FLA
ELECT STORAGE BATTERY MISSILE BATTERY DIV
2510 LOUISBURG RD RALEIGH N C
ELECT STORAGE BATTERY CO DIV EXIDE IND
2 PENN CENTER PLAZA PHILA PA
ELECTRA MFG CO
4051 BROADWAY KANSAS CITY MO
ELECTRA SCIENTIFIC CORP
ELECTRA WAY FULLERTON CALIF
ELECTRALAB PRINTED ELECT
1105 SECOND ST ENCINITAS CALIF
ELECTRALAB PRINTED ELECT CORP
NEEDHAM HTS MASS
ELECTRAMATIC INC
3324 HIAWATHA AVE MINN MINN
ELECTRAN MFG CO
1901 CLYBOURN AVE CHICAGO ILL
ELECTREND PRODUCTS CORP
BOX 110 ST JOSEPH MICH
ELECTRI WIRE ASSEMBLIES
700 W VIRGINIA MILWAUKEE WISC
ELECTRIC AUTO-LITE CO
WIRE & CABLE DIV PORT HURON MICH
ELECTRIC AUTO-LITE CO
HAZELTON PENNA
ELECTRIC AUTOLITE CO THE
901 N SELBY ST EL SEGUNDO CALIF
THE ELECTRIC AUTOLITE CO
P O BOX 366 HAZELTON PENNA
ELECTRIC AUTOLITE DIE CASTING CO
1ST & CLAY STS WOODSTOCK ILL
ELECTRIC AUTOLITE CO
PENNSBURG PA
ELECTRIC AUTOLITE CO
VINCENNES IND
ELECTRIC CORDS & SUPPLY CORP
413 E THIRD ST LOS ANG CALIF
ELECTRIC DESIGN & MFG CO
722 JEFFERSON ST BURLINGTON IOWA
ELECTRIC EYE EQUIPMENT CO
1948 E FAIRCHILD ST DANVILLE ILL
ELECTRIC INDICATOR CO INC
CAMP AVE SPRINGDALE CONN
ELECTRIC MACHINERY MFG CO
800 CENTRAL AVE MINNEAPOLIS 13 MINN
ELECTRIC MOTORS & SPECIALTIES
KING & HAMPSHER ST GARRETT IND
ELECTRIC POWER DOOR CO INC
MINNEAPOLIS MINN
ELECTRIC REGULATOR CORP
PEARL ST NORWALK CONN
ELECTRIC SOLDERING IRON CO
W ELM ST DEEP RIVER CONN
ELECTRIC STORAGE BATTERY CO EXIDE IND DIV
RISING SUN & ADAMS AVES PHILA PA
ELECTRIC STORAGE BATTERY CO
5335 WESTERN BLVD S CHICAGO 9 ILL
ELECTRIC TACHOMETER CORP
68TH & UPLAND STS PHILA PENNA
ELECTRIC TERMINAL CORP
PO BOX 2217 PROVIDENCE 5 RI
ELECTRIC TRADING CO
313 CANAL ST NEW YORK 13 N Y
ELECTRICAL INSULATION CO INC
1245 MARCONI BL COPIAGUE N Y
ELECTRICAL INSTRUMENT CORP
200 HARVARD AVE STAMFORD CONN
ELECTRICAL INDUSTRIES
691 CENTRAL AVE MURRAY HILL NJ
ELECTRICAL PRODUCTS RESEARCH & DEV CO INC
1206 CHERRY ST TOLEDO 4 OHIO
ELECTRICAL REFRACTORIES CO
E CLARK ST E PALESTINE OHIO
ELECTRICAL SERVICE CO
1271 MISSION ST SAN FRANCISCO CALIF
ELECTRICAL SPECIALTY CO
2820 E 12ST LOS ANG CALIF
ELECTRICAL SPECIALTY CO
158 ELEVENTH ST SAN FRAN CALIF
ELECTRICAL UTILITIES CO
2427 ST VINCENTS AVE LA SALLE ILL
ELECTRICAL WINDINGS INC
2015 N KOLMAR AVE CHICAGO ILL
ELECTRO-AIR CLEANER CO INC
OLIVIA & SPROUL ST MCKEES ROCKS PA
ELECTRO ASSEMBLIES INC
4444 N KEDZIE AVE CHICAGO 25 ILL
ELECTRO-CERAMICS INC
120 STATE ST NEW HAVEN CONN
ELECTRO CERAMICS INC
2645 S 2ND W SALT LAKE CITY UTAH
ELECTRO CHEMICAL ENGRAVING CO INC
1100 BROOK AVE BRONX N Y
ELECTRO CHEMICAL ENGG & MFG CO
750 BROAD ST EMMAUS PA
ELECTRO CHEMICAL DIV REPUBLIC FOIL INC
SALISBURY NC
ELECTROCHEMICAL INDUSTRIES INC
35 ARMORY ST WORCESTER 3 MASS
ELECTRO CIRCUITS INC
176 WALKER STREET LOWELL MASS
ELECTRODATA DIV BURROUGHS CORP
460 SIERRA MADRE VILLA PASADENA CALIF
ELECTRO-DEVELOPMENT CO
14701 KESWICK ST VAN NUYS CALIF
ELECTRO DEVICES INC
75 ADAMS ST NEWTON MASS
ELECTRO DEVICES INC
4 GODWIN AVE PATERSON N J
ELECTRO ENGG WORKS
401 PREDA ST SAN LEANDRO CALIF
ELECTRO-ETCH CIRCUITS INC
7112 SO VICTORIA AVE LOS ANGELES 43 CALIF
ELECTRO FLEX HEAT INC
83 WOODBINE ST HARTFORD CONN
ELECTROFLOR INC
7356 SANTA MONICA BL LOS ANGELES CALIF
ELECTRO GEAR CORP ELECTRO PROD DIV
132 W COLORADO BLVD PASADENA CALIF
ELECTRO IMPULSE LAB INC
208 RIVER ST RED BANK N J
ELECTRO INSTRUMENT INC
8611 BALBOA AVE SAN DIEGO 11 CALIFORNIA
ELECTRO INTERNATIONAL INC
GREENWOOD ACRES SECOND ST ANNAPOLIS MD
ELECTRO LOGIC CORP
110 W 131 ST LOS ANGELES 61 CALIF
ELECTROMAGNETIC TECHCORP
1375 CALIF AVE PALO ALTO CALIF
ELECTROMATIC EQUIP CO
562 ALBERMARLE RD CEDARHURST N Y
ELECTROMATION CO
4254 GLENCOE AVE VENICE CALIF
ELECTRO-MECHANICAL DIV GENERAL RIVETERS INC
785 HERTEL AVE BUFFALO 7 N Y
ELECTRO-MECHANICAL INSTRUMENT CO
8 & CHESTNUT ST PERKASIE PA
ELECTRO MECHANICAL RESEARCH
BOX 44 PRINCETON NJ
ELECTRO MECHANICAL SPEC
528 LAMBERT RD WHITTIER CALIF
ELECTRO-MECHANICAL SPECIALTIES CO
407 N MAPLE DR BEVERLY HILLS CALIF
ELECTRO MED INC
4748 FRANCE AVE N MINNEAPOLIS MINN
ELECTRO-MEDICAL LAB INC
S WOODSTOCK 10 VT
ELECTRO MEDICAL ENG CO
703 MAIN ST BURBANK CALIF
ELECTRO-MINIATURES CORP
604 HUYLER ST SOUTH HACKENSACK NJ
ELECTROMODE
P O BOX 1052 ROCHESTER 3 N Y
ELECTRO MOTIVE MFG CO INC
WILLIMANTIC CONN
THE ELECTRO NUCLEAR SYS CORP
9449 SCIENCE CENTER DR MINN MINN
ELECTROPHONO & PARTS CORP
530 CANAL ST NEW YORK N Y
ELECTRO PHYSICS CO
297 BROADWAY NEW YORK 7 N Y
ELECTRO PHYSICS LABS
1900 WALKER AVE MONROVIA CALIF
ELECTRO PRODUCTS LABS INC
4501 N RAVENSWOOD AVE CHICAGO 40 ILL
ELECTRO PRODUCTS DIV WESTERN GEAR CORP
132 COLORADO ST PASADENA CALIF
ELECTRO PRODUCTS INC
15050 SCHAFER HWY DETROIT MICH
ELECTRO-PULSE INC
11861 TEALE ST CULVER CITY CALIF
ELECTRO SCIENTIFIC IND INC
7524 S W MACADAM AVE PORTLAND ORE
ELECTRO-SECURITY CORP
275 MAIN ST WEBSTER MASS
ELECTRO SOLID CONTROLS INC
8001 BLOOMINGTON FREEWAY MINN MINN
ELECTRO-SONIC LABS
35-54 36 ST LONG ISLAND CITY 6 N Y
ELECTRO SWITCH CORP
KING AVE WEYMOUTH 88 MASS

ELECTRONIC MANUFACTURERS—A TO Z

ELECTRO-SWITCH & CONTROLS INC
5755 CAMILLE AVE CULVER CITY CALIF
ELECTRO-TEC CORP
1 HENDERSON DRIVE WEST CALDWELL NJ
ELECTRO TEC CORP VIRGINIA DIV
BOX 219 BLACKSBURG VA
ELECTRO-TECHNICAL LABS
5134 GLENMONT DR HOUSTON 36 TEXAS
ELECTRO TECHNICAL PRODUCTS
113 E CENTRE ST NUTLEY N J
ELECTRO TECHNIQUES
11301 E OCEAN AVE LA HABRA CALIF
ELECTRO VISION LAB
41-08 45TH ST LONG ISLAND CITY 1 N Y
ELECTRO VOICE INC
CARROLL CECIL STS BUCHANAN MICH
ELECTRO WELO CO
55 GOFFLE ROAD HAWTHORNE N J
ELECTRON CORP
747 S CENTRAL EXPWY RICHAROSON TEXAS
ELECTRONAUTICS CORP
BLDG 1 MAYNARD IND MASS
ELECTRON ENTERPRISES
6917 W STANLEY AVE BERWYN ILL
ELECTRONIC APPLICATIONS INC
194 RICHMOND HILL AVE STAMFORO CONN
ELECTRONIC ASSEMBLY CO INC
5 PRESCOTT ST ROXBURY 19 MASS
ELECTRONIC ASSOCIATES INC
LONG BRANCH & NABERAL AVES LONG BRANCH NJ
ELECTRONIC BRAZING CO
140 GLENRIDGE AVE MONTCLAIR N J
ELECTRONIC CHEMICAL CORP
813 COMMUNIPAW AVE JERSEY CITY 4 N J
ELECTRONIC COILS INC
P O BOX 1665 SPRINGFIELD MASS
ELECTRONIC COMPONENTS DIV TELECOMPUTING CORP
14706 ARMINTA ST VAN NUYS CALIF
ELECTRONIC COMMUNICATION EQPT CO
1249 W LOYOLA AVE CHICAGO 26 ILL
ELECTRONIC COMMUNICATIONS
1501 72ND ST N ST PETERSBURG FLA
ELECTRONIC COMPONENTS
520 INTERSTATE RD ADDISON ILL
ELECTRONIC COMPONENTS CORP
311 W MULBERRY ST WATSEKA ILL
ELECTRONIC COMPUTER CORP
BOX 177 PIPER CITY ILL
ELECTRONIC COMPUTER CD
618 MAPLE ST CONSHOHOCKEN PA
ELECTRONIC CONTRACTORS INC
2101 SE 6 AVE PORTLAND 14 ORE
ELECTRONIC CONTROL CORP
15341 DALE DETROIT MICH
ELECTRONIC CONTROLS DIV
1330 QUINCY ST MINN MINN
ELECTRONIC COUNTERS INC
164 EILEEN WAY SYOSSET LI N Y
ELECTRONIC CRAFTSMEN INC
3305 RUTGERS ST W HYATTSVILLE MD
ELECTRONIC DESIGN & DEVELOP CO
60 PENNINTON ST NEWARK N J
ELECTRONIC DEVELOPMENT LABS
71 NASSAU ST N Y N Y
ELECTRONIC DEVICES INC
429 12TH ST BROOKLYN 15 N Y
ELECTRONIC DEVICES INC
50 WEBSTER AVE N ROCHELLE N Y
ELECTRONIC ENGG CO
362 W BOWERY ST AKRON OHIO
ELECTRONIC ENTERPRISES INC
65 7 AVE NEWARK N J
ELECTRONIC ENGG CO OF CALIF
1601 CHESTNUT SANTA ANA CALIF
ELECTRONIC EQUIPMENT SUPPLY CO
249 N 48TH ST LINCOLN NEB
ELECTRONIC FITTINGS CORP
RT 7 AT DANBURY AIRPORT DANBURY CONN
ELECTRONIC INSTRUMENT CO INC
3300 NORTHERN BLVO LONG ISLAND CITY N Y
ELECTRONIC INDUST INC
18 MARSHALL ST NORWALK CONN
ELECTRONIC INTL CO
145 MAGNOLIA BLVD BURBANK CALIF
ELECTRONIC MACHINE PARTS INC
128 11 18TH AVE COLLEGE POINT N Y
ELECTRONIC MEASUREMENTS CO INC
EATONTOWN N J
ELECTRONIC MEASUREMENTS CORP
625 BROADWAY NEW YORK 12 N Y
ELECTRONIC MECHANICAL PROD CO
929 ATLANTIC AVE ATLANTIC CITY NJ
ELECTRONIC PARTS MFG CO
508 25 ST UNION CITY NJ
ELECTRONIC PLASTICS CORP
675 BARBEY ST BROOKLYN 7 N Y
ELECTRONIC PLASTICS CORP
16 SALEM ST WAKEFIELD MASS
ELECTRONIC PRODUCTS DIV POST MACHINERY
140 ELLIOT ST BEVERLY MASS
ELECTRONIC PROCESSES CORP OF CALIF
436 BRYANT ST SAN FRAN CALIF
ELECTRONIC PRODUCTION & DEVELOPMENT
501 N PRAIRIE AVE HAWTHORNE CALIF
ELECTRONIC PRODUCTS CO
111 E 3RD ST MOUNT VERNON N Y
ELECTRONIC PRODUCTS CORP
2315 CECIL AVE BALTIMORE 18 MARYLAND
ELECTRONIC RECTIFIERS INC
2102 SPANN AVE IND IND
ELECTRONIC RESEARCH ASSOCIATES INC
67 FACTORY PL CEOAR GROVE NJ
ELECTRONIC SECRETARY INDUSTRIES INC
1101 S PRAIRIE AVE WAUKESHA WISC
ELECTRONIC SPECIALTY CO
TECHNICRAFT DIVISION THOMASTON CONN

ELECTRONIC SPECIALTIES MFG CORP
100 LAMARTINE ST WORCESTER MASS
ELECTRONIC SYSTEMS
7309 VARNA AVE N HOLLYWOOD CALIF
ELECTRONIC SYSTEMS ENGG CO
2838 WILSHIRE BLVD OKLAHOMA CITY OKLA
ELECTRONIC TIMERS CO
PANA ILL
ELECTRONIC TUBE COIL CO
557 EAGLE ROCK AVE ROSELAND NJ
ELECTRONIC TUBE & INST DIV
1200 E MERMAID LANE PHILA PA
ELECTRONICS & OROANCE DV
2630 GLENOALE CINCINNATI OHIO
ELECTRONICS & ORDANCE DIV AVCO CORP
CINCINNATI OHIO
ELECTRONICS BATTERIES INC
28 34 35 ST BROOKLYN N Y
ELECTRONICS CORP OF AMERICA
1 MEMORIAL DR CAMBRIDGE 42 MASS
ELECTRONICS CORP OF AMER
104 ADVANCE RD TORONTO ONTARIO CANADA
ELECTRONICS DEVELOPMENT CO
3743 CAHUENGA BLVD N HOLLYWOOD CALIF
ELECTRONICS DEVELOPMENT INC
521 MARYLYN AVE BOX 813 STATE COLLEGE PA
ELECTRONICS INTL CO INC
20 N LEE ST OKLAHOMA CITY 2 OKLA
ELECTRONICS INC OF PA
2440 MARYLANO AVE WILLOW GROV E PA
ELECTRONICS INC
127 SUSSEX AVE NEWARK N J
ELECTRONICS OF CLEARFIELO INC
PO BOX 792 CLEARFIELD PA
ELECTRONICS RESEARCH INC
P O BOX 327 EVANSVILLE IND
ELECTRON PROOUCTS DIV MARSHALL INDUSTRIES
430 N HALSTEAD ST PASADENA 8 CALIF
ELECTRON RESEARCH INC
530 W 12TH ST ERIE PENNA
ELECTRON TECHNOLOGY INC
626 SCHUYLER AVE KEARNY N J
ELECTROPAC INC
PETERBOROUGH N H
ELECTROPOT INC
3155 W SEGUNDO BLVD HAWTHORNE CALIF
ELECTROSOLIDS CORP
13745 SATICOY ST PANORAMA CITY CALIF
ELECTROSONIC ENGINEERING CO
2120 PONTIUS AVE LOS ANGELES 25 CALIF
ELECTROVART INC
240 MADISON AVE NEW YORK 16 N Y
ELEKTRO-SERV CO
480 JOHNSON AVE BROOKLYN 37 N Y
ELEMATIC EQUIPMENT CORP
6731 S CHICAGO AVE CHICAGO 37 ILL
ELGENCO INC
1231 COLORADO AVE SANTA MONICA CALIF
ELGIN MICRONICS DIV ELGIN NAT WATCH CO
366 BLUFF CITY BLVD ELGIN ILL
ELGIN NATIONAL WATCH CO
366 BLUFF CITY BLVD ELGIN ILL
ELECTRONICS DIV ELGIN NATL WATCH CO
2435 N NAOMI ST BURBANK CALIF
ELGIN LABS INC
WATERFORO PA
ELIN DIV INTL ELECT RESCH CORP
145 W MAGNOLIA BLVD BURBANK CALIF
ELION INSTRUMENTS INC
ROUTE 130 NORTH BURLINGTON N J
ELJAY CORP
2908 HERBERT ST BALTIMORE MO
ELK ELECTRONICS LABS INC
333 W 52 ST NEW YORK 19 N Y
ELLIOTT BROS LONOON LTD OAMELLIT DIV
ELSTREE WAY BOREHAMWOOO HERTS ENGLAND
ELLIOTT BROS LTD
BOREHAMWOOD HERTS ENGLAND
ELLIOTT BROTHERS LONOON LTD
ELSTREE WAY BOREHAMWOOO HERTFORDSHIRE ENG
ELLIOTT BROTHERS LONOON LTD RADAR DIV
ELSTREE WAY BOREHAMWOOD HERTFORDSHIRE ENG
ELLIS & WATTS PROOUCTS INC
P O BOX 33 CINCINNATI 36 OHIO
ELLIS ASSOCIATES
67 LINCOLN AVE PELHAM N Y
ELLISON DRAFT GAGE CO
548 W MONROE ST CHICAGO 6 ILL
ELM INSTRUMENT
30 CHASNER ST HAMPSTEAO LI NY
ELM MFG CO INC
PO BOX 14 HASTINGS ON HUDSON NY
ELPAC INC
4270 ARTESIA ST FULLERTON CALIF
EL PRODUCTS CORP
P O B 41 NEW YORK 63 N Y
EL-RAD MFG CO
4300 N CALIFORNIA AVE CHICAGO 18 ILL
ELY SALES CO
130 LAFAYETTE ST NEW YORK 13 N Y
ELZEE METAL PROOUCTS CO
775 39 ST BROOKLYN 32 N Y
EMARCO CORP
1950 NEVA DRIVE DAYTON 14 OHIO
EMC CORPORATION
180 E 6TH ST ST PAUL 1 MINN
EMERSON & CUMING INC
869 WASHINGTON ST CANTON 1 MASS
EMERSON ELECTRIC
8100 W FORISSANT AVE ST LOUIS 21 MO
EMERSON ELECTRIC MFG CO ELECT & AVIONICS DIV
8100 FLORISSANT AVE ST LOUIS 36 MO
EMERSON PLASTICS CORP
SEABURY AVE & BUTLER PL BRONX 61 N Y
EMERSON RAOIO & PHONOGRAPH CORP
14 & COLES STS JERSEY CITY 2 N J

EMERSON-RITTENHOUSE CO INC
68 EAST ST HONEDYE FALLS N Y
EMI COSSOR ELECTRONICS
WOODSIDE DARTMOUTH NOVA SCOTIA
EMI US
1750 VINE ST LOS ANG CALIF
EMI US LTD
FORT ATKINSON WISC
EMI/US
13259 SHERMAN WAY NO HOLLYWOOD CALIF
E M J MFG CO
760 REED SANTA CLARA CALIF
EMMCO PLASTIC FAB DIV
68 VINE ST EVERETT MASS
EMMERT MFG CO
1051 E MAIN ST WAYNESBORO PA
EMPIRE DEVICES PRODUCTS CORP
37 PROSPECT ST AMSTEROAM NY
EMPIRE ELECTRONICS CO INC
60 SPRUCE ST PATERSON 1 NJ
EMPIRE PRODUCT SALES CORP
37 PROSPECT ST AMSTERDAM N Y
ENDECO ENGG DEVELOPMENT CO OF LOS ANGELES
8021 LONG BEACH VIKING WY LONG BEACH 8 CAL
ENDERES OIV MUTER CO
GUTTENBERG IOWA
ENDEVCO CORP
161 E CALIFORNIA BLVD PASADENA CALIF
ENFAB INC
312 E BROKAW RD SAN JOSE CALIF
ENFLO CORP
FELLOWSHIP RO ROUTE 73 MAPLE SHAOE N J
ENG NORTHWEST
2309 SNELLING MINN MINN
ENG SPECIALITIES INC
LAKEVILLE MINN
ENGELHARD HANOVIA INC
100 CHESTNUT ST NEWARK 5 NJ
ENGELHARD INDUSTRIES
850 PASSAIC AVE E NEWARK NJ
ENGERLAND INOUSTRIES INC
113 ASTOR ST NEWARK N J
ENGINEEREO ELECTRONICS CO
1441 E CHESTNUT AVE SANTA ANA CALIF
ENGINEEREO MAGNETICS
13041 CERISE AVE HAWTHORNE CALIF
ENGINEERING ASSOCIATES
434 PATTERSON RD DAYTON 19 OHIO
ENGG & MFG CORP OF TEXAS
PO BOX 14216 OALLAS 34 TEXAS
ENGIS EQUIP CO
431 E DEARBORN ST CHICAGO ILL
ENGLER INSTRUMENT CO
250 CULVER JERSEY CITY 5 N J
ENGLISH ELECTRIC VALVE CO LTO
CHELMSFORD ESSEX ENGLAND
ENSIGN COIL CO
2520 S PULASKI CHICAGO 23 ILL
ENTHONE INC
442 ELM ST NEW HAVEN 8 CONN
ENTHOVEN SOLDERS LTD
113 N WATER ST ROCHESTER 4 N Y
ENTRON INC
4902 LAWRENCE ST BLADENSBURG MD
ENVIRONMENTAL EQUIPMENT CO
369 LINDEN ST BROOKLYN 27 N Y
E O ELECTRONICS INC
14 MORRIS AVE MOUNTAIN LAKES NJ
EONETICS
3800 COHASSET BURBANK CALIF
EPCO PROOUCTS INC
2500 ATLANTIC AVE BROOKLYN 7 NY
EPIC INC
150 NASSAU ST NEW YORK 38 N Y
EPM CORP
675 BARBEY ST BROOKLYN N Y
EPOXY PRODUCTS OIV JOS WALDMAN & SONS
133 COIT ST IRVINGTON NJ
EPPLEY LAB INC
12 SHEFFIELD AVE NEWPORT RI
EPRAD INC
1206 CHERRY ST TOLEOO 4 OHIO
EPSCO INC
588 COMMONWEALTH AVE BOSTON 15 MASS
EPSCO INC
275 MASSACHUSETTS AVE CAMBRIDGE 39 MASS
EQUIPMENT AND SERVICE CO
7118 ENVOY CT DALLAS 7 TEXAS
EQUIPTO DIV AURORA EQUIPMENT CO
AURORA ILL
EQUIPTO ELECTRONICS CORP
319 N WEBSTER ST NAPERVILLE 6 ILL
ERA DYNAMICS
CEDAR GROVE NJ
ERA RESEARCH INC
1009MONTANA AVE SANTA MONICA CALIF
ERASER CO
1068 S CLINTON ST SYRACUSE 4 NY
ERCA TOOL DIE & STAMPING CO
19 ASH ST BROOKLYN 22 N Y
ERCO RAOIO LABS INC
637 STEWART AVE GARDEN CITY NY
ERCONA CORP
16 W 46TH ST NEW YORK 36 N Y
EROCO ENGG CORP
136 OFFICIAL RD ADDISON ILL
ERICSON MFG CO
1660 HAYDEN AVE CLEVELANO OHIO
ERIE ELECTRONICS DIV
ERIE PA
ERIE PACIFIC
12932 S WEBER WAY HAWTHORNE CALIF

ERIE RESISTOR OF CANADA LTD
7 FRASER AVE TRENTON ONT CANADA
ELECTRONICS DIV ERIE RESISTOR CORP
644 W 12TH ST ERIE PA
ERIE RESISTOR CORP
644 W 12 ST ERIE 6 PA
ERIE TECHNICAL CERAMICS INC
BOX 677 STATE COLLEGE PANNA
ERIKSON SPECIALIZED TOOL CO
P O BOX 424 PICO CALIF
ERWOOD INC
1770 W BERTEAU AVE CHICAGO 13 ILL
ESC ELECTRONICS CORP
534 BERGEN BLVD PALISADES PARK NJ
ESCO GROUP DIV ELECTRONIC SPECIALTY CO
5121 SAN FERNANDO RD LOS ANGELES 39 CALIF
ESPEY MFG & ELECTRONICS CORP
CONGRESS BALLSTON AVES SARATOGA SPRINGS NY
ESSEX ELECTRONICS DIV NYTRONICS INC
550 SPRINGFIELD AVE BERKELEY HEIGHTS N J
ESSEX ELECTRONICS OF CANADA LTD
99 WRAGGE ST TRENTON ONT CANADA
ESSEX MFG CO
8213 GRAVOIS AVE ST LOUIS 23 MO
ESSEX WIRE CORP
1601 WALL ST FT WAYNE 6 IND
ESTERLINE ANGUS INSTRUMENT COMPANY INC
PO BOX 596 INDIANAPOLIS 6 IND
E-T-A PRODUCTS CO OF AMERICA
6284 N CICERO AVE CHICAGO 46 ILL
E T C INCORPORATED
990 E 67ST CLEVELAND OHIO
ETS HOKIN & GALVAN
2295 E BELT ST SAN DIEGO CALIF
ETCHING CORP OF CALIF
865 HINCKLEY ROAD BURLINGAME CALIF
EUBANKS ENG CO
260 N ALLEN AVE PASADENA CALIF
EUGENE ENGINEERING CO INC
1217 HYDE PARK AVE HYDE PARK 36 MASS
EUREKA X-RAY TUBE CORP
3250 N KILPATRIC AVE CHICAGO 41 ILL
EUTECTIC WELDING ALLOYS NEW ENG DIV INC
167 BRIGHTON AVE BOSTON MASS
EUTECTIC WELDING ALLOYS CORP
538 20TH ST OAKLAND CALIF
EUTECTIC WELDING ALLOYS CORP
40 40 172 ST FLUSHING N Y
EWALD INSTRUMENTS
ROUTE 7D KENT CONN
EWEN KNIGHT CORP
EAST NATICK MASS
EXACT ELECTRONICS INC
PO BOX 234 HILLSBORO OREGON
EXACT ENGG MFG INC
PO BOX 447 OCEANSIDE CALIF
EXACT WEIGHT SCALE CO
538 E TOWN ST COLUMBUS 15 OHIO
EXACTEL INSTRUMENT CO
89 ALICE AVE MOUNTAIN VIEW CALIF
EXAKTA CAMERA CO
705 BRONX RIVER RD BRONXVILLE 8 N Y
EX-CELL CORP
1200 OAKMAN BLVD DETROIT MICH
EXCELLEX ELECTRONICS INC
39-51 60TH ST WOODSIDE N Y
EYELEMATIC INC
STRAITS TURNPIKE OAKVILLE CONN
EYELET TOOL CO
31 CARLETON SO CAMBRIDGE MASS
E-Z-HOOK TEST PRODUCTS
1536 WOODBURN AVE COVINGTON KY
E-Z-WAY TEMPLATES
PO BOX 535 RESEDA CALIF
E-Z WAY TOWERS INC
5901 E BROADWAY BX 5767 TAMPA 5 FLA

F

FABRA PRINT INC
801 S E 8TH ST MINNEAPOLIS 14 MINN
FABRA-PRINT INC
1531 E FRANKLIN MINNEAPOLIS MINN
FABRI TEK CIRCUITS INC
1111 E EXCELSIOR BLVD HOPKINS MINN
FACTORY SERVICE CO
4615 N 21ST ST MILWAUKEE 9 WISC
FAE INSTRUMENT CORP
16 NORDEN LANE HUNTINGTON STA L I N Y
FAESY & BESTHOFF INC
25 E 26TH ST NEW YORK 10 N Y
FAFNIR BEARING CO
37 BOOTH ST NEW BRITAIN CONN
FAFNIR BEARING CO
9000 DIRECTORS ROW DALLAS TEXAS
FAFNIR BEARING CO
NEW BRITAIN CONN
FAIR RITE PRODUCTS CORP
COMMERCIAL ROW WALLKILL N Y
FAIRBANKS CO
393 LAFAYETTE ST NEW YORK 3 N Y
FAIRBANKS WIRE CO
WALNUT ST NEWBURGH N Y
FAIRCHILD CAMERA AND INSTRUMENT CORP
ROBBINS LA SYOSSET N Y
FAIRCHILD CONTROLS CORP COMPONENTS DIV
225 PARK AVE HICKSVILLE L I N Y
FAIRCHILD CONTROLS CORP
6111 E WASHINGTON BLVD LOS ANGELES CALIF
FAIRCHILD RECORDING EQUIPMENT CO
10-40 45 AVE LONG ISLAND CITY 1 N Y
FAIRCHILD SEMICONDUCTOR CORP
545 WHISMAN RD MOUNTAIN VIEW CALIF
FAIRCHILD SEMICONDUCTOR
DIODE PLANT SAN RAFAEL CALIF
FAIRCHILD SEMICONDUCTOR CORP
4300 REDWOOD HGWY SAN RAFEL CALIF
FAIRMOUNT CHEMICAL CO INC
136 LIBERTY ST NEW YORK N Y
FALSTROM CO
12 FALSTROM COURT PASSAIC N J
FANON ELECT INDUST INC
439 FRELINGHUYSEN AVE NEWARK N J
FANSTEEL METALLURGICAL CORP
2200 SHERIDAN RD N CHICAGO ILL
FARADAY INC
ADRAIN MICH
FARADYNE ELECT CORP
471 CORTLANDT ST BELLEVILLE NEW JERSEY
FARINON ELECTRIC
935 WASHINGTON ST SAN CARLOS CALIF
FARMER ELECTRIC PRODUCTS CO
2300 WASHINGTON ST NEWTON LOWER FALLS MASS
FARRALL INSTRUMENT CO
BOX 658 GRAND ISLAND NEB
FARRELLOY CO
1243 N 26TH ST PHILA PA
FARRINGTON ELECT INC
7019 EDSALL RD ALEXANDRIA VA
FARWELL METAL FABRICATING
83 W FAIRFIELD AVE ST PAUL 7 MINN
FASCO INDUSTRIES INC
255 N UNION ST ROCHESTER N Y
FAULTLESS CASTER CORP
1427 N GARVIN ST EVENSVILLE 7 IND
FEAY CO NEAL
133 LA PATERA AVE COLETA CALIF
FECKER INC J W
6592 HAMILTON AVE PITTSBURGH PA
FEDERAL ANTI CAPACITY SWITCH CORP
BOX 25 LANCASTER N Y
FEDERAL ENG & MFG CORP
1004 6TH ST N W WASHINGTON D C
FEDERAL EQUIPMENT CO
38 BRADY ST SAN FRANCISCO 3 CALIF
FEDERAL INSTRUMENT DIV IT & T
100 KINGSLAND RD CLIFTON N J
FEDERAL LAB INC
SALTSBURG PA
FEDERAL MACHINE CO
835 GARFIELD AVE JERSEY CITY 5 N J
FEDERAL MFG & ENGG CORP
1055 STEWART AVE GARDEN CITY LI N Y
FEDERAL MFG & ENG CORP TV SPECIALTY DIV
1055 STEWART AVE GARDEN CITY N Y
FEDERAL PACIFIC ELECTRIC COMPANY
FTY AVENUE L INC NEWARK 1 N J
FEDERAL SCREW PRODUCTS INC
3917 N KEDZIE AVE CHICAGO 18 ILL
FEDERAL SHOCKMOUNT CORP
DIVISION OF THE KORFUND CO
1060 WASHINGTON AVE NEW YORK 56 NY
FEDERAL STAMPING CO
7347 ATOLL AVE N HOLLYWOOD CALIF
FEDERAL TOOL & MFG CO
3600 ALABAMA AVE MINNEAPOLIS 16 MINN
AMERICAN SMELTING REFINING CO
FEDERATED METALS DIV
150 ST CHARLES ST NEWARK 5 NJ
FEEDBACK CONTROLS INC
8 ERIE DRIVE NATICK MASS
FEILER ENGG & MFG CO
8026 N MONTICELLO AVE SKOKIE ILL
FEINER & SONS P
522 W 45 ST NEW YORK N Y
FELSINTHAL & SONS INC G
3500 N KEOZIE AVE CHICAGO 18 ILL
FELT PRODUCTS MFG CO
7450 MCCORMICK BLVD SKOKIE ILL
FELTERS CO
350 5TH AVE NEW YORK 1 N Y
FEN-TONE CORP
106 5TH AVE NEW YORK 11 N Y
FENWAL ELECTRONIC INC
63 FOUNTAIN ST FRAMINGHAM MASS
FENWAL INC
PLEASANT ST ASHLAND MASS
FERRANTI ELECT INC
INDUSTRIAL PK PLAINVIEW L I N Y
FERRIS INDUSTRUMENT CORP
110 CORNELIA ST BOONTON N J
FERRO DYNAMICS CORP
GREGG ST & RTE 17 LODI N J
FERROTHERN CO
1861 E 65TH ST CLEVELAND OHIO
FERROTRAN ELECTRONICS CO INC
693 BROADWAY NEW YORK 12 N Y
FERROXCUBE CORP OF MAER
35 E BRIDGE ST SAUGERTIES N Y
FF&M ELECTRONICS
12820 PANAMA ST LOS ANG CALIF
FIBRE GLASS EVERCOAT CO
BLUE ASH KIGLER MILLS RDS CINN OHIO
CINCINNATI 36 OHIO
FIDELITONE MICROWAVE INC
6415 RAVENSWOOD AVE CHICAGO ILL
FIDELITY AMPLIFIER CO
1633 HALSTEAD ST CHICAGO ILL
FIDELITY CHEMICAL PRODUCTS CORP
470 FRELINGHUYSEN AVE NEWARK 12 N J
FIDELITY ELECTRIC CO
332 N ARCH ST LANCASTER PA
FILM CAPACITORS INC
3400 PARK AVE NEW YORK 56 NY
FILMOHM CORP
48 W 25 ST NEW YORK 10 N Y
FILTORS INC
30 SAGMORE HILL PORT WASH N Y
FILTRON CO
131-15 FOWLER AVE FLUSHING 55 N Y
FILTRON CO INC WESTERN DIV
10023 JEFFERSON BLVD CULVER CITY CALIF
FINNELL SYSTEM INC
ELKHART IND
FINNEY CO
34 INTERSTATE ST BEDFORD OHIO
FIRE CONTROL CO INC
703 THORNTON ST WILMINGTON 1 DEL
FIRST ELECTRONICS CORP
13 ST ANNE ST JAMAICA PLAIN MASS
FISCHER & CO R A
517 COMMERCIAL ST GLENDALE 3 CALIF
FISCHER & PORTER CO
WARMINSTER PA
FISCHER ELECTRONICS INC
2238 BAILEY AVE BUFFALO 11 N Y
FISH-SCHURMAN CORP
70 PORTMAN RD NEW ROCHELLE N Y
FISHER & CROME
109 N CAMAC ST PHILA 7 PA
FISHER BERKELEY CORP
1475 POWELL ST EMERYVILLE CALIF
FISHER CO INC OSCAR
P O BOX 426 NEWBURGH N Y
FISHER ENG& INC
P O BOX 327 HUNTINGTON IND
FISHER GOVERNOR CO
BOX 307 MARSHALLTOWN IOWA
FISHER PIERCE CO
170 PEARLS ST BRAINTREE MASS
FISHER RADIO CORP
2121 44 DR LONG ISLAND CITY N Y
FISHER RESEARCH LAB
1975 UNIVER AVE PALO ALTO CALIF
FISHER SCIENTIFIC CO
1 REAGENT LANE FAIR LAWN NJ
FISHER SCIENTIFIC CO INSTRUMENT DIV
INDIANA PENNA
FISHER SPECIAL MFG CO
446 MORGAN ST CINN OHIO
FLAME RESEARCH INC
BOX 10502 PITTSBURGH 35 PA
FLAMEMASTER CHEMICAL INC
3813 HOKE CULVER CITY CALIF
FLEXONICS DIV OF CALUMET & HECLA
300 E DEVAN AVE BARTLETT ILL
FLEETWOOD LABS INC
35 ROCKWOOD PL N ROCHELLE N Y
FLEXAUST CO
100 PARK AVE NEW YORK 7 N Y
FLEXO INTERNATIONAL CORP
3720 MILWAUKEE AVE CHICAGO ILL
FLEXO WIRE DIV COPPERWELD STEEL CO
OSWEGO N Y
FLEXROCK CO
3609 FILBERT ST PHILA PENNA
FLOQUIL PRODUCTS INC
COBLESKILL N Y
FLORIDA GEARS & SYSTEMS INC
16550 N W 10TH AVE MIAMI FLA
FLORMAN & BABB INC
68 W 45 ST NEW YORK 36 N Y
FLO-TRONICS INC ELECT CONTROLS DIV
1330 QUINCY ST NE MINNEAPOLIS 13 MINN
FLOW CORP
11 CARLETON ST CAMBRIDGE MASS
FLUIDYNE ENG CORP
5740 WAYZATA BLVD MINN MINN
FLUKE MFG CO INC JOHN
BOX 7161 SEATTLE WASH
THE FLUOROCARBON CO
1754 S CLENTINE ST ANAHEIM CALIF
FLUORULON LABS INC
BOX 305 CALDWELL N J
FLUSH WALL RADIO CO
1012 CLEVELAND ST CLEARWATER FLA
F & M SCIENTIFIC CORP
RT 41 & STARR RD AVONDALE PA
FONDA GAGE CO INC
STAMFORD CONN
FORBER & WAGNER INC
SILVER CREEK N Y
FORBES & WAGNER INC
345 CENTRAL AVE SILVER CREEK N Y
WM A FORCE & CO INC
216 NICHOLS AVE BROOKLYN 8 NY
FORD ELECTRONICS CORP
11747 VOSE ST N HOLLYWOOD CALIF
FORD INSTRUMENT CO DIV SPERRY RAND CORP
31-10 THOMSON AVE LONG ISLAND CITY 1 N Y
FORD RADIO MICA CORP
536 63 ST BROOKLYN N Y
FORDHAM MFG CO
2220 PEARSALL AVE NEW YORK 69 N Y
FOREDOM ELECTRIC CO INC
BETHEL CONN
THE FOREST ELECT CO
1001 N 25TH AVE MELROSE PARK ILL
FORK STANDARDS INC
WEST CHICAGO ILL
FORM-IT PRODUCTS INC
16-19 W WALNUT ST CHICAGO 12 ILL
FORMCRAFT TOOL CO
2465 ARCHER AVE CHICAGO ILL
FORMED PLASTICS INC
207 STONEHINGE LANE CARLE PL N Y
FORMICA CORP
4614 SPRING GROVE AVE CINCINNATI 11 OHIO
FORMICA METAL PROD CO
COPR WAY MEDFORD MASS
FORMSPRAG INC
23601 HOOVER RD WARREN MICH
FORSBERG MFG CO
125 SEAVIEW AVE BRIDGEPORT CONN
FORT WAYNE METALS INC
3211 MACARTHUR DR FT WAYNE IND

FORWAY INDUSTRIES INC
122 GREEN AVE WOODBYRY N J
FOSTER TRANSFORMER CO
3820 COLERAIN AVE CINNATI OHIO
FOSTORIA CORP DEPT D2
BUCK & COUNTY LINE RDS HUNTINGDON VAL PA
FOSTORIA CORP
1200 MAIN ST FOSTORIA OHIO
FOTO VIDEO LABS
36 COMMERCE RD CEDAR GROVE N J
FOURDEE INC
5440 E COLONIAL DR ORLANDO FLA
FOURJAY INDUSTRIES
2801 ONTARIO AVE DAYTON OHIO
FOX CO THOMAS T
304 MT PLEASANT AVE NEWARK 4 N J
FOX PRODUCTS CO
4720 N 18 ST PHILA PA
FOXBORO CO
NEPONSET AVE FOXBORO MASS
F & R ENTERPRISES
910 VALENCIA ST SAN FRAN CALIF
FRANCE MFG CO
10325 BEREA RD CLEVELAND 2 OHIO
FRANKE GEAR WORKS INC
4401 RAVENSWOOD AVE CHICAGO ILL
FRANKEL CONNECTOR CO
27 VESTRY ST NEW YORK 13 N Y
FRANKLIN ELECTRONICS INC
E 4TH ST BRIDGEPORT PA
FRANKLIN MFG CO
65 NE 22ND AVE MINN MINN
FREBANK CO
711 W BROADWAY GLENDALE CALIF
FREDERICK ELECT CORP
414 PINE AVE FREDERICK MD
FREDERICKS CO
PHILMONT ANNE ST BETHAYRES PENNA
FREED TRANSFORMER CO
1718-36 WEIRFIELD ST BROOKLYN 27 N Y
FREELAND PRODUCTS CO
706 OKEEFE ST N ORLEANS LA
FREEMAN CO
8TH & WALNUT YANKTON S D
FREEWAY WASHER & STAMPING CO
4911 GRANT AVE CLEVELAND OHIO
FRENCHTOWN PORCELAIN CO
FRENCHTOWN N J
FRENCHY RADIO MFG CO
164 W PARKER ST SCRANTON PA
FREQUENCY ENGG LABS
BOX 504 ASBURY PARK NJ
FRICK GALLAGHER MFG CO
200 S MICHIGAN WELLSTON OHIO
FRIDEN CALCULATING MACHINE CO
2350 WASHINGTON AVE SAN LEANDRO CALIF
FRIDEN COMMERCIAL CONTROLS CORP
1 LEIGHTON AVE ROCHESTER N Y
FRONTIER ELECT CO
4608 MEMPHIS AVE CLEVE OHIO
FRYLING ELECT PROD INC
HOLLY SPRINGS MISS
FRYLING MFG CO
531 W 11TH ST ERIE 6 PA
FUEL WATCHMAN INC
77 29 138 ST FLUSHING N Y
FUGLE MILLER LABS INC
301 CENTRAL AVE CLARK N J
FULLER CO H B
1201 FULLER RD LINDEN N J
FULLER CO H B
904 W BLACKHAWK ST CHICAGO ILL
FURANE PLASTICS INC
4516 BRAZIL ST LOS ANGELES 39 CALIF
FURANE PLASTICS INC
42 CHASNER ST HEMPSTEAD L I N Y
FURNAS ELECTRIC CO
1000 MCKEE ST BATAVIA ILL
FURZEHILL LABS LTD
THEOBALD ST BOREHAMWOOD HERTS ENG
FUSITE CORP
6000 FERNVIEW AVE CINCINNATI 12 OHIO
F X R INC
26-12 BOROUGH PLACE WOODSIDE 77 N Y
FYR-FYTER ELECTRONIC & ALARM CORP
EDISON N J

G

GABRIEL ELECTRONICS DIV GABRIEL CO
MILLIS MASS
GAI-TRONICS CORP
525 LANCASTER AVE READING PENNA
GALLAND-HENNING NOPAK DIV
2753 S 31ST ST MILWAUKEE WISC
GAP INSTRUMENT CORP
116 E MERRICK RD FREEPORT N Y
GAP INSTRUMENT CORP
17 BROOKLYN AVE WESTBURY L I N Y
GAR PRECISION PARTS
190 HENRY ST STAMFORD CONN
GARDE MFG CO
53 JOHN ST CUMBERLAND R I
GARDINER ELECTRONIC CO
2545 E INDIAN SCHOOL RD PHOENIX ARIZ
GARDNER LAB INC
P O BOX 5728 BETHESDA MD
GARDNER-DENVER CO
FRONT ST QUINCY ILL
GARLOCK ELECTRONIC PRODUCTS
402 MAIN ST PALMYRA N Y
GARLOCK ELECTRONIC PRODUCTS
600 N 10TH ST CAMDEN 1 NJ
GARNER T H CO
177 S INDIAN HILL BLVD CLAREMONT CALIF
GARRARD SALES CORP
80 SHORE RD PORT WASHINGTON N Y
GARY WELLS CO
361 ROCKAWAY AVE VALLEY STREAM N Y
GASSER METAL PRODUCTS
69-15 50TH AVE WOODSIDE N Y
GATES & CO GEO W
HEMPSTEAD TPKE & LUCILLE AVE FRANK SQ N Y
GATES ELECTRONIC CO
2243 WHITE PLAINS RD BRONX N Y
GATES RADIO CO
123 HAMPSHIRE ST QUINCY ILL
GAVITT WIRE & CABLE CO DIV OF AMERACE CORP
455 N QUINCE ST ESCONDIDO CALIF
GAVITT WIRE & CABLE CO PLANT & GEN OFFICE
DIV AMERACE CORP
BROOKFIELD MASS
GAYLOR PRODUCTS CO
11100 CUMPSTON ST N HOLLYWOOD CALIF
GAYLORD RIVES CO
181 N HILL ST PASADENA CALIF
G C ELECT CO
400 S WYMAN ST ROCKFORD ILL
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV
400 SO WYMAN ST ROCKFORD ILL
G-C ELECTRONICS CO KNOB & RESISTOR DIV
400 S WYMAN ST ROCKFORD ILL
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS
400 S WYMAN ST ROCKFORD ILL
GEARTRONICS CORPORATION
114 CHELMSFORD RD BILLERICA MASS
GEBE ELECTRONIC SERVICE
4112 W JEFFERSON BLVD LOS ANG CAL
GEE LAR MFG CO
400 WYMAN ST ROCKFORD ILL
GEER MACHINE WORKS INC
200 NEVADA ST EL SEGUNDO CALIF
GEFCO MFG CORP
101 PINE ST BOX 436 GRAYSLAKE ILL
GEMCO ELECTRIC CO
25685 W EIGHT MILE RD DETROIT MICH
GEMS CO
SHEPPARD LANE BOX 255 FARMINGTON CONN
GEN AMERICAN TRANSPORTATION CORP
135 S LASALLE ST CHICAGO 90 ILL
GENALEX DIV BRITISH INDUSTRIES CORP
80 SHORE RD PORT WASHINGTON N Y
GENERAL APPLIED SCIENCE LAB
MERRICK & STEWART AVE WESTBURY N Y
GENERAL ATOMATICS INC
331 ALMA ST PALO ALTO CALIF
GENERAL ATRONICS CORP ATRONIC PROD DIV
1200 E MERMAID LANE PHILA PA
GENERAL ATRONICS CORP
UNION HILL W CONSHOHOCKEN PENNA
GENERAL ATRONICS CORP
ELECTRONIC TUBE AND INSTRUMENT DIVISION
1200 EAST MERMAID LANE PHILA 18 PA
GENERAL AUTOMATIC CORP
111 33RD ST UNION CITY N J
GENERAL AUTOMATICS INC
331 ALMA ST PALO ALTO CALIF
GENERAL BOX CO
1825 MINER ST DES PLAINES ILL
GENERAL CABLE CORP
QUINCY MICH
GENERAL CABLE CORP
730 3RD AVE NEW YORK N Y
GENERAL CABLE CORP
25 WASHINGTON ST PERTH AMBOY N J
GENERAL CABLE CORP
1278 ORGILL AVE MEMPHIS TENN
GENERAL CABLE CORP
600 RAILROAD ST ROME N Y
GENERAL CERAMICS DIV IND GENERAL CORP
CROWS MILL RD KEASBEY N J
GENERAL CHEMICAL DIV
40 RECTOR ST NEW YORK 6 N Y
GENERAL COIL PRODUCTS CORP
147 12 LIBERTY AVE JAMAICA N Y
GENERAL COMMUNICATION CO
677 BEACON ST BOSTON 15 MASS
GENERAL COMPUTERS INC
9000 W PICO BLVD LOS ANG CALIF
GENERAL CONTROLS CO TRIMOUNT INSTRUMENT DIV
8080 MCCORMICK BLVD SKOKIE ILL
GENERAL CONTROL CO
1200 SOLDIERS FIELD RD BOSTON 34 MASS
GENERAL CONTROLS CO
801 ALLEN AVE GLENDALE 1 CALIF
GENERAL CONTROLS CO IRON MOUNTAIN DIV
IRON MOUNTAIN MICH
GENERAL CONTROLS CO CANADA LTD
171 SURREY ST GUELPH ONT CANADA
GENERAL CONTROLS CO
8080 MCCORMICK BLVD SKOKIE ILL
GENERAL CRYSTAL CO INC
P O BOX 9 BURLINGTON WISC
GENERAL DEVICES INC
P O BOX 253 PRINCETON N J
GENERAL DYNAMICS TELECOMMUNICATION
100 CARLSON RD ROCHESTER N Y
GENERAL DYNAMICS ELECT
3302 PACIFIC HWY SAN DIEGO CALIF
GENERAL DYNAMICS POMONA
P O BOX 1011 POMONA CALIF
GENERAL DYNAMICS/ASTRONAUTICS
DIV OF GENERAL DYNAMICS CORP
PO BOX 1128 SAN DIEGO 12 CALIF
GENERAL DYNAMICS/ELECTRONICS
INFORMATION TECHNOLOGY DIV
1895 HANCOCK ST SAN DIEGO 12 CALIF
GENERAL DYNAMICS ELECTRONICS
1400 GOODMAN ST ROCHESTER N Y
GENERAL ELECTRIC CO
1034 66TH AVE OAKLAND 21 CALIF
GENERAL ELECTRIC CO
10 MANSION ST P O BOX 278 COXSACKIE N Y
GENERAL ELECTRIC CO APPARATUS SALES DIV
1 RIVER RD SCHENECTADY 5 NY
GENERAL ELECTRIC CO
ELECTRONIC PARK SYRACUSE N Y
GENERAL ELECTRIC CO
FRENCH RD UTICA N Y
GENERAL ELECTRIC CO
SILICONE PRODUCTS DEPT A WATERFORD N Y
GENERAL ELECTRIC CO
CAROLINA WELDS PLANT GOLDSBORO NC
GENERAL ELECTRIC CO
21800 TUNGSTEN RD CLEVELAND 17 OHIO
GENERAL ELECTRIC CO
1285 BOSTON AVE BRIDGEPORT CONN
GENERAL ELECTRIC CO
SHELBYVILLE IND
GENERAL ELECTRIC CO
SYRACUSE N Y
GENERAL ELECTRIC CO
100 W BROADWAY DOVER OHIO
GENERAL ELECTRIC CO ANNISTON TUBE PLANT
BOX 1400 ANNISTON ALA
GENERAL ELECTRIC CO ATOM POWER EQUIP
2151 S 1ST ST SAN JOSE CALIF
GENERAL ELECTRIC CO AUDIO PRODUCTS DEPT
2200 N 22 ST DECATUR ILL
GENERAL ELECTRIC CO CAPACITOR DEPT
JOHN ST HUDSON FALLS N Y
GENERAL ELECTRIC CAPACITOR DEPT
IRMO S C
GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT
ELECTRONICSPARK SYRACUSE N Y
GENERAL ELECTRIC CO CIRCUIT PROTECTIVE
41 WOODFORD AVE PLAINVILLE CONN
GENERAL ELECTRIC CO COMPUTER DIV
13430 N BLACK CANYON HWY PHOENIX ARIZ
GENERAL ELECTRIC DIST TRANSFORMER DEPT
60 JACKSON ST HOLYOKE MASS
GENERAL ELECT CO ELEC COMPONENTS DIV
1 RIVER RD SCHENECTADY N Y
GENERAL ELECTRIC HEAVY MILITARY ELECT DEPT
COURT ST SYRACUSE NY
GENERAL ELECTRIC HOTPOINT DIV
E PLEASANT ST DEKALB ILL
GENERAL ELECTRIC CO INDUSTRY CONTROL DEPT
1501 ROANOKE BLVD SALEM VA
GENERAL ELECTRIC CO INSULATOR DEPT
S CHARLES & CROMWELL ST BALTIMORE 30 MD
GENERAL ELECTRIC LAMINATED PRODUCTS DEPT
COSHOCTON OHIO
GENERAL ELECTRIC CO LTD OF ENGLAND
11 UNIVERSITY RD CAMBRIDGE 38 MASS
GENERAL ELECTRIC CO MAGNETIC MATERIALS SEC
EDMORE MICHIGAN
GENERAL ELECT CO METALLURIGICAL PROD
E EIGHT MILE RD DETROIT MICH
GENERAL ELECTRIC CO MISSILE PRODUCTION SEC
LAKESIDE AVE BURLINGTON VT
GENERAL ELECTRIC CO MINIATURE LAMP DEPT
NELA PARK CLEVELAND 12 OHIO
GENERAL ELECT RECEIVING TUBE DEPT
BOX 47 SPRINGFIELD N J
GENERAL ELECT RECTIFIER COMPONENTS DEPT
COLUMBIA ST CLYDE N Y
GENERAL ELECTRIC CO MISSILE & SPACE VEH DPT
VALLEY FORGE SPACE TECH CTR
PO BOX 8555 PHILADELPHIA 1 PA
GENERAL ELECTRIC CO ORDNANCE DEPT
100 PLASTICS AVE PITTSFIELD MASS
GENERAL ELECTRIC CO POWER TUBE DEPT
SCRANTON PENNA
GENERAL ELECTRIC CO POWER TUBE DEPT
BLDG 267 SCHENECTADY N Y
GENERAL ELECTRIC CO POWER TUBE DEPT
PALO ALTO CALIF
GENERAL ELECTRIC CO RECEIVING TUBE DEPT
316 E 9TH ST OWENSBORO KY
GENERAL ELECTRIC CO SEMICONDUCTOR DEPT
SYRACUSE N Y
GENERAL ELECTRIC CO SPECIALTY CONTROL DEPT
P O BOX 812 WAYNESBORO VA
GENERAL ELECTRIC CO SPECIALTY MOTOR DEPT
1635 BROADWAY FORT WAYNE 2 IND
GENERAL ELECTRIC CO TELEVISION RECEIVER DEPT
ELECTRONICS PARK SYRACUSE N Y
GENERAL ELECT CO X RAY DEPT
4855 ELECTRIC AVE MILWAUKEE WISC
GENERAL ELECT CONTROL INC
8001 BLOOMINGTON FREEWAY MINN MINN
GENERAL ELECTRODYNAMICS CORP
4430 FOREST LANE GARLAND TEXAS
GENERAL ELECTRONICS INC
101 HAZEL ST PATERSON N J
GENERAL ELECTRONIC LAB INC
SIMON ST NASHUA NH
GENERAL ELECTRO MECHANICAL CORP
785 HERTEL AVE BUFFALO N Y
GENERAL FINDINGS INC
LEACH & GARNER BLDG ATTLEBORO MASS
GENERAL FORMULATIONS INC
320 S UNION SPARTA MICH
GENERAL INDUSTRIES CO
OLIVE & TAYLOR STS ELYRIA OHIO
GENERAL INDUSTRIES CO
RTE 97 BELLEVILLE OHIO
GENERAL INST CORP MAGNE HD & SYSTMTCS DIV
3216 EL SEGUNDO BLVD HAWTHORNE CALIF
GENERAL INSTRUMENT CO
DARLINGTON SC
GENERAL INSTRUMENT CORP CAPACITOR DIV
ORANGE ST DARLINGTON SC
GENERAL INSTRUMENT CORP
65 GOUVEURNER ST NEWARK N J

GENERAL INSTRUMENT CORP F W SOCKLES DIV
165 FRONT ST CHICOPEE MASS
GENERAL INSTRUMENT CORP CAPACITOR DIV
TAZEWELL VA
GENERAL INSULATED WIRE WORKS
69 GORDON AVE PROVIDENCE 5 R I
GENERAL INSULATED WIRE WORKS INC
69 GORDON AVE PROVIDENCE 5 RI
GENERAL KINETICS INC
2611 SHIRLINGTON RD ARLINGTON VA
GENERAL MAGNETICS INC
135 BLOOMFIELD AVE BLOOMFIELD N J
GENERAL MAGNETIC CORP
10001 ERWIN AVE DETROIT MICH
GENERAL MAGNETICS INC
2641 LOUISANA AVE MINN MINN
GENERAL METAL PROD CO
CENTRE & GLENDALE STS EASTON PA
GENERAL METAL PROD CO
1010 CENTRE ST EASTON PA
GENERAL METERS INC
P O BOX 1701 GRAND JUNCTION COLO
GENERAL MICROWAVE CORP
155 MARINE ST FARMINGDALE N Y
GENERAL MILLS INC
1620 CENTRAL AVE MINNEAPOLIS 13 MINN
GENERAL MILLS INC CHEMICAL DIV
S KENSINGTON RD KANKAKEE ILL
GENERAL MOTORS CORP NEW DEPT DIV
HAYES AVE SANDUSKY OHIO
GENERAL PLASTICS CORP
55 LA FRANCE AVE BLOOMFIELD N J
GENERAL PRECISION EQUIP LIBRASCOPE DIV
670 ARQUES AVE SUNNYVALE CALIF
GENERAL PRODUCTS CORP
SALEM ST UNION SPRINGS N Y
GENERAL RADIO CO
WEST CONCORD MASS
GENERAL RAILWAY SIGNAL CO
P O BOX 600 ROCHESTER N Y
GENERAL RELAY CORP
39 LEONARD ST DOVER N J
GENERAL RESISTANCE INC
430 SOUTHERN BLVD NEW YORK 55 N Y
GENERAL RF FITTINGS INC
702 BEACON ST BOSTON MASS
GENERAL SCIENTIFIC EQUIP CO
7516 LIMEKLIN PIKE PHILA PA
GENERAL SCIENTIFIC CORP
1509 FIRST ST SAN FERNANDO CALIF
GENERAL STENCILS INC
827 E 92ND ST BROOKLYN 36 N Y
GENERAL TEL & ELECT LEICH ELECT CO
333 E FIRST ST GENOA ILL
GENERAL TEL & ELECT EMPORIUM PLANT
EMPORIUM PA
GENERAL TEL & ELECT MUNCY PLANT
MUNCY PA
GENERAL TEL & ELECT FULLERTON PLANT
1401 ORANGETHORPE AVE FULLERTON CALIF
GENERAL TEL & ELECT ANNARBOR PLANT
405 FOURTH ST ANN ARBOR MICH
GENERAL TEL & ELECT WALTHAM PLANT
63 SECOND AVE WALTHAM MASS
GENERAL TEL & ELECT WILLIAMSPORT PLANT
1891 E THIRD ST WILLIAMSPORT PA
GENERAL TEL & ELECT HILLSBORO PLANT
HILLSBORO N H
GENERAL TRANSFORMER CO
18240 HARWOOD AVE HOMEWOOD ILL
GENERAL TRANSISTOR CORP
600 W JOHN ST HICKSVILLE N Y
GENERAL VACUUM CORP
81 HICKS AVE MEDFORD MASS
GENISCO INC
2233 FEDERAL AVE LOS ANGELES CALIF
GENISTRON
6320 W ARIZONA CIRCLE LOS ANG CALIF
GENISTRON INC
2301 FEDERAL AVE LOS ANG CALIF
GENTAPE CORP
51 LA FRANCE AVE BLOOMFIELD N J
GEOPHYSICAL INST CO INC
315 TUDOR RD MANASSAS VA
GEOPHYSICAL SPECIALTIES CO
3110 SHORES BLVD WAYZATA MINN
GEOPHYSICAL SPEC CO
BOX 301 ROUTE 3 HOPKINS MINN
GEOPHYSICS CORP OF AMER
BURLINGTON RD BEDFORD MASS
GEORGE E KAERCHER CO
4911 36TH AVE S MINN MINN
GEORGE GORTON MACHINE CO
1321RACINE ST RACINE WISC
GEOSCIENCE INSTRUMENTS CORP
110 BEEKMAN ST NEW YORK N Y
GEOTECHNICAL CORP
3401 SHILOH RD GARLAND TEXAS
GEOTRONIC LABS INC
1314 CEDAR HILL AVE DALLAS 8 TEXAS
GERBER SCIENTIFIC INST CO
1505 RTE 5 S WINDSOR CONN
GERST & CO PAUL E
4868 N CLARK ST CHICAGO 40 ILL
GERTSCH PRODUCTS INC
3211 LA CIENGA BLVD LOS ANGELES 16 CALIF
GETTERS ELECTRONICS INC
3279 GRAND ISLAND BLVD GRAND ISLAND NY
GIANNINI CONTROLS CORP
1133 FLOWER GLENDALE CALIF
GIANNINI CONTROLS CORP GYRO DIV
1600 S MOUNTAIN AVE DUARTE CALIF
GIANNINI CONTROLS CORP SYSTEMS DIV
1600 S MOUNTAIN AVE DUARTE CALIF
GIANNINI CONTROLS CORP CONRAC DIV
GLENDORA CALIF
GIANNINI CONTROLS CORP TRANSDUCER DIV
55 N VERNON AVE PASADENA CALIF
GIANNINI CONTROLS CORP CRAMER DIV
OLD SAYBROOK CONN
GIANNINI CONTROLS CORP NJ DIV
SHERWOOD LANE CALDWELL TWP NJ
GIBBS MFG RESEARCH CORP
450 N MAIN ST JANESVILLE WISC
GIBSON ELECTRIC CO
OLD WM PENN HWY DELMONT PA
GILBERT & BAKER MFG CO
WEST SPRINGFIELD MASS
GILFORD INSTRUMENT LABS INC
OBERLIN OHIO
GILLIES CO INC DUNCAN M
66 CENTRAL ST WEST BOYLSTON MASS
GILMORE INDUSTRIES INC
3355 RICHMOND RD CLEVELAND OHIO
GIRARD-HOPKINS
1000 40 AVE OAKLAND 1 CALIF
GIRDLER PROCESS EQUIP DIV
2820 BROADWAY BOX 43 LOUISVILLE KY
GISHOLT MACHINE CO
1245 WASHINGTON MADISON WISC
GITS BROS MFG CO
1846 S KILBOURN AVE CHICAGO ILL
GLADDING MCBEAM & CO
2901 LOS FELIZ BLVD LOS ANGELES CALIF
GLADDING MCBEAM & CO
1551 PRIMROSE ST MONROVIA CALIF
GLASER STEERS CORP
155 ORATON ST NEWARK N J
GLASPLY CORP
S SIXTH ST VERPLANCK N Y
GLASS-SOLDER ENGG
4232 TEMPLE CITY BLVD ROSEMEADE CALIF
GLASS-TITE INDUSTRIES INC
725 BRANCH AVE PROVIDENCE 4 R I
GLASSEAL PRODUCTS CO INC
725 COMMERCE RD LINDEN N J
GLEASON AVERY INC
AUBURN N Y
G L ELECTRONICS CO INC
300 HARVARD AVE WESTVILLE N J
THE GLIDDEN CO
5662 BRIDGE ST JOHNSTOWN PENNA
GLOBE ELECTRICAL MFG CO
1729 W 134 ST GARDENA CALIF
GLOBE ELECTRONICS CO
400 S WYMAN ST ROCKFORD ILL
GLOBE INDUSTRIES INC
1784 STANLEY AVE DAYTON 4 OHIO
GLYCO CHEMICALS DIV C L HUISKING & CO INC
417 5TH AVE NEW YORK 16 N Y
G-M LABORATORIES INC
4300 N KNOX AVE CHICAGO 41 ILL
G M MFG CO
12 E 12ST NEW YORK N Y
GODFREY MFG CO
1633 HALSTED ST CHICAGO ILL
GOE ENGG CO
P O BOX 22004 LOS ANGELES CALIF
GOLDEN CO
1054 38 ST BROOKLYN 19 N Y
GOLDING MFG CO
90 PORETE AVE N ARLINGTON N J
GOLDSMAN CO
1328 34 N 4TH ST PHILA PA
GOMBOS INC CO JOHN
WEBRO ROAD CLIFTON N J
GOOD ALL ELECTRIC MFG CO
112 W FIRST ST OGALLALA NEBR
GOOD ELECTRONICS CORP
P O BOX 2406 W PALM BEACH FLA
GOOD-ALL ELECTRIC MFG CO
ALLIANCE NEB
GOODRICH AVIATION PRODUCTS DIV B F GOODRICH
500 S MAIN ST AKRON 18 OHIO
GORDON CO CLAUD S
RICHMOND ILL
GORDON ENTERPRISES
5362 N CAHUENGA BLVD N HOLLYWOOD CALIF
GORODS CORP
250 GLENWOOD AVE BLOOMFIELD N J
GORE & ASSOC INC W L
555 PAPER MILL RD NEWARK DEL
GORHAM ELECT DIV GORHAM MFG CO
PROVIDENCE R I
GORHAM ELECTRONICS DIV GORHAM MFG CO
333 ADELAIDE AVE PROVIDENCE 7 R I
GORN ELECTRIC CO CORN ELECT DIV
845 MAIN ST STAMFORD CONN
GOTHAM AUDIO DEVELOPMENT CORP
2 W 46 ST NEW YORK 36 N Y
GOW MAC INSTRUMENT CO
100 KINGS RD MADISON N J
G P E CONTROLS INC
240 E ONTARIO ST CHICAGO 11 ILL
GPL DIV GENERAL PRECISION INC
63 BEDFORD RD PLEASANTVILLE N Y
GPS INSTRUMENT CO
180 NEEDHAM ST NEWTON 64 MASS
GRACE ELECTRONIC CHEMICALS INC
101 N CHARLES ST BALTIMORE 1 MD
GRAFLEX INC
3750 MONROE AVE ROCHESTER N Y
GRAFO COLLOIDS CORP
310 WILKES PL SHARON PA
GRAHAM MFG CO
147 BRIDGE ST EAST GREENWICH 1 RI
GRAHAM RESEARCH INC
666 22ND AVE N E MINNEAPOLIS 18 MINN
GRAHAM TRANSMISSION INC
MENOMONIE FALLS WISC
W W GRAINGER INC
118 S OAKLEY BLVD CHICAGO ILL
GRAMER HALLOORSON TRANSFORMER CORP
700 W 7TH ST MT CARMEL ILLINOIS
GRANCO PRODUCTS INC
83 30 KEW GARDENS RD KEW GARDENS N Y
GRAND COIL WINDERS
14306 LAKESHORE AVE GRAND HAVEN MICH
GRAND TRANSFORMERS INC
BEECHTREE & MARION STS GRAND HAVEN MICH
GRAND TRANSFORMERS INC
PAW PAW AVE BENTON HARBOR MICH
GRANER T H CO
177 S INDIAN HILL BLVD CLAREMONT CALIF
GRANGER ASSOC
974 COMMERCIAL ST PALO ALTO CALIF
GRANITE STATE MACH CO INC
124 JOLIETTE ST MANCHESTER N H
GRANT GEAR WORKS
154 W 2 ST S BOSTON MASS
GRANT PULLEY & HARDWARE CORP INDUSTRIAL DIV
HIGH ST W NYACK N Y
GRANT PULLEY & HDWE CORP
944 LONG BEACH AVE LOS ANGELES CALIF
GRAPHIC SYSTEMS
925 DANVILLE ROAD YANCEYVILLE NC
GRAPHICS INC
590 BELLEVILLE TURNPIKE KEARNY N J
GRAPHICS INC
PO BOX 72 STATE 59 POTEAU OKLA
GRAPHIK CIRCUITS DIV CINCH MFG CORP
200 TURNBULL CANYON RD CITY OF INDUST CAL
GRAPHITE METALLIZING CORP
1050 NEPPERHAN AVE YONKERS NY
GRASON-STRADLER CO INC
WEST CONCORD MASS
GRAY & KUHN
10 PELHAM PKWAY PELHAM N Y
GRAY INSTRUMENT CO
448 MILL RD ANDALUSIA PA
GRAY MFG CO
16 ARBOR ST HARTFORD CONN
GRAY RADIO CO
501 FOREST HILL BLVD W PALM BEACH FLA
GRAYHILL INC
561 HILLGROVE AVE LA GRANGE ILL
GRAYHILL MOLOTRONICS INC
229 BURLINGTON AVE CLARENDON HILLS ILL
GREAT EASTERN MFG CO
163-165 REMSEN AVE BROOKLYN 12 N Y
GREAT FALLS PRODUCTS CO INC
GREAT FALLS AVE ROCHESTER N H
GREAT LAKES ELECTRIC MFG CO
17 S DESPLAINES ST CHICAGO 6 ILL
GREEN INSTRUMENTS INC H J
2500 SHAMES DR WESTBURY N Y
GREEN INSTRUMENT CO
295 VASSAR ST CAMBRIDGE MASS
GREEN RECTIFIER CO
1-10 30 ST FAIRLAWN N J
GREENBRIER INSTRUMENTS INC
RONCEVERTE WEST VA
GREENE CO L CHARLTON
MILLSTREAM CHELMSFORD MASS
GREENE CORP G G
WARREN PA
GREENE TWEED & CO
NORTH WALES PA
GREENLEAF DIV OF SYSTRON DONNER CORP
7814 MAPLEWOOD INDUST ST LOUIS MO
GREENTREE ELECTRONICS CORP
2020 PLACENTIA AVE COSTA MESA CALIF
GREGORY MAGNETIC INDUST INC
2133 N E 19TH AVE FT LAUDERDALE FLA
GREIBACH INSTRUMENT SCORP
315 NORTH AVE NEW ROCHELLE N Y
GREINER CO EMIL
22 N MOORE ST NEW YORK 13 N Y
GREM ENGG CO
923 LONGVIEW RD KING OF PRUSSIA PA
GREMAR MFG CO
7 NORTH AVE WAKEFIELD MASS
GRIES REPRODUCER CORP
5 2ND ST NEW ROCHELLE N Y
GROOV-PIN CORP
1125 HENDRICKS CAUSEWAY RIDGEFIELD N J
GROVER PHOTO PROD
341 ARDEN GLENDALE CALIF
GRUENBERG ELECTRIC CO INC
9 COMMERCIAL AVE GARDEN CUTY N Y
GUARDIAN ELECTRIC MFG CO
1550 W CARROLL ST CHICAGO 12 ILL
GUARDIAN ELECTRIC MFG CO
333 W CARROLL CHICAGO ILL
GUARDIAN ELECTRIC MFG CO
WOODSTOCK ILL
GUDEBROD BROS SILK CO
225 W 34 ST NEW YORK 1 N Y
THE GUDEMAN CO
340 HURON ST CHICAGO ILL
GUDEMAN CO OF CALIF
7473 AVE 304 VISALIA CALIF
GUENTHER WILLY K G
39 HUMBOLDT ST NUERNBERG GERMANY
GUIDANCE TECHNOLOGY INC
2500 BROADWAY SANTA MONICA CALIF
GUIDE LAMP DIV
2915 PENDLETON AVE ANDERSON IND
GUILD ELECTRONICS INC
388 BROADWAY NEW YORK N Y
GULTON INDUSTRIES INC
212 DURHAM AVE METUCHEN N J
GULTON INDUSTRIES INC ENG MAGNETICS DIV
13031 CERISE AVE HAWTHORNE CALIF
GULTON INDUSTRIES INC WEST INSTRUMENT CORP
4363 MONTROSE AVE CHICAGO ILL
GULTON INDUSTRIES INC ORTHOLOG DIV
4054 QUAKER BRIDGE RD TRENTON N J
GULTON INDUSTRIES INC
15000 CENTRAL EAST ALBUQUERQUE N M
GUNNAR LABS
3333 26TH ST BOX 546 RT 1 BRADENTON FLA
GURLEY W & L E
514 FULTON ST TROY N Y

G-V CONTROLS INC
OKNER PARKWAY LIVINGSTON N J
GWILLIAM CO
342 FURMAN ST BROOKLYN 1 N Y
GYRA ELECTRONICS CORP
WASHINGTON & ELM STS LA GRANGE ILL
LA GRANGE ILL
GYREX CORP
3003 PENNA AVE SANTA MONICA CALIF
GYRO ELECTRONICS CO
36 WALKER ST NEW YORK N Y

H

HACKENSACK CABLE CORP
110 ORCHARD ST HACKENSACK N J
HACKER INSTRUMENTS INC
SHERWOOD LANE PASSAIC AVE CALDWELL TW N J
HAGAN CHEMICALS & CONTROLS INC
BOX 1346 PITTSBURGH PA
HAIRSPRING VIBRATING CO
406 32ND ST UNION CITY N J
HAL HEN CO
36 14 11 ST LONG ISLAND CITY N Y
HALEDY ELECT CO
1949 51 MCDONALD AVE BROOKLYN N Y
HALEX CORP
27302 W 7 MILE RD DETROIT MICH
HALL MFG CO
3901 WESLEY TERRACE SCHILLER PK ILL
HALLAMORE ELECTRONICS CO
714 N BROOKHURST ST ANAHEIM CALIF
HALLETT MFG CO
5910 BOWCRAFT ST LOS ANGELES CALIF
HALLICRAFTERS CO
4401 W 5TH AVE CHICAGO 26 ILL
HALLIKAINEN INSTRUMENTS
1341 7 ST BERKELEY CALIF
HALLMARK INST CORP
2215 COMMERCE ST DALLAS TEXAS
HALM INSTRUMENT CO
180 GLEN HEAD RD GLEN HEAD N Y
HALOGEN INSULATOR & SEAL CORP
9960 PACIFIC AVE FRANKLIN PARK ILL
HANLON & WILSON CO
321 PENN WOOD AVE PITTSBURGH PA
HAMILTON ELECTRONICS CORP
2726 W PRATT AVE CHICAGO ILL
HAMILTON HALL INC
227 N WATER MILWAUKEE WISC
HAMILTON KENT MFG CO
427 GRANT ST KENT OHIO
HAMILTON MFG CO
TWO RIVERS WISC
HAMILTON STANDARD ELECTRONICS DEPT
MAIN ST BROAD BROOK CONN
HAMILTON STANDARD DIV OF UNITED AIRCRAFT
WINDSOR LOCKS CONN
HAMILTON WATCH CO ELECT DIV
COLUMBIA AVE LANCASTER PA
HAMLIN INC
LAKE & GROVE STS LAKE MILLS WISC
HAMMARLUND MFG CO
460 W 34TH ST NEW YORK 1 N Y
HAMMARLUND MFG CO INC
MARS HILL N CAROLINA
HAMNER ELECTRONICS CO INC
P O BOX 531 PRINCETON N J
HANCOCK TELECONTROL CORP
143 SOUND BEACH AVE OLD GREENWICH CONN
HANOEE HOUSEHOLD PRODUCTS
408 12 ST BROOKLYN NY
HANDY & HARMAN
850 THIRD AVE NEW YORK N Y
HANDY & HARMAN
BRIDGEPORT CONN
HANDY & HARMON
330 N GIBSON RD EL MONTE CALIF
HANOVIA LAMP DIV/ENGLEHART INDUSTRIES INC
100 CHESTNUT ST NEWARK 5 N J
HANSEN MFG CO
R R 1 PRINCETON IND
HARDER CO DONALD C
2580 K ST SAN DIEGO 2 CALIF
HARDMAN CO H V
583 CORTLANDT ST BELLEVILLE 9 N J
HARKINS RADIO INC
4444 E WASHINGTON ST PHOENIX ARIZ
HARMON KARDON INC
520 MAIN ST WESTBURY LI NY
HARMON LICHTENSTEIN & CO
26 BROADWAY NEW YORK 4 N Y
HAROWE SERVO CONTROLS INC
W CHESTER PK AT WESTTOWN RD W CHESTER PA
HARPER LEADER INC
1046 S MAIN ST WATERNURY CONN
HARREL INC
16 FITCH ST E NORWALK CONN
HARRISON LABS
45 INDUSTRIAL RD BERKELEY HGTS N J
HARRISON PAINT & VARNISH CO
1329 HARRISON AVE S W CANTON 1 OHIO
HARRISON SHARPE CORP
8060 SALT LAKE AVE HUNTINGTON PK CALIF
HARRIS REFRIGERATION CO
308 RIVER ST CAMBRIDGE 39 MASS
HARRISTAHL LABORATORIES
474 E 2ND ST BROOKLYN 26 N Y
HARSHAW CHEMICAL CO
1945 E 97 ST CLEVELAND 6 OHIO
HART MFG CO
128 BARTHOLOMEW AVE HARTFORD CONN
HART MFG CO
ANN ARBOR MICH
HARTLEY PROD RESCH LAB
397 W 21 ST HOLLAND MICH
HARTLEY PRODUCTS CO
517 519 E 162 ST NEW YORK N Y
HARTMAN ELECTRICAL MFG CO
175 N DIAMOND ST MANSFIELD OHIO
HARVEY ALUMINUM
19200 S WESTERN AVE TORRANCE CALIF
HARVEY WELLS ELECTRONICS INC
14 HURON DRIVE NATICK MASS
HARVEY WELLS ELECTRONICS INC R & D DIV
E NATICK INDUSTRIAL PARK NATICK MASS
HARWALD CO INC
1245 CHICAGO AVE EVANSTON ILL
HARWIC HINDLE INC
40 HERMON ST NEWARK N J
HARWORTH MFG CO
409 EL COMINO REAL MENLO PARK CALIF
HASSALL INC JOHN
CANTIAGUE RD WESTBURY LI N Y
HASTINGS-RAYDIST INC
NEWCOMB AVE HAMPTON VA
HATHAWAY INSTRUMENTS DIV LIONEL
5800 E JEWELL AVE DENVER 22 COLO
HAVEG INDUSTRIES INC
900 GREENBANK RD WILMINGTON 8 DELA
HAVIR MFG CO
436 CLEVELAND AVE ST PAUL MINN
HAWLEY PRODUCTS CO
333 N 6TH ST ST CHARLES ILL
HAYDON CO A W
232 N ELM ST WATERBURY 20 CONN
HAYDON CORP
3815 9TH AVE NEW YORK 34 N Y
THE A W HAYDON CO
4060 INCE BLVD CULVER CITY CALIF
HAYDON DIV GENERAL TIME CORP
245 E ELM ST TORRINGTON CONN
HAYDON INSTRUMENT CO
17 BROWN ST WATERBURY CONN
HAYDON SWITCH INC
536 S LEONARD ST WATERBURY CONN
HAYES INC C I
875 WELLINGTON AVE CRANSTON R I
HAYNES LABS INC C W
61 CHANDLER ST SPRINGFIELD 9 MASS
HAYNES STELLITE CO
1020 PARK AVE KOKOMO IND
HAYS CORP
742 E 8TH ST MICHIGAN CITY IND
HAZELTINE ELECTRONICS DIV/HAZELTINE CORP
59-25 LITTLE NECK PKWY LITTLE NECK 62 N Y
H B INSTRUMENT CO
AMERICAN BRISTOL STS PHILA PA
HEALY-RUFF CO
2255 UNIVERSITY AVE ST PAUL 14 MINN
HEAREVER CO INC
2644 CASTRO VALLEY BLVD CASTRO VALLEY CAL
HEATH CO SUB OF DAYSTROM INC
BENTON HARBOR MICH
HEATRON CO
333 EBERTS ST YORK PA
HEHN LESTER C
30 MANORHAVEN BLVD PRT WASH N Y
HEINEMANN ELECTRIC CO
BRUNSWICK PIKE TRENTON N J
HEINRICH CO CARL
711 CONCORD AVE CAMBRIDGE 38 MASS
HEINZ MUELLER ENGG CO
4725 IOWA ST CHICAGO 51 ILL
HEINZE ELECT CO
685 LAWRENCE S T LOWELL MASS
HELCO PRODUCTS CORP
7832 BALBOA BLVD VAN NUYS CALIF
HELDOR MFG CORP
238 LEWIS ST PATERSON N J
HELICAL PROD CO INC
622 THIRD ST HERMOSA BCH CALIF
HELI-COIL CORP
SHELTER ROCK LANE DANBURY CONN
HELIPOT DIV BECKMAN INSTRUMENTS INC
2500 FULLERTON RD FULLERTON CALIF
HELIPOT DIV OF BECKMAN INSTRS INC
3 SIX POINTS RD TORONTO 18 ONT CANADA
HELKO PRODUCTS CO
243 W 55 ST NEW YORK 19 N Y
HELLER CO GERALD K
2673 WESTERN ST LAS VEGAS NEV
HELLIGE INC
877 STEWART AVE GARDEN CITY NY
HELWIG CO
2550 N 30TH ST MILWAUKEE 10 WISC
HEMINWAY & BARTLETT MFG CO
500 5 AVE NEW YORK 36 N Y
HENNEKE ENG CO
STONE RIDGE N Y
HENRY & MILLER INDUSTRIES INC
675 GARFIELD AVE JERSEY CITY 5 N J
HENSCHEL CORP
14 CEDAR ST AMESBURY MASS
HEPPNER MFG CO
BOX 608 ROUND LAKE ILL
HERCULES CHEMICAL CO INC
416 BROADWAY NEW YORK 13 N Y
HERMASEAL CO
1010 N MAIN ST ELKHART IND
HERMES PLASTICS INC
13-19 UNIVERSITY PL NEW YORK 3 N Y
HERMES-SONIC CORP
13-19 UNIVERSITY PL NEW YORK N Y
HERMETIC PACIFIC CORP
4232 TEMPLE CITY ROSEMEAD CALIF
HERMETIC SEAL CORP
NORTH ARLINGTON N J
HERMETITE CORP
100 LADGE DRIVE AVON MASS
HEROLD RADIO & ELECTRONICS CORP
MT VERNON N Y
HERZOG MINIATURE LAMP WORKS
50 17 5 ST LONG ISLNAD CITY N Y
HETCO INC
110-114 TREMONT ST EVERETT MASS
HEVI-DUTY ELECTRIC CO DIV BASIC PROD CORP
3002 W BURLEIGH ST PO BOX 563 MILWKEE WIS
HEWLETT PACKARD CO
1501 PAGE MILL RD PALO ALTO CALIF
HEXACON ELECTRIC CO
161 W CLAY AVE ROSELLE PARK N J
HEXCEL PRODUCTS INC EASTERN DIV
HAVRE DE GRACE MD
HEYER INDUSTRIES INCORPORATED
500 CORTLANDT ST BELLEVILLE N J
HEYMAN MFG CO
147 MICHIGAN AVE KENILWORTH N J
H & H MACHINE CO INC
NOBLE & JACKSON STS NORRISTOWN PA
H & H PRODUCTS CO
766 RAMSEY AVE HILLSIDE N J
HICKOK ELECTRICAL INSTRUMENT CO
10514 DU PONT AVE CLEVELAND 8 OHIO
HICO CORP
76 COOLIDGE HILL RD WATERTOWN MASS
HIDYNE INSTRUMENT & ENGRG CO
309 ANDERSON ST TULLAHOMA TENN
HIEATT ENGG CO
2228 N HOLLYWOOD WAY BURBANK CALIF
HI G INC
BRADLEY FIELD WINDSOR LOCKS CONN
HIGH SPEED HAMMER CO
313 NORTON ST ROCHESTER N Y
HIGH VACUUM EQUIPMENT CORP KINETICS DIV
2 CHURCHILL RD HINGHAM MASS
HIGH VACUUM EQUIP CORP
HINGHAM MASS
HIGH VACUUM FURNACE & ELECT DV
90 AIRPORT RD CONCORD N H
HIGH VOLTAGE ENG CORP
BURLINGTON MASS
HIGHLAND DESIGN INC
90 MAGNOLIA AVE WESTBURY N Y
HIGHSIDE CHEMICALS INC
11 COLFAX AVE CLIFTON N J
HILDEBRAND JOHN CO
45 BRIGHTON ST BELMONT MASS
HILL & CO E VERNON
PO BOX 189 LAKE GENEVA WISC
HILL ELECTRONICS INC
300 CHESTNUT ST MECHANICSBURG PA
HILLBURN ELECTRONIC PRODUCTS CO
55 NASSAU AVE BROOKLYN 22 N Y
HI LO MFG CORP
1122 NEWPORT AVE CHICAGO, ILL
HINDLE TRANSFORMER CO
WOODS CHURCH RD RD 3 FLEMINGTON NJ
HI-PAR PRODUCTS CO
347 LUNENBURG ST FITCHBURG MASS
HI PURITY METALS INC
340 HUDSON ST HACKENSACK N J
HIQ DIV
AEROVOX CORP OLEAN N Y
HI-Q DIV AEROVOX CORP
BOX 68 MYRTLE BEACH S C
HI-SHEAR RIVET TOOL CO
2600 W 247TH ST TORRANCE CALIF
HISONIC INC
P O BOX 534 SHAWNEE KANS
HI SPEC ELECTRONICS CORP
7328 ETHEL AVE HOLLYWOOD CALIF
HI-SPEED EQUIPMENT CO
73 POND ST WALTHAM 54 MASS
HITCHINER MFG CO INC
PO BOX 330 MILFORD NH
HITEMP INC
1532 CALIFORNIA AVE MONROVIA CALIF
HITEMP WIRES INC
1200 SHAMES DRIVE WESTBURY NY
HI TEST CHEMICAL CORP
722 64TH ST BROOKLYN 20 N Y
HOBBS CORP JOHN W DIV STEWART-WARNER CORP
SPRINGFIELD ILL
HOBBS MFG CO
26 SALISBURY ST WORCHESTER MASS
HOBSON BROS
4940 LAWRENCE AVE CHICAGO ILL
HOFFMAN CO P R
321 CHERRY ST CARLISLE PA
HOFFMAN ELECT CORP SEMICONDUCTORS DIV
1001 N ARDEN DR EL MONTE CALIF
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV
2621 S HILL ST LOS ANGELES 7 CALIF
HOFFMAN ELECTRONICS CORP
2205 LEE ST EVANSTON ILL
HOFFMAN ELECTRONICS CORP
3740 GRAND AVE LOS ANG CALIF
HOFFMAN ENG CORP
9TH & TYLER ANOKA MINN
HOGAN FAXIMILE CORP
635 GREENWICH ST NEW YORK N Y
HOKE INC
1 TENAKILL PARK CRESSKILL N J
HOLEX INC
P O BOX 148 HOLLISTER CALIF
HOLLAND ELECTRONICS
772 E 53 ST BROOKLYN N Y
HOLLINGSWORTH CO
FORT LAUDERDALE FLA
HOLO-KROME SCREW CORP
HARTFORD 10 CONN
HOLT INSTRUMENT LABS
DIV HOLT HARKWOOD CO INC OCONTO WISC
HOLTZER CABOT DIV NATL PNEUMATIC CO
125 AMORY ST BOSTON 19 MASS
HOLUB INDUSTRIES INC
413 DE KALB AVE SYCAMORE ILL

HOMALITE CORP
11-13 BROOKSIDE DR WILMINGTON DEL
HOME ELECT MFG CO
14914 BURBANK BLVD VAN NUYS CALIF
HOMMEL CO
HOPE & MAPLE STS CARNEIGIE PENNA
HONEYWELL CONTROLS LTD
VANDERHOOF AVE TORONTO ONTARIO CANADA
HOOKER CHEMICAL CORPORATION
28 IROQUOIS ST NIAGARA FALLS N Y
HOOVER ELECTRIC CO
2100 STONER AVE LOS ANGELES CALIF
HOOVER ELECTRONICS CO
110 W TIMONIUM RD TIMONIUM MD
HOPKINS ENG CO
12900 FOOTHILL BLVD SANFERNANDO CAL96
HORLICK CO INC WM I
266 SUMMER ST BOSTON 10 MASS
HOSKINE ALLOYS OF CANADA LTD
TORONTO ONT CANADA
HOSKINS MFG CO
4445 LAWTON AVE DETROIT MICH
HOTPACK CORP
5074A COTTMAN AVE PHILA PA
HOTWATT INC
DANVERS MASS
HOUDAILLE INDUSTRIES INC
BUFFALO 11 N Y
HOULIHAN CO T J
2510 W LAWRENCE CHICAGO 25 ILL
HOUSTON INSTRUMENT CORP
BOX 22234 HOUSTON TEXAS
HOWARD CRYSTAL HOLDERS INC
2600 GRAND AVE KANSAS CITY 8 MO
HOWARD FOUNDRY CO
1700 N KOSTNER AVE CHICAGO 39 ILL
HOWARD INDUSTRIES INC
P O DRAWER 232 FESTUS MO
HOWARD INDUSTRIES INC
1760 STATE ST RACINE WISC
HOWARD INSTRUMENT CO
RED BANK N J
HOWELL INSTRUMENTS INC
3479 VICKERY BLVD FT WORTH TEXAS
HOYT ELECTRICAL INSTRUMENT WORKS
42 CARLETON ST CAMBRIDGE 42 MASS
HRB SINGER INC
SCIENCE PARK STATE COLLEGE PA
HUBBARD - SPOOL DIV
GARRETT IND
HUBER INDUSTRIES INC
4974 HILLSIDE AVE CINN OHIO
HUDSON LAMP CO
528 ELM ST KEARNY N J
HUDSON TOOL & DIE CO
18 MALVERN ST NEWARK 5 N J
HUDSON WIRE CO WINSTED DIV
981 MAIN ST WINSTED CONN
HUDSON WIRE CO
OSSINING NEW YORK
HUFCO INDUSTRIES
2815 OLIVE AVE BURBANK CALIF
HUGGINS LABS INC
999 E ARQUES SUNNYVALE CALIF
HUGHES AIRCRAFT CO-GROUND SYSTEMS DIV
PO BOX 2097 FULLERTON CALIF
HUGHES AIRCRAFT CO
P O BOX 11337 TUCSON ARIZ
HUGHES AIRCRAFT CO-EL SEGUNDO
LOS ANGELES 45 CALIF
HUGHES AIRCRAFT CO
5261 W IMPERIAL LOS ANG CALIF
HUGHES AIRCRAFT CO ELECT PROD DIV
P O BOX 278 NEWPORT BEACH CALIF
HUGHES AIRCRAFT CO
BOX 45426 AIRPORT STA LOS ANG CALIF
HUGHES AIRCRAFT CO VACUUM TUBE PROD DIV
2020 SHORT ST OCEANSIDE CALIF
HUGHES AIRCRAFT CO MICROWAVE TUBE DIV
11105 S LA CIENEGA BLVD LOS ANGELES 9 CAL
HUGHES PRODUCTS GROUP HUGHES AIRCRAFT CO
BOX 90427 LOS ANGELES 45 CALIF
HUGHES SEMICONDUCTORS DIV
500 SUPERIOR AVE NEWPORT BEACH CALIF
HUGHES TREITLER MFG CORP
1045 39TH ST BROOKLYN N Y
HUGHEY & PHILLIPS
3200 SAN FERNANDO BLVD BURBANK CALIF
HUGHSON CHEM CO DIV LORD MFG CO
GREEN GARDEN 12TH ERIE PA
HULL CORP
DAVISVILLE RD AT PA TWPK HATBORO PA
HUMPHREY INC
2805 CANON ST SAN DIEGO CALIF
HUNT CO PHILIP A
5150 GRANT AVE CLEVELAND OHIO
HUNT CORP
453 LINCOLN ST CARLISLE PA
HUNT ELECTRONICS
2617 ANTON DR DALLAS TEXAS
HUNTER SPRING CO
1 SPRING AVE LANSDALE PA
HUNTER TOOLS
9851 ALBURTIS AVE SANTA FE SPRINGS CALIF
HUPPERT CO K H
6830 COTTAGE GROVE AVE CHICAGO 37 ILL
HURLETRON INC EMS DIV
528 WEST LAMBERT ROAD WHITTIER CALIFORNIA
HURLETRON INCORPORATED ELECTRIC EYE EQP DIV
1938 E FAIRCHILD ST DANVILLE ILL
HURON INDUSTRIES
PO BOX 557 PORT HURON MICH
HURST TOOL & MFG CO
RD 46 PRINCETON IND
HUSE-LIBERTY MICA CO
PEABODY INDUSTRIAL CENTER PEABODY MASS
HUYCK SYSTEMS CO DV OF HUYCK CORP
360 WOLF HILL RD HUNTINGTON STA L I N Y

HY GAIN ANTENNA PRODUCTS CO
1135 N 22 ST LINCOLN NEBR
HYCON MFG CO
700 ROYAL OAKS DR MONROVIA CALIF
HYDRA POWER CO
10 PINE COURT NEW ROCHELL N Y
HYDRAULIC PRESS MFG CO DIV KOEHRING CO
MARION RD MT GILEAD OHIO
HYDRAULIC RES ELECT DIV
1675 SHELDON AVE SUNVALLEY CALIF
HYDRO MOLDING CO
100 SHARRON AVE PLATTSBURGH N Y
HYDROMATICS INC
5 LAWRENCE ST BLOOMFIELD N J
HYLETRONICS CORP
165 CAMBRIDGE ST BURLINGTON MASS
HYPERION INC
127 COOLIDGE HILL RD WATERTOWN MASS
HYSER ELECT MFG CO
556 SEVENTH AVE MINN MINN
HYSOL CANADA LTD
P O BOX 53 POSTAL STA R TORONTO ONT CANADA
HYSOL CORP
OLEAN N Y
HYSOL OF CALIF DIV
1706 POTRERO S EL MONTE CALIF
HYSON MFG CO
P O BOX N PASADENA CALIF

I

ICONIX INC
945 INDUSTRIAL PALO ALTO CALIF
IDAHO MARYLAND MINES CORP MAGNETICS DIV
4310 SAN FERNANDO RF GLENDALE 4 CALIF
IDEAL AEROSMITH INC DIV ROYAL INDUSTRIES
3913 EVANS AVE CHEYENNE WYO
IDEAL ELECTRIC & MFG CO
300 E 1 ST MANSFIELD OHIO
IDEAL INDUSTRIES INC
5127 PARK AVE SYCAMORE ILL
IDEAL INDUSTRIES INC
PETERSBURG ILL
IDEAL PRECISION METER CO
214 FRANKLIN ST BROOKLYN 22 NY
IDEAS INC
214 IVINSON AVE LARAMIE WYO
IDENTIFICATION SERVICE CORP
144 W 46 ST NEW YORK 36 N Y
IDESPATCH OVEN CO
619 S E 8 ST MINNEAPOLIS MINN
IE MFG
3039 CARROLL AVE CHICAGO 12 ILL
IERC DIV INTERNTL ELECT RESCH CORP
135 W MAGNOLIA BLVD BURBANK CALIF
I H MFG CO
121 GREENE ST NEW YORK N Y
ILEX OPTICAL COMPANY
690 PORTLAND AVE ROCHESTER 21 NY
ILG ELECTRIC VENTILATING CO
2850 PULASKI RD CHICAGO ILL
ILG ELECTRIC VENTILATING CO
1709 W 8TH ST LOS ANG CALIF
ILLINOIS CONDENSER CO
1616 N THROOP ST CHICAGO 22 ILL
ILLUMITRONIC ENGG CO
680 E TAYLOR AVE SUNNYVALE CALIF
I-L-S INSTRUMENT DIV MERIAM INSTRUMENT CO
4525 W 160 ST CLEVELAND 35 OHIO
IMC MAGNETICS CORP
570 MAIN ST WESTBURY LI NY
IMC MAGNETICS CORP WESTERN DIV
6058 WALKER AVE MAYWOOD CALIF
IMC MAGNETICS CORP
917 W MADISON ST PHOENIX ARIZ
IMPACT-O-GRAPH CORP
1508 BF KEITH BLDG CLEVELAND 15 OHIO
IMPERIAL ELECT INC
8530 ROLAND ST BUENA PARK CALIF
INCELOID CO INC
8127 33 ORLEANDER ST N ORLEANS LA
IND ELEC RUBBER CO
31945 AURORA RD SOLON OHIO
IND HARDWARE MFG CO INC
109 PRINCE ST NEW YORK NY
INDAMER ELECTRONICS
1038 W EVELYN SUNNYVALE CALIF
INDAR CORP SUB PR MALLORY CO
3448 SHELBY ST INDIANAPOLIS IND
INDIANA GENERAL CORP
EICOR DIV OGLESBY ILL
INDIANA GENERAL CORPORATION
GENERAL CERAMICS DIVISION
KEASBEY NH
INDIANA STEEL & WIRE CO
2200 E JACKSON ST MUNCIE IND
INDIANA STEEL PRODUCTS DIV IND GEN CORP
405 ELM ST VALPARISO IND
INDIKON CO
76 COOLIDGE HILL RD WATERTOWN MASS
INDIUM CORP OF AMERICA
1676 LINCOLN AVE UTICA 4 N Y
INDUCTION HEATING CORP
181 WYTHE AVE BROOKLYN 11 N Y
INDUCTOR ENGG INC
117 SCHLEY AVE LEWES DELA
INDUSTRIAL ACOUSTICE CO
341 JACKSON AVE N Y N Y
INDUSTRIAL CONDENSER CORP
3243 N CALIFORNIA AVE CHICAGO 18 ILL

INDUSTRIAL CONTROL CO
CENTRAL AVE AT PINELAWN FARMINGDALE LI NY
INDUSTRIAL DEVICES INC
EDGEWATER N J
INDUSTRIAL DEVELOPMENT LABS INC
982 RIVER RD EDGEWATER NJ
INDUSTRIAL ELECTRONIC ENGINEERS INC
5528 VINELAND AVE N HOLLYWOOD CALIF
INDUSTRIAL ELECTRONICS INC
8060 WHEELER ST DETROIT 10 MICH
INDUSTRIAL ELECTRONICS OF OMAHA INC
6614 BLONDO ST OMAHA NEBR
INDUSTRIAL ELECTRICAL WORKS
1509 CHICAGO ST OMAHA 2 NEBR
INDUSTRIAL ENGRAVERS INC
2212 MCDONALD AVE BROOKLYN 23 N Y
INDUSTRIAL INSTRUMENTS INC
89 COMMERCE RD CEDAR GROVE N J
INDUSTRIAL MATERIALS CO
383 BRANNAN ST SAN FRANCISCO CALIF
INDUSTRIAL NUCLEONICS CORP
650 ACKERMAN RD COLUMBUS 21 OHIO
INDUSTRIAL RADIO CORP
462 N PARKSIDE AVE CHICAGO 44 ILL
INDUSTRIAL RETAINING RING CO
57 CORDIER ST IRVINGTON 11 NJ
INDUSTRIAL TEST EQUIPMENT CO
55 E 11TH ST NEW YORK 3 NY
INDUSTRIAL TECTONICS INC
3686 JACKSON AVE ANN ARBOR MICH
INDUSTRIAL TIMER CORP
1407 MCCARTER HWY NEWARK 4 N J
INDUSTRIAL TRANSFORMER CORP
GOULDSBORO PA
INDUSTRIAL WASHING MACH CORP
32 MAIN ST MATAWAN N J
INDUSTRIAL WINDING MACHINERY CORP
BX 744 CHURCH ST STA NEW YORK 8 NY
INDUSTRIAL WIRE & CABLE CO INC
110-114 TREMONT ST EVERETT MASS
INDUSTRO TRANSISTOR CORP
35-10 36TH AVE LONG ISLAND CITY 6 NY
INDUSTRONIONICS CONTROLS INC
20 VANDAM ST NEW YORK N Y
INERTIA SWITCH INC
311 W 43 ST NEW YORK 36 NY
INFORMATION SYSTEMS INC
10131 NATIONAL BLVD LOS ANG CALIF
INFOTRONICS CORPORATION
1401 S POST OAK ROAD HOUSTON TEXAS
INFRARED INDUSTRIES INC
62 4TH AVE WALTHAM 54 MASS
INFRARED INDUSTRIES INC
PO BOX 989 SANTA BARBARA CALIF
INGERSOLL-RAND CO
PHILLIPSBURG N J
INGERSOLL-RAND CO
11 BROADWAY NEW YORK 4 N Y
INGERSOLL PRODUCTS DIV BORG-WARNER CORP
1000 W 120TH ST CHICAGO 43 ILL
INJECTORALL CO
12 BAY 50 ST BROOKLYN 14 N Y
INLAND MOTOR CORP
RADFORD VA
INMANCO INCORPORATED
712 SOUTH FEDERAL STREET CHICAGO 5 ILL
INSCO CO DIV BARRY CONTROLS
HOLLIS ST GROTON MASS
INSCO COMPANY
MAIN STREET GROTON MASS
INSL X CO INC
WATER ST AT BROADWAY OSSINING N Y
INSO ELECT PROD INC
103 PARK AVE NUTLEY NJ
INSO PRODUCTS LTD
404 FIFTH AVE NEW YORK 18 N Y
INSTRON ENGG CORP
2500 WASHINGTON ST CANTON MASS
INSTRU-LEC CORP
520 HOMESTEAD AVE MOUNT VERNON NY
INSTRUMENT CASE DIV TA MFG CORP
4607 ALGER ST LOS ANGELES 39 CALIF
INSTRUMENT CORP OF FLA
PO BOX 1226 MELBOURNE FLA
INSTRUMENT CORP OF AMER
516 GLENWOOD AVE BALTIMORE MD
INSTRUMENT DEVELOPMENT LABS INC
67 MECHANIC ST ATTLEBORO MASS
INSTRUMENT ELECTRONICS CORP
PO BOX 830 PORT WASHINGTON NY
INSTRUMENT LABS CORPORATION
315 W WALTON PL CHICAGO 10 ILL
INSTRUMENT MASTERS INC
11 HAMBURG TURNPIKE RIVERDALE N J
INSTRUMENT RESISTORS CO
1036 COMMERCE AVE UNION N J
INSTRUMENTATION ASSOCIATES
17 W 60 ST NEW YORK 23 NY
INSTRUMENTS FOR INDUSTRY INC
101 NEW SOUTH RD HICKSVILLE LI NY
INSTRUMENTS INC
3102 CHARLES PAGE BLVD BX 556 TULSA OKLA
INSTRUMENTS OF N E
108 GREENWOOD LANE WALTHAM MASS
INSULATING FABRICATORS OF NE INC
69 GROVE ST WATERTOWN 72 MASS
INSULATING FABRICATORS INC
150 UNION AVE E RUTHERFORD NJ
INSULATION MFRS CORP
565 W WASHINGTON BLVD CHICAGO 6 ILL
INSULEX CO
1504 10TH ST NORTH BERGEN N J
INSUL VICON CORP
1369 INDUSTRIAL RD SAN CARLOS CALIF
INT EASTERN CO
801 6TH AVE NEW YORK NY
INTEGRATED MICA CORP
202 FRANKLIN PLACE WOODMERE NY

INTELLUX INC
30 S SALSIPUEDES ST SANTA BARBARA CALIF
INTERCONTINENTAL ELECTRONICS CORP
1551 FRANKLIN AVE MINEOLA NY
INTERELECTRONICS CORP
2432 GRD CONCOURSE NEW YORK 58 NY
INTERFERENCE MEASUREMENT LAB INC
907 E 51 ST BROOKLYN 3 N Y
INTERLAKE STAMPING CORP
12415 EUCLID AVE CLEVELAND 6 OHIO
INTERLECTRIC DIV EL TRONICS
1401 LEXINGTON AVE WARREN PA
INTERNATION AUDIO STYLUS CORP
107 LAKE AVE TUCKAHOE N Y
INTERNATIONAL BALSA CORP
86 BOYD AVE JERSEY CITY N J
INTERNATIONAL BUSINESS MACH
NEW CIRCLE RD LEXINGTON KY
INTL BUSINESS MACHINES CORP
590 MADISON AVE NEW YORK 22 N Y
INTL CRYSTAL MFG CO INC
18 N LEE OKLAHOMA CITY OKLA
INTERNATIONAL DIODE CORP
88 90 FORREST ST JERSEY CITY N J
INTERNATIONAL ELECTRIC INDUSTRIES INC
468 GRAND AVE BROOKLYN 38 NY
INTL ELECTRIC INDUSTRIES INC
14 SUFFOLK ST FREEPORT LI NY
INTERNATIONAL ELECT INDUST
P O BOX 9036 NASHVILLE TENN
INTL ELECTRONIC INDUSTRIES
9036 MELROSE NASHVILLE TENN
INTERNATIONAL ELECT MAGNETICS INC
1901 MARGUETTE ST N CHICAGO ILL
INTL ELECTRONIC RESEARCH CORP
135 W MAGNOLIA BLVD BURBANK CALIF
INTL ELECT RESCH CORP
177 W MAGNOLIA BLVD BURBANK CALIF
INTERNATIONAL ELECTRONICS CORP
81 SPRING ST NEW YORK 12 N Y
INTL ELECTRONICS MFG CO
2ND ST EXT GREENWOOD ACRES ANNAPOLIS MD
INTERNATIONAL ENGG INC
PO BX 536 FAR HILLS BRANCH DAYTON 19 OHIO
INTERNATIONAL INSTRUMENTS INC
BOX 2954 NEW HAVEN 15 CONN
INTL INSTRUMENT INC
88 MARSH HILL RD ORANGE CONN
INTERNATIONAL NICKEL CO
67 WALL ST NEW YORK 5 N Y
INTL POWDER METALLURGY CO
439 W MAIN ST RIDGEWAY PENNA
INTL PUMP & MACHINE WORKS
81 DORSIA AVE LIVINGSTON N J
INTERNATIONAL RADIANT CORP
577 EAST 156TH ST NEW YORK 55 N Y
INTERNATIONAL RADIO ELECTRONICS CORP
R 4 BOX 261 ELKHART IND
INTL RADIO & ELECTRON
17TH & MISHAWAKA ELKHART IND
INTERNATIONAL RECTIFIER CORP
233 KANSAS ST EL SEGUNDO CALIF
INTERNATIONAL RESEARCH & DEVELOPMENT CORP
PO BOX 55 WORTHINGTON OHIO
INTERNATIONAL RESISTANCE CO ST PETERSBG DIV
2801 72ND STREET N ST PETERSBURG FLA
INTERNATIONAL RESISTANCE CO
BURLINGTON IOWA
INTERNATIONAL RESISTANCE CO
401 N BROAD ST PHILADELPHIA 8 PA
INTL RESISTANCE CO
BOONE NC
INTERSTATE ELECTRONICS CORP
707 E VERMONT AVE ANAHEIM CALIF
INTERTECH INC
333 STATE ST NORTH HAVEN CONN
INVAR ELECTRONICS CORP
323 W WASHINGTON BLVD PASADENA CALIF
INVENGINEERING INC
PO BOX 360 BELMAR N J
INVESTMENT CASTING CO
60 BROWN AVE SPRINGFIELD N J
INVEX INC
1100 N E 125 ST N MIAMI FLA
IONIC ELECTROSTATIC CORP
111 MONROE ST GARFIELD N J
IPPOLITO & CO INC JAMES
1624 STILLWELL AVE BRONX N Y
IRCO CORP
16 HUDSON ST NEW YORK 13 NY
IRON FIREMAN MFG CO ELECTRONICS DIV
2838 S E 9 AVE PORTLAND 2 ORE
INSULATING FABRICATORS OF NE INC
69 GROVE ST WATERTOWN 72 MASS
IRWIN LABS INC
1238 S GERHART AVE LOS ANGELES 22 CALIF
ISOCHEM RESINS CO
221 OAK ST PROVIDENCE 9 R I
ISOCYANATE PRODUCTS INC
900 WILMINGTON RD NEW CASTLE DELA
ISOLANTITE MFG CORP
337 WARREN AVE STIRLING N J
ISOMET CORP
430 COMMERCIAL AVE PALISADES PARK NJ
ISOTOPE ACCESSORIES CO INC
5312 WESTMINSTER AVE PHILA 31 PA
ISOTOPES INC
123 WOODLAND AVE WESTWOOD NJ
ISOTOPES SPEC CO
P O BOX 688 BURBANK CALIF
ITEK ELECTRO - PRODUCTS
75 CAMBRIDGE PKWY CAMBRIDGE 42 MASS
I-T-E CIRCUIT BREAKER CO
601 E ERIE AVE PHILA 34 PENNA
I T I BEARING DIVN
18301 SANTE FE AVE COMPTON CALIF
ITI ELECTRONICS INC
369 LEXINGTON AVE CLIFTON N J
ITT COMPONENTS DIV
100 KINGSLAND RD CLIFTON N J
ITT COMPONENTS DIV
P O BOX 7065 ROANOKE VA
ITT FEDERAL LABS DIV INT TEL & TEL CORP
3301 WAYNE TRACE FORT WAYNE IND
ITT FEDERAL LABORATORIES DIV INTL TEL & TELH
500 WASHINGTON AVE NUTLEY NJ
ITT INFORMATION SYSTEMS DIV
320 PARK AVE NEW YORK 22 NY
IT & T INDUSTRIAL PRODUCTS DIV
15191 BLEDSOE ST SAN FERNANDO CAL
ITT KELLOGG
6650 S CICERO AVE CHICAGO 38 ILL
ITT KELLOGG
951 COMMERCIAL ST PALO ALTO CALIF

J

JACK & HEINTZ DIV SIEGLER CORP
BOX 6719 CLEVELAND 1 OHIO
JACKES-EVANS MFG CO
4427 GERALDINE ST LOUIS 15 MO
JACKSON BROS LONDON LTD
KINGSWAY WADDON SURREY ENGLAND
JACKSON ELECTRICAL INSTRUMENT CO
124 MCDONOUGH ST DAYTON 2 OHIO
JACOBS INSTRUMENT CO
BETHESDA 14 MD
JACOBSON NUT MFG CORP
MARK RD KENILWORTH N J
JADARO MACHINE PRODUCTS
325 S SHILOH RD GARLAND TEXAS
JAIDINGER MFG CO
1921 W HUBBARD ST CHICAGO 22 ILL
JALBERT AEROLOGY LAB
40 20TH ST BOX 155 BOCA RATON FLA
JAMESBURY CORP
45 NEW ST WORCESTER MASS
JAMES ELECTRONICS INC
4050 N ROCKWELL ST CHICAGO ILL
JAMES PLATING WORKS INC
1609 N ELSTON AVE CHICAGO 22 ILL
JAMISON PLASTIC CORP
1225 NEW BRIDGE RD N BELLMORE LI NY
JAMPRO ANTENNA CO
7500 14TH AVE SACRAMENTO CALIF
JAN ENG
2018 PICO BLVD SANTA MONICA CALIF
JAN HARDWARE MFG CO
38-01 QUEENS BLVD LONG ISLAND CITY 1 N Y
JANCO CORP
3111 WINONA AVE BURBANK CALIF
JANDOR INC
948 IRVING AVE DAYTON OHIO
JANSA WOODWORKING CORP
350 MESEROLE ST BROOKLYN 6 N Y
JANSEN ELECT MFG CO INC
2285 UNIVERSITY AVE ST PAUL MINN
JARRELL ASH CO
26 FARWELL ST NEWTONVILLE MASS
JARVIS ELECTRONICS CORP
1140 CHERRY ST WINNETKA ILL
JAVEX ELECTRONICS
PO BOX 646 REDLANDS CALIF
J B L INSTRUMENT CO
SYCAMORE MILL RD CLIFTON HGTS PA
JEFFERS ELECTRONICS DIV SPEER CARBON CO
HOOVER AVE DUBOIS PA
JEFFERSON ELECTRONIC PRODUCTS CORP
322 STATE ST SANTA BARBARA CALIF
JEFFERSON WIRE & CABLE CORP
181 GREENWOOD ST WORCESTER MASS
JEFFREY MFG CO
803 N 4 ST COLUMBUS 16 OHIO
JELLIFF MFG CORP C O
PEQUOT RD SOUTHPORT CONN
JENNINGS RADIO MFG CORP
970 MCLAUGHLIN AVE SAN JOSE 8 CALIF
JENSEN INDUSTRIES INC
7333 HARRISON ST FOREST PARK ILL
JERROLD ELECTRONICS CORP
15TH & LEHIGH AVE PHILA PENNA
JERSEY SPECIALTY CO INC
PO BOX 235 WAYNE N J
JETA INC
957 SAW MILL RIVER RD YONKERS 2 NY
JET-O-MATIC ENGINEERING INC
2126 RIVERSIDE AVE MINNEAPOLIS 4 MINN
JETRONIC INDUSTRIES
MAIN & COTTON ST PHILA 27 PA
JETTRON PRODUCTS
56 ROUTE 10 HANOVER N J
JFD ELECTRONIC CORP
6101 16 AVE BROOKLYN 4 N Y
J & G MACHINE CO INC
42 LA GRANGE ST WORCESTER MASS
JO-BELL PRODUCTS INC
5456 W 111 ST OAK LAWN ILL
JOCLIN MFG CO
LUFBERY AVE WALLINGFORD CONN
JODEE PLASTIC INC
9903 FOSTER AVE BROOKLYN N Y
JOHANSON MFG CO
PO BOX 329 BOONTON NJ
JOHN OSTER MFG CO
5055 N LYDELL AVE MILWAUKEE 17 WISC
JOHNS-MANVILLE
22 E 40TH ST NEW YORK 16 N Y
JOHNS-MANVILLE
TILTON N H
JOHNSON & CO INC K W
1825 WEBSTER ST DAYTON 4 OHIO
JOHNSON & HOFFMAN MFG CORP
31 E 2ND ST MINEOLA L I N Y
JOHNSON AIRCRAFT ENGG CO M J
BOX 10 MORRISTOWN AIRPORT MORRISTOWN N J
JOHNSON CO E F
299 10 AVE S W WASECA MINN
JOHNSON CO E F
2210 SECOND AVE S W WASECA MINN
JOHNSON ELECTRONICS INC
P O BOX 1675 HWY 17-92 CASSELBERRY FLA
JOHNSON MFG CO INC
MOUNT VERNON IOWA
JOHNSON SERVICE CO
507 E MICHIGAN ST MILWAUKEE 2 WISC
JOHNSON WILLIAMS INC
2300 LEGHORN ST MT VIEW CALIF
JOHNSTON FOIL MFG CO
6106 S BROADWAY ST LOUIS 11 MO
JOHNSTON HEARING AID MFG CO
708 WEST 40 TH ST MINNEAPOLIS 9 MINN
JO-LINE TOOLS INC
8442 OTIS ST SOUTH GATE CALIF
JONATHAN MFG CO
720 E WALNUT FULLERTON CALIF
JONES ELECTRONICS CO INC M C
185 N MAIN ST BRISTOL CONN
JONES ELECTRONICS HIRAM
2313 W OLIVE AVE BURBANK CALIF
JONES ELECTRONIC CO INC
185 N MAIN ST BRISTOL CONN
JONES & LAUGHLIN STEEL CORP
WIRE ROPE DIV MUNCY PA
JONES OPTICAL WORKS A D
2400 MASSACHUSETTS AVE CAMBRIDGE 4 MASS
JONESVILLE PAPER TUBE CORP
474 BECK RD JONESVILLE MICH
JONTZ MFG CO INC
1101 E MCKINLEY AVE MISHAWAKA IND
JORDAN CONTROLS INC
3235 W HAMPTON AVE MILWAUKEE 9 WISC
JORDAN ELECTRONICS DIV VICTOREEN
3025 W MISSION RD ALHAMBRA CALIF
JOR MAC CO
704 10TH AVE GRAFTON WISC
JOSLYN MFG & SUPPLY CENTRAL MFG DIV
3700 S MORGAN ST CHICAGO ILL
JOVAL PRODUCTS
250 MCWHORTER ST NEWARK N J
JOY MFG CO
338 S BROADWAY NEW PHILA OHIO
JSC ENGINEERING & DEVELOPMENT CORP
P O BOX 295 HIALEAH FLA
JUALL GEAR CO INC
1108 GOFFLE RD HAWTHORNE NJ
JUDD WIRE MFG CORP
TURNPIKE RD TURNERS FALLS MASS
JULIE RESEARCH LABS
603 W 130 ST NEW YORK 27 NY
J-V-M DIVISION FIDELITONE MICROWAVE INC
9300 W 47TH BROOKFIELD ILL

K

KAAR ENGG CORP
2995 MIDDLEFIELD RD PALO ALTO CALIF
GEORGE E KAERCHER CO
4911 36TH AVE S MINNEAPOLIS 17 MINNESOTA
KAHLE ENGG CO
3300 HUDSON AVE UNION CITY N J
KAHLENBERG BROS CO
TWO RIVERS WISC
KAHN & CO
885 WELLS ROAD WETHERSFIELD HARTFORD CONN
KAHN RESEARCH LABS
81 S BERGEN PL FREEPORT N Y
KAISER AIRCRAFT & ELECTRONICS
2222 W PEORIA AVE PHOENIX ARIZ
KAISER ELECTRONICS INC
13 MONROE ST UNION N J
KAMAN AIRCRAFT CORP
OLD WINDSOR RD BLOOMFIELD CONN
KANE MFG CORP
P O BOX 641 N FRALEY ST KANE PA
KANO LABS
1000 S THOMPSON LANE NASHVILLE TENN
KANTHAL CORP
AMELIA PLACE STAMFORD CONN
KAPITOL MAGNETIC CORP
2241 N KNOX AVE CHICAGO 39 ILL
KARG LAB INC
30 MEADOW ST SOUTH NORWALK CONN
KARG LABS INC
162 ELY AVENUE SO NORWALK CONN
KARLSON ASSOCIATES INC
433 HEMPSTEAD AVE W HEMPSTEAD N Y
KARTRON
P O BOX 472 BEACH CALIF
KAUKE & CO INC
1632 EUCLID ST SANT MONICA CALIF
KAUPP & SON C B INC
610 NEWARK WAY MAPLEWOOD N J
KAWECKI CHEMICAL CO
P O BOX 60 BOYERTOWN PENNA
KAY ELECTRIC CO
MAPLE AVE PINE BROOK N J
KAY-ESS CO
8 NORTH ST DANBURY CONN
KAYNAR CO
7875 TELEGRAPH RD PICO RIVERO CALIF

KAYNAR MFG CO INC
BOX 2001 TERMINAL ANNEX LOS ANGELES CALIF
KAY-TOWNES ANTENNA CO
BOX 593 ROME GA
KEARFOTT DIV GENERAL PRECISION INC
LITTLE FALLS NJ
KEARFOTT CO INC
253 N VINEDO AVE PASADENA CALIF
KEARFOTT DIV GPI INC
12690 ELMWOOD AVE CLEVELAND 11 OHIO
KEASBEY & MATTISON CO
BURLER AVE AMBLER PA
KEIL ENGG PRODUCTS CORP
6833 MANCHESTER AVE ST LOUIS 10 MO
KEISER IND INC
LAUMAN ST P O BOX MT HOLLY SPRINGS PA
KEITHLEY INSTRUMENTS INC
12415 EUCLID AVE CLEVELAND 6 OHIO
KELEKET X RAY DV LABS FO ELECT
1601 TRAPELO RD WALTHAM MASS
KELL STROM TOOL CO INC ELECT DIV
214 CHURCH ST WETHERSFIELD CONN
KELLER JR HUGO P
50 E 42ND ST NEW YORK 17 N Y
KELSEY-HAYES CO
38481 HURON RIVER DR ROMULUS MICH
KELVIN ELECTRIC CO
5919 NOBLE AVE VAN NUYS CALIF
KEMET CO DIV UNION CARBIDE CORP
PO BOX 6087 CLEVELAND 1 OHIO
KEMET CO DIV OF UNION CARBIDE CORP
11901 MADISON AVE CLEVELAND 1 OHIO
KEMLITE LABS INC
1819 W GRAND AVE CHICAGO 22 ILL
KEMODE MFG CO
161 W 18 ST NEW YORK 11 N Y
KEMTRON ELECTRON PRODUCTS INC
14 PRINCE PL NEWBURYPORT MASS
KEN-DEL PRODUCTIONS INC
515 SHIPLEY ST WILMINGTON 1 DEL
KENHOS CORP DV
BOX 2 NORTON HGTS STA DARIEN CONN
KENNAMETAL INC
LLOYD AVE LATROBE PA
KENNEDY & CO D S
432 S MAIN ST COHASSET MASS
KENNEDY INDUSTRIES
1581 E CHARLES ST BANNING CALIF
KENRU CO
PO BOX 121 PARSIPPANY N J
KENSICO TUBE CO DIV
MT KISCO N Y
KENT CORP F C
135 MANCHESTER PLACE NEWARK 4 N J
KENT LIGHTING CORP
500 JOHNSON AVE BROOKLYN 37 N Y
KENTRON
1140 WAIMANU ST HONOLULU 14 HAWAII
KEN TRON CORP
395 LYNNWAY LYNN MASS
KENT TV INC
505 DRIGGS AVE BROOKLYN 11 NY
KENWOOD ENGG CO
265 COLFAX AVE KENILWORTH N J
KENYON TRANSFORMER CO
1057 SUMMIT AVE JERSEY CITY 7 N J
KEPCO INC
131 38 SANFORD AVE FLUSHING 55 N Y
KERN INSTRUMENTS ONC
120 GRAND ST WHITE PLAINS NY
KERRCO PRODUCTS
PO BOX 4178 LINCOLN 7 NEBR
KERSSILK PRODUCTS INC
73 MURRAY ST NEW YORK N Y
KESSLER CHEMICAL CO INC
STATE RD & COTTMAN AVE PHILA 35 PA
KESTER SOLDER CO
4201 WRIGHTWOOD AVE CHICAGO 39 ILL
KESTER SOLDER CO
88 FERGUSON ST NEWARK N J
KETAY DEPT NORDEN DIV UNITED AIRCRAFT CORP
JERICHO TPK COMMACK LI N Y
KEUFFEL & ESSER CO
DEPT EI 6 HOBOKEN N J
KEWAUNEE SCIENTIFIC EQUIP
4012 LOGAN ST ADRAIN MICH
KEY RESISTOR CORP
321 W REDONDO BEACH BLVD GARDENA CALIF
KEYSTONE BOLT & NUT CORP OF TENN
422 FIFTH AVE S NASHVILLE TENN
KEYSTONE CARBON CO
1935 STATE ST ST MARYS PA
KEYSTONE ELECTRONICS CO
65 7 AVE NEWARK 4 N J
KEYSTONE ELECTRONICS CORP
49 BLEECKER ST NEW YORK 12 N Y
KEYSTONE PRODUCTS CO
904-6 23RD ST UNION CITY N J
K-F DEVELOPMENT CO
2606 SPRING ST REDWOOD CITY CALIF
KFR CORP
6006 W WASHINGTON BLVD CULVER CITY CALIF
KIBBY INSTRUMENT CO
P O BOX 50 PERKINS CALIF
KICKHAEFER MFG CO
901 S 2ND ST MILWAUKEE 4 WISC
KIDCO INC
PO BOX 178 RT 70 MEDFORD NJ
KIDDE & CO WALTER
1156 MAIN ST BELLEVILLE 9 NJ
KIDDE ULTRASONIC & DETECTION ALARMS INC
1156 BRIGHTON RD CLIFTON N J
KILO ENG CO
2011 3RD ST LAVERNE CALIF
KIMBALL ELECTRONICS CO INC
3620 N W 48 TERRACE MIAMI FLA
KINETICS CORP
410 S CEDROS AVE SOLANA BEACH CALIF
KING LABS INC
127 SOLAR ST SYRACUSE 3 N Y
KING RADIO CORP
139 S BROCKWAY BX 106 OLATHE KANS
KINGS ELECTRONICS CO INC
40 MARBLEDALE RD TUCKAHOE NY
KINGSLEY MACHINE CO
850 CAHUENGA BLVD HOLLYWOOD 38 CAL
KINNELECTRONICS CORP
4125 HAYWARD AVE BALTIMORE 15 MD
KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO
3529 WASHINGTON ST BOSTON 30 MASS
KINSMAN MFG CO INC
54 MILL ST LACONIA N H
KIP ELECTRONICS CORP
29 HOLLY PL BOX 562 STAMFORD CONN
KIRKLAND CO H R
10 KING ST MORRISTOWN N J
KIRSCH MUSIC CORP
15 58 127 ST FLUSHING N Y
KISTLER INSTRUMENT CORP
15 WEBSTER ST N TONAWANDA NY
KLANN ORGAN SUPPLY CO
PARK STATION WAYNESBORO VA
KLEER-TRONICS INC
1933 OCEAN AVE SAN FRANCISCO CALIF
KLEER VUE MFG CO INC
P O BOX 10326 PITTSBURGH 34 PA
KLEIN ELECT CO LEO
8526 WASHINGTON BLVD CULVER CITY CALIF
KLEINSCHMIDT DIV SMITH-CORONA MARCHANT INC
COUNTY LINE RD DEERFIELD ILL
KLEIN & SONS MATHIAS
7200 MCCORMICK RD CHICAGO 45 ILL
KLIEGL BROS UNIV ELEC STAGE LIGHTING CO INC
321 W 50TH ST NEW YORK 19 NY
KLINCHER LOCKNUT CORP
2153 HILLSIDE AVE INDIANAPOLIS 18 IND
KLINE IRON & STEEL CO
P O BOX 1013-1225-35 HUGER ST COLUMBIA S C
KLING METAL SPINNING & STAMPING CO
245 CENTRE ST NEW YORK 13 N Y
KLIPSCH & ASSOCIATES
P O DRAWER 96 HOPE AEK
KNAPIC ELECTRO PHYSICS INC
936-38 INDUSTRIAL AVE PALO ALTO CALIF
KNIGHT ELECTRONICS CORP
2200 W MAYWOOD DRIVE MAYWOOD ILLINOIS
KNIGHTS CO JAMES
CHURCH & WELLS STS SANDWICH ILL
KNOPP INC
1307 66TH ST OAKLAND 8 CALIF
KNOWLES ELECTRONICS INC
10545 ANDERSON PLACE FRANKLIN PARK ILL
KOBZY TOOL CO
1535 N DAYTON CHICAGO ILL
KOILED KORDS DIV WHITNEY BLAKE CO
106 PERSHING ST NEW HAVEN 14 CONN
KOLLMORGEN OPTICAL CORP
347 KING ST NORTHAMPTON MASS
KOLLSMAN INST CORP STD KOLLSMAN IND INC
80-08 45TH AVE ELMHURST 73 NY
KOLLSMAN INSTRUMENT CORP
SYOSSET L I N Y
KOLLSMAN MOTOR CORP
DUBLIN PA
KOLLSTAN SEMICDT ELMNT DIV KOLLSMN INST CORP
111 NEW YORK AVE WESTBURY LI NY
KOLTON ELECTRIC MFG CO
123 N J RAILROAD AVE NEWARK 5 N J
KOMAK INC
2632 CUMBERLAND ST PHILA PA
KONIGSLOW STAMPING & TOOL CO E
ELWOOD IND
KOOLTRONIC FAN CO
PO BOX 504 PRINCETON NJ
KOONTZ WAGNER ELECT CO INC
516 MICHIGAN ST S BEND IND
KOPP GLASS INC
SWISSVALE PITTSBURGH 18 PENNA
KOPPERS CO INC
KOPPERS BLDG PITTSBURGH 19 PA
KORFUND CO INC
CANTIAGUE RD WESTBURY L I N Y
KORRY MANUF CO
223 8TH AVE SEATTLE WASH
KPT MFG CO
ROSELAND N J
KRAEUTER & CO
585 18TH AVE NEWARK N J
KRAUS ELECTRONICS INC
543 CENTER DR PALO ALTO CALIF
KRAUTTER ELECTRIC MACHINE CO
360 GROVE ST NEWARK 3 N J
KRAUTTER-WEBER TOOL CO
69 12TH AVE NEWARK 2 NJ
KRECKMAN CO HERB
CRESCO PA
KRENGEL MFG CO
227 FULTON ST NEW YORK CITY N Y
KRESKY MFG CO INC
2ND & H STS PETALUMA CALIF
KRESSILK PROD INC
73 MURRAY ST NEW YORK 7 NY
KRISS ELECTRONICS INC
191-195 ORATON ST NEWARK 4 NJ
KROKER ENGG & DEVEL CO
9947 FRANKLIN AVE FRANKLIN PARK ILL
KROHN-HITE CORP
580 MASSACHUSETTS AVE CAMBRIDGE 39 MASS
KRYLON INC
FORD & WASHINGTON STS NORRISTOWN PA
KRYSTINAL CORP
BOX 6 FOX ISLAND RD PORT CHESTER N Y
KTV TOWER COMMUNICATION EQUIP CO
BOX 294-820 S HAMILTON ST SULLIVAN ILL
KUHN ELECTRONICS INC
1801 MILLS AVE NORWOOD 12 OHIO
KULICKE & SOFFA MFG CO
401 N BROAD ST PHILA 8 PA
KULITE BYTREX CORP
50 HUNT ST NEWTON MASS
KULITE SEMICONDUCTOR PROD INC
1030 HOYT AVE RIDGEFIELD N J
KULITE TUNGSTEN CO
1040 HOYT AVE RIDGEFIELD NJ
KULKA ELEC CORP
633 S FULTON ST MT VERNON NY
KURMAN ELECTRIC CO SUB CRESCENT PETROLEUM CO
191 NEWEL ST BROOKLYN 22 N Y
KURTSTON ELECTRONICS
702 BAY ST STATEN ISLAND 4 NY
KURZ-KASCH INC
1421 S BROADWAY DAYTON 1 OHIO
KUTHE LABS
730 S 13 ST NEWARK 3 N J
K V TRANSFORMER CORP
81 WATER ST OSSINING N Y
K W ENGINEERING WORKS
PIN OAK COURT MENOMONEE FALLS WISC
KWIKHEAT MFG CO
3732 SAN FERNANDO RD GLENDALE CALIF
KYLE PRODUCTS
9 & MARION S MILWAUKEE WISC

L

LAB CORP
E ONONDAGA SKANEATELES N Y
LABELLE INDUSTRIES INC
510 S WORTHINGTON ST OCONOMOWOC WISC
LABLINE INC
3070 W GRAND AVE CHICAGO 22 ILL
LAB INDUST DE PHYSIQUE APPLIQUEE
67 RUE MARIE ANNE COLOMBIER 67
BAGNOLET SEINE PARIS FRANCE
LABORATORY EQUIPMENT CORP
LAKEVIEW HILLTOP RD ST JOSEPH MICH
LABORATORY FOR ELECTRONICS INC
1079 COMMONWEALTH AVE BOSTON 15 MASS
LAB-TRONICS INC
3656 N LINCOLN AVE CHICAGO 13 ILL
LACESA ENGG CORP
5614 W GRAND AVE CHICAGO 39 ILL
LACONIA MALLEABLE IRON CO INC
71 WATER ST LACONIA N H
LAI I & E DIV
2133 ADAMS AVE SAN LEANDRO CALIF
THE LAKE CHEMICAL CO
3052 W CARROLL AVE CHICAGO ILL
LAKE CITY INC SUB OF CONTROLS CO OF AMERICA
110 WOODSTOCK ST CRYSTAL LAKE ILL
LAKE MFG CO
2323 CHESTNUT ST OAKLAND 7 CALIF
LAMACO OF FLORIDA
BOX 1386 HAINES CITY FLORIDA
LAMARCHE MFG CO
3955 25TH AVE SCHILLER PARK ILL
LAMBDA ELECTRONICS CORP
515 BROAD HOLLOW RD HUNTINGTON L I N Y
LAMINAIR INC
18530 S BROADWAY GARDENA CALIF
LAMINATED SHEET PRODUCTS CORP
449 NEPONSET ST NORWOOD MASS
LAMINATED SHIM CO
UNION STREET GLENBROOK CONN
LA MOREE C D
2433 BIRKDALE ST LOS ANGELES 31 CALIF
LAMOTTE CHEMICAL PRODUCTS CO
CHESTERTOWN MD
LAMPKIN LAB INC FDC DIV
BRADENTON FLA
LAMPKIN LABS INC
TECHNICAL DIVISION BRADENTON FLA
LAMSON & SESSIONS CO
5025 W 73 ST CHICAGO ILL
LANCASTER GLASS CORP
LANCASTER OHIO
LANCE ANTENNA MFG CORP
1730-1802 1ST ST SAN FERNANDO CALIF
LAND AIR INC CHEYENNE DIV
PO BOX 2327 CHEYENNE WYO
LAND AIR INSTRUMENT & ELECT DIV
440 HESTER SAN LEANDRO CALIF
LANDAU METAL PROD CORP
2 62 51ST AVE LONG ISLAND CITY N Y
LANDIS & GYR
45 W 45 ST NEW YORK 36 N Y
LANOSVERK ELECTROMETER CO
641 SONORA AVE GLENDALE CALIF
LANES INDS CORP DIV CORNELL DEEP DRAWING CO
612 COLORADO AVENUE SANTA MONICA CALIF
LANG ELECTRIC MFG CO
EDINBORO PA
LANGE MACHINE WORKS INC
166 N MAY ST CHICAGO 7 ILL
LANGEVIN DIV OF SONOTEC INCORP
503 S GRAND AVE SANTA ANA CALIF
LANGLEY CORP
310 EUCLID AVE SAN DIEGO CALIF
LANSDALE ELECTROMETER CO
641 SONORA AVE GLENDALE CALIF
LANSING SOUND INC JAMES B
3249 CASITAS LOS ANGELES 39 CALIF
LAPHAM HICKEY STEEL CORP
3333 W 47TH ST PL CHICAGO ILL
LAPMASTER DIV CRANE PACKING CO
6400 OAKTON ST MORTON GROVE ILL

ELECTRONIC MANUFACTURERS—A TO Z

LAPP INSULATOR CO RADIO SPECIALTIES DIV
318 GILBERT ST LE ROY NY
LA POINTE INDUSTRIES INC
155 W MAIN ST ROCKVILLE CONN
LA ROSE & ASSOC INC W T
BOX F LANS STA TROY NY
LARSON INSTRUMENT CO
GREENBUSH RD ORANGEBURG N Y
LAS LAB INC
1113 N ROLLING RD BALTIMORE MD
LAUREHK RADIO MFG CO
3927 WAYNE RD WAYNE MICH
LAVELLE AIRCRAFT CORP
STERLING ST NEWTOWN PA
LA VEZZI MACHINE WORKS
4635 W LAKE ST CHICAGO 44 ILL
LAVOIE LABS INC
MATAWAN-FREEHOLD RD MORGANVILLE NJ
LEACH CORP INET DIV
18435 SUSANA RD COMPTON CALIF
LEACH CORP LEACH RELAY DIV
5915 AVALON BLVD LOS ANGELES 3 CALIF
LEACH CORP SPECIAL PRODUCTS DIV
717 NORTH CONEY AZUSA CALIF
LEACH & GARNER CO INDUSTRIAL DIVISION
LEACH & GARNER BLDG ATTLEBORO MASS
LEAR INC ASTRONICS DIV
3171 S BUNDY DR SANTA MONICA CALIF
LEAR INC ELECTRO-MECHANICAL DIV
110 IONIA AVE NW GRAND RAPIDS MICH
LEAR INCORPORATED INSTRUMENT DIVISION
110 IONIA AVENUE N W GRAND RAPIDS MICH
LEAR ROMEC DIV LEAR INC
ELYRIA OHIO
LECLANCHE S A
48 AVE DEGRANDSON YVERDON SWITZERLAND
LECTROHM INC
5560 NORTHWEST HWY CHICAGO ILL
LEDEX INC
123 WEBSTER ST DAYTON 2 OHIO
LEE ELECTRIC INC
566 52ND ST WEST N Y N JERSEY
LEECRAFT MFG CO INC
2116 44TH RD LONG ISLAND CITY N Y
LEEDAL INC
2929 S HALSTED CHICAGO ILL
LEED INSULATOR CORP
781 E PICO BLVD LOS ANGELES 21 CALIF
LEEDS & NORTHRUP CO
4901 STENTON AVE PHILA PA
L E E INC
625 N Y AVE N W WASHINGTON 1 D C
LEESONA CORPORATION
WARWICK RHODE ISLAND
LEETRONICS INC
30 MAIN ST BROOKLYN 1 N Y
LEFFINGWELL CHEMICAL CO
P O BOX 1187 PERRY ANNEX WHITTIER CALIF
LEHIGH VALLEY ELECT ENGG & MFG CO
RD 1 BREININGSVILLE PA
LEIGHTON LABS H W
YORK RD & SUNSET LANE HATBORO PA
LEIGHTON PAIGE CORP
76 INDIANA AVE W ST PAUL MINN
LEIMAN BROS
146 CHRISTIE ST NEWARK 5 NJ
LEITCH ENGG CORP
326 LINCOLN ST MANCHESTER N H
LEITCH HUARD CORP
STARK & COMMERCIAL ST MANCHESTER N H
LEKTRA LABS INC
154 11 AVE NEW YORK 11 N Y
LELAND AIRBORNE PRODUCTS
740 E NATIONAL RD VANDALIA OHIO
LEL INC
75 AKRON ST COPIAGUE NY
LEMERT ENGG CO
1313 WESTERN AVENUE PLYMOUTH IND
LENK MFG CO
FRANKLIN KY
LENKURT ELECTRIC CO
1105 COUNTY RD SAN CARLOS CALIF
LENZ ELECTRIC MFG CO
1751 N WESTERN AVE CHICAGO 47 ILL
LEONARD ELECT PROD CO INC
67 87 34TH ST BROOKLYN N Y
LEPEL HIGH FREQUENCY LABS
54-18 37 AVE WOODSIDE 77 NY
LERCO ELECTRONICS INC
501 S VARNEY ST BURBANK CALIF
LESA COSTRUZIONI ELETTROMECCANICHE SPA
VIA BERGAMO 21 MILANO ITALY
LESLIE CO
LYNDHURST NJ
LESLIE CREATIONS
LAFAYETTE HILL PENNA
LESSELLS & ASSOCIATES INC
916 COMMONWEALTH AVE BOSTON 15 MASS
LE SUEUR MFG CO INC
PATTONS CHAPEL BIRMINGHAM ALA
LEVEY LABS HAROLD A
8127-33 OLEANDER ST NEW ORLEANS 18 LA
LEVIN & SON LOUIS
3610 S BROADWAY LOS ANGELES 7 CALIF
LEVOLOR LORENTZEN INC H K LORENTZEN DIV
391 W BROADWAY NEW YORK 12 N Y
LEWIS CO E B
11 BRASS ST E HARTFORD 8 CONN
THE LEWIS ENGINEERING CO
339 CHURCH ST NAUGATUCK CONN
LEWIS & KAUFMAN ELECTRONICS TUBE DIV
17320 EL RANCHO AVE LOS GATOS CALIF
LEYGHTON-PAIGE CORP
76 INDIANA AVE W ST PAUL 7 MINN
LEYMAN MAGNETICS DIV
5178 CROOKSHANK RD CINCINNATI OHIO
LEYSE ALUMINUM CO
KEWAUNEE WISC
LIBBEY OWENS FORD GLASS CO
LIBERTY MIRROR DIV
BRACKENRIDGE PA
LIBRASCOPE DIV GENERAL PRECISION INC
808 WESTERN AVE GLENDALE 1 CALIF
LIBRASCOPE DIV GENERAL PRECISION INC
100 E TUJUNGA AVE BURBANK CALIF
LICON DIV ILLINOIS TOOL WORKS
6615 W IRVING PARK RD CHICAGO 34 ILL
LICON SWITCH & CONTROL
2501 N KEELER AVE CHICAGO 30 ILL
LIEBEL-FLARSHEIM CO
111 E AMITY RD CINCINNATI 15 OHIO
LIECO INC
130 EILEEN WAY SYOSSET L I NY
LIFE INSTRUMENT CO
BROOK ST FRANKLIN MASS
LIGHT ELECTRIC CORP
214 LACKAWANNA AVE NEWARK 3 N J
LIGHT METALS INC
1100 E 24TH ST INDIANAPOLIS 5 IND
LIGNACRAFT
66 TRAVIS AVE BINGHAMTON N Y
LIGNACRAFT DESIGN & DRAFTING SERVICE
66 TRAVIS AVE BINGHAMTON N Y
LIND INSTRUMENTS INC
2294 MORA DRIVE MOUNTAIN VIEW CALIF
LINDBERG ENGG CO
2450 W HUBBARD ST CHICAGO 12 ILL
LINDE CO DIV UNION CARBIDE CORPORATION
270 PARK AVENUE NEW YORK 17 N Y
LINDGREN & ASSOC ERIK A
4515 N RAVENSWOOD CHICAGO 40 ILL
LINDLY & CO
248 HERRICKS RD MINEOLA NY
LINDSAY STRUCTURE INC DIV INTL STEEL CO
EVANSVILLE IND
LINEAR INC
DALLAS PENNA
LINE ELECTRIC CO DIV IND TIME CORP
229 RIVER STREET ORANGE NJ
LINELL ENGG CORP CHAS S
3974 N AVONDALE AVE CHICAGO 41 ILL
LINEMASTER SWITCH CORP
WOODSTOCK CONN
LINE MATERIAL INDUSTRIES
CENTRAL PLANT S MILWAUKEE WISC
LING-ELECTRONICS DIV LING-TEMCO VOUGHT
1515 S MANCHESTER ANAHEIM CALIF
LINGO & SON INC JOHN E
2814 BUREN AVE CAMDEN N J
LING-TEMCO VOUGHT INC ELECT DIV
BOX 6191 DALLAS TEXAS
LINK AVIATION INC
BINGHAMTON N Y
LINK AVIATION INC SUB GEN PREC EQUIP CORP
HILLCREST BINGHAMTON NY
LINK-BELT CO
DEPT EI PRUDENTIAL PLAZA CHICAGO 1 ILL
LINK-BELT CO
200 LYNDALE AVE MINNEAPOLIS MINN
LINK-BELT COMPANY DEPT 62 - EI
3405 SIXTH AVE SEATTLE 4 WASH
LINK-BELT COMPANY DEPT 62-EI
300 W PERSHING RD CHICAGO ILL
LINK-BELT COMPANY DEPT 62-EI BEARING PLANT
7601 ROCKVILLE ROAD INDIANAPOLIS 41 IND
LINK-BELT COMPANY DEPT 62 - EI
3203 S WAYSIDE HOUSTON 1 TEXAS
LINK-BELT COMPANY DEPT 62-EI
2045 W HUNTING PARK AVE PHILADELPHIA 40 PA
LINK-BELT COMPANY DEPT 62-EI
COLMAR PA
LINK-BELT COMPANY DEPT 62-EI EWART PLANT
220 S BELMONT AVE INDIANAPOLIS 6 IND
LINK-BELT COMPANY DEPT 62-EI
400 PAUL AVE SAN FRANCISCO 19 CALIF
LINK-BELT COMPANY DEPT 62 - EI
1200 SYCAMORE ST MNTBLO LOS ANGELES 22 CAL
LINK DIV GENERAL PRECISION INC
BINGHAMTON N Y
LIONEL - WADSWORTH ULTRASONICS INC
1440 BROADWAY NEW YORK 18 NY
LIONEL CORP
HOFFMAN PLACE HILLSIDE N J
LIONEL CORP LIONEL ELECTRONIC LABS DIV
1226 FLUSHING AVE BROOKLYN 37 NY
LION FASTENER CO INC
HONEOYE FALLS N Y
LION FASTNER CO INC
LESTER PA
LIPPS CO EDWIN A
1511 COLORADO AVE SANTA MONICA CALIF
LIQUIDOMETER CORP
41-03 36 ST LONG ISLAND CITY 1 N Y
LIQUIDOMETER CORP
ROCKINGHAM RD BELLOWS FALLS VERMONT
LISK CO G W
CLIFTON SPRINGS N Y
LITTELFUSE INC
1865 MINER ST DES PLAINES ILL
LITTLE FALLS ALLOYS INC
189 CALDWELL AVE PATERSON 1 NJ
LITTLEFORD BROS INC
451 E PEARL ST CINCINNATI 2 OHIO
LITTON ENGG LABS
PO BOX 949 GRASS VALLEY CALIF
LITTON INDUSTRIES ELECTRONIC EQUIP DIV
336 N FOOTHILL RD BEVERLY HILLS CALIF
LITTON INDUSTRIES U S ENGG DIV
13536 SATICOY ST VAN NUYS CALIF
LITTON INDUSTRIES POTENTIOMETER DIV
215 S FULTON AVE MT VERNON N Y
LITTON INDUSTRIES ELECTRON TUBE DIVISION
960 INDUSTRIAL RD SAN CARLOS CAL
LITTON INDUSTRIES MARYLAND DIV
4900 CALVERT COLLEGE PARK MD
LITTON SYSTEMS INC APPLIED SCIENCE DIVISION
8535 WARNER DRIVE CULVER CITY CALIFORNIA
LITTON SYS INC GUIDANCE & CONTROL DIV
5500 CANOGA AVE WOODLAND HILLS CALIF
LITTON SYST INC GUIDANCE & CONTROL DIV
2211 WEST NORTH TEMPLE SALT LAKE CITY UTAH
LITTON SYSTEMS CANADALIMITED
123 REXDALE BLVD REXDALE TORONTO ONT CAN
LIVINGSTON AUDIO PRODUCTS CORP
BOX 202 CALDWELL N J
LIVINGSTON ELECT CORP
320 RUNNYMEDE RD ESSEX FALLS N J
LMB
2528 W 9TH ST LOS ANGELES CALIF
LOCKHEED AIRCRAFT LOCKHEED AIRCRAFT SER
ONTARIO AIRPORT ONTARIO CALIF
LOCKHEED ELECT CO STAVID DIV
U S ROUTE 22 PLAINFIELD N J
LOCKHEED ELECT CO INFORMATION TECHNOLOGY DIV
US HIGHWAY 1 METUCHEN NJ
LOCKREY CO
P O BOX J SOUTHAMPTON N Y
LOEWY-HYDROPRESS DIV
111 5TH AVE NEW YORK 3 N Y
LOGE ELECTRONICS INC
2171 W WASHINGTON BLVD LOS ANGELES 18 CAL
LOGEMAN CO C W
633 BERGEN ST BROOKLYN 38 NY
LOGETRONICS INC
500 E MONROE AVE ALEXANDRIA VA
LONDON CHEMICAL CO INC
1535 N 31ST AVE MELROSE PARK ILL
LONG INC THOMAS J
215 STONEHINGE LA CARLE PL LI NY
LORAIN COUNTY RADIO CORP
203 9TH ST LORAIN OHIO
LORAL ELECTRONICS CORP
825 BRONX RIVER AVE NEW YORK 72 N Y
LORD MFG CO
1635 W 12TH ST ERIE 6 PA
LOUCKS & NORLING
418 W 54TH ST NEW YORK 19 N Y
LOUD MACHINE WORKS INC
969 E 2ND ST POMONA CALIF
LOUTHAN MFG CO DIV FERRO CORP
2000 HARVY AVE E LIVERPOOL OHIO
LOUTHAN PLANT REFRACTORIES DIV FERRO CORP
BOX 781 E LIVERPOOL OHIO
LOWELL MFG CO
3030 LACLEDE STATION RD ST LOUIS 17 MO
L & R MFG CO
577 ELM ST ARLINGTON NJ
LUCAS MILHAUPT ENGG CO
5051 S LAKE DR CUDAHY WISC
LUCCI AIRCRAFT INC
SARASOTA-BRADENTON AIRPORT SAROSOTA FLA
LUCKENBACH & CO PAUL
312 W 231ST ST NEW YORK 63 N Y
LUDLOW-SAYLOR WIRE CLOTH CO
634 S NEWSTEAD AVE ST LOUIS MO
LUDWIG HONOLD MFG CO
CHESTER PIKE & FOLCROFT AVE FOLCROFT PA
LUFKIN RULE CO
1730 HESS ST SAGINAW MICH
LUHRS & CO C H
297 HUDSON ST HACKENSACK N J
LUMA ELECTRIC EQUIPMENT CO
P O BOX 132 TOLEDO 1 OHIO
LUMEN INC
BOX 905 JOLIET ILLINOIS
LUMINATOR INC
630 TERMINAL WAY COSTA MESA CALIF
LUMINOUS PROCESSES INC
161 E 42 ST NEW YORK 17 NY
LUMINOUS PROCESSES INC
444 GREEN BAY RD KENILWORTH ILL
LUNDEY ASSOCIATES INC
694 MAIN ST WALTHAM 54 MASS
LUPER & SUNBERG
AVON ILL
LUTHER ELECTRONIC MFG CO
5728 W WASHINGTON BLVD LOS ANGELES 16 CALF
LUXO LAMP CANADA LTD
370 STE CROIX BLVD MONTREAL 9 P Q CANADA
LUXO LAMP CORP
DOCK STREET PORT CHESTER N Y
LUXO LAMP CORP
1683 JERROLD AVE SAN FRAN CALIF
LYMAN ELECTRONIC CORP
P O BOX 1649 SPRINGFIELD 1 MASS
LYN TRON INC
5350 RIVERTON AVE N HOLLYWOOD CALIF
LYNCH COMMUNICATION SYSTEMS INC
695 BRYANT ST SAN FRANCISCO CALIF
LYNCH CORPORATION
2304 CRYSTAL ST ANDERSON IND
LYNCH MFG CO R H
7831 ARROYO DR SAN GABRIEL CALIF
LYNCOACH & TRUCK CO INC
ONEONTA N Y
LYON AIRCRAFT SERVICE
2701 N ONTARIO ST BURBANK CALIF
LYON METAL PRODUCTS INC
P O BOX 671 AURORA ILL

M

MAAS & WALDSTEIN CO
2121 MCCARTER HWY NEWARK N J
MACALLEN CO INC
BAY RD NEWMARKET N H
MACARR INC
4360 BULLARD AVE NEW YORK 66 N Y

MACDONALD AND COMPANY
1324 ETHEL ST GLENDALE 7 CALIF
MACHINE O MATIC
717 CHICAGO AVE EVANSTEN ILL
MACHINERY ELECTRIFICATION INC
35 HUDSON ST NORTHBORO MASS
MACHLETT LABS INC
1063 HOPE ST SPRINGDALE CONN
MACK ELECTRIC DEVICES INC
48 GLENSIDE AVE WYNCOTE PENNA
MACK ENGINEERING
2626 31ST AVE SO MINNEAPOLIS 6 MINN
MACKAY INC A D
198 BROADWAY NEW YORK 38 N Y
MACKAY RADIO & TELEGRAPH CO MARINE DIV
133 TERMINAL AVE CLARK N J
MACKAY RESEARCH LABS
P O BOX 148A BENSON ARIZ
MACKENZIE ELECTRONICS INC
1025 N MCCADOEN PL HOLLYWOOD 38 CALIF
MACLEOD & HANOPOL
10 ROLAND ST CHARLESTOWN 29 MASS
MADIGAN CORP
2119 W CENTRAL AVE ORLANDO FLA
MADIGAN ELECTRONIC CORP
200 STONEHINGE LANE CARLE PLACE NY
MAGNADYNE CORP
PORT CHESTER NY
MAGNAFLUX CORP
7328 W LAWRENCE AVE CHICAGO 31 ILL
MAGNASYNC MFG CO
5546 SATSUMA AVE N HOLLYWOOD CALIF
MAGNATRAN INC
PO BOX 211 KEARNY NJ
MAGNAVOX
US HWY 11 E JEFFERSON CITY TENN
MAGNAVOX
1505 E MAIN ST URBANA ILL
MAGNAVOX CO
2255 CARMELINA AVE LOS ANG CALIF
MAGNAVOX COMPANY THE
2131 BUETER RD FT WAYNE 4 IND
MAGNE HEAD DIV GENERAL INST CORP
2660 S LACIENEGA BLVD LOS ANG CALIF
MAGNE-TRONICS INC
49 W 45 ST NEW YORK N Y
MAGNECESSORIES
BOX 6960 WASHINGTON 20 DC
MAGNECORD DIV MIDWESTERN INSTRUMENTS INC
P O BOX 7186 TULSA OKLA
MAGNECRAFT ELECTRIC CO
5575 N LYNCH AVE CHICAGO 30 ILL
MAGNETIC AMPLIFIERS INC
632 TINTON AVE NEW YORK 55 N Y
MAGNETIC ANALYSIS CORP
42-44 12TH ST LONG ISLAND CITY NEW YORK
MAGNETIC CIRCUIT ELEMENTS INC
3722 PARK PL MONTROSE CALIF
MAGNETIC CONTROLS CO
6403 CAMBRIDGE ST MINNEAPOLIS 16 MINN
MAGNETIC CONTROLS CO
6405 CAMBRIDGE ST MINN MINN
MAGNETIC CORE CORP
JOHN & LAWRENCE STS BOX 368 NEWBURGH N Y
MAGNETIC CORP
7232 ETON AVE CANOGA PARK CALIF
MAGNETIC DEVICES INC
712 EAST ST FREDERICK MD
MAGNETIC INSTRUMENT CO INC
546 COMMERCE ST THORNWOOD NY
MAGNETIC METALS CO
HAYES AVE & 21 ST CAMDEN 1 N J
MAGNETIC RECORDERS CO
7120 MELROSE AVE LOS ANGELS 46 CAL
MAGNETIC RESEARCH CORP
3160 W EL SEGUNDO BLVD HAWTHORNE CALIF
MAGNETIC SHIELD DIV PERFECTION MICA CO
1322 N ELSTON AVE CHICAGO 22 ILL
MAGNETICO INC
6 RICHTER CT E NORTHPORT LI NY
MAGNETICS DIV
5178 CROOKSHANK RD
MAGNETICS INC
BUTLER PA
MAGNETICS RESEARCH CO
179 WESTMORELAND AVE WHITE PLAINS N Y
MAGNUSON ENGINEERS INC
509 EMORY ST SAN JOSE 10 CALIF
MAGTROL INC
240 SENECA ST BUFFALO 4 NY
MAHLER RESEARCH FOUNDATION
PO BOX 1159 NEW YORK 1 NY
MAHONEY TELETRONIC LABS INC
209 16 AVE NEWARK 3 N J
MAICO ELECTRONICS INC
21 N 3RD ST MINNEAPOLIS 1 MINN
MAICO ELECTRONICS INC DYNAMU MAGNETRONICS DV
21 N 3 ST MINNEAPOLIS 1 MINN
MAICO ELECTRONICS INC ENG DIV
123 NORTH 3RD ST MINN MINN
MAIDA DEVELOPMENT CO
214 ACADEMY ST HAMPTON VA
MAILINK STEEL SAFE CO GIANT VIEW NETWORK
1672 OAKWOOD AVE TOLEDO 6 OHIO
MAJESTIC EXTRUDERS INC
32-37 DOWNING ST FLUSHING 52 N Y
MAJOR ELECTRONICS CORP
762 WYTHE AVE BROOKLYN 11 N Y
MAKEPEACE DIV D E ENGLEHARD INDUSTRIES INC
PINE & DENHAM STS ATTLEBORO MASS
MALCO MFG CO
4025 W LAKE ST CHICAGO 24 ILL
MALKIN-ILLION CO
400 COIT ST IRVINGTON 11 N J
MALLINCKRODT CHEMICAL WORKS
2 & MALLINCKRODT STS ST LOUIS 7 MO
MALLINCKRODT CHEMICAL WORKS
223-243 W SIDE AVE JERSEY CITY N J
MALLINCKRODT CHEMICAL WORKS
3600 N 2ND ST ST LOUIS MO
P R MALLORY & CO INC
3029 E WASHINGTON ST INDIANAPOLIS 6 IND
MALLORY & CO INC P R
42 S GRAY ST INDIANAPOLIS 6 IND
MALLORY BATTERY CO OF CANADA LTD
228 ST HELENS AVE TORONTO 4 ONTARIO
MALLORY CAPACITOR CO DIV P R MALLORY&CO INC
CRAWFORDSVILLE IND
MALLORY CAPACITOR CO DIV P R MALLORY CO INC
HUNTSVILLE ALA
MALLORY CAPACITOR CO DIV PR MALLORY CO INC
42 S GRAY ST INDIANAPOLIS IND
MALLORY CAPACITOR CO
GREENCASTLE IND
MALLORY CONTROLS CO DIV PR MALLORY CO INC
HWY 20 WEST FRANKFORD IND
MALLORY ELCTMGNTC CO DIV PR MALLORY & CO INC
DUQUOIN ILL
MALLORY ELECTRONICS CO PR MALLORY CO INC
3302 ENGLISH AVE INDIANAPOLIS 6 IND
MALLORY ELECT CO
3625 INDUSTRY AVE LAKEWOOD CALIF
MALLORY METALLURGICAL CO
3029 E WASHINGTON ST IND IND
MAMCO CORP
532-542 4TH ST RACINE WISC
MANDEX MFG CO INC
2614 W 48TH ST CHICAGO 32 ILL
MANDREL INDUSTRIES INC MEG PRODUCTS DIVISION
BOX 3115 SEATTLE 14 WASHINGTON
MANGER ELECTRIC CO
MILLER ST STAMFORD CONN
MANNING PAPER CO JOHN A
P O DRAWER 328 TROY N Y
MANOSTAT CORP
20-26 N MOORE ST NEW YORK 13 NY
MANSOL CERAMICS CO
140 LITTLE ST BELLEVILLE NJ
MANSON LABORATORIES INC
375 FAIRFIELD AVE STAMFORD CONN
MANUFACTURERS ENGG & EQUIP CORP
YORK RD & SUNSET LANE HATBORO PA
MANUFACTURERS CHEMICAL CO INC
1450 FERRY ST CAMDEN N J
MARANTZ CO
25-14 BOWY LONG ISLAND CITY N Y
MARATHON BATTERY CO
840 HENRIETTA ST WAUSAU WISC
MARATHON ELECTRIC MFG CO
EARLVILLE ILL
MARBLETTE CORP
37-31 30 ST LONG ISLAND CITY 1 N Y
MARBON CHEMICAL DIV BORG-WARNER CORP
P O BOX 68 WASHINGTON W VA
MARCH DYNAMICS INC
920 SOUTH OYSTER BAY ROAD HICKSVILLE NY
MARCHANT MACHINING CORP
4704 RHODE ISLAND AVE HYATTSVILLE MD
MARCONI INSTRUMENTS
111 CEDAR DRIVE ENGLEWOOD N J
MARCONIS WIRELESS TELEGRAPH CO LTD
750 3RD AVE NEW YORK 17 N Y
ROBERT J MARCY ASSOCIATES
80 8TH AVE NEW YORK 11 NY
MARDUTH PROD
1387 LEDGE RD HINCKLEY OHIO
MARINE ELECTRIC CORP
600 4TH AVE BROOKLYN 15 N Y
MARINE VIEW ELECTRONICS INC
88-06 VAN WYCK EXPRESSWAY JAMAICA 18 N Y
MARION INSTRUMENT DIV
GRENIER FIELD MANCHESTER NH
MARK PRODUCTS CO
5439 FARGO AVE SKOKIE ILL
MARKAL COMPANY
3052 W CARROLL AVE CHICAGO ILL
MARKEL & SONS LFRANK
SCHOOL LANE NORRISTOWN PA
MARKEM MACHINE CO
150 CONGRESS ST KEENE N H
MARKITE CORP
155 WAVERLY PL NEW YORK N Y
MARLIN-ROCKWELL CORP
402 CHANDLER ST JAMESTOWN NY
MARLIN-ROCKWELL CORP
FALCONER N Y
MARMA ELECTRONICS CO
1633 N HALSTED ST CHICAGO 14 ILL
MARQUARDT CORP POMONA DIV
2709 N GAREY AVE POMONA CALIF
MARQUETTE DIV CURTISS-WRIGHT CORP
1145 GALEWOOD DR CLEVELAND 10 OHIO
G S MARSHALL CO
2065 HUNTINGTON DRIVE SAN MARINO CALIF
MARS INDUSTRIES INC
5209 W BROADWAY MINNEAPOLIS 22 MINN
MARSHALL ASSOCIATES INC JOHN
BOX 2463 BRIDGEPORT 8 CONN
MARSHALLTOWN MFG CO
810 E NEVADA ST MARSHALLTOWN IOWA
MARSLAND ENGG LTD
350 WEBER ST N WATERLOO ONT CANADA
MARSTAN ELECTRONICS CORP
204 BABYLON TURNPIKE ROOSEVELT LI NY
MARTIN MARIETTA CORP ORLANDO DIV
BOX 5837 ORLANDO FLA
MARTIN MARIETTA CORP
DENVER 1 COLO
MARTIN COMPANY ELECT SYS & PROD DIV
BALTIMORE 1 MARYLAND
MARTIN PROD INC
139 E CENTRAL BLVD PALISADES PARK N J
MARTRONICS INC
82 SANFORD ST HAMDEN 14 CONN
MARTIN & RDBER CO INC
535 W WAYNE FT WAYNE IND
MARYLAND CERAMIC & STEATITE CO INC
BOX 127 BELAIR MD
MASON ELECTRIC CORP
3839 VERDUGO RD LOS ANGELES 65 CALIF
MASON-NEILAND DIV WORTHINGTON CORP
55 NAHATAN ST NORWOOD MASS
MASONITE CORP
LAUREL MISSISSIPPI
MASONITE FABRICATORS
1577 RIO VISTA AVE LOS ANGELES CALIF
MASONITE FABRICATORS
10360 EVENDALE DR CINN OHIO
MASSA DIV OF COHU ELECTRONICS INC
5 FOTTLER RD HINGHAM MASS
MAST DEVELOPMENT CO INC
2212 E 12TH ST DAVENPORT IOWA
MASTER APPLIANCE INC
1600 FACTORY AVE MARION IND
MASTER ENGRAVING STUDIOS
135 LIBERTY ST NEW YORK 6 NY
MASTER MOBILE MOUNTS INC
4125 W JEFFERSON BLVD LOS ANG CALIF
MASTER SPECIALTIES CO
956 E 108TH ST LOS ANGELES 59 CALIF
MASTER TAPE PRINTERS INC
3400 N HALSTED ST CHICAGO ILL
MASTERCRAFT INSTRUMENT CO
DUBUQUE IOWA
MASTERITE INDUSTRIES INC
835 W OLIVE ST INGLEWOOD CALIF
MASTRA CO
2104 SUPERIOR AVE CLEVELAND 14 OHIO
MATHIS CO G E
6100 S OAK PARK AVE CHICAGO 38 ILL
MATRIX CORP
839 NEW YORK AVE TOLEDO OHIO
MATTERN CORPORATION
7444 W WILSON AVENUE CHICAGO 31 ILL
MATTHEWS & CO JAS
3823 FORBES ST PITTSBURGH 13 PA
MAURER INC J A
3701 31 ST LONG ISLAND CITY 1 NY
MAXSON ELECTRONICS CORP
475 10TH AVE NEW YORK 18 N Y
MAXSON ELECTRONICS CORP
MAXSON DR OLD FORGE PENNA
MAXSON INSTRUMENTS
460 W 34 ST NEW YORK 1 NY
MAY RESEARCH INC
1405 11 AVE SO BOX 1167 MPLS 40 MINN
MAYBERRY ELECTRONICS CO
111 S OAK ST INGLEWOOD 1 CALIF
MAYFLOWER ELECTRONIC DEVICES INC
20 INDUSTRIAL AVE LITTLE FERRY NJ
MAYSTEEL PRODUCT INC
MAYVILLE WISC
MAYTAG ELECTRONICS INC
730 S TEJON STREET COLORADO SPRINGS COLO
MB ELECT VIBRATION ENGG PLANT
781 WHALLEY AVE NEW HAVEN CONN
MB ELECTRONICS DIV TEXTRON ELECT INC
781 WHALLEY AVE NEW HAVEN CONN
MC CLURE PROJECTORS
BX 1338 1012 CHURCH ST EVANSTON ILL
MCALISTER INC J G
1117 N MCCADDEN PL HOLLYWOOD 38 CALIF
MCCARRON ELECTRIC CO
721 MONTEREY PASS RD MONTEREY PK CALIF
MCCORMICK SELPH ASSOC
HOLLISTER AIRPORT HOLLISTER CALIF
MCCOY ELECTRONICS CO
CHESTNUT & WATTS STS MT HOLLY SPRINGS PA
MCCULLOUGH TOOL CO
5820 S ALAMEDA ST LOS ANG CALIF
MCDONNELL & MILLER INC
3500 N SPAULDING AVE CHICAGO 18 ILL
MCDONNELL AIRCRAFT CORP
LAMBERT-ST LOU ARPT BX 516 ST LOUIS 66 MO
MCGILL MFG CO ELECTRICAL DIV
1002 N CAMPBELL ST VALPARAISO IND
MCGOHAN INC DON
3700 W ROOSEVELT RD CHICAGO 24 ILL
MCGRAW EDISON PRIMARY BATTERY DIV
BLOOMFIELD N J
MCGREGOR ELECTRONIC INDUSTRIES INC
132 FIRST ST MCGREGOR IOWA
MCINTOSH LABS INC
2 CHAMBERS ST BINGHAMTON N Y
MCKENNA LABORATORIES
1503 MAIN ST SANTA MONICA CALIF
MC KINSTRY METAL WORKS INC
285 MCKINSTRY AVE CHICOPEE MASS
MCLEAN CORP
WEST HURLEY N Y
MCLEAN SYNTORGUE CORP
WEST HURLEY N Y
MCMILLAN COMPANIES
BROWNVILLE AVE IPSWICH MASS
MEAGHER ELECTRONICS CO
177 WEBSTER STREET MONTEREY CALIF
MEASUREMENT ENGG LTD
232 JOHN ST ARNPRIOR ONTARIO CAN
MEASUREMENTS DIV MC GRAW-EDISON CO
BOX 180 BOONTON NJ
MEASURMENTS RESEARCH CO DIV PRUDENTIAL IND
3801 CASTOR AVE PHILA 24 PA
M E C INC
796 BERRY RD P O BOX 577 NASHVILLE TENN
MECA ELECTRONICS
107 E 8TH ST GIBSON CITY ILL
MECH-TRONIC EQUIPMENT CO
P O BOX 510 SILVER SPRING MD
MECHANICAL ENGRAVING CO INC
10 VAN CORTLANDT AVE NEW YORK 68 NY
MECHANICAL INDUSTRIES PRODS CO
217 ASH ST AKRON 8 OHIO

MECHANICAL INDUST SOUTHERN CORP
1500 S W 40TH ST FORT LAUDERDAL EFLA

MECHANICAL PRODUCTS INC
1824 RIVER ST JACKSON MICH

MECHATROL DIV SERVOMECHANISIMS INC
1200 PROSPECT AVE WESTBURY NY

MECTRON CO
166 RIDGE AVE NORTH PLAINFIELD NJ

MECTRON CO
501 E 1ST AVE ROSELLE N J

MEDCRAFT ELECTRONIC CORP
426 GREAT EAST NECK RD BABYLON NY

MEDISTOR INST CO
1443 NORTHLAKE WAY SEATTLE 3 WASH

MEDTRONIC INC
3055 HIWAY NO 8 MINNEAPOLIS 18 MINN

MELABS
3300 HILLVIEW AVE PALO ALTO CALIF

MELCO PRODUCTS INC
301 5 AVE S MINNEAPOLIS 15 MINN

MELCOR ELECT CORP
48 TOLEDO ST FARMINGDALE N Y

MELETRON CORP
950 N HIGHLAND AVE LOS ANGELES 38 CALIF

MELETRON CORP
940 N ORANGE DR LOS ANG CALIF

MELODY MASTER MFG CO
2149 W ROSCOE ST CHICAGO 18 ILL

MELPAR INC
3000 ARLINGTON BLVD FALLS CHURCH VA

MEL-RAIN CORP
2100 E FLETCHER AVE INDIANAPOLIS 3 IND

MELROY ELECTRONIC MFG CO
1012 CLEVELAND ST CLEARWATER FLA

MEL SCHWARTZ CO
48 PINE ST EAST PATERSON NJ

MENLO PARK ENGG
711 HAMILTON AVE MENLO PARK CALIF

MEPCO INC
35-37ABBETT AVE MORRISTOWN NJ

MERCAST MFG CORP
2620 I ST LA VERNE CALIF

MERCK & CO INC CHEMICAL DIV
RAHWAY N J

MERCOID CORP
4201 BELMONT AVE CHICAGO 41 ILL

MERCURY AIR PARTS CO INC
BX 135 9310 W JEFFERSON CULVER CITY CALIF

MERCURY CONTACTS INC
1950 NEVA DRIVE DAYTON 14 OHIO

MERCURY ENGG CORP
339 E COTTAGE PL YORK PA

MERCURY TRANSFORMER CORP
12964 PANAMA ST LOS ANGELES 66 CALIF

MEREDITH & CO LTD C C
80 THOMAS ST STREETSVILLE ONT CANADA

MERIDIAN METALCRAFT INC
8739 S MILLERGROVE DR WHITTIER CALIF

MERIT SHORT WAVE DIATHERMY CO
2758 WHITTIER BLVD LOS ANGELES 23 CALIF

MERIX CHEMICAL CO
2234 E 75TH ST CHICAGO 49 ILL

MERRIMAC RESEARCH & DEVELOPMENT INC
517 LYONS AVE IRVINGTON N J

MESA PLASTICS CO
12270 NEBRASKA AVE LOS ANGELES 25 CALIF

MESUR MATIC ELECTRONICS CORP
BRADFORD NH

METACHEM RESINS CORP MERECO PRODS DIV
530 WELLINGTON AVE CRANSTON 10 R I

ELECTRONICS DIV METAL TEXTILE CORP
647 E 1ST AVE ROSELLE N J

METAL CRAFT INC
BURGESS PL WAYNE N J

METAL CRAFT MFG CORP M K
3775 10TH AVE NEW YORK 34 N Y

METAL EDGE INDUSTRIES
GLOUSTER PIKE BARRINGTON NJ

METAL FABRICATORS CORP
73 POND ST WALTHAM 54 MASS

METAL FORGING CORP
373 VAN SINDEREN AVE BROOKLYN 7 N Y

METAL HYDRIDES INCORP
12 24 CONGRESS ST BEVERLY MASS

METAL SPECIALTY PRODUCTS CORP
27-01 BROOKLYN QUEENS EXP W WOODSIDE 77 NY

METAL & THERMIT CORP
CARTERET NJ

METALECTRO LAB
11423 VANOWEN ST HOLLYWOOD CALIF

METALLIC PLASTICS CORP
27-10 44 DR LONG ISLAND CITY 1 NY

METALLIZING CO OF LOS ANG INC
1233 S BOYLE AVE LOS ANG CALIF

METALLO GASKET CO
16 BETHANY ST NEW BRUNSWICK N J

METALPHOTO CORP
18531 S MILES RD CLEVELAND OHIO

METALPHOTO OF CINCINNATI
7 E 75TH ST CINCINNATI OHIO

METALS & CONTROLS INC COMMERCIAL CONTRLS DPT
300 N MAIN VERSAILLES KY

METAVAC INC
45-68 162 ST FLUSHING 58 N Y

METEOR PRODUCTION ENGRG INC
1465 S VANDEVENTER AVE ST LOUIS MO

METER MAKERS INC
1101 W ARMITAGE CHICAGO ILL

METERS INC
5353 N KEYSTONE AVE INDIANAPOLIS 20 IND

METEX ELECTRONICS
WALNUT AVE CLARK N J

METHODE MFG CORP
7447 W WILSON AVE CHICAGO 31 ILL

METHODS RESEARCH CORP
105 W WILLOW AVENUE STATEN ISLAND 5 NY

METOX
68 RUE VILLIERES DE 1 PARIS 20EME FRANCE

METPRO INC R I
230 TORONTO AVE PROVIDENCE 5 R I

METROLOG CORP SUB AIR LOGISTICS CORP
169 N HALSTEAD PASADENA CALIF

METRON INSTRUMENT CO
432 LINCOLN ST DENVER 3 COLO

METRONIX INC
75 WILSON MILLS RD CHESTERLAND OHIO

METROPOLITAN TELECOMMUNICATIONS CORP
COIL WINDERS DIV
AMES CT PLAINVIEW NY

METZ REFINING CO
369 MULBERRY ST NEWARK 2 NJ

MEYER MANUFACTURING
410 NW 2ND ST PIPESTONE MINN

M & ELECTEONICS CORP
118 E 25 ST NEW YORK NY

M-G METAL PRODS CO
1217 WEBSTER AVE CHICAGO 14 ILL

M-H STANDARD CORP
510 COMMUNIPAW AVE JERSEY CITY 4 NJ

MICA CORP
4031 ELENDA ST CULVER CITY CALIF

MICA INSULATOR DIV MINNESOTA MINING MFG CO
797 BROADWAY SCHENECTADY 1 NY

MICACRAFT PRODUCTS INC
701 MCCARTER HWY NEWARK 5 N J

MICACRAFT PRODUCTS INC
49 LIBERTY STREET NEWARK NJ

MICA FAB CO
53 CENTRAL AVE ROCHELLE PARK N J

MICAMOLD ELECTRONICS MFG CORP
65 GOUVERNEUR ST NEWARK 4 NJ

MIAC PRODUCTS CO
8506 ILL RD HWY 14 FORT WAYNE IND

MICARTA FABRICATORS INC
5324 N RAVENSWOOD AVE CHICAGO 40 ILL

MICHIGAN MAGNETICS INC
VERMONTVILLE MICH

MICHIGAN MAGNETICS INC
656 GRAND ALLEGAN MICH

MICHIGAN WIRE CLOTH CO
2100 HOWARD ST DETROIT MICH

MICO INSTRUMENT CO
80 TROWBRIDGE ST CAMBRIDGE 38 MASS

MICON ELECTRONICS INC SUB METALCRAFT INC
ROOSEVELT FIELD GARDEN CITY L I N Y

MICRO BALANCING INC
191 HERRICKS RD GARDEN CITY N Y

MICRO-CIRCUITS CO
NEW BUFFALO MICH

MICRODOT INC
220 PASADENA AVE S PASADENA CALIF

MICRODOT INC MAGNETICS DIV
5960 BOWCROFT ST LOS ANG CALIF

MICRO GEE PROD INC
6319 SLAUS AVE CULVER CITY CALIF

MICROFLECT CO
3450 S 25 ST SALEM ORE

MICROLAB
570 W MT PLEASANT AVE LIVINGSTON N J

MICRO LECTRIC INC
19 DEBEVOISE AVE ROOSEVELT N Y

MICROMAG INSTRUMENT CO
115 HALLECK ST ROXBURY 20 MASS

MICROMAT CO
548 PIERMONT AVE HILLSIDE N J

MICROMATIC MACHINE CORP
45 MORGAN AVE BROOKLYN 37 N Y

MICROMECH MFG CO
695 RAHWAY AVE UNION N J

MICROMEGA CORPORATION
4134 DEL REY AVE VENICE CALIF

MICROMETALS
72 E MONTECITO AVE SIERRA MADRE CALIF

MICROMETRICAL MFG CO
3621 S STATE ANN ARBOR MICH

MICROMODULAR COMPONENTS DIV
BOX S 1 ANAHEIM CALIF

MICROMOLD PRODUCTS CORP
1 SCHOOL ST YONKERS N Y

MICRON GEAR MFG CO
73 PUSHMORE ST WESTBURY L I NY

MICROPHASE CORP
BOX 1166 GREENWICH CONN

MICRO PUMP CORP
BOX 392 DANVILLE CALIF

MICRO-RADIONICS INC
14844 OXNARD ST VAN NUYS CALIF

MICROSECOND ELECT INC
3213 E WASHINGTON PHOENIX ARIZONA

MICRO SONIC INDUSTRIES INC
5305 CHICAGO AVE MINNEAPOLIS MINN

MICROSONICS INC
349 LINCOLN ST HINGHAM MASS

MICRO STATE ELECTRONICS CORP
152 FLORAL AVE MURRAY HILL N J

MICRO SWITCH
INDEPENDENCE IOWA

MICRO SYSTEMS INC
319 AGUSTINO RD SAN GABRIEL CALIF

MICROMECH MFG CO
695 RAHWAY AVE UNION NJ

MICROTECH INC
MILLDALE RD CHESHIRE CONN

MICROTRAN CO
145 E MINEOLA AVE VALLEY STREAM NY

MICROWAVE ASSOCIATES INC
BURLINGTON MASS

MICROWAVE DEVELOPMENT LABS
15 STRATHMORE ROAD NATICK MASS

MICROWAVE ELECTRONIC TUBE CO INC
76 LAFAYETTE ST SALEM MASS

MICROWAVE ELECT CORP
4061 TRANSPORT ST PALO ALTO CALIF

MICROWAVE ENG LABS
943 INDUSTRIAL AVE PALO ALTO CALIF

MICROWAVE SERVICES INTL INC
ROUTE 46 CISCO RD DENVILLE NJ

MID-CONTINENT ENGINEERING
1712 NORTHEAST MARSHALL MINN MINN

MIDDLESEX PAPER TUBE CO
345 CHELMSFORD ST LOWELL MASS

MID-EASTERN ELECTRONICS INC
32 COMMERCE ST SPRINGFIELD NJ

MIDGET LOUVER CO
6-8 WALL ST NORWALK CONN

MIDLAND INDUSTRIAL FINISHES CO
E WATER ST WAUKEGAN ILL

MIDLAND MFG CO
3155 FIBERGLAS RD KANSAS CITY 15 KANSAS

MIDWEST COIL & TRANSF CO
1640 N HALSTED ST CHICAGO ILL

MIDWEST ELECTRIC PRODUCTS INC
1515 N FRONT ST MANKATO MINN

MIDWEST METAL PRODUCTS INC
450 E DONOVAN ROAD KANSAS CITY 15 KANS

MIDWEST MOLDING & MFG CO
GURNEE ILL

MID-WEST SPRING CO
ETNA ST MENTON IND

MIDWESTERN INSTRUMENTS
PO BOX 7509 TULSA OKLA

MIKROS INC
7620 S W MACADAM AVE PORTLAND ORE

MILAM ELECTRIC MFG CO
1100 ELMWOOD AVE PROVIDENCE 7 RI

MILES REPRODUCER CO
812 BROADWAY NEW YORK 3 N Y

MILFORD DEPT-NORDEN DIV-UNITED AIRCRAFT
MILFORD CONN

MILFORD RIVET & MACHINE CO
MILFORD CONN

MILFORD RIVET & MACH CO
801 ILL AVE AURORA ILL

MILFORD RIVET & MCH CO
ELYRIA OHIO

MILGO ELECT CORP
7620 N W 36TH AVE MIAMI FLA

MILLEN MFG CO JAMES
150 EXCHANGE ST MALDEN 48 MASS

MILLER ASSOCIATES
P O BOX 369 LAKEVILLE CONN

MILLER CO J W
5917 S MAIN ST LOS ANGELES 3 CALIF

MILLER CO M C
288 SADDLE RIVER RD UPPER SADDLE RV N J

MILLER CORP HARRY
4TH & BRISTOL STS PHILA PA

MILLER DIAL & NAMEPLATE CO
4400 N TEMPLE CITY BLVD EL MONTE CALIF

MILLER ELECTRO RESEARCH LABS
5529 S 5TH ST MILWAUKEE 7 WISC

MILLER FRANKLIN P & SON INC
36 MEADOW ST EAST ORANGE N J

MILLER-HARRIS INSTRUMENT CO
1134 S FIRST ST MILWAUKEE 4 WISC

MILLER-TROJAN CO INC
TROY OHIO

MILLERS FALLS CO
57 WELLS ST GREENFIELD MASS

MILLI SWITCH CORP
FRANKFORT IND

MILLI-SWITCH CORP
PO BOX 67 MILL CREEK RD GLADWYNE PA

MILLIPORE FILTER CORP
36 PLEASANT ST WATERTOWN 72 MASS

MILLIPORE FILTER CORP
P O BOX 427 BEDFORD MASS

MILLITEST CORP
88 MADISON AVE HEMPSTEAD N Y

MILLIVAC INSTR DIV COHU ELECTRONICS INC
2315 2ND AVE SCHENECTADY 3 N Y

MILLIVAC INSTRUMENTS INC
BOX 997 SCHENECTADY N Y

MILRO CONTROLS CO INC
280 MIDLAND AVE SADDLE BROOK N J

MILTON-ROY CO
6301 49TH BOX 12169 ST PETERSBURG FLA

MILWAUKEE RESISTOR CO
700 W VIRGINIA ST MILWAUKEE 4 WISC

MILWAUKEE STAMPING CO
800 S 72 ST MILWAUKEE 14 WISC

MINARIK ELECTRIC CO
224 E 3RD ST LOS ANG CALIF

MINATRON CORP
BELLE MEAD 9 N J

MINIATURE INSTRUMENTS INC
PEPTONE ELECTRONICS DIVISION
9440 SCIENCE CENTER DRIVE MINN 27 MINN

MINCO PRODUCTS INC
740 WASHINGTON AVE MINNEAPOLIS 1 MINN

MINCOM DIV MINN MINING & MFG CO
2049 S BARRINGTON AVE LOS ANGELES 25 CAL

MINE SAFETY APPLIANCES CO
201 N BRADDOCK AVE PITTSBURGH 8 PA

MINELCO
21 PLYMOUTH ST HOLBROOK MASS

MINERALS & INSULATION CO
ROCHELLE PARK NJ

MINI-MOLD INC
14759 BESSEMER ST VAN NUYS CALIF

MINICORD CORP OF AMERICA
1915 ATLANTIC AVE ATLANTIC CITY N J

MINISINK RUBBER CO INC
ORANGE COUNTY UNIONVILLE N Y

MINITEC
5423 DELAWARE AVE LOS ANGELES 4 CALIF

MINNEAPOLIS ELECT
2233 UNIVERSITY AVE ST PAUL MINN

MINNEAPOLIS-HONEYWELL HEILAND DIV
5200 E EVANS AVE DENVER COLO

MINNEAPOLIS-HONEYWELL MICRO SWITCH DIV
CHICAGO & SPRING STS FREEPORT ILL

MINNEAPOLIS-HONEYWELL BOSTON DIV
1400 SOLDIERS FIELD RD BOSTON MASS
MINNEAPOLIS-HONEYWELL FALL RIVER DIV
PENN & BAY STS FALL RIVER MASS
MINNEAPOLIS-HONEYWELL ELECT PROC DIV
60 WALNUT ST WELLESLEY HILLS MASS
MINNEAPOLIS HONEYWELL APPARATUS CONTROLS DIV
2753 4TH AVE MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL CERAMIC LAB
1885 DOUGLAS DR N MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL ORDANCE DIV
600 2ND ST N HOPKINS MINN
MINNEAPOLIS-HONEYWELL AERO DIV
2600 RIDGWAY RD MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL SEMICOND PROD DIV
1015 S 6 ST MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL PRECISION METER DIV
GRENIER FIELD MANCHESTER N H
MINNEAPOLIS-HONEYWELL BROWN INST DIV
WAYNE & WINDRIM AVES PHILA PA
MINNEAPOLIS-HONEYWELL RUBICON DIV
RIDGE AVE 35 ST PHILA PA
MINNEAPOLIS-HONEYWELL SPECIAL SYS DIV
QUEEN & S BAILEY POTTSTOWN PA
MINN MINING & MFG CO ELECT PRODS DIV
900 BUSH ST ST PAUL 6 MINN
MINN MINING & MFG CO IRVINGTON DIV
BOX 108 FREEHOLD N J
MINN MINING MFG CO CHEMICAL DIV
900 BUSH ST ST PAUL 6 MINN
MINNESOTA MINING & MFG CO
900 BUSH AVE ST PAUL 6 MINN
MINNESOTA MINING & MFG CO
HUTCHINSON MINN
MINNESOTA RUBBER CO
3630 WOODALE AVE MINN MINN
MINOR RUBBER CO
ACKERMAN ST BLOOMFIELD N J
MINSHALL ORGAN INC
28 BIRGE ST BRATTLEBORO VT
MINSTER MACHINE CO
1500 S 5TH ST MINSTER OHIO
MIRATEL INC
1 ST SE & RICHARDSON NEW BRIGHTON MINN
MIRATEL INC
1080 DIONNE ST ST PAUL 13 MINN
MISCO
3806 GRAND AVE MINNEAPOLIS MINN
MISKELLA INFRA-RED CO
E 73 & GRAND AVE CLEVELAND 4 OHIO
MISSILE SYSTEMS CORP CALIFORNIA DIVISION
11949 VOSE ST N HOLLYWOOD CALIF
MISSILE TRONICS CORP
245 4TH ST PASSAIC N J
MISSIMERS INC
3737 SAN FERNANDO RD GLENDALE CALIF
MISSOURI RESEARCH LABORATORIES INC
2109 LOCUST ST ST LOUIS 3 MO
MITCHELL CAMERA CORP
666 W HARVARD ST GLENDALE 1 CALIF
MITCHELL CAMERA CORP ASTROMICS DIV
666 W HARVARD ST GLENDALE CALIF
MITCHELL INDUSTRIES INC
MUNICIPAL A P PO BOX 17 MINERAL WELLS TEX
MITCHELL RAND MFG CORP
51 MURRAY ST NEW YORK 7 N Y
MITRONICS INC
132 FLORAL AVE MURRAY HILL NJ
M & O PLASTICS PRODUCTS
BOX 402 BANNARD ST FREEHOLD NJ
MOBIL ELECTRONICS MFG CO
1111 STATE RD 67 E ANDERSON IND
MODEL ENGG & MFG INC
50 FREDERICK ST HUNTINGTON IND
MODEL RECTIFIER CORP
1675 UTICA AVENUE BROOKLYN 34 N Y
MODELECTRIC PRODUCTS CORP
ASBURY PARK N J
MODERN DESIGN DIV H C SCHLOER INC
VESTAL PARKWAY EAST VESTAL N Y
MODERN INDUSTRIES INC
5755 CAMILLE AVE CULVER CITY CALIF
MODERN LABORATORY EQUIP CO
1811 1 AVE NEW YORK 28 N Y
MOHAWK ELECTRONICS CORPORATION
944 HALSEY ST BROOKLYN 33 NY
MOHAWK MFG CO
P O BOX 1110 MIDDLETOWN CONN
MOHAWK WIRE & CABLE CORP
45 SUMMER ST LEOMINSTER MASS
MOISTURE REGISTER CO
P O BOX 910 ALHAMBRA CALIF
MOLDED FIBRE GLASS BODY CO
4601 BENEFIT AVE ASHTABULA OHIO
MOLDED FIBER GLASS CO
4401 BENEFIT AVE ASHTABULA OHIO
MOLDED INSULATION CO
335 E PRICE ST PHILADELPHIA 44 PA
MOLDED INSULATION CO
123 E 8TH AVE CONSHOHOKEN PENNA
MOLDOMATIC CORP
17301 RODGELAND AVE TINLEY PARK ILL
MOLE-RICHARDSON CO
937 N SYCAMORE AVE HOLLYWOOD 38 CALIF
MOLECULAR DIELECTRICS INC
101 CLIFTON BLVD CLIFTON NJ
MOLECU-WIRE CORP
SCOBEYVILLE N J
MOLEX PRODUCTS CO
9515 SOUTHVIEW AVE BROOKFIELD ILL
MOLLY CORP
230 N 5 ST READING PA
MOLON MOTOR & COIL CORP
3737 INDUSTRIAL AVE ROLLING MEADOWS ILL
MOLONEY ELECTRIC CO
5390 BIRCHER BLVD ST LOUIS 20 MO
MONA INDUSTRIES INC
PO BOX 1786 PATERSON 17 NJ

MONADNOCK MILLS
1977 FIRST AVE SAN LEANDRO CALIF
MONAGHAM CO J J
500 ALCOTT ST DENVER 4 COLO
MONITOR CONTROLLER
99 GROVE ST ROCKLAND MASS
MONITOR PRODUCTS CO INC
815 FREMONT AVE S PASADENA CALIF
MONITOR SYSTEMS INC
FORT WASHINGTON PA
MONODE INC
3751 PROSPECT AVE CLEVE OHIO
MONOSILICON INC
139 E 157ST GARDENA CALIF
MONROE CALCULATING MACHINE COMPANY
555 MITCHELL ST ORANGE N J
MONROE CALCULATING MACHINE CO
VALLEY DRIVE BRISTOL VA
MONROVIA AVIATION CORP
801 ROYAL OAKS DR MONROVIA CALIF
MONTEK ASSOCIATES INC
4675 S STATE ST SALT LAKE CITY 7 UTAH
MONTGOMERY MFG CO
206 S MAIN ST OWENSVILLE IND
MONTRONICS INC
1212 W MAIN ST BOX 135 BOZEMAN MONT
MONTROSE PRODUCTS CO INC
AUBURN INDUSTRIAL PARK AUBURN MASS
MONTROSE DIV BENDIX CORP
SOUTH MONTROSE PA
MOODY MACHINE PRODUCTS CO INC
40 DUDLEY ST PROVIDENCE 5 RI
MOORADIAN HIGH FREQUENCY LABS
13 E FORT LEE RD BOGOTA N J
MOORE ASSOCIATES INC
893 AMERICAN ST SAN CARLOS CALIF
MOORE CO HOWARD J
105 E 16ST NEW YORK N Y
MOORE CORP JOHN B
PO BOX O DEPT EI PEERLESS BLDG NUTLEY U NJ
T R MORAN CO INC
P O BOX 185 EL SEGUNDO BLVD EL SEGUNDO CAL
MORAN INSTRUMENT CORP
170 E ORANGE GROVE BLVD PASADENA CALIF
MORAN PRODUCTS CO
7199 WENTWORTH AVE CLEVELAND 2 OHIO
MOREY CORP
2014 N MAJOR AVE CHICAGO 39 ILL
MORGAN ADHESIVES CO
4650 DARROW RD STOW OHIO
MORNINGSTAR PAISLEY FACTORIES
1111 CHESTNUT ST REDWOOD CITY CALIF
MORRIS BEAN & CO
YELLOW SPRINGS OHIO
MORRIS CO J I
390 ELM ST SOUTHBRIDGE MASS
MORROW RADIO MFG CO
2794 MARKET ST SALEM OREGON
MORSE CO FRANK W
354 CONGRESS ST BOSTON 10 MASS
MORSE INSTRUMENT CO
20 CLINTON ST HUDSON OHIO
MOSAIC FABRICATION INC
205 CHAPIN ST SOUTHBRIDGE MASS
MOSELEY CO F L
409 FAIR OAKS AVE PASADENA CALIF
MOSER JEWEL CO
544 FAYETTE ST PERTH AMBOY NJ
MOSINEE PAPER MILLS CO
MOSINEE WISC
MOSLER RESEARCH PROD INC
9 SOUTH ST DANBURY CONN
MOSLEY ELECTRONICS INC
4610 N LINDBERGH BRIDGETON MO
MOSSMAN INC DONALD P
PO BOX 265 BREWSTER NY
MOSSMAN-ELLIOTT CORP
204 SO LARKIN AVE JOLIET ILL
MOTIOGRAPH INC
4441 W LAKE ST CHICAGO 24 ILL
MOTORDYNE INC
2221 BARRY AVE LOS ANG CALIF
MOTOROLA AVIATION ELECTRONICS INC
10916 W WASHINGTON BLVD CULVER CITY CALIF
MOTOROLA COMMUNICATIONS & ELECT INC
4501 W AUGUSTA BLVD CHICAGO ILL
MOTOROLA DAHLBERG CO
BOX 549 MINNEAPOLIS MINN
MOTOROLA INC
1400 W 30TH ST QUINCY ILL
MOTOROLA INC
1400 N CICERO AVE CHICAGO 51 ILL
MOTOROLA INC SEMICONDUCTOR PRODUCTS DIV
5005E MCDOWELL RD PHOENIX ARIZ
MOTOROLA INC
9401 GRAND AVE FRANKLIN PARK ILL
MOTORESEARCH CO
1600 JUNCTION AVE RACINE WISC
MOTSON CO J FRANK
1717 BETHLEHEM PIKE FLOURTOWN PA
MOULIC SPECIALITES CO
1007 W WASHINGTON ST BLOOMINGTON ILL
MOVIOLA MFG CO
1451 N GORDON ST HOLLYWOOD 28 CALIF
MOXNESS PRODUCTS INC
1914 INDIANA ST RACINE WISC
MOYEN CO C P
8157 MONTICELLO AVE SKOKIE ILL
MP ENGINEERING CO
FAIRFIELD 3 CONN
M & O PLASTICS PRODUCTS
BOX 402 BANNARD ST FREEHOLD NJ
MUCKLE MFG CO
U S HWY 14 OWATONNA MINN
MUCON CORP
9 ST FRANCIS ST NEWARK 5 N J

MUELLER BRASS CO
1925 LAPEER AVE PORT HURON MICH
MUELLER ELECTRIC CO
1583 E 31 ST CLEVELAND 14 OHIO
MUIRHEAD & CO LTD
BECKENHAM KENT ENGLAND
MUIRHEAD INSTRUMENTS LTD
STRATFORD ONTARIO CANADA
MUIRHEAD INSTRUMENTS INC
441 LEXINGTON AVE NEW YORK 17 NY
MULLARD EQUIPMENT LTD
MANOR ROYAL CRAWLEY SUSSEX ENG
MULLARD OVERSEAS LTD
MULLARD HOUSE TORRINGTON OL LONDON ENG
MULTI AMP ELECT CORP
61F MYRTLE ST CRANFORD N J
MULTI-AMP ELECTRONIC CORP
465 LEHIGH AVE UNION N J
MULTICORE SALES CORP
80 SHORE RD PORT WASHINGTON N Y
MULTICORE SOLDERS LTD
MAYLANDS AVE HEMEL HEMP HERTFORDSHIRE ENG
MULTI-PRODUCTS CO
21470 COOLIDGE HWY OAK PARK 37 MICH
MULTRONICS INC
BX 227 1747 E MONTGOMERY AV ROCKVILLE MD
MUNDT & SONS CHARLES
53 FAIRMOUNT AVE JERSEY CITY 4 N J
MUNSTON MFG & SERVICE INC
BEECH ST ISLIP N Y
MUNTZ INDUSTRIES INC
1000 GREY AVE EVANSTON ILL
MURRAY MFG CORP
1250 ATLANTIC AVE BROOKLYN 16 NY
MUTER CO
1255 S MICHIGAN AVE CHICAGO 5 ILL
M-W LABS INC
1824 N MILWAUKEE AVE CHICAGO ILL
MY-T-GRIP CO INC
623 GLIDE ST ROCHESTER N Y
MY-T-GRIP MFG CO INC
176 BROADWAY NEW YORK 38 N Y
MYCALEX CORP OF AMERICA
125 CLIFTON BLVD CLIFTON NJ
MYERS & SONS INC E A
375 VALLEY BROOK RD CANNONSBURY PA
MYKROY INC
645 WHEELING ROAD WHEELING ILL
MYTRON MFG CO
4522 BRAZIL ST LOS ANGELES 39 CALIF
MYTRON PRODUCTS INC
656 ATKINS AVE BROOKLYN 8 NY

N

NAGEL-CHASE MFG CO
2811 N ASHLAND AVE CHICAGO 13 ILL
NAMEPLATES INC
421 E 101 ST BROOKLYN N Y
NANILOA CORP
P O BOX 2791 STATION TOLEDO OHIO
NAPOLEON PRODUCTS CO
410 FILMORE ST NAPOLEON OHIO
NARDA MICROWAVE CORP
COMMERCIAL ST PLAINVIEW NY
NARROW FABRIC CO
P O BOX 742 READING PA
NASCO SERVICE CORP
6405 N W 36TH ST MIAMI FLA
NASH-HAMMOND CO
10141 E RUSH ST EL MONTE CALIF
NASHVILLE ELECTRONICS INC
2950 FOSTER CREIGHTON DR NASHVILLE TENN
NATIONAL AERONAUTICAL CORP
COMMERCE DR FT WASHINGTON PENNA
NATIONAL BERYLLIA CORP
1ST & HASKELL AVE HASKELL N J
NATIONAL CARBON CO DIV UNION CARBIDE CORP
270 PARK AVENUE NEW YORK 17 N Y
NATIONAL CASH REGISTER CO
MAIN & K STS DAYTON 9 OHIO
NATIONAL CERAMIC CO
500 SOUTHARD ST TRENTON N J
NATIONAL CINE EQUIPMENT INC
209 W 48 ST NEW YORK 36 N Y
NATIONAL COIL CO
P O BOX 1237 SHERIDAN WYO
NATIONAL COMPANY INC
61 SHERMAN ST MALDEN 48 MASS
NATIONAL CONNECTOR CORP
SCIENCE INDUSTRY CENTER MINN 27 MINN
NATIONAL ELECTRONICS LABS INC
1713 KALARAMA RD N W WASHINGTON 9 D C
NATIONAL ELECT COIL DIV
800 KING AVE COLUMBUS OHIO
NATIONAL ELECTRONICS INC
628 NORTH ST GENEVA ILL
NATIONAL ELECTRONICS LAB
304 BURNT MILLE AVE SILVER SPRING MD
NATIONAL ENGG PRODUCTS INC
435 WASHINGTON BLDG WASHINGTON D C
NATIONAL GASKET & WASHER MFG CO
124 E 25 ST NEW YORK 16 N Y
NATIONAL INSTRUMENT LABS INC
828 EVARTS ST N E WASHINGTON D C
NATIONAL METALLIZING CORP
825 NEW YORK AVE TRENTON 8 N J
NATIONAL MOLDITE CO
250 SOUTH AVE NEWARK N J
NATL RADIAC INC
475 WASHINGTON ST NEWARK N J

NATL RADIO CO INC
37 WASHINGTON ST MELROSE MASS
NATIONAL SCIENTIFIC LABS INC
2010 MASSACHUSETTS AVE WASHINGTON D C
NATIONAL SCREW & MANUFACTURING CO
2440 E 75 ST CLEVELAND 4 OHIO
NATL SEMICONDUCTORS LTD
230 AUTHIER SR MONTREAL QUE CANADA
NATIONAL SPECTROGRAPHIC LABS INC
6300 EUCLID AVE CLEVELAND 3 OHIO
NATIONAL STANDARD CO
8TH & HOWARD STS NILES MICH
NATL TELEVISION TUBE INC
ROUTE 46 SADDLE BROOK N J
NATIONAL TELEVISION TUBE INC
PO BOX 133 ROCHELLE PARK NJ
NATIONAL TEL TRONICS CORP
52 ST CASIMIR AVE YONKERS N Y
NATL ULTRASONIC CORP
95 PARK AVE NUTLEY N J
NATIONAL UNION ELECT CORP ELECT DIV
1201 BELL ST BLOOMINGTON ILL
NATL UTILITIES CORP
826 S ARROYO PARKWAY PASADENA CALIF
NATIONAL VACUUM PLATERS INC
2633 E HAGERT ST PHILA PA
NATIONAL VIDEO CORP
4300 W 47TH ST CHICAGO 32 ILL
NATIONAL VULCANIZED FIBRE CO
2415 GARDNER RD BROADVIEW ILL
NATIONAL VULCANIZED FIBRE CO
BOX 311 WILMINGTON DELA
NATIONAL VULCANIZED FIBRE CO
YORKLYN DEL
NATL VULCANIZED FIBRE CO
MULBERRY LAFAYETTE KENNETT SQ PA
NATL WATER LIFT CO DIV PNEUMO DYNAMICS CORP
2220 PALMER AVE KALAMAZOO MICH
NATURAL LIGHTING CORP
630 S FLOWER BURBANK CAL
NATVAR CORP
211 RANDOLPH AVE WOODRIDGE N J
NAUGLER ENGG INC
19 MADISON AVE BEVERLY MASS
NAVCOR
960 RITTENHOUSE RD VALLEY FORGE IND PK
NORRISTOWN PENNA
NAVIGATION COMPUTER CORP
VALLEY FORGE INDUSTRIAL PARK NORRISTOWN PA
NAYBOR LAB INC E V
26 MANORHAVEN BLVD PORT WASH N Y
NAZ-DAR CO
465 MILWAUKEE AVE CHICAGO 10 ILL
NAZ-DAR CO
461 MILWAUKEE AVE CHICAGO 10 ILL
NEDMAC INC
708-42ND AVE NO MINNEAPOLIS 12 MINN
NEFF INSTRUMENT CORP
1088 HAMILTON RD DUARTE CALIF
NELSON VACUUM PUMP CO GEO F
2133 4 ST BERKELEY 10 CALIF
NEMS-CLARKE CO DIV VITRO CORP OF AMERICA
919 JESUP-BLAIR DR SILVER SPRING MD
NEOSIL PRODUCTS CO
10 E 39TH ST NEW YORK 16 N Y
NEPTUNE ELECTRONICS CO
30 W 15TH ST NEW YORK 11 NY
NESHAMINY ELECT CORP
EASTON RD NESHAMINY PA
NESOR ALLOY PRODUCTS CO
666 PASSAIC AVE W CALDWELL N J
NETWORK INDUSTRIES INC
P O BOX 397 BAYONNE N J
NETWORKS ELECT CORP
9750 DESOTS CHATSWORTH CALIF
NEUSES INC P K
511 DWYER ST ARLINGTON HGTS ILL
NEUTRONIC ASSOCIATES INC
32 TENNESSEE AVE HEMPSTEAD N Y
NEVADA AIR PRODUCTS CO
PO BOX 1090 N VALLEY RD RENO NEV
NEVEDA ANTENNA CO
P O BOX 530 COLUSA CALIF
NEWARK CONTROLS CO
15 WARD ST BLOOMFIELD N J
NEWARK SPINNING & STAMPING
472 BLOY ST HILLSIDE N J
NEWARK WIRE CLOTH CO
351 VERONA AVE NEWARK N J
NEWBURY INDUSTRIES INC
NEWBURY OHIO
NEWCASTLE FABRICS CORP
75 N 11TH ST BROOKLYN 11 N Y
NEWCOMB AUDIO PROD CO
6824 LEXINGTON AVE HOLLYWOOD CALIF
NEWCOMB SPRING CORP
77 E HAWTHORNE AVE VALLEY STREAM N Y
NEWCOMB SPRING OF ATLANTA INC
1200 SPRING ST NW ATLANTA GA
NEWCOMB SPRING OF CONN
510 QUEEN ST SOUTHINGTON CONN
NEW DEPARTURE DIV GMC
269 N MAIN ST BRISTOL CONN
NEW DEPARTURE DIV GMC
HAYES AVE SANDUSKY OHIO
NEW ENG ELECT WORKS INC
365 MAIN ST LISBON N H
NEW ENGLAND INSTRUMENT CO
39 GREEN ST WALTHAM MASS
NEW ENGLAND LAMINATES CO
481 CANAL ST STAMFORD CONN
NEW ENGLAND NUCLEAR CORP
575 ALBANY ST BOSTON MASS
NEW ENGLAND TAPE CO
30 TOWER ST HUDSON MASS
NEW ENGLAND TRANSFORMER CO
47 MCGRATH HWY SOMERVILLE 43 MASS

NEW HAMPSHIRE BALL BEARINGS INC
ROUTE 202 PETERBOROUGH N H
NEW HERMES ENGRAVING MACHINE CORP
1346 N HIGHLAND AVE LOS ANGELES 28 CALIF
NEW HERMES ENGRAVING MACHINE CORP
154 W 14TH ST NEW YORK 11 NY
NEW JERSEY ZINC CO
160 FRONT ST NEW YORK 38 N Y
NEW JERSEY WOOD FINISHING CO
AMBOY AVE WOODBRIDGE N J
NEW LONDON INST CO INC
82 UNION ST NEW LONDON CONN
NEWMAN CORP M M
79 CLIFTON AVE MARBLEHEAD MASS
NEW PRODUCTS INC
CAMERON VILLAGE STA RELEIGH N C
NEWTON CO
55 ELM ST MANCHESTER CONN
NEWTON INSERT CO
6500 AVALON BLVD LOS ANG CALIF
NEW-TRONICS CORP
3455 VEGA AVE CLEVELAND 13 OHIO
NEW YORK AIR BRAKE CO
230 PARK AVE NEW YORK 17 N Y
N Y MFG & GENERAL SUPPLY CO
144 46 70TH AVE FLUSHING N Y
NEW YORK COIL CO
40 2 AVE PHOENIXVILLE PA
NEW YORK SOLDER CO
684 E 133 ST NEW YORK 54 N Y
NEW YORK TRANSFORMER CO
3 AVE ALPHA N J
NEW YORK TWIST DRILL CO INC
30 N CLIFTON ST CHICAGO ILL
N Y TWIST DRILL MFG CORP
99 MAGNOLIA AVE WESTBURY N Y
NEY CO J M
P O BOX 990 HARTFORD 1 CONN
NIAGARA ELECTRON LABS
BOX 128 MAIN ST ANDOVER N Y
NIAGARA ELECTRON LABS
MAIN & GREENWOOD ST ANDOVER N Y
NIAGARA MACH & TOOL WKS
683 NORTHLAND AVE BUFFALO N Y
NICAD DIV GOULD NATIONAL BATTERIES INC
EASTHAMPTON MASS
NICAD DIV GOULD NATL BATTERIES INC
931 N VANDALIA ST ST PAUL MINN
NICHOLS & CLARK INC
321 NEWBURY PORT TURNPIKE HATHORNE MASS
NICHOLS ELECTRONICS
85 SO 13TH ST MINNEAPOLIS 3 MINN
NICHOLS PRODUCTS CO
325 W MAIN ST MOORESTOWN NJ
NIELSEN HARDWARE CORP
770 WETHERSFIELD AVE HARTFORD CONN
NIEMAND BROS INC
45-10 94TH ST ELMHURST 13 N Y
NILSSON ELECTRICAL LABORATORY INC
103 LAFAYETTE ST NEW YORK 13 N Y
NIPPERT ELECTRIC PRODUCTS CO
1759 W MOUND ST COLUMBUS 23 OHIO
NJE CORP
20 BORIGHT AVE KENILWORTH NJ
NOBLE & WESTBROOK MFG CO
EAST HARTFORD 8 CONN
NOEL MFG CO
3 W 18 ST NEW YORK 11 N Y
NON LINEAR SYSTEMS INC
DEL MAR AIRPORT DE L MAR CALIF
NONOTUCK MFG CO
CANAL ST S HADLEY FALLS MASS
NOPCO CHEMICAL CO
60 PARK PLACE NEWARK N J
NOPCO CHEMICAL CANADA LTD
PO BOX 68 LONDON ONT CANADA
NOPCO CHEMICAL CO PLASTICS DIV
175 SCHUYLER AVE NORTH ARLINGTON NJ
NORCO PRODUCTS MFG CO
392 BLEECKER ST NEW YORK 14 N Y
NORDEN DIV UNITED AIRCRAFT CORP
HELEN ST NORWALK CONN
NORDEN DIV UNITED AIRCRAFT CORP DATA SYS DPT
3501 HARBOR BLVD COSTA MESA CALIF
NORMAN JONES INC
SO MERRIMACK N H
NORPLEX FABRICATIRS INC
BLACK RIVER FALLS WISC
NORRICH PLASTICS CORP
107 W 18TH ST NEW YORK N Y
NORRMAN LABORATORIES ERNST
WILLIAMS BAY WISC
N AMERICAN AVIATION INC MISSILE DIV
12214 LAKEWOOD BLVD DOWNEY CALIF
NORTH AMERICAN AVIATION AUTONETICS DIV
9150 E IMPERIAL HWY DOWNEY CALIF
NORTH AMERICA ELECTRONICS
723 3RD AVE W BIRMINGHAM ALA
NORTH AMERICAN ELECT INC
71 LINDEN ST WEST LYNN MASSACHUSETTS
NORTH ATLANTIC INDUST INC
603 MAIN ST WESTBURY N Y
NORTHEAST ELECT CORP
AIRPORT RD CONCORD N H
NORTHEASTERN ENG INC
25 S BEDFORD ST MANCHESTER N H
NORTHEAST SCIENTIFIC CORP
30 WETHERBEE ST ACTON MASS
NORTH ELECTRIC CO
GALION OHIO
NORTHERN ELECT INC
8440 PILLSBURY AVE S MINN MINN
NORTHERN ENGG LABS
845 BELOIT ST BURLINGTON WISC
NORTHERN METAL PRODUCTS CORP
9595 W GRAND AVE FRANKLIN PARK ILL
NORTHERN ORDNANCE INC
48TH & MARSHALL ST NE ST PAUL 21 MINN

NORTHERN PLASTICS CORP
2ND MARKET ST LACROSSE WISC
NORTHERN RADIO CO
143 W 22 ST NEW YORK 11 N Y
NORTHERN RADIO MFG CO
1950 BANK ST OTTAWA ONT CANADA
NORTH HILLS ELECTRIC CO INC
ALEXANDER PL GLEN COVE L I N Y
NORTHMOOR RECORDING
BOX 691 ST LOUIS 88 MO
NORTH SHORE NAMEPLATE DIV ANODYNE INC
214-27 NORTHERN BLVD BAYSIDE 61 N Y
NORTON ASSOC INC
240 OLD COUNTRY RD HICKSVILLE NY
NORTON CO NEW PRODS DEPT
WORCESTER MASS
NORTRONICS CO INC
1015 S 6TH ST MINNEAPOLIS 4 MINN
NORTRONICS CO INC
8101 W 10TH AVE N MINNEAPOLIS MINN
NORTRONICS DIV NORTHROP CORP
222 N PRAIRIE AVE HAWTHORNE CALIF
NORWALK CUTTER SHARPENING CO
69 CONN AVE BOX 588 S NORWALK CONN
NORWOOD CO TROLS UNIT DETROIT CONTROLS DIV
5900 TRUMBULL AVE DETROIT MICH
NOTHELFER WINDING LABS INC
P O BOX 455 TRENTON 3 N J
NP KFR CORP
6006 WASHINGTON BLVD CULVER CITY CALIF
NRC EQUIPMENT CORP
160 CHARLEMONT ST NEWTON 61 MASS
NRK MICROWAVE DIV COOK ELECT CO
4601 W ADDISON ST CHICAGO 41 ILL
NUCLEAR-CHICAGO CORP
333 E HOWARD AVE DES PLAINES ILL
NUCLEAR CORP OF AMER
2 RICHWOOD PL DENVILLE NJ
NUCLEAR CORP OF AMER
3540W OSBORN RD PHOENIX ARIZ
NUCLEAR DEVELOPMENT LAB
P O BOX 7034 KANSAS CITY 13 MO
NUCLEAR-ELECTRONICS CORP
2925 N BROAD ST PHILADELPHIA 32 PA
NUCLEAR ENTERPRISES G B LTD
BANKHEAD MEDWY SIGHTHL EDINBURGH 11 SCTLND
NUCLEAR MEASUREMENTS CORP
2460 N ARLINGTON AVE INDIANAPOLIS 18 IND
NUCLEAR PROD INC
10173 RUSH ST EL MONTE CALIF
NUCLEONIC CORP OF AMERICA
196 DEGRAW ST BROOKLYN 31 N Y
NUCLEONIC PROD CO
3133 E 12TH ST LOS ANGELES 23 CALIF
NUCLIDE ANALYSIS ASSOC
P O BOX 752 STATE COLLEGE PA
NUGENT ELECT CO INC
802 E 8TH ST NEW ALBANY IND
NU-LINE INDUSTRIES
1015 SO SIXTH ST MINNEAPOLIS 4 MINN
NU STEEL CO
1714 S ASHLAND AVE CHICAGO 8 ILL
NUTMEG SCREW MACH PROD CO
P O BOX 147 WATERBURY CONN
NUTONE INC
MADISON & RED BANK RDS CINCINNATI OHIO
NUTRON DIV WESTMORE INC
137 SOUTH AVE FANWOOD NJ
N WOOD COUNTER LAB INC
1525 E 53 CHICAGO ILL
NYGLASS INC
7314 E MADISON PARAMOUNT CALIF
NYLOGRIP PROD
570 PLEASANT ST WATERTOWN MASS
NYLOK CORP
8046 CENTRAL PARK AVE SKOKIE ILL
NYTRONICS INC
550 SPRINGFIELD AVE BERKELEY HEIGHTS N J
NYTRONICS INC
480 FAIRMAN RE PO BOX 259 LEXINGTON KENTY

O

OAK MFG CO
CRYSTAL LAKE ILLINOIS
O DELL BROS
2950 GRANT RD MOUNTAIN VIEW CALIF
OGDEN COIL TRANSFORMER CO
3323 W CERMAK RD CHICAGO 23 ILL
OHIO BRASS CO
380 N MAIN ST MANSFIELD OHIO
OHIO CARBON CO
12508 BEREA RD CLEVELAND 11 OHIO
OHIO CHEMICAL & SURGICAL EQUIPMENT CO
1177 MARQUETTE ST CLEVELAND 14 OHIO
OHIO CHEMICAL & SURGICAL EQUIPMENT CO
1130 GRAND ST HOBOKEN NJ
OHIO CRANKSHAFT CO TOCCO DIV
3800 HARVARD AVE CLEVELAND 5 OHIO
OHIO SEAMLESS TUBE DIV COPPERWELD STEEL CO
SHELBY OHIO
OHIO SEMICONDUCTORS
1205 CHESAPEAKE AVE COLUMBUS OHIO
OHMART CORP
4241 ALLENDORF DR CINN OHIO
OHMITE MFG CO
3601 HOWARD ST SKOKIE ILL
OHMWEVE CO INC
43 DARCY ST WEST HARTFORD CONN
OIL RITE CORP
2318 WALDO BLVD MANITOWOC WISC
OK ELECTRONICS CORP
7 HUNT PL NUTLEY 1 NJ

OKONITE CO
PASSAIC N J
OLSEN TINIUS TESTING MACH CO
EASTON ROAD WILLOW GROVE PA
OLTRONIX INC
247 UNDERWOOD DR NW ATLANTA 5 GA
OLYMPIC INSTRUMENTS INC
VASHON WASH
OLYMPIC PLASTICS CO INC
3471 S LACIENEGA BLVD LOS ANGELES 16 CALIF
OLYMPIC PRODUCTS CO INC
3 AVE ALPHA NJ
OLYMPIC RADIO & TV DIV SIEGLER CORP
34-01 38 AVE LONG ISLAND CITY 1 NY
OMCO
BOX 1110 US 93 & LAS PALMS ST KINGMAN ARIZ
OMEGA LABS INC
HAVERHILL ST ROWLEY MASS
OMNITRONICS INC
511 N BROAD ST PHILA PA
OMTRONICS MFG INC
PO BOX 1419 PEONY PARK ST OMAHA NEBR
ONAN DV OF STUDEBAKER PACKARD CORP
2515 UNIVERSITY AVE S E MINN MINN
ON MARK COUPLINGS INC
4440 YORK BLVD LOS ANGELES 41 CALIF
ONONDAGA ELECTRONICS DIV SPEER CARBON CO
1810 W FAYETTE ST SYRACUSE 1 N Y
ONSRUD MACHINE WORKS INC
7720 N LEHIGH AVE MILES 48 ILL
OPAD ELECTRIC CO
43 WALKER ST NEW YORK 13 N Y
OPTICAL COATING LAB INC
977 SEBASTOPOL RD SANTA ROSA CALIF
OPTICAL GAGING PRODUCTS INC
26 FORBES ST ROCHESTER 11 N Y
OPTICS TECHNOLOGY INC
248 HARBOR BLVD BELMONT CALIF
OPTIMIZED DEVICES INC
864 FRANKLIN AVE THORNWOOD NY
OPTOMECHANISMS INC
216 E 2ND ST MINEOLA N Y
OPTRON CORP
335 S SALINAS ST SANTA BARBARA CALIF
ORANGE ROLLER BEARINGS CO INC
557 MAIN ST ORANGE NJ
ORBITT ELECTRONICS IND
306 N ALBANY AVE N MASSAPEQUE L I N Y
ORBIT INDUSTRIES
BOX 666 RESEDA CALIF
ORBITRAN CO INC
11487 WOODSIDE AVE LAKESIDE CALIF
ORDNANCE OPERATION ELECT OIV AVCO CORP
RICHMOND IND
OREGON ELECTRONICS MFG CO
2105 SE 6 AVE PORTLAND 14 ORE
ORIGINAL ENDERES CO
GUTTENBERG IOWA
DRION ELECTRONICS CORP
108 COLUMBUS AVE TUCKAHOE N Y
ORTHO FILTER CORP
7 PATERSON ST PATERSON 1 N J
ORTHOLOG DIV
P O BOX 37 PRINCETON JUNCTION N J
DRTHOLDG DIV GULTON INDUST
4054 QUAKER BRIDGE RD TRENTON NJ
ORTHO MAGNETICS INC
BOX 240 KUTZTOWN PENNA
ORTHO PRECISION RESISTORS INC
7 PATTERSON ST PATERSON N J
ORTMAN-MILLER MACHINE CO INC
19 143RD ST HAMMOND IND
OSBORNE ELECTRONIC CORP
712 SE HAWTHORNE BLVD PORTLAND 14 ORE
OSBORNE TRANSFORMER CORP
3834 MITCHELL AVE DETROIT 7 MICH
OSCAR A SCHOTT CO
500-11TH AVE SO MINNEAPOLIS 4 MINN
O & S RESEARCH INC
1811 BANNARD ST RIVERTON N J
OSTER MFG CO JOHN AVIONIC DIV
1 MAIN ST RACINE WISC
OTARION LISTENER CORP
SCARBOROUGH PK OSSINING N Y
OTIS ELEVATOR CO DEFENSE & INDUSTRIAL DIV
35 RYERSON ST BROOKLYN 5 N Y
OVENAIRE INC
706 FOREST ST CHARLOTTESVILLE VA
DVERHEAD DOOR CORP
PO BOX 188 HARTFORD CITY IND
OVERLOAD CONTROL CO
151 PENNA AVE N LONG BEACH ISLAND PARK N Y
OWEN LABS INC
55 BEACON PL PASADENA CALIF
OXFORD COMPONENTS DIV OXFORD ELECT CORP
3911 S MICHIGAN CHICAGO 15 ILL
DXFORD ELECTRIC CORP
3911 S MICHIGAN AVE CHICAGO 15 ILL
OXYGEN EQUIPMENT & SERVICE CO
8335 S HALSTED ST CHICAGO 20 ILL
OZONE METAL PRODUCTS CORP
101-32 101ST OZONE PARK L I N Y

P

PACE ELECTRICAL INSTRUMENTS CO
70-31 84 ST GLENDALE 27 L I N Y
PACE ENGINEERING CO
13035 SATICOY ST N HOLLYWOOD CALIF
PACIFIC AUTOMATION PRODUCTS
1200 AIR WAY GLENDALE 1 CALIF
PACIFIC ELECTRO MAGNETIC CD INC
942 COMMERCIAL ST PALO ALTO CALIF
PACIFIC MERCURY ELECT INC
8345 HAYVENHURST AVE SEPULVEDA CALIF
PACIFIC MERCURY TV MFG CORP
8345 HAYVENHURST AVE SEPULVEDA CALIF
PACIFIC OPTICAL CORP DIV CHICAGO AERIAL IND
120 GLASGOW AVE INGLEWOOD 1 CALIF
PACIFIC RELAYS INC
13915 SATICOY ST VAN NUYS CALIF
PACIFIC SCIENTIFIC CO
P O BOX 22019 LOS ANGELES 22 CALIF
PACIFIC SEMICONDUCTORS INC
12955 CHADRON AVE HAWTHORNE CALIF
PACIFIC SEMICONDUCTORS INC
14520 AVIATION BLVD LAWNDALE CALIF
PACIFIC TECHNICAL CO
2047 SAWTELLE BLVD LOS ANGELES 25 CALIF
PACIFIC TRANSDUCER CORP
11836 W PICO BLVD LOS ANGELES CAL
PACIFIC UNIVERSAL PROD CORP
168 VISTA AVE PASADENA 8 CALIF
PACKARD BELL COMPUTER CORP
1905 ARMACOST AVE LOS ANGELES 25 CALIF
PACKARD BELL ELECTRONICS CORP
12333 W OLYMPIC BLVD LOS ANGELES 64 CALIF
PACKARD BELL ELECTRONICS
2341 MICHIGAN AVE SANTA MONICA CALIF
PACKARD INSTRUMENT CO
P O BOX 428 LAGRANGE ILL
PACO ELECTRONICS CO INC
70-31 84TH ST GLENDALE 27 LI NY
PACO PRECISION
70-31 84TH ST GLENDALE 27 LI N Y
PAGE FOGWELL CORP
3014 N COOLIDGE AVE LOS ANGELES CALIF
PAKTRON DIV ILL TOOL WORKS
1321 LESLIE AV ALEXANDRIA VA
PALCO ENG CO
355 COLUMBIA ST P O BOX 291 FRANKFORT IND
PALNUT CO
25 GLEN RD MOUNTAINSIDE NY
PALO ALTO ENGG CO
620 PAGE MILL RD PALO ALTO CALIF
PALOMAR EQUIP CO
4254 NIAGARA AVE SAN DIEGO 7 CALIF
PAMPA ELECT CORP
221 ROCK HILL RD BALA-CYNWYD PA
PANDUIT CORP
17301 RIDGELAND AVE TINLEY PARK ILL
PAN-ELECTRONICS CORP
PO BOX 404 GRIFFIN GA
PANEL ENG CORP
222 W HURON ST CHICAGO ILL
PANELLIT INC DIV INFORMATION SYS INC
7401 HAMLIN AVE SKOKIE ILL
PANELLIT LTD
MEMBER OF ELLIOTT AUTOMATION GROUP
ELSTREE WAY BOREHAMWOOD HERTS ENGLAND
PANELYTE DIV ST REGIS PAPER CO
ENTERPRISE AVE TRENTON 4 NEW JERSEY
PAN FAX INC
401 OLD COAST HWY SANTA BARBARA CALI
PANOB CORP
49 BEECH PORT CHESTER N Y
PANORAMIC ELECTRONICS
520 S FULTON AVE MT VERNON NY
PANTEK CO
P O BOX 212 EL SEGUNDO CALIF
PANTHER ELECTRONICS INC
901 S MAIN ST BURBANK CALIF
PAPER PRODUCTS MINNESOTA MINING & MFGING CO
HARTFORD CITY INDIANA
PAPESCH & KOLSTAD INC
BOX 3726 10703 CAPITAL AV OAK PARK 37 MICH
PARABAM INC
12822 YUKON HAWTHORNE CALIF
PARAGON ELECTRIC CO
1600 12 ST TWO RIVERS WISC
PARAGON REVOLUTE DIV CHARLES BRUNING CO INC
77 SOUTH AVE ROCHESTER 4 N Y
PARAMOUNT PAPER TUBE CORP
614 S LAFAYETTE ST FORT WAYNE 2 IND
PARK NAMEPLATE CO
34-10 LINDEN PL FLUSHING 54 N Y
PARKER ELECTRICAL INSTRUMENT CORP
200 HARVARD AVE STAMFORD CONN
PARKER KALON GENERAL AMER TRAN CO
1 PEEKAY DR CLIFTON N J
PARKER METAL GOODS CO
85 PRESCOTT ST WORCESTER MASS
PARKER SEAL CO DIV PARKER-HANNIFIN CORP
10567 JEFFERSON BLVD CULVER CITY CALIF
PARKS LAB HENRY FRANCIS
P O BOX 1665 LAKE CITY STA SEATTLE 55 WASH
PARMENTER & BULLOCH MFG CO LTD
GANANOQUE ONTARIO CANADA
PAR-METAL PRODUCTS CORP
32-62 49 ST LONG ISLAND CITY 3 NY
PAR PRODUCTS CORP
602 COLORADO AVE SANTA MONICA CALIF
PARSONS CO RALPH M ELECTRONICS DIV
151 S DE LACEY AVE PASADENA CALIF
PARTLOW CORP
211 CAMPION RD NEW HARTFORD N Y
PARTRICK & WILKINS CO
51 N 7 ST PHILA PA
PARTRIDGE TRANSFORMERS LTD
ROEBUCK RD TOLWORTH SURREY ENGLAND
PASTORIZA ELECT INC
285 COLUMBUS AVE BOSTON MASS
PATTERSON MOOS RESEARCH DIV LEESONA CORP
90 28 VAN WYCK EXPRESSWAY JAMAICA N Y
PATWIN DIV PATENT BUTTON
WATERBURY CONN
PAUL F H & STEIN BROS INC
235 5 AVE NEW YORK N Y
THE PAVELLE CORP
32 DEPOT PLAZA WHITE PLAINS N Y
PCA ELECTRONICS INC
16799 SCHOENBORN ST SEPULVEDA CALIF
PICKERING CO INC
SUNNYSIDE BLVD PLAINVIEW N Y
PEARCE SIMPSON INC MARINE & COMM DIVISION
2295 NW 14TH ST MIAMI 35 FLA
PEARCE SIMPSON CO
8040 S W 69TH AVE S MIAMI FLA
PEARSON ELECTRONICS INC
707 URBAN LA PALO ALTO CALIF
PECK SPRING CO
89 WHITING ST PLAINVILLE CONN
PECK STOW WILCOX CO
217 274 CENTER ST SOUTHINGTON CONN
PEE WEE MOLDING CO
1720 ATLANTIC AVE BROOKLYN N Y
PEEBLES & CO LTD BRUCE
EAST PILTON EDINBURGH 5 SCOTLAND
PEER INC
1200 MILTON ST BENTON HARBOR MICH
PEER INC PROFESSIONAL ELECT ENG
2624 SHELBY ST DALLAS TEXAS
PEERLESS ELECTRICAL PRODUCTS
1515 S MANCHESTER AVE ANAHEIM CAL
PEERLESS ELECT PRODS DIV ALTEC LANSING CORP
1515 S MANCHESTER AVENUE ANAHEIM CALIF
PEERLESS ENGG PRODUCTS CO
30-81 21ST LONG ISLAND CITY 2 N Y
PEERLESS PRODUCTS INDUSTRIES
812 N PULASKI RD CHICAGO 51 ILL
PEGASUS LABS INC
3500 W ELEVEN MILE RD BERKLEY MICH
PEK LABS INC
4024 TRANSPORT ST PALO ALTO CALIF
PELLEY CO
37 HURLEY ST CAMBRIDGE MASS
PELTON DIV BALDWIN LIMA HAMILTON CORP
2929 19TH ST SAN FRAN CALIF
PENCO DIV ALAN WOOD STEEL CO
OAKS PENNA
PENDAR INC
14744 ARMINTA ST VAN NUYS CALIF
PENETONE CO
TENAFLY N J
PENN ENGG & MFG CORP
DOYLESTOWN PA
PENN FIBRE SPECIALTY CO
2020 WESTMORELAND ST PHILA PA
PENN KEYSTONE CORP
P O BOX 350 DERBY CONN
PENN METER CO
4110 HAVERFORD AVE PHIA PA
PENN TRANSFORMER CORP
E BISHOP ST BELLEFONTE PA
PENNWOOD NUMECHRON CO
7249 FRANKSTOWN AVE PITTSBURG 8 PA
PENSINULAR MFG CO INC
1600 W SMITH ST ORLANDO FLA
PENTA LAB INC
312 NOPAL ST SANTA BARBARA CALIF
PENTRON ELECT CORP
777 S TRIPP AVE CHICAGO ILL
PERENY EQUIP CO INC
BOX 5064 TRIVILLAGE STA COLUMBUS OHIO
PERFECTION MICA CO MAGNETIC SHIELD DIV
1322 ELSTON AVE CHICAGO ILL
PERFORMANCE MEASUREMENTS CO
15120 THIRD AVE DETROIT 5 MICH
PERKIN ELMER CORP
MAIN AVE NORWALK CONN
PERKIN ELMER CORP VERNISTAT DIV
EMERALD ST NORWALK CONN
PERKIN ENGG CORP
345 KANSAS ST EL SEGUNDO CALIF
PERMAG CORP
88 06 VAN WYCK EXPRESSWAY JAMAICA N Y
PERMALI INC
P O BOX 718 MT PLEASANT PA
PERMA-POWER CO
3102 N ELSTON AVE CHICAGO 18 ILL
PERMOFLUX CORP
4101 SAN FERNANDO RD GLENDALE CALIF
PERMOFLUX DIV
2300 W ARMITAGE AVE CHICAGO 47 ILL
PERMONITE MFG CO
910 JACKSON BLVD CHICAGO ILL
PERMUTIT CO DIV PFAUDLER PERMUTIT INC
50 W 44 ST NEW YORK N Y
PESCHEL ELECTRONICS INC
TOWNERS RT 216 PATTERSON N J
PESCO PRODUCTS DIV WESTERN BRANCH
3310 VANOWEN ST BURBANK CALIF
PESCO PRODUCTS DIV BORG WARNER CORP
24700 N MILES RD BEDFORD OHIO
PETTINOS GRAPHITE CORP
1 E 42ND ST NEW YORK 17 N Y
PFANSTIEHL CHEMICAL CORP
104 LAKE VIEW AVE WAUKEGAN ILL
PFI PRODUCTS FOR INDUSTRY INC
PENNDEL PA
PHALO PLASTICS CORP
530 BOSTON TWPK SHREWSBURY MASS
PHAOSTRON INSTRUMENT & ELECTRONIC CO
151 PASADENA AVE S PASADENA CALIF
P & H ELECTRONICS
424 COLUMBIA LAFAYETTE IND
P & H SALES CORP
5650 N WESTERN AVE CHICAGO 45 ILL
PHELPS DODGE COPPER PRODUCTS CORP
300 PARK AVE NEW YORK 22 N Y
PHEOLL MFG CO
5700 W ROOSEVELT RD CHICAGO 50 ILL
PHILA INSULATED WIRE CO
333 NEW ALBANY RD MORRESTOWN N J
PHILA SCIENTIFIC GLASS CO
RIDGE AVE PERKASIE PENNA
PHILBRICK RESEARCHES INC GEORGE A
127 CLARENDON ST BOSTON MASS

PHILCO CORP
TIOGA & C STS PHILADELPHIA 24 PA
PHILCO CORP
SANDUSKY OHIO
PHILCO CORP
WILLOW GROVE PA
PHILCO CORP
SPRING CITY PENNA
PHILCO CORP
4700 WISSAHICKON AVE PHILA PENN
PHILCO CORP
3875 FABIAN WAY PALO ALTO CALIF
PHILCO CORP COMMUNICATIONS & WEAPONS DIV
4700 WISSAHICKON AVE PHILA PENNA
PHILCO CORP G & I DIV
4700 WISSAHICKON AVE PHILA 44 PENNA
PHILCO CORP GOVT & INDUSTRIAL GROUP
4700 WISSAHICKON AVE PHILADELPHIA 44 PA
PHILCO CORP LANSDALE DIV
CHURCH RD LANSDALE PA
PHILCO CORP SIERRA ELECTRONIC DIV
3885 BOHANNAN DR MENLO PARK CALIF
PHILIPS ELECTRONIC INSTRUMENTS
750 S FULTON AVE MT VERNON N Y
PHILIPS ELMET CORP
LISBON RD LEWISTON ME
PHILLIPS CONTROL CORP
JOLIET ILL
PHILLIPS PROCESS CO
192 MILL ST ROCHESTER 14 N Y
PHILMON LABS INC
90 HOPPER ST WESTBURY N Y
PHILMORE MFG CO INC
130-01 JAMAICA AVENUE RICHMOND HILL 18 N Y
PHILSON MFG CO INC
47 BERGEN ST BROOKLYN 1 N Y
PHOENIX ENGINEERING & MFG CO
1320 N 52ND ST PHOENIX ARIZ
PHOENIX PRECISION INSTRUMENT CO
3805 N 5 ST PHILADELPHIA 40 PA
PHOTOMATRION INC
280 POLARIS AVENUE MOUNTAIN VIEW CALIF
PHOTOBELL CO
12 EAST 22ND ST NEW YORK N Y
PHOTOCHRON RESEARCH IN
24 HOWARD ST NEW YORK N Y
PHOTOCIRCUITS CORP
31 SEA CLIFF AVE GLEN COVE N Y
PHOTOCON RESEARCH PRODUCTS
421 N ALTADENA DR PASADENA CALIF
PHOTO - CRYSTALS
605 PRAIRIE ST ST CHARLES ILL
PHOTO-RESEARCH CORP
837 N CAHUENGA BLVD HOLLYWOOD 38 CALIF
PHOTO-TRONIC PRODUCTS CORP
517 OAK ST FORT ATKINSON WIS
PHOTOVOLT CORP
95 MADISON AVE NEW YORK 16 N Y
PHOTRON INSTRUMENT CO
6516 DETROIT AVE CLEVELAND 2 OHIO
PHYS CHEMICAL RES CORP
40 E 12TH ST NEW YORK N Y
PHYSICAL SCIENCES CORP
389 N FAIR AVE LOS ANG CALIF
PIC AUTOMATION CONTROLS
8080 MCCORMICK BLVD SKOKIE ILL
PIC DESIGN CORP SUB OF BENRUS WATCH CO INC
477 ATLANTIC AVE E ROCKAWAY LI NY
PICKERING CO INC
SUNNYSIDE BLVD PLAINVIEW NY
PICKER X-RAY CORP WAITE MFG DIV INC
17325 EUCLID AVE CLEVELAND OHIO
PIEZO CRYSTAL CO
265 POMFRET ST CARLISLE PA
PIEZO PRODUCTS CD
WHITNEY ST SHERBORN MASS
PILGRIM SCREW CORP
P O BOX 1452 PROVIDENCE R I
PILOT CHEMICALS INC
36 PLEASANT ST WATERTOWN MASS
PILOT RADIO CORP
37-06 36 ST LONG ISLAND CITY 1 N Y
PIONEER ELECTRIC & RES CO
743 CIRCLE AVE FOREST PARK ILL
PIONEER INDUSTRIES INC
2700 HAWKEYE DR SIOUX CITY IOWA
PIONEER MAGNETICS INC
850 PICO BLVD SANTA MONICA CALIF
PIONEER PATENTS & PRODUCTS CO
3720 N NEW ENGLAND AVE CHICAGO 34 ILL
PITOMETER LOG CORP
237 LAFAYETTE ST NEW YORK 12 N Y
PIONEER GEN-E-MOTOR CORP
5841 W DICKENS AVE CHICAGO 39 ILL
PHOTOVOLT CORP
1115 BROADWAY NEW YORK N Y
PIX MFG CO
75 HUDSON ST NEWARK NJ
PLANET MFG CORP
225 BELLEVILLE AVE BLOOMFIELD N J
PLANET PLATING CO INC
1333 FLUSHING AVE BKLYN N Y
PLANETRONICS INC
CENTER AT GLENDALE STS EASTON PA
PLASTIC ASSOCIATES
773 BROADWAY LAGUNA BEACH CALIF
PLASTIC CAPACITORS INC
2620 N CLYBOURN AVE CHICAGO 14 ILL
PLASTIC FAB INC
N MAIN ST FRANKLIN N H
PLASTIC FACTORS INC
926 BROADWAY REDWOOD CITY CALIF
PLASTIC MOLD & ENGG CO
WAMPANOAG TRAIL E PROVIDENCE 14 RI
PLASTIC PROCESS DIV MONADNOCK MILLS
11200 HINDRY AVE LOS ANG CALIF
PLASTIC WIRE & CABLE CORP
BOX 486 JEWETT CITY CONN
PLASTIC WIRE & CABLE CORP
EAST MAIN ST JEWETT CITY CONN
PLASTICRAFT PRODUCTS CO
1 STATION PLAZA WEST NYACK N Y
PLASTICRAFTS INC
2800 N SPEER BLVD DENVER COLO
PLASTICS & RESINS DIV SHELL CHEMICAL CO
110 W 51ST ST NEW YORK 20 N Y
PLASTICS STAMPING CO
932 PRINCE ST POMONA CALIF
PLASTIGAGE CORP
915 E SOUTH ST JACKSON MICH
PLASTOFILM INC
916 W UNION AVE WHEATON ILL
PLASTOID CORP
45 GINGERBREAD RD HAMBURG N J
PLASTOID CORP
42 61 24TH ST LONG ISLAND CITY N Y
PLAS TRON CORP
815 S W VIEWMONT DR PORTLAND OREGON
PLECTRON CORP
OVERTON NEBR
PLISCO WILLIAM B
62 SCHENECTADY AVE BROOKLYN NY
PLUG IN INSTRUMENTS INC
1416 LEBANON RD NASHVILLE TENN
PLYMOUTH RUBBER CO
REVERE ST CANTON MASS
P M DIV CRANE CO
1960 BRIDGE ST JOHNSTOWN PA
PM ELECTRONICS INC
5221 UNIVERSITY AVE SAN DIEGO CALIF
PNEU-HYDRO VALVE CORP
52 HORSE HILL RD CEDAR KNOLLS N J
PNEUMAFIL CORP
2516 WILKINSON BLVD CHARLOTTE 8 N C
PNEUMO DYNAMICS CORP INST & CONTROL DIV
305 W FULTON ST GRAND RAPIDS MICH
POLACOAT INC
9750 CONKLIN RD BLUE ASH OHIO
POLARAD ELECTRONICS CORP
4320 34 ST LONG ISLAND CITY N Y
S B POLARIMETERS
SPENCER HILL RD CORNING N Y
POLLAK CORP JOSEPH
81 FREEPORT ST BOSTON 22 MASS
POLYCO INC
145 ROSWELL RD SMYRNA GA
POLY KOTE INC
82 CHESTNUT NORTH ATTLEBORO MASS
POLYMER CORP
2120 FAIRMONT AVE READING PA
POLYMICA & INSULATION CO INC
WILLIMANTIC CONN
POLYPHASE INSTRUMENT CO
E 4 ST BRIDGEPORT PA
POLY-SCIENTIFIC CORP
COLLEGE AVE BLACKSBURG VA
POLYTECHNIC RESEARCH & DEVELOPMENT CO
202 TILLARY ST BROOKLYN 1 N Y
POLYTRONIC RESEARCH INC
7326 WESTMORE RD ROCKVILLE MD
POLYTRONICS CO
582 BATHURST ST TORONTO ONT CANADA
POMONA ELECTRONICS CO INC
1500 E NONTH ST POMONA CALIF
POOLE INSTRUMENTS INC
150 EXPRESS ST DALLAS 21 TEXAS
PORAY INC
3369 W GRAND AVE CHICAGO 51 ILL
PORCELAIN PRODUCTS CO
224 N PATTERSON ST CAREY OHIO
PORTER CO INC H K RIVERSIDE-ALLOY METAL DIV
RIVERSIDE N J
H K PORTER CO INC
WASHINGTON ST LISBON OHIO
PORTER INC H K
74 FOLEY ST SOMERVILLE 43 MASS
PORT O VOX CORP
521 W 43RD ST NEW YORK 36 N Y
POSITIVE LOCK WASHER CO
181 VANDERPOOL ST NEWARK 5 NJ
POSSIS MACHINE CORP
825 RHODE ISLAND AVE S MINNEAPOLIS MINN
POST ELECTRONICS PROD
12 LOTHROP ST BEVERLY MASS
THE POTTER CO
950 CONGRESS ST BROOKHAVEN MISS
POTTER AERONAUTICAL CORP
U S ROUTE 22 UNION N J
POTTER & BRUMFIELD
1200 BROADWAY PRINCETON IND
POTTER & BRUMFIELD
FRANKLIN KY
POTTER CO THE
WESSON MISS
POTTER ENG CO
1410 SANTA ANNA DR DUNEDIN FLA
POTTER INSTRUMENT CO
SUNNYSIDE BLVD PLAINVIEW N Y
POTTER PACIFIC CORP
23917 CRAFTSMAN RD CALABASAS CALIF
POWER DESIGN INC
1700 SHAMES DR WESTBURY LI NY
POWER DESIGNS INC
89 25 130 ST RICHMOND HILL N Y
POWERDYNE DIVISION
28 RANICK DRIVE AMITYVILLE L I NY
POWER INSTRUMENTS INC
7352 N LAWNDALE AVE SKOKIE ILL
POWERS CO JJ
818 N 22ND AVE P O BOX 254 MELROSE PK ILL
POWER SOURCES INC
SOUTH AVE BURLINGTON MASS
POWER SOURCES DIV TELECOMPUTING CORPORATION
3850 OLIVE ST DENVER 7 COLO
POWER SUPPLIES INC
1005 OLIVE ST HIGHLAND ILL
POWERTON ULTRASONICS CORP
PATTERSON PL ROOSVELT FIELD N Y
POWERTRAN CORP
10230 CAPITAL AVE OAK PARK MICH
POWER TRONIC SYSTEMS INC
10 PINE COURT NEW ROCHELLE N Y
POWERS CO J J
MELROSE PARK ILL
PRATT ALBERT
114 W LAKE VIEW AVE MILWAUKEE WISC
PRD ELECTRONICS INC
202 TILLARY ST BROOKLYN N Y
PRECISE DEVELOPMENT CORP
2 NEIL CT OCEANSIDE N Y
PRECISE DIE & STAMPING CO
5931 N RAVENSWOOD CHICAGO ILL
PRECISE ELECTRONICS & DEVELOPMENT CORP
76 E 2ND ST MINEOLA NY
PRECISE INST PARTS CO
4520 SAN FERNANDO RD GLENDALE CALIF
PRECISION APPARATUS CO
70-31 84 ST GLENDALE 27 L I N Y
PRECISION CAPACITORS INC
150 W CYPRESS ST BURBANK CALIF
PRECISION CIRCUITS INC
85 WEYMAN ST NEW ROCHELLE N Y
PRECISION CONNECTORS INC
134-20 JAMAICA AVE JAMAICA L I N Y
PRECISION CORPORATION
236 W 23RD ST HIALEAH FLA
PRECISION CRYSTAL LAB
2223 WARWICK AVE SANTA MONICA CALIF
PRECISION ELECTRONICS INC
9101 KING ST FRANKLIN PK ILL
PRECISION ELECTROPLATING CO
6045 NORTH KEYSTONE AVE CHICAGO ILL
PRECISION INSTRUMENT CO
1011 COMMERCIAL ST SAN CARLOS CALIF
PRECISION LINE INC
63 MAIN ST MAYNARD MASS
PRECISION MADE PRODUCTS INC
7 HARRIS CT WORCHESTER MASS
PRECISION METALCRAFT INC
4748 FRANCE AVE N MINNEAPOLIS MINN
PRECISION METAL PRODUCTS CO
41 ELM ST STONEHAM MASS
PRECISION METALSMITHS INC
1081 E 200 ST CLEVELAND OHIO
PREC METHODS & MCH DV TEXTRON INC
CUMBERLAND DR WATERBURY CONN
PRECISION PAPER TUBE CO
2035 W CHARLESTON ST CHICAGO ILL
PRECISION PAPER TUBE CO
1 FLOWER ST HARTFORD CONN
PRECISION RADIATION INSTRUMENTS INC
5810 S NORMANDIE AVE LOS ANGELES CALIF
PRECISION RESISTOR CO
109 U S HWY 22 HILLSIDE N J
PRECISION SCIENTIFIC CO
3737 W CORTLAND ST CHICAGO 47 ILL
PRECISION THEROMETER & INST CO
1434 1434 BRANDYWINE ST PHILA PA
PRECISION TUBE CO
CHURCH RD & WISSACHICKON AVE N WALES PA
PREIS ENGRAVING MACHINE CO H P
651 U S HWY 22 HILLSIDE N J
PREMAX PRODUCTS DIV CHISHOLM RYDER CO
COLLEGE HIGHLAND AVES NIAGARA FALLS N Y
PREMIER INSTRUMENT CORP
33 NEW BROAD ST PORT CHESTER N Y
PREMIER METAL PRODUCTS CO
337 MANIDA ST NEW YORK 59 N Y
PREMIER RESEARCH LABS INC
79 7 AVE NEW YORK 11 N Y
PREMMCO INC
5470 VALLEY BLVD LOS ANG CALIF
PREMMCO INC OF NORTHERN CALIF
P O BOX 412 ALAMEDA CALIF
PRENCO INCORP
246 PARK AVENUE GARDEN CITY NY
PRENTISS WIRE MILLS
HOLYOKE MASS
PRESCOTT TV CO
920 CITRUS AVE LOS ANG CALIF
PRESCRIPTION HEARING AID CO INC
2233 UNIVERSITY AVE ST PAUL MINN
PRESSED STEEL TANK CO
1445 S 66TH ST MILWAUKEE WISC
PRESIN CO INC
2014 BROADWAY SANTA MONICA CALIF
PRESSTEEL CD
9705 GARVEY AVE EL MONTE CALIF
PRESSTITE DIV AMER MARIETTA
39TH & CHOUTEAU ST ST LOUIS MO
PRESTLE CORP
1345 MIAMI ST TOLEDO OHIO
PRICE ELECTRIC CORP
E CHURCH & 2 ST FREDERICK MD
PRICE & RUTZEBECK
P O BOX 30 HAYWARD CALIF
PRINCETON APPLIED RESEARCH CORP
P O BOX 565 PRINCETON N J
PRINCETON DIV ELECTRO MECHANICAL RESCH INC
44 WALLACE RD PRINCETON N J
PRINCETON ELECT CORP
PRINCETON N J
PRINTED CIRCUITS INC
7800 COMPUTER AVE MINNEAPOLIS 6 MINN
PRINTED ELECT CORP
INDUSTRIAL CENTER NEEDHAM HGTS MASS
PRINTLOID CORP DEPT E
10-08 44TH AVE LONG ISLAND CITY 1 N Y
PROBESCOPE CO INC
8 SAGAMORE HILL DR PORT WASHINGTON N Y
PROCESS & INSTRUMENTS
15 STONE AVE BROOKLYN 33 N Y
PROCESS GEAR CO INC
3313 W NEWPORT CHICAGO ILL

PRODELIN INC
HIGHTSTOWN N J
PRODUCERS SALES CORP & PHOTO-SONICS INC
820 SOUTH MARIPOSA ST BURBANK CALIF
PRODUCTION SERVICES CORP
81 MARKET SQ NEWINGTON 11 CONN
PRODUCTS & INDUSTRIAL ENGRG CORP
3806 S FOUR MILE RUN DR ARLINGTON VA
PROFEXRAY INC
1401 N 1 AVE MAYWOOD ILL
PROGRESS ELECTRONICS CO
107 FRANKLIN ST NEW YORK 13 N Y
PROJECTS UNLIMITED INC
1926 E SIEBENTHLER AVE DAYTON OHIO
PROSPECT MACHINE PROD INC
REX LANE PROSPECT CONN
PROTECTION EQUIPMENT CO INC
1025 HILL STREET HOPKINS MINN
PROTECTION EQUIPMENT CO INC
2924 EMERSON AVE S MINNEAPOLIS MINN
PROTECTIVE COATINGS CORP
596 RIVER RD CLIFTON NJ
PROTECTOWIRE CO
WASHINGTON ST HANOVER MASS
PRO-TEX REEL BAND CO
200 FILM BLDG CLEVELAND 14 OHIO
PROTO TOOL CO LOS ANGELES DIV
BOX 3519 TERMINAL ANNEX LOS ANGELES CALIF
PROVIDENCE BASE PLANT
586 ATWELLS AVE PROVIDENCE RI
PRY WELDING & MFG INC
MODENA PA
PSP ENGINEERING CO DIV IMC MAGNETICS CORP
6058 WALKER AVE MAYWOOD CALIF
PULSE ENG INC
560 ROBERT AVE SANTA CLARA CALIF
PULSE TECHNIQUES INC
1411 PALISADE AVE W ENGLEWOOD N J
PUROLATOR PRODUCTS INC
970 NEW BRUNSWICK AVE RAHAWAY N J
PYE CANADA LTD
82 NORTHLINE RD TORONTO ONTARIO CANADA
PYE CORP OF AMERICA
1149 RARITAN AVE HIGHLAND PARK N J
PYE TELECOMMUNICATIONS LTD
NEWMARKET RD CAMBRIDGE ENGLAND
PYLE-NATIONAL CO
1334 N KOSTNER AVE CHICAGO 51 ILL
PYRAMID ELECT CO
DARLINGTON S C
PYRAMID SCREEN CORP
181 HARVARD ST BROOKLINE BOSTON MASS
PYRAMID SCREEN CORP
NICHOLS & CLARK BLDG DANVERS MASS
PYROCIRCUITS DIV MICROTRON INC
6 MANHASSET AVE PRT EASHINGTON N Y
PYRO-ELECTRIC INC
BOX 65 MUSKIN RD WALKERTON IND
PYROFERRIC CO INC
621 E 216ST NEW YORK 67 N Y
PYROFILM RESISTOR CO
U S HIGHWAY 46 PARSIPPANY N J
PYROMETER INSTRUMENT CO
92 PORTLAND AVE BERGENFIELD N J

Q

Q L C CORP
409 MAIN ST GREENPORT N Y
Q-LINE MFG CORP
1562 61 ST BROOKLYN 19 N Y
QOS CORP
621 E 216 ST BRONX N Y
QUALITONE CO
4318 UPTON AVE S MINNEAPOLIS 10 MINN
QUALITY COMPONENTS INC
ST MARYS PA
QUALITY CONTROL CORP
10 DEPOT PLAZA WHITE PLAINS N Y
QUALITY ELECTRONICS INC
319 CHURCH ST NEW YORK 13 N Y
QUALITY STAMPING CO
6311 CEDAR AVE MINNEAPOLIS 23 MINN
QUAM NICHOLS CO
234 E MARQUETTE RD CHICAGO 37 ILL
QUANTA DYNE
19730 VENTURA BLVD WOODLAND HILLS CALIF
QUANTAMETRIC DEVICES INC
BOX 1107 BINGHAMPTON N Y
QUANTAMETRIC DEVICES INC
109 WASHINGTON BINGHAMTON NY
QUANTATRON INC
2520 COLORADO AVE SANTA MONICA CALIF
QUAN TECH LAB INC
60 PARSIPPANY BLVD BOX 187 BOONTON N J
QUICK CHARGE DIV LINE SCALE CO INC
3737 NW 37TH ST OKLAHOMA CITY OKLA
QUIETROLE CO
395 ST JOHN ST SPARTANBURG S C
QUIK CHEK CORP
5212 PULASKI AVE PHILA PA
QUINCY COMPRESSOR CO
QUINCY ILL
QUINCY SPEAKER MFG CORP
221 OAK ST QUINCY ILL
QUTRONIC TRANSFORMER CORP
525 BROADWAY NEW YORK 12 N Y
Q V S INC
20 N 15 ST ORANGE N J

R

RACAL ELECTRONICS LTD
WESTERN RD BRACKNELL BERKS ENG
RACINE HYDRAULICS & MACH INC
2000 ALBERT RACINE WISC
RACON ELECTRIC CO
67 HANFORD ST MIDDLETOWN N Y
RADA PRODUCTS CO
2911 CARROLL AVE CHICAGO ILL
RADAR DESIGN CORP
PICKARD DR SYRACUSE N Y
RADAR ENGINEERS
4719 BROOKLYN SEATTLE 5 WASH
RADAR MEASUREMENTS CORP
190 DUFFY AVE HICKSVILLE LI N Y
RADAR RELAY INC
1631 TENTH ST SANTA MONICA CALIF
RADEX CORP
2076 ELSTON AVE CHICAGO ILL
RADIANT LAMP CORP
300 JELLIFF AVE NEWARK 8 NJ
RADIAPHONE CO
600 E EVERGREEN AVE MONROVIA CALIF
RADIATION AT STANFORD
3180 HANOVER ST PALO ALTO CALIF
RADIATION COUNTER LABS INC
5121 W GROVE ST SKOKIE ILL
RADIATION ELECT CO DIV COMPOMETER CORP
5600 JARVIS AVE CHICAGO ILL
RADIATION ENGG LABS
MAIN ST MAYNARD MASS
RADIATION INC
MELBOURNE FLA
RADIATION INC PRODUCTION DIV
501 COMMONWEALTH AVE ORLANDO FLA
RADIATION INSTRUMENT CO
PO BOX 733 SILVER SPRING MD
RADIATION INSTRUMENT DEVELOPMENT LAB INC
4501 W N AVE MELROSE PARK ILL
RADIATION RESEARCH CORP
314 FLORIDA AVE W PALM BEACH FLA
RADIATION RESEARCH CORP
1150 SHAMES DR WESTBURY N Y
RADIATRONICS INC
14801 CALIF ST VAN NUYS CALIF
RADIO ACTIVITIES INC
119 DAWSON AVE BOONTON N J
RADIO CITY PROD CO
CENTRE & GLENDALE ST EASTON PA
RADIO COND CO SUB THOMPSON RAMO WOOLDRIDGE
DAVIS & COPEWOOD STS CAMDEN 3 NJ
RADIO CONDENSER CO LTD
6 BERMONDSEY RD TORONTO CANADA
RADIO CONDENSER CO WESTERN CONDENSER DV
WATSEKA ILL
RADIO CONDENSER CO WESTERN CONDENSER DIV
HOOPESTON ILL
RADIO CORES INC
9540 S TULLEY AVE OAK LAWN ILL
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
11819 W OLYMPIC BLVD LOS ANGELES 64 CALIF
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
8500 BALBOA BLVD VAN NUYS CALIF
RADIO CORP OF AMERICA ELECT DATA PROC DIV
3900 MONET ROAD WEST PALM BEACH FLA
RADIO CORP OF AMERICA HOME INSTRS DIV
1300 SOUTH ROGERS STREET BLOOMINGTON IND
RADIO CORP OF AMERICA ELECTRN TUBE DIV
501 N LASALLE ST INDIANAPOLIS IND
RADIO CORP OF AMERICA HOME INSTRS DIV
501 N LASALLE ST INDIANAPOLIS IND
RADIO CORP OF AMERICA ELECTRN TUBE DIV
3300 S ADAMS ST MARION INDIANA
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
BURLINGTON MASS
RADIO CORP OF AM SEMI-CNDCTRS & MTRLS DIV
64 A STREET NEEDHAM HEIGHTS MASS
RADIO CORP OF AMER
13541 AUBURN DETROIT MICH
RADIO CORP OF AMERICA
SEMICONDUCTOR & MATERIAL DIV SOMERVILLE NJ
RADIO CORP OF AMERICA BRDCST & COMM PROD DIV
FRONT & COOPER STS CAMDEN NJ
RADIO CORP OF AMER DEFENSE ELECT PORO
FRONT & COOPER STS CAMDEN 2 NJ
RADIO CORP OF AMER ELECT TUBE DIV
415 S 5TH ST HARRISON N J
RADIO CORP OF AMERICA ASTRO ELCTS DIV
EDINBURG ROAD LOCUST CORNERS NJ
RADIO CORP OF AMERICA DEFENSE ELECTRONICS
MARNE HWY & BORTON LANDING MOORESTOWN NJ
RADIO CORP OF AMERICA ELECTRN TUBE DIV
1550 ST GEORGE AVE WOODBRIDGE NJ
RADIO CORP OF AMERICA DEFNS ELECT PRODS
CAMBRIDGE OHIO
RADIO CORP OF AMERICA ELECT TUBE DIV
5040 LESTER ROAD CINCINNATI OHIO
RADIO CORP OF AMERICA SEMI CNDCTR & MTRS DIV
FINDLAY OHIO
RADIO CORP OF AMERICA DFNS ELECT PRODS
COVENTRY & LAKESIDE AVES CROYDON PA
RADIO CORP OF AMERICA ELECTRN TUBE DIV
NEW HOLLAND PIKE LANCASTER PA
RADIO CORP OF AM BROADCAST & COM PROD DIV
BROADCAST & COMM PROD DIV MEADOW LANDS PA
RADIO CORP OF AMERICA SEMI CNDCTRS & MTRS DV
CRESTWOOD ROAD MOUNTAINTOP PA
RADIO ENGG CO
8 STATE ST NEW YORK 4 N Y

RADIO ENG LABS INC
2901 BORDEN AVE LONG IS CITY N Y
RADIO ENGG PRODUCTS
1080 UNIVERSITY ST MONTREAL 3 QUE CANADA
RADIO FREQUENCY CO
44 PARK ST MEDFIELD MASS
RADIO FREQUENCY LABS INC
BOONTON N J
RADIO INDUSTRIES INC
666 GARLAND PL DES PLAINES ILL
RADIO MFG ENGG INC
501 WALNUT ST WASHINGTON ILL
RADIO MATERIALS CO DIV PR MALLORY & CO INC
4242 W BRYNMAWR AVE CHICAGO 46 ILL
RADIO MATIC OF AMERICAN INC
1550 SPRINGFIELD AVEMAPLEWOOD N J
RADIO MERCHANDISE SALES INC
2016 BRONXDALE AVE BRONX 62 N Y
RADIO MUSIC CORP
84 S WATER ST PORT CHESTER N Y
RADIO RECEPTOR CO INC SELENIUM DIV
240 WYTHE AVE BROOKLYN 11 N Y
RADIO RECEPTOR CO GEN INST CORP SEMICN DIV
120 WYTHE AVE BROOKLYN NY
RADIO SHACK CORP
730 COMMONWEALTH AVE BOSTON 17 MASS
RADIO SPECIALTY MFG CO
2023 S E 6 AVE PORTLAND ORE
RADION CORP
345 TERRA COTTA AVE CRYSTAL LAKE ILL
RADIONICS INC
P O BOX 86 COCKEYSVILLE MD
RADIOPLANE DIV NORTHROP AIRCRAFT INC
8000 WOODLEY AVE VAN NUYS CALIF
RADIO T V PRODUCTS CORP
308 N LAKE ST GRASS LAKE MICH
RADIUM CHEMICAL CO
161 E 42ND ST NEW YORK 17 N Y
RADIX WIRE CO
26260 LAKELAND BLVD CLEVELAND 32 OHIO
RAECO
1351 DELOSS INDIANAPOLIS 3 IND
RAE MOTOR CORP
BOX 518 MCHENRY ILL
RAILWAY COMMUNICATIONS INC
9351 E 59 ST RAYTHOWN MO
RAM CHEMICALS INC
210 E OLIVE ST GARDENA CALIF
RAM METER INC
1100 HILTON RD FERNDALE MICH
RAMSEY ENG CO
1853 COUNTY RD ST PAUL MINN
RAMYR MFG CO
1779 N MAIN LOS ANGELES 31 CALIF
RANDALL INC DOUGLAS
6 PAWCATUCK AVE WESTERLY R I
RANDOLPH PRODUCTS CO
CARLSTADT N J
RANGERTONE INC
73 WINTHROP ST NEWARK N J
RANK CINTEL LTD
WORSLEY BR RD LWR SYDENHAM ENGLAND
RANSOM REASEARCH
BOX 269 SAN PEDRO CALIF
RAPID ELECTRIC CO
2881 MIDDLETOWN RD BRONX 61 N Y
RAPID ELECTRIC CO
BROOKFIELD CONN
RAPID ELECTROPLATING PROCESS INC
1414 S WABASH AVE CHICAGO 5 ILL
RAPID SPECIALTIES CO
327 W HURON ST CHICAGO 10 ILL
RAPIDS STANDARD CO INC
RAPISTAN BLDG GRAND RAPIDS MICH
RARITAN IND CORP SCHMELING ELECT DIV
20 1ST ST KEYPORT NJ
RATEL INC
1 EL CAMINO RATEL GOLETA CALIF
RA TONE ELECTRONIC SALES CO
1848 W CAMPBELL AVE PHOENIX ARIZ
RAU FASTENER CO
102 WESTFIELD ST PROVIDENCE R I
RAU FASTNER CO
50 ALEPPO ST PROVIDENCE RI
RAULAND CORP
4245 N KNOX AVE CHICAGO 41 ILL
RAVEN INDUSTRIES INC
205 E 6TH ST SIOUX FALLS S D
RAWAY BEARING CO INC
141 CHRYSTIE ST NEW YORK N Y
RAWDON SMITH ASSOC INC
1735 20 ST N W WASHINGTON D C
RAWSON ELECTRICAL INSTRUMENT CO
116 POTTER ST CAMBRIDGE 42 MASS
RAYBESTOS-MANHATTAN INC
P O BOX 1021 BRIDGEPORT 2 CONN
RAYBESTOS-MANHATTAN INC
61 WILLETT ST PASSAIC N J
RAYBESTOS-MANHATTAN INC PLASTIC PRODUCTS DIV
MANHEIM PA
RAYCHEM CORP
OAKSIDE NORTHSIDE REDWOOD CITY CALIF
RAYCHEM CORP
2821 FAIR OAKS AVE REDWOOD CITY CAL
RAYCLAD TUBES INC
OAKSIDE AT NORTHSIDE REDWOOD CITY CALIF
RAYCO ELECTRONIC MFG INC
7229 ATOLL AVE N HOLLYWOOD CALIF
RAYMOND ENGINEERING LABORATORY INC
SMITH ST MIDDLETOWN CONN
RAY O VAC INC
WILLIAMSPORT PA
RAY-O-VAC CO
212 E WASHINGTON AVE MADISON WISC
RAYPAR INC
7800 W ADDISON ST CHICAGO 34 ILL
RAY PROOF CORP
843 CANAL ST STAMFORD CONN

ELECTRONIC MANUFACTURERS—A TO Z

RAYTHEON COMPANY INDUSTRIAL OPERATION
KEELER AVE S NORWALK CONN
RAYTHEON COMPANY INDUSTRIAL COMPONENTS DIV
NORTH WINDHAM MAINE
RAYTHEON CO MICROWAVE & POWER TUBE DIVISION
SPENCER LABORATORY BURLINGTON MASS
RAYTHEON CO
CORPORATE GOVT MKTG LEXINGTON MASS
RAYTHEON CO SEMICONDUCTOR DIV
CHELMSFORD ST LOWELL MASS
RAYTHEON CO INDUSTRIAL COMPONENTS DIV
55 CHAPEL ST NEWTON MASS
RAYTHEON COMM & DATA PROC OPER
1415 BOSTON & PROVIDENCE TPK NORWOOD MASS
RAYTHEON CO COMMERCIAL APPARATUS SYS
225 CRESCENT ST WALTHAM MASS
RAYTHEON CO DIST PROD DIV
PROVIDENCE TURNPIKE WESTWOOD MASS
RAYTHERM CORP
OAKSIDE AT NORTHSIDE REDWOOD CITY CALIF
R B M CONTROLS DIV ESSEX WIRE CORP
131 GODFREY ST LOGANSPORT IND
R B M DIV ESSEX WIRE CORP
131 GODFREY ST LOGANSPORT IND
RCL MFG CO
NEW JERSEY AVE RIVERSIDE N J
RDF CORP
HUDSON N H
REA MAGNET WIRE CO
3610 E PONTIAC ST FT WAYNE IND
READY POWER CO
11231 FREUD AVE DETROIT 14 MICH
READY POWER CO
3826 GRAND RIVER AVE DETROIT MICH
RECORA CO
POWIS RD BOX 68 ST CHARLES ILL
RECORDED PUBLICATIONS LABS
1558PIERCE AVE CAMDEN N J
RECORDED TAPE OF THE MONTH CLUB
76 W 47 ST NEW YORK N Y
RECORDIO CORP
600 SEMINARY ST CHARLOTTE MICH
RECOTON CORP
5235 BARNETT AVE LONG ISLAND CITY N Y
RECTICO INC
20 FACTORY ST CEDAR GROVE N J
RECTIFIER CORP
1521 E GRAND AVE EL SEGUNDO CALIF
RECTIFIER CORP
FAJARDO PUERTO RICO
RECTIFIER DIV AUDIO DEVELOPMENT
620 E DYER RD SANTA ANA CALIF
RED DEVIL MFG CO
1412 N OGDEN AVE CHICAGO 10 ILL
REDFORD CORP INSTRUMENT DIV
33 CRANE ST STATION SCHENECTADY 3 NY
REDMAN ELECTRONICS CORP
92 PROSPECT ST THOMPSONVILLE CONN
REDMOND CO
MONROE ST OWOSSO MICH
REDMOND CO INC
ITHACA MICH
RED POINT CORP
105 W SPAZIER AVE BURBANK CALIF
RED SEAL ELECTRIC CO
10307 DETROIT AVE CLEVELAND 2 OHIO
REEDER & CO CHARLES M
173 VICTOR AVE DETROIT MICH
REED RESEARCH INC
1048 POTOMAC ST WASHINGTON D C
REED REESE INC
717 LAKE AVE PASADENA CALIF
REEVE ELECTRONICS INC
609 W LAKE ST CHICAGO 6 ILL
REEVES HOFFMAN DIV
CHERRY & NORTH STS CARLISLE PA
REEVES INSTRUMENT CORP
ROOSEVELT FIELD GARDEN CITY NY
REEVES PULLEY CO DIV RELIANCE ELEC & ENG CO
1225 7TH ST COLUMBUS IND
REEVES SOUNDCRAFT CORP
15 GREAT PASTURE ROAD DANBURY CONN
REFLECTONE ELECT
POST RD STAMFORD CONN
REF MFG CORP
393 JERICHO TURNPIKE MINEOLA N Y
REGCO INC
3025 W MISSION RD ALHAMBRA CALIF
REGENCY ELECTRONICS INC
7900 PENDLETON PIKE INDIANAPOLIS IND
REGENT CONTROLS INC
HARVARD AVE STAMFORD CONN
REGO INSULATED WIRE CO
830 MONROE ST HOBOKEN N J
REICHHOLD CHEMICALS INC
525 N BROADWAY WHITE PLAINS N Y
REID ENTERPRISES
2610 E 67 ST LONG BEACH 5 CALIF
REIGNER RECORDING LIBRARY
3401BROOK RD RICHMOND 27 VA
REILLY TAR & CHEMICAL CORP
1615 MERCHANT BANK BLDG INDIANAPOLIS 4 IND
REITER CO F
3340 BONNIE HILL DR HOLLYWOOD 28 CALIF
REK O KUT COMPANY INC
38 19 108TH ST CORONA 68 L I N Y
RELCOIL PRODUCTS
75 & SPRING ST WINDSOR LOCKS CONN
RELIANCE TIME CONTROLS INC
1927 MEAD ST RACINE WISC
RELIANCE ELECTRIC & ENGG CO
24701 EUCLID AVE CLEVELAND 17 OHIO
RELIANCE ELEC & ENG CANADA LTD
127 JUDGE RD TORONTO 18 ONT CANADA
RELIANCE ELECTRIC & ENG CO IVANHOE DIV
5618 CLEVELAND OHIO
RELIANCE MICA CO INC
341 39TH ST BROOKLYN 32 N Y
RELIANCE PAINT CO CORROSITE DIV
64 S 6TH ST BROOKLYN 11 N Y
REMANCO INC
1805 COLORADO SANTA MONICA CALIF
REMINGTON CORP
WILLEY ST AUBURN N Y
REMINGTON RAND UNIVAC DIV SPERRY RAND CORP
315 PARK AVE NEW YORK N Y
REMINGTON RAND UNIVAC DIV SPERRY RAND
UNIVAC PARK ST PAUL 16 MINN
REMINGTON RAND UNIVAC DIV OF SPERRY RAND CRP
1900 W ALLEGHENY AVENUE PHILADELPHIA 32 PA
REMLER CO
2101 BRYANT ST SAN FRAN CALIF
RENBRANDT INC
6 PARMELEE ST BOSTON 18 MASS
RENFREW ELECTRIC CO LIMITED
349 CARLAW AVE TORONTO ONT CANADA
RENWELL ELECTRONICS CORPORATION
755 NEW LUDLOW RD SOUTH HADLEY FALLS MASS
REON RESISTOR CORP
155 SAWMILL RIVER RD YONKERS N Y
REPUBLIC AVIATION CORP
FARMINGDALE LI NY
REPUBLIC ELECT INDUST CORP
575 BROAD HOLLOW RD HUNTINGTON N Y
REPUBLIC FLOW METERS CO
2240 DIVERSEY PKWY CHICAGO ILL
REPUBLIC FOIL & METAL MILLS INC
55 TRIANGLE ST DANBURY CONN
REPUBLIC LENS CO
31 E 169TH ST NEW YORK 52 N Y
REPUBLIC RUBBER DIV LEE RUBBER & TIRE CORP
1410 ALBERT ST YOUNGSTOWN OHIO
RESDEL ENGG CORP
330 S FAIR OAKS AVE PASADENA CALIF
RESEARCH CHEMICALS
170 W PRODICENCIA BURBANK CALIF
RESEARCH DEVELOPMENT MFG INC
429 E COLLOM ST PHILADELPHIA 44 PA
RESEARCH INC
STATE HGY 169 @ CO RD 18 MINNEAPOLIS MINN
RESEARCH INC
PO BOX 6164 EDINA STA MINNEAPOLIS 24 MINN
RESEARCH INDUSTRIAL LAB OF ELECTRONICS
ROSLYN PA
RESEARCH INST CO INC
558 MAIN ST WESTBURY L I N Y
RESEARCH SPECIALTIES CO
200 S GARRARD BLVD RICHMOND CALIF
RESE ENGG INC
A AND COURTLAND STS PHILA PA
RESISTANCE PRODUCTS CO
914 S 13 ST HARRISBURG PA
RESISTOFLEX CORP
WOODLAND RD ROSELAND N J
RESISTOFLEX CORP SOUTHWESTERN DIV
135 GLASS ST DALLAS 7 TEX
RESISTOR NETWORKS INC
556 W 168TH ST NEW YORK N Y
RESISTORS INC
5226 W 26 ST CHICAGO ILL
RESITRON LABS INC
2908 NEBRASKA AVE SANTA MONICA CALIF
RETICO INC
20 FACTORY ST CEDAR GROVE N J
REUTER INC
3965 MEADOWBROOK RD MINN MINN
REUTER STOKES ELECT COMPONENTS
2149 HAMILTON AVE CLEVELAND OHIO
REVCOR INC
251 EDWARDS ST CARPENTERSVILLE ILL
REVERE CORP OF AMERICA
N COLONY RD WALLINGFORD CONN
REVERE SCREW & RIVET CORP
1728 W WALNUT ST CHICAGO ILL
REVOLVATOR CO
86TH ST US RT 169 N BERGEN N J
REX CORP
HAYWARD RD W ACTON MASS
REX RHEOSTAT CO
149 BABYLON TURNPIKE ROOSEVELT N Y
REYNOLDS DIV NATIONAL STANDARD CO
DIXON ILL
REYNOLDS ELECTRIC CO
3000 RIVER RD RIVER GROVE ILL
REYNOLDS INDUSTRIES INC
2105 COLORADO AVE SANTA MONICA CALIF
REYNOLDS WIRE DIV NATIONAL STANDARD CO
809 E 2ND ST DIXON ILL
R F PRODUCTS INC DIV AMPHENOL BORG
33 E FRANKLIN DANBURY CONN
RHEEM CALIFONE CORP
5922 BOWCROFT ST LOS ANG CALIF
RHEEM SEMICONOUCTOR CORP
350 ELLIS ST MOUNTAIN VIEW CALIF
R H ELECTRONICS CO
PO BOX 35121 DALLAS 35 TEXAS
RHG ELECTRONICS LAB INC
94 MILBAR BLVD FARMINGDALE N Y
RHODES INC M H
30 BARTHOLOMEW AVE HARTFORD CONN
RHO ENG CO
2242 SEPULVEDA BLVD LOS ANGELES CALIF
RICHARDSON ALLEN CORP
116 15 15 AVE COLLEGE POINT N Y
RICHARDSON CO
2790 LAKE ST MELROSE PARK ILL
RICHARDSON CO
409 CODWISE AVE NEW BRUNSWICK N J
RICHARDSON LABS KENNETH
254 VINCENT AVE LYNBROOK N Y
RICHARDSON SCALE CO
668 VAN HOUTEN AVE CLIFTON,NJ
RICH ELECTRONICS INC
212 NW 8TH AVE MIAMI 36 FLA
RICHFIELD COINED PRODUCTS CO
722 BROAD ST CLIFTON N J
RICHMOND ENGINEERING CO INC
19 CONCORD ST S NORWALK CONN
RIEGEL PAPER CORP
1143 E FOURTH ST CHARLOTTE N C
RIESTER & THESMACHER CO
1526 W 25 ST CLEVELAND OHIO
RIGGS NUCLEONICS CORP
177 W MAGNOLIA BLVD BURBANK CALIF
RIMAK ELECT INC
10929 VANOWEN ST N HOLLYWOOD CALIF
RIPLEY CO
1 FACTORY ST MIDDLETOWN CONN
RISCO
1086 FOLSOM ST SAN FRAN CALIF
RI TONE PRODS INC
157 LIVINGSTON ST BROOKLYN N Y
RIVERBANK LABS ENGG DEPT
P O BOX 65 GENEVA ILL
RIVERSIDE ALLOY METAL DIV
1 PAVILION AVE RIVERSIDE N J
RIVETT LATHE & GRINDER INC
P O BOX 7 BOSTON 35 MASS
RIXON ELECTRONICS INC
2121 INDUSTRIAL PKWY SILVER SP MD
R M E DIV ELECTRO VOICE INC
BUCHANAN MICH
R M S ASSOCIATES INC
112 W BOSTON POST RD MAMARONECK N Y
R M S ASSOCIATES INC
805 MAMARONECK AVE MAMARONECK NY
RMS ENG INC
95 BENNETT ST N W ATLANTA GA
ROANWELL CORP
180 VARICK ST NEW YORK 14 N Y
ROBBINS & MYERS INC
1345 LAGONDA AVE SPRINGFIELD OHIO
ROBERT J MARCY ASSOC
80 8TH AVE NEW YORK N Y
ROBERTS ELECTRONICS INC
1028 LABREA AVE HOLLYWOOD CALIF
ROBERTSHAW-FULTON CONTROLS CO
SANTA ANA FRWY EUCLID AVE ANAHEIM CALIF
ROBERTSHAW-FULTON CO ACRO DIV
COLUMBUS 16 OHIO
ROBERTSHAW FULTON CON CO FULTON SYLPHON DIV
P O BOX 400 KNOXVILLE 1 TENN
ROBERTSON ELEC CO INC
124 S ELMWOOD AVE BUFFALO N Y
ROBERTSON INSTRUMENT CO
240 MOTOR AVE BOX 834 AZUSA CALIF
ROBERTS R O
8338 S ALLPORT SANTA SPRINGS CALIF
ROBERTS TOLEDO RUBBER CO
4143 MONROE ST TOLEDO 6 OHIO
ROBINAIR MANUF CORP
1224 S E AVE MONTPELIER OHIO
ROBINS INDUSTRIES CORP
15 58 127 ST FLUSHING N Y
ROBINSON MACHINE CO INC
286 PREAKNESS AVE PATERSON N J
ROBINSON MACHINE WORKS INC
802 E EIGHTH ST NEW ALBANY IND
ROBINSON RECORDING LABS
35 S 9 ST PHILA PA
ROBINSON TECHNICAL PRODUCTS INC
TETERBORO N J
ROBOT INDUSTRIES INC
7041 ORCHARD AVE DEARBORN MICH
ROBOTOMICS ENTERPRISES INC
2422 INDIAN SCHOOL PHOENIX ARIZ
ROBOTRON CORP
21300 W 8 MILE RD DETROIT 19 MICH
ROCKBAR CORP
650 HALSTEAD AVE MAMARONECK N Y
ROCKBESTOS WIRE & CABLE CO
NICOLL & CANNER STS NEW HAVEN CONN
ROCKER SOLENOID CO
140 MARINE ST WILMINGTON CALIF
ROCKWELL ENGINEERING
2133 E 45 ST INDIANAPOLIS 5 IND
ROCKWELL MFG
510 LANSING AVE TULSA OKLA
ROCKWELL PRODUCTS CORP
146 CENTRAL AVE NEWARK N J
RODALE MFG CO
6 & MINOR STS EMMAUS PA
RODE INC
5 GREEN ST WOBURN MASS
RODNEY METALS INC
1357 RODNEY FRENCH BLVD NEW BEDFORD MASS
ROEBLINGS SONS JOHN A DIV
640 S BROAD ST TRENTON N J
ROESCH COMMUNICATIONS DOUGLAS
2727 SAN FERNANDO RD LOS ANG CALIF
ROGAN BROS INC
8031 MONTICELLO SKOKIE ILL
ROGERS ELECTRONIC CORP
49 BLEECKER ST NEW YORK 12 N Y
ROHDE & SCHWARZ
111 LEXINGTON AVE PASSAIC NEW JERSEY
ROHDEN MFG CO INC
4739 W MONTROSE AVE CHICAGO 41 ILL
ROHN MFG CO
BOX 2000 PEORIA ILL
ROHR AIRCRAFT CORP
FOOT OF H ST VISTA CALIF
ROLA CO
ROUTE 28 HAWTHORNE PA
ROLA CO
2530 SUPERIOR AVE CLEVELAND OHIO
ROLLAN ELECTRIC CO
8233 S PRINCETON AVE CHICAGO 20 ILL
ROLOCK INC
1350 KINGS HWY FAIRFIELD CONN
ROMAC PRODUCTS CO
48-01 25 AVE LONG ISLAND CITY 3 N Y
ROME CABLE DIV ALCOA
RIDGE ST ROME N Y

ROME TURNEY RADIATOR CO
BOX 32 ROME N Y
RONAN & KUNZL INC
502 S KALAMAZOO AVE MARSHALL MICH
RONDO OF AMERICA INC
100 SANFORD ST HAMDEN CONN
RON ELECTRONICS CORP
150 PINE ST MONTCLAIR NJ
RONETTE ACOUSTICAL CORP
190 EARLE AVE LYNBROOK N Y
ROSCO LABS INC
29 MOORE ST BROOKLYN 6 N Y
ROSEMOUNT ENG CO
4900 W 78TH ST MINN MINN
ROSENTHAL ISOLATOREN GMBH OF SELB W GERMANY
CO U MNRL & CHEM CO 16 HUDSON ST NY 13 NY
ROSS METALS CO MILTON
237 JACKSONVILLE RD HATBORO PA
ROSTAN CORP
101 VARICK AVE BROOKLYN N Y
ROSTONE CORP
STATE RD 52 S LAFAYETTE IND
ROTARY LIFT CORP DIV DOVER CORP
1054 KANSAS ST MEMPHIS TENN
ROTATING COMPONENTS INC
1560 FIFTH AVE BAY SHORE L I N Y
ROTH J INSTRUMENTS DIVISION BUDD CO
P O BOX 245 PHOENIXVILLE PA
ROTOTEST LABS INC
2800 LOS FLORES BLVD LYNWOOD CALIF
ROTRON MFG CO
HASBROUCK LANE WOODSTOCK N Y
ROWAN CONTROLLER CO
30 BRIDGE AVE RED BANK N J
ROWAN CONTROLLER CO
2315 HOMEWOOD AVE BALTIMORE 18 MD
ROWE ENGRAVERS INC
68 UNION AVE CLIFTON N J
ROWE INDUSTRIES
1702 WAYNE ST TOLEDO OHIO
ROY CO MILTON
1300 MERMAID LANE PHILA PA
ROYAL COMMUNICATION SYSTEMS
4501 PROSPECT AVE CLEVELAND 3 OHIO
ROYAL ELECTRIC CORP
95 GRAND AVE PAWTUCKET RI
ROYAL MCBEE INST DEVELOP LAB
67 MECHANIC ST ATTLEBORO MASS
ROYCO INSTRUMENTS INC
4440 OLIVE ST PALO ALTO CALIF
R S ELECTRONICS CORP
BOX 11368 STA PALO ALTO CALIF
RUBBER & ASBESTOS CORP
225 BELLEVILLE AVE BLOOMFIELD N J
RUBBERCRAFT CORP OF CALIFORNIA
1800 W 220TH ST TORRANCE CALIF
RUBBER TECK INC
19115 S HAMILTON ST GARDENA CALIF
RUBY CHEMICAL CO
68-70 MCDOWELL ST COLUMBUS 16 OHIO
RUCKELSHAUS LABORATORIES INC JOHN G
110 POMEROY RD MADISON NJ
RUCKER CO
EMERYVILLE CALIF
RUE PRODUCTS
10539 CLARKSON RD LOS ANG CALIF
RUNZEL CORD & WIRE CO
4727 MONTROSE ST CHICAGO ILL
RUSSELL BURDSALL & WARD BOLT & NUT CO
P O BOX 110 PORT CHESTER N Y
RUSSELL GASKET CO
7424 BESSEMER AVE CLEVELAND 27 OHIO
RUSSELL REINFORSED PLASTICS CORP
521 HOFFMAN AVE LINDENHURST N Y
RUSSELL & STOLL CO INC
125 BARCLAY ST NEW YORK 7 N Y
RUST-LICK INC
755 BOYLESTON ST BOSTON 16 MASS
RUTHERFORD ELECTRONICS CO
8944 LINDBLADE ST CULVER CITY CALIF
RYTRON CO INC
7303 LANKERSHIM BLVD HOLLYWOOD CALIF

S

S & A ELECTRONICS
102 NEVADA ST TOLEDO 5 OHIO
SAFE LIGHTING INC
527 LEXINGTON AVE NEW YORK N Y
SAFE-T-MIKE CORP
2904 CHAPMAN ST OAKLAND CALIF
SAGE CRAFT INC
NORWICH N Y
SAGE ELECTRONICS CORP
O BOX 126 ROCHESTER 10 NY
SAGE LABS INC
159 LINDEN ST WELLESLEY 81 MASS
SAG HARBOR INDUSTRIES
BOX N SAG HARBOR NY
SAINE EQUIPMENT LAB HARRY T
RT 2 BOX 407 E MAIN AVE MORGAN HILL CALIF
SAMPSON CHEMICAL & PIGMENT CORP
2830 W LAKE ST CHICAGO 12 ILL
SANBORN CO
175 WYMAN ST WALTHAM 54 MASS
SANDERS ASSOCIATES
95 CANAL ST NASHUA N H
SAN FERNANDO ELECTRIC MFG CO
1509 1 ST SAN FERNANDO CALIF
SANFORD MILLER CO
11 LYNCH ST BROOKLYN 11 N Y
SANGAMO ELECTRIC CO
1207 N 11TH ST SPRINGFIELD ILL
SONNEBORN CHEMICALS & REFINING CORP
300 PARK AVE S NEW YORK 10 NY
SANTA ANITA ENGG CO OF CALIF
2451 E COLORADO ST PASADINA CALIF
SARASOTA ENG CO INC
2010 PINE TERRACE SARASOTA FLA
SARATOGA INDUSTRIES
CONGRESS & BALLSTON AVES SARATOGA SPRINGS NY
SARATOGA PLASTICS INC
N WALPOLE NH
SARGEANT & WILBUR HEAT TREATING CORP
170 YORK AVE PAWTUCKET R I
SARGENT ELECTRIC CORP
23-16 40 AVE LONG ISLAND CITY NY
SARKES TARZIAN INC
EAST HILLSIDE DR BLOOMINGTON IND
SARKES TARZIAN INC
415 N COLLEGE AVE BLOOMINGTON IND
SARTRON INC
114 MAIN ST NEWBERG ORG
SATELLITE CORP OF AMERICA
CHEWONKI RD WISCASSET MAINE
SATURN ELECTRONICS CORP
10665 HARRY HINES BLVD DALLAS TEXAS
BOX 13305 DALLAS TEXAS
SAUEREISEN CEMENTS CO
SAUEREISON BLVD PITTSBURGH PENNA
SAVAGE-ROWE PLATING CO INC
2152 PORTAGE ST KALAMAZOO MICH
SAVOY ELECTRONICS INC
P O BOX 584 GRIFFIN GA
SAVOY ELECTRONICS INC
1314 NE 17 CT BOX 7127 FT LAUDERDALE FLA
SAXONBURG CERAMICS INC
BOX 157 SAXONBURG PA
SAXTON PRODUCTS INC
4320 PARK AVE NEW YORK 57 N Y
SAYOY ELECTRONICS INC
1314 N E 17TH COURT FORT LAUDERDALE FLA
BOX 7127 FORT LAUDERDALE FLA
SCAICO CONTROLS INC
210 TAYLOR ST RIVERSIDE NJ
SCALA RADIO CO
2814 19 ST SAN FRANCISCO 10 CALIF
SCANTLIN ELECTRONICS INC
2215 COLBY AVE LOS ANGELES 64 CALIF
SCHAEVITZ ENGG
US RTE 130 & SCHAEVITZ BLVD CAMDEN NJ
SCHAFER CUSTOM ENGG
235 S 3 ST BURBANK CALIF
SCHAFFER AIR INDUSTRIES
290 N HENRY ST BROOKLYN 22 N Y
SCHAUER MFG CORP
4501 ALPINE AVE CINCINNATI OHIO
SCHENECTADY VARNISH CANADA LTD
409 COMSTOCK RD SCARSBOROUGH ONT CANADA
SCHENECTADY VARNISH CO
ROTTERDAM JCT N Y
SCHERMA MFG CO F A
424 BROOME ST NEW YORK 13 N Y
SCHERR CO GEORGE
200 LAFAYETTE ST NEW YORK 12 N Y
SCHINDLERS
195 GREENFIELD AVE LOS ANGELES 49 CALIF
SCHIRMER-NATIONAL ALARM CORP
20 WESTSIDE AVE BERGENFIELD N J
SCHJELDAHL CO G T
BOX 170 NORTHFIELD MINN
SCHLIEBUS ELECTRONIC INSTRUMENT OC
14 ABBOTT LANE CHELMSFORD MASS
SCHMELING ELECTRONICS DIV RARITAN INDS CORP
20 1ST ST KEYPORT NJ
SCHMITT MFG CO
1821 UNIVERSITY AVE ST PAUL MINN
SCHOENE ELECTRONICS LABORATORY
915 WASHINGTON AVE EVANSVILLE 13 IND
SCHONSTEDT ENG CO
9170 BROOKVILLE RD SILVER SPRING MD
SCHOTT CO OSCAR A
500 11TH AVE S MINNEAPOLIS 4 MINN
SCHRACK ELECTRICAL SALES CORP
1100 MADISON AVE NEW YORK 28 NY
SCHULMERICH ELECTRONICS INC
CARILLON HILL SELLERSVILLE PA
SCHLUMBERGER RIDGEFIELD INSTRUMENTS
RIDGEFIELD CONN
SCHUTTE & KOERTING CO
CORNWELL HTS BUCKS CO PA
SCHWEITZER DIV P J KIMBERLY CLARK CORP
MT HOLLY SPRINGS PA
SCHWEITZER INC PETER J DIVN
LEE MASS
SCIAKY BROS
4915 W 67 ST CHICAGO 38 ILL
SCIENCE-ELECTRONICS INC
195 MASSACHUSETTS AVE CAMBRIDGE MASS
SCIENTIFIC ATLANTA INC
2162 PIEDMONT RD NE ATLANTA 9 GA
SCIENTIFIC ELECTRIC INC
105 119 MONROE ST GARFIELD N J
SCIENTIFIC ELECTRONIC LABS INC
24 WOODSIDE AVE LITTLE FALLS NJ
SCIENTIFIC GLASS APPARATUS CO
100 LAKEWOOD TERRACE BLOOMFIELD N J
SCIENTIFIC RADIO PRODS INC
2303 W 8TH ST LOVELAND COLORADO
SCIENTIFIC RADIO SERVICE
4301 SHERIDAN ST UNIV PARK HYATTSVILLE MD
SCINTILLA DIV BENDIX CORP
DELAWARE AVE SIDNEY NY
SCIOTO SIGN CO
370 VINE ST KENTON OHIO
SCOPES CO INC
PO BOX 56 MONSEY NY
SCOTT INC H H
111 POWDER MILL RD MAYNARD MASS
SCOTT INSTRUMENT LAB
17 EAST 48TH ST NEW YORK 17 N Y
SEABOARD ELECTRONIC CORP
417-421 CANAL STREET NEW YORK 13 NY
SEABORD PACIFIC DIV ASSOC SPRING
15001 S BROADWAY PO BX 231 GARDENA CALIF
SEAGER STANDARD CARBON CO
291 CHURCH ST NEW YORK 13 N Y
SEAL-A-METIC CO DIV OF FILTORS INC
1 JOHN ST HALEDON N J
SEALECTRIC SWITCH & RELAY CORP
6025 N KEYSTONE AVE CHICAGO 3 ILLINOIS
SEALECTRO CORP
610 FAYETTE AVE MAMARONECK NY
SEALOL INC
WARWICK INDUSTRIAL PARK PROVIDENCE 5 RI
SEAL PEEL INC
775 STEPHENSON HWY ROYAL OAK MICH
SEALTRON CORP
READING RD AT AMITY CINCINNATI 15 OHIO
SECODE CORP
555 MINNESOTA ST SAN FRANCISCO 7 CALIF
SECO ELECTRONICS INC
5015 PENN AVE S MINN MINN
SECO ELECTRONICS INC
5015 PENN AVE SO MINNEAPOLIS MINN
SECON METALS CORP
7 INTERVALE ST WHITE PLAINS NY
SECURITY CONTROLS INC
503 FRANKLIN ST BUFFALO 2 N Y
SECURITY DEVICES INC
818 S CHOCTAW AVE EL RENO OKLAHOMA
SEEBURG CORP
1500 N DAYTON ST CHICAGO 22 ILL
SEELY INSTRUMENT CO INC
377 4TH ST PO BOX 387 NIAGARA FALLS NY
SEGAL EDWARD INC
132 LAFAYETTE ST NEW YORK 13 NY
SEG ELECTRONICS CO INC
12 HINSDALE ST BROOKLYN 7 NY
SEISCOR MFG CO DIV SEISMOGRAPH SERVICE CORP
PO BOX 1590 TULSA OKLAHOMA
SEKONIC INC
130 WEST 42ND ST NEW YORK 36 NY
SELAS CORP OF AMERICA
DRESHER PENNA
SELECTRONS LTD
520 FIFTH AVE NEW YORK 36 NY
SEL REX CORP
75 RIVER RD NUTLEY 10 N J
SEMCOM
262 E 16 ST PATERSON 4 NJ
SEMCOR
3536 W OSBORN RD PHOENIX ARIZ
SEMI-ALLOYS INC
550 S FULTON AVE MOUNT VERNON N Y
SEMICON ASSOCIATES INC
PO BOX 832 LEXINGTON KY
SEMICON INC
SWEETWATER RD PO BOX 328 BEDFORD MASS
SEMI-ELEMENTS INC
SAXONBURG BLVD SAXONBURG PENNA
SEMIMETALS INC
172 SPRUCE ST WESTBURY LI
SEMITRONICS INC
63 SCRANTON ST WINCHESTER MASS
SEMROW PRODUCTS CO
4317 N RAVENSWOOD AVE CHICAGO 13 ILL
SENECA FALLS MACHINE CO
314 FALL ST SENECA FALLS NY
SENSITIVE RESCH INSTRUMENTS CORP
310 MAIN ST NEW ROCHELLE N Y
SENSORY INC
7 MAPLE AVE MORRISTOWN N J
SEQUOIA WIRE
2201 BAY RD REDWOOD CITY CALIF
SERCO ELECT RESEARCH CORP
15735 AMBAUM BLVD SEATTLE WASH
SERDEX INC
12 BOWDOIN SQ BOSTON MASS
SERVICE ASSOCIATED INC
9236 S VINCENNES ST CHICAGO 20 ILL
SERVICE INSTRUMENTS CORP
426 S WESTGATE DR ADDISON ILL
SERVICE INSTRUMENT CORP
171 OFFICIAL RD ADDISON ILL
SERVICE PARTS SYSTEMS
13380 E 9 MILE RD E DETROIT MICH
SERVO CONSULTANTS LTD
70 STATE ST WESTBURY NY
SERVO CONTROL DIV OILGEAR CO
160 BEAR HILL RD WALTHAM 54 MASS
SERVO CORP OF AMERICA
111 NEW SOUTH RD HICKSVILLE NY
SERVO DYNAMICS CORP
MAIN ST SOMERSWORTH NH
SERVO SYSTEMS CO
14 CARMER AVE BELLEVILLE N J
SERVO-TEK OF CALIF
14736 ARMINTA ST VAN NUYS CALIF
SERVOMECHANISMS INC VACUUM FILM PROD DIV
200 NO AVIATION EL SEGUNDO CALIF
SERVOMECHANISMS INC
625 MAIN ST WESTBURY NY
SERVOMECHANISNS INC
200 AVIATION BLVD EL SEGUNDO CALIF
SERVONIC INSTRUMENTS INC
1644 WHITTIER AVE COSTA MESA CALIF
SERVOSPEED DIV ELECTRO DEVICES INC
4 GODWIN AVE PATERSON NJ
SERVO TEK PRODUCTS CO
1086 GOFFLE RD HAWTHORNE NJ
SERVWELL PRODUCTS CO
6541 EUCLID AVE CLEVELAND OHIO
SESSIONS CLOCK CO INDUSTRIAL TIMING DIV
61 E MAIN ST FORESTVILLE CONN

SETCHELL-CARLSON INC
NEW BRIGHTON ST PAUL 12 MINN
SETHCO MFG CO
2284 BABYLON TPKE MERRICK N Y
SETTER BROS INC
CATTARAUGUS N Y
SEYMOUR MFG CO
200 FRANKLIN ST SEYMOUR CONN
SHALLCROSS MFG CO
PRESTON ST SELMA NC
SHALLITE INC
128 W FIRST AVE ROSELLE N J
SHAMBAN & CO W S
11617 W JEFFERSON BLVD CULVER CITY CALIF
SHAMBAN & CO W S
2531 BREMER DRIVE FT WAYNE 8 IND
SHAND & JURS CO
2600 8TH ST BERKELEY 10 CALIF
SHAW INSULATOR CO
201 1ST ST STROUDSBURG PENNA
SHAW INSULATOR CO
276 SNYDER AVE BERLELEY HEIGHTS N J
SHEFFCO MFG CORP
FAIRVIEW N J
SHEFFIELD COPR SUB THE BENDIX CORP
BOX 893 MIU SPRINGFIELD ST DAYTON OHIO
SHELL ELECTRONIC MFG CORP
112 STATE ST WESTBURY N Y
SHELTERED WORKSHOPS INC
2619 MAIN ST SANTA MONICA CALIF
SHEPARD LABS INC
480 MORRIS AVE SUMMIT NJ
SHEPHERD INDUSTRIES INC
103 PARK AVE NUTLEY 10 NJ
SHEPPARD CO R H
101 PHILADELPHIA ST HANOVER PA
SHERIDAN GRAY INC
21000 S NORMANDIE TORRANCE CALIF
SHERIDAN-GRAY INC
24701 CRENSHAW BLVD TORRANCE CALIF
SHERMAN MFG CO H B
22 BARNEY ST BATTLE CREEK MICH
SHEROLD CRYSTALS INC
1510-12 MCGEE TRAFFICWAY KANSAS CITY 8 MO
SHEROLD CRYSTALS INC
TRUMAN/MCGEE TRAFFIC WAY KANSAS CITY 8 MO
SHERWOOD ELECTRONIC LABS INC
4300 N CALIFORNIA AVE CHICAGO 18 ILL
SHIELDALLOY CORP
NEWFIELD N J
SHIELDING INC
N READ AVE RIVERTON N J
SHIPLEY CO INC
WALNUT ST WELLESLEY 81 MASS
SHOCKLEY TRANSISTOR UNIT CLEVITE CORP
1801 PAGE MILL ROAD PALO ALTO CALIF
SHORT BROS & HARLAND LTD
CASTLEREAGH BELFAST NORTHERN IRELAND
SHRADER SOUND INC
2803 M ST N W WASHINGTON 7 D C
F W SHRODER CO
11623 S BROADWAY LOS ANG CALIF
SHURCLOSE SEAL CO
17411 E WARREN AVE DETROIT 24 MICH
SHURE BROS
222 HARTREY AVE EVANSTON ILL
SHURITE METERS
130 WALLACE ST NEW HAVEN 8 CONN
SHUR-LOK CORP
879 S EAST ST PO BOX 563 ANAHEIM CALIF
SICKLES F W DIV GIC
165 FRONT ST CHICOPEE MASS
SIERRA ELECTRONIC CORP
3885 BOHANNON DR MENLO PARK CALIF
SIERRA ENGG CO
123 E MONTECITO AVE SIERRA MADRE CALIF
SIFCO METACHEMICAL INC
935 E 63RD ST CLEVELAND 22 OHIO
SIGHTMASTER CORP
111 CEDAR ST NEW ROCHELLE N Y
SIGHTMASTER CORP
50 ALEPPO ST PROVIDENCE R I
SIGHTMASTER CORP
50 ALEPPO ST PROVIDENCE R I
SIGMA INSTRUMENTS INC
170 PEARL ST S BRAINTREE MASS
SIGMUND COHN CORP
121 S COLUMBUS AVE MT VERNON N Y
SIGNAL ENGG MFG CO
273 BRANCHPORT AVE LONG BRANCH NJ
SIGNALITE INC
1933 HECK AVENUE NEPTUNE NJ
SIGNAL TRANSFORMER CO
1661 MCDONALD AVE BROOKLYN N Y
SILICON TRANSISTER CORP
150 GLEN COVE RD CARLE PLACE NY
SILICONE INSULATION INC
1383 SEABURY AVE BRONX 61 NY
SILICONE SEALS INC
3694 MILWAUKEE AVE CHICAGO 41 ILL
SILLCOCKS MILLER CO
MAPLEWOOD N J
SILLOCKS-MILLER CO
400 W PARKER AVE MAPLEWOOD N J
SIMMONDS AEROCESSARIES INC
VERGINNES VT
SIMMONDS PRECISION PRODUCTS INC
105 WHITE PLAINS RD TARRYTOWN NY
SIMMONS FASTENER CORP
N BROADWAY ALBANY 1 NY
SIMONDS SAW & STEEL CO
INTERVALE RD FITCHBURG MASS
SIMPLATROL PRODUCTS CORP
24 SALISBURY ST WORCESTER MASS
SIMPLEX TIME RECORDER CO
24 S LINCOLN ST GARDNER MASS
SIMPLEX VALVE & METER CO
7 E ORANGE ST LANCASTER PA
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO
BOX 249 LAC DU FLAMBEAU WISC
SIMPSON ELECTRIC CO
MERCER WISC
SIMS CASTING CORP
2174 E ERIE BLVD SYRACUSE
SINCLAIR MFG CO
S WORCESTER ST CHARTLEY MASS
SINGER MFG
FINDERNE NJ
SINGLETON CO
11770 BEREA RD CLEVE OHIO
SITTLER CORP
18 N ADA ST CHICAGO 7 ILL
SIVERS LAB
BOX 42018 STOCKHOLM SWEDEN
SJOSTROM MACH CO
N W 16TH ST & 1ST AVE BOCA RATON FLA
C SJOBERG & SON
415 STATION ST CRANSTON 10 R I
SKF INDUSTRIES INC
5 W AYLESBURY ROAD TIMONIUM MD
SKF INDUSTRIES
TULIP & KENNEDY ST PHILA PA
SKIATRON ELECTRONICS TV CORP
180 VARICK ST NEW YORK 14 NY
SKIDMORE-WILHELM MFG CO
442 GREEN RD CLEVELAND 21 OHIO
SKIL CORP
5033 ELSTON AVE CHICAGO 30 ILL
SKOTTIE ELECTRONICS INC
204 BRIDGE ST PECKVILLE PA
SKYDYNE INC
RIVER RD PORT JERVIS NY
SKYSWEEPER INC
PO BOX 92 MCHENRY ILL
SKYTRON ELECTRONICS
2032 SCOTT ST HOLLYWOOD FLA
SLATER ELECTRIC INC
45 SEA CLIFF AVE GLEN COVE NY
SLAUGHTER CO
YOUNG AND COLLEGE STS PIQUA 9 OHIO
SLIP RING CO OF AMERICA
3622 W JEFFERSON BLVD LOS ANGELES 16 CAL
SMALL MOTORS INC
2076 ELSTON AVE CHICAGO 14 ILL
SMALLWOOD LTD S G
391-397 KING ST E KITCHENER ONTARIO CANADA
SMITH CORP A O
531 N 4 ST TIPP CITY OHIO
A O SMITH CO
ELKHORN WIS
SMITH ELECTRONIC INC
8200 SNOWVILLE RD BRECKSVILLE OHIO
SMITH-FLORENCE INC
OVERLAKE IND PARK BOX 717 REDMOND WASH
SMITH & FLORENCE INC
4228 23RD AVE W SEATTLE 99 WASH
SMITH INC HERMAN H
2326 NOSTRAND AVE BROOKLYN 10 NY
SMITH-MEEKER ENGG CO
157 CHAMBERS ST NEW YORK 7 N Y
SMITH THERMOTRONICS INC
FORREST HECTOR STS CONSHOHOCKEN PA
SMOOTH-ON MFG CO
572 COMMUNIPAW AVE JERSEY CITY 4 N J
SNAP-ON TOOLS CORP
KENOSHA WISC
SNAP TITE INC
201 TITUSVILLE RD UNION CITY PENNA
SNC MFG CO
PO BOX 277 OSHKOSH WISC
SNYDER MFG CO
22 & ONTARIO STS PHILADELPHIA 40 PA
SODERBERG MFG CO
620 S PALM AVE ALHAMBRA CALIF
SOLA ELECT CO SOLA TRANSFORMER DV
BUSSE RD AT LUNT AVE ELK GROVE ILL
SOLAR MFG CORP
4553 SEVILLE AVE LOS ANGELES 58 CALIF
THE SOLARTRON ELECTRONIC GROUP LTD
VICTORIA ROAD FARNBOROUGH HANTS ENGLAND
SOLAR VOLT CO INC
SOUTH BEND IND
SOLID STATE PRODUCTS INC
1 PINGREE ST SALEM MASS
SOLITRON DEVICES INC
500 LIVINGSTON ST NORWOOD N J
SOMERS BRASS CO
94 BALDWIN AVE WATERBURY CONN
SONAR RADIO CORP
3050 W 21 ST BROOKLYN 24 NY
SONEX INC
20 E HERMAN ST PHILA 44 PA
SONIC INDUSTRIES
19 WILBUR ST LYNBROOK N Y
SONOBOND CORP SUB OF AEROPROJECTS INC
202 W MARKET WEST CHESTER PA
SONOTONE CORP
PO BOX 200-SAW MILL RIVER RD ELMSFORD NY
SONOTONE CORP
COLD SPRING NY
SONY CORP
514 BROADWAY NEW YORK N Y
SORENSEN & CO
RICHARDS AVE NORWALK CONN
SORENSEN INDUSTRIAL ELECTRONIC CO
ROUTE 10 DOVER NJ
SORENSEN-UNIT OF RAYTHEON CO
RICHARDS AVENUE SOUTH NORWALK CONN
SOROBAN ENGG INC
PO BOX 1717 MELBOURNE FLA
S D S CIMENA SUPPLY CORP
602 W 52 ST NEW YORK 19 N Y
SOUND SCREEN SUPPLIERS INC
757 BROADWAY NEW YORK 3 N Y
SOUNDSCRIBER CORP
6 MIDDLETOWN AVE NEW HAVEN CONN
SOUTH BEND LATHE WORKS
425 E MADISON ST SOUTH BEND 22 IND
SOUTHCO DIV SOUTH CHESTER CORP
LESTER PA
SOUTHERN ELECTRONICS CORP
150 W CYPRESS AVE BURBANK CALIF
SOUTHERN ELECTRONICS CO INC
MOSHEIM TENN
SOUTHERN INSTRUMENTS COMPUTER DIV
FRIMLEY RD CAMBERLEY SURREY ENGLAND
SOUTHERN PLASTICS CO
408 PENDLETON ST COLUMBIA SC
SOUTHERN SCREW CO
PO BOX 1360 E I D STATESVILLE NC
SOUTHERN TOOL & MACH CO
N BIRMINGHAM WHY ANNISTON ALA
SOUTHWESTERN INDUSTRIAL ELECT CO
10201 W HEIMER RD HOUSTON TEXAS
SOUTHWEST PRODUCTS INC
RT 4 BOX 90 SAN ANTONIA TEXAS
SOUTHWIRE CO
FERTILLA ST CARROLLTON GA
SOUTHWORTH MACH CO
30 WARREN AVE PORTLAND MAINE
SPACE CONTROL CORP
1416 W 166TH ST GARDENA CALIF
SPARTA MFG CO
DOVER OHIO
SPARTON ELECTRONICS
JACKSON MICH
SPAULDING FIBRE CO INC
1325 SAN JULIAN ST LOS ANGELES 15 CALIF
SPAULDING FIBRE CO
310 WHEELER ST TONAWANDA N Y
SPAULDING FIBRE CO
N ROCHESTER NH
SPAULDING FIBRE CO INC
MILTON N H
SPAULDING PRODUCTS CO
550 W BARNER ST FRANKFORT IND
SPEC TOOL CO
9626 E BEVERLY RD PICO RIVERA CALIF
SPEC-HEATING INC
13942 SATICOY ST VAN NUYS CALIF
SPEC-PLATING INC
13871 SATICOY ST VAN NUYS CALIF
SPEC-SWITCH INC
13901 SATICOY ST VAN NUYS CALIF
SPEC-TRONICS
13901 SATICOY ST VAN NUYS CALIF
SPECIAL CHEMICALS CORP
100 S WATER ST OSSINING N Y
SPECIAL INSTRUMENTS LABORATORY INC
312 W VINE AVE KNOXVILLE 2 TENN
SPECIALTIES INC
SKUNKS MISERY RD SYOSSET LI N Y
SPECIALTIES INC
CHARLLOTTESVILLE VA
SPECIALTY AUTOMATIC MACHINE CORP
80 CAMBRIDGE ST BURLINGTON MASS
SPECIALTY ELECTRONICS DEVELOPMENT CORP
131-03 39TH AVE FLUSHING NY
SPECIFIC PLATING CORP
3002 DOWNEY RD LOSANGLES CALIF
SPECIFIC PRODUCTS CO
21051 COSTANSO WOODLAND HILLS CALIF
SPECIFIC PROD
P O BOX 425 WOODLAND HILLS CALIF
SPEC TOOL CO
9626 E BEVERLY RD PICO RIVERA CALIF
SPECTRA ELECT CORP
250 E THIRD ST MT VERNON N Y
SPECTRA-STRIP WIRE & CABLE CORP
10052 LARSON AVE GARDEN GROVE CALIF
SPECTRAN ELECTRONICS CORP
146 MAIN ST MAYNARD MASS
SPECTRO MAGNETIC INDUST
PO BOX 3306 HAYWARD CALIF
SPECTROL ELECTRONICS CORP
AMES CT PLAINVIEW NY
SPECTROL ELECTRONICS CORP
1704 S DEL MAR AVE SAN GABRIEL CALIF
SPEER RESISTOR DIV SPEER CARBON CO
BRADFORD PA
SPELLMAN HIGH VOLTAGE CO
1930 ADEE AVE NEW YORK 69 NY
SPENCER-KENNEDY LABS INC
1320 SOLDIERS FIELD RD BOSTON 35 MASS
SPERRY ELECTRONIC TUBE DIV SPERRY RAND CORP
GAINESVILLE FLA
SPERRY FARRAGUT CO DIV SPERRY RAND CORP
FARRAGUT RD BRISTOL TENN
SPERRY GYROSCOPE CO SUNNYVALE OEV CENTER
294 COMMERCIAL ST SUNNYVALE CALIF
SPERRY GYROSCOPE CO
AIR ARM DIV GREAT NECK N Y
SPERRY GYROSCOPE CO DIV SPERRY RAND CORP
GREAT NECK NY
SPERRY GYROSCOPE CO
ELECTRONIC TUBE DIV GREAT NECK NY
SPERRY MICROWAVE ELECT INC
BOX 1828 CLEAWATER FLA
SPERRY PHOENIX CO DV
19TH & DEER VALLEY RD PHOENIX ARIZ
SPERRY PIEDMONT CO DIV SPERRY RAND CORP
CHARLOTTESVILLE VA
SPERRY PRODUCTS CO DIV HOWE SOUND CO
SHELTER ROCK RD DANBURY CONN
SPERRY RAND REMINGTON RAND DIV
311 TURNER ST UTICA N Y
SPERRY RAND REMINGTON RAND DIV
7 SPRUCE ST ILION N Y
SPERRY SEMICONDUCTOR DIV SPERRY RAND CORP
NORWALK CONN
SPERRY SYROSCOPE CO DIV SPERRY RAND CORP
GREAT NECK NY
SPERRY UTAH CO DV SPERRY RAND CORP
322 N 21ST WEST SALT LAKE CITY UTAH

SPERTI FARADAY INC
1322 E CHURCH ST ADRIAN MICHIGAN
THE SPHERE CO INC
25 AMITY ST LITTLE FALLS N J
SPICO ELECTRONICS INC
HENRIETTA & DUFFY HICKSVILLE N Y
SPINCRAFT INC
4122 W STATE ST MILWAUKEE 8 WISC
SPIRLING PRODUCTS CO
HENRIETTA ST & DUFFY AVE HICKSVILLE LI NY
SPIVEY INC JAMES S
4908 HAMPDEN LANE WASHINGTON 14 DC
SPLIT BALLBEARING DIV INC
LEBANON NEW HAMPSHIRE
SPRAUGUE ELECT CO
PEMBROKE RD CONCORD N H
SPRAGUE ELECTRIC CO
NORTH ADAMS MASS
SPRAGUE OF WISCONSIN INC
6 & BEECH STS GRAFTON WISC
SPRAYLAT CORP
1 PARK AVE NEW YORK 16 N Y
SPRINGER AIRCRAFT RADIO CORP
ROUTE 11 BOX 330 INDIANAPOLIS IND
SPRINGER AIRCRAFT RADIO CORP
IND IND
SPRUCE PINE MICA CO
PO BOX 456 SPRUCE PINE N CAROLINA
SPS WESTERN
5625 CENTURY BLVD LOS ANG CALIF
SQUARE D EC & M DIV
4500 LEE RD CLEVELAND OHIO
S RIVER METAL PRODUCTS CO
377 TURNPIKE S RIVER N J
S & S MACHINERY CO
140 53RD ST BROOKLYN 32 N Y
ST CROIX PLASTICS CORP
PRODUCTION DIV UNITED FAB & ELECT
DRESSER WIS
ST JOE MACHINES INC
ST JOSEPH MICH
ST JOHN X-RAY LABORATORY
CALIFON NJ
ST MARYS CARBON CO
STATE ST ST MARYS PA
ST REGIS PAPER CO
ENTERPRISE AVE TRENTON 8 N J
ST REGIS PAPER CO
150 E 42 ST NEW YORK 17 NY
STACKPOLE CARBON CO
ST MARYS PA
STACKPOLE FARBON CO
KANE PENNA
STAHLIN BROS INC
500 MAPLE ST BELDING MICH
STAINLESS INC
3 ST NORTH WALES PA
STA LIT LIGHTER CO ELECTRO LAB DIV
647 NORTH ST DAYTON BEACH FLA
STAMFORD METAL SPECIALTY CO
427 W BROADWAY NEW YORK N Y
STAMFORD STAMPINGS CO
WOODBURY CONN
STANAT MFG CO
523 SHAMES DR WESTBURY NY
STANCIL-HOFFMAN CORP
921 N HIGHLAND AVE HOLLYWOOD 38 CALIF
STANCOR ELECTRONICS INC
3501 W ADDISON ST CHICAGO 18 ILL
STANDARD AUTO CORP
333 CEDAR ST WYANDOTTE MICH
STANDARD COIL PRODUCTS CO
2085 N HAWTHORNE AVE MELROSE PARK ILL
STANDARD COMPONENTS CORP
780 S 3RD AVE MOUNT VERNON N Y
STANDARD CONTROLS INC
1130 POPLAR PLACE SEATTLE WASHINGTON
STANDARD ELECTRIC MFG CO
HADDON AVE W BERLIN NJ
STANDARD ELECTRIC PRODUCTS
2240 E THIRD ST DAYTON OHIO
STANDARD ELECTRIC TIME CO
89 LOGAN ST SPRINGFIELD 2 MASS
STANDARD ELECTRONICS
FARMINGDALE NJ
STANDARD GLOVE CO OF N J
101 FRELINGHUYSEN AVE NEWARK NJ
STANDARD INSTRUMENT CORP
657 BROADWAY NEW YORK 12 NY
STANDARD KOLLSMAN
BOX 618 OSHKOSH WISC
STANDARD KOLLSMAN INDUSTRIES INC TUNER DIV
920 RATHBONE AURORA ILL
STANDARD KOLLSMAN INDUSTRIES INC TUNER DIV
MELROSE PARK ILL
STANDARD LOCKNUT & LOCKWASHER INC
2250 VALLEY AVE INDIANAPOLIS 18 IND
STANDARD METALS CORP
262 BROAD ST N ATTLEBORO MASS
STANDARD PLASTICS CO INC
62 WATER ST ATTLEBORO MASS
STANDARD PRESSED STEEL CO
BOX 899 JENKINTOWN PA
THE STANDARD PRODUCTS CO
FORT LAUDERDALE FLA
STANDARD RECORD MFG CO
70 N SAN GABRIEL BLVD PASADENA 8 CALIF
STANDARD REGISTER CO
626 ALBANY ST DAYTON 1 OHIO
STANDARD TELEPHONES & CABLES LTD
BRIXHAM RD PAIGNTON DEVON ENGLAND
STANDARD TELEVISION & TUBE CORP
3233 CONTI ST NEW ORLEANS 19 LA
STANDARD T V TUBE CORP
700 DRYADES ST NEW ORLEANS 12 LA
STANDARD WINDING CO DIV OF OVITRON CORP
44-62 JOHNES ST NEWBURGH NY

STANLEY TRANSFORMER CO
31-23 VERNON BLVD LONG ISLAND CITY N Y
STANPAT CO
150 42 12TH RD WHITESTONE N Y
STANWYCK WINDING CO
137-151 WALSH AVE NEWBURGH N Y
STAPLEX CO
775 5 AVE BROOKLYN 32 NY
STAR-A ELECTRIC MFG CO INC
41 VARICK AVE BROOKLYN 37 NY
STAR ENGRAVING & NAME PLATE CO
3222 E OLYMPIC BLVD LOS ANG CALIF
STAR EXPANSION PRODUCTS
719 A SECOND AVE NEW YORK N Y
STARK TOOL CO
BOX 288 ANN HARBOR MICH
STAR PORCELAIN CO
21 MUIRHEAD AVE TRENTON 9 NJ
STAR-TRONICS INC
MOULTON ST GEORGETOWN MASS
STATE LABS CO
649 BROADWAY NEW YORK 12 NY
STATES CO
19 NEW PARK AVE HARTFORD 6 CONN
STATES ELECTRONICS CORP BLUDWORTH MARINE DIV
96 GOLD ST NEW YORK 38 NEW YORK
STATHAM INSTRUMENTS INC OF PUERTO RICO
HATO REY IND SUBDIV
HATO REY PUERTO RICO
STATHAM INSTRUMENTS INC
12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF
STATIKIL INC
1220 W 6TH ST CLEVELAND OHIO
STAVER CO
41-51 N SAXON AVE BAY SHORE L I N Y
STA WARM ELECTRIC CO
222 CHESTNUT ST RAVENNA OHIO
STEARNS MAGNETIC PRODUCTS
635 S 28 ST MILWAUKEE 46 WISC
STEEL CO HERMAN D
LAFAYETTE BLDG PHILADELPHIA 6 PA
STEINEN MFG CO WM
43 BRUEN ST NEWARK 5 N J
STELMA INC
200 HENRY ST STAMFORD CONN
STELMA INC
200 HENRY ST STAMFORD CONN
STEPHENS ADAMSON MFG CO SEAL MASTER BEARING
RIDGEWAY AVE AURORA ILL
STEPHENS TRU-SONIC INC
8538 WARNER DR CULVER CITY CALIF
STEPPER MOTOR DIV LAND AIR INC
16226 BROADWAY GARDENA CALIF
STERLING ELECTRIC MOTORS INC
5401 TELEGRAPH RD LOS ANGELES 22 CALIF
STERLING ELECT MOTORS INC
4610 SMITH RD NORWOOD CINN OHIO
STERLING MFG CO
2880 DETROIT AVE CLEVELAND 13 OHIO
STERLING PRECISION CORP
17 MATINECOCK E PORT WASHINGTON NY
STERLING TRANSFORMER CORP
510 DRIGGS AVE BROOKLYN NY
STEVENS MFG CO GEO
6022 N ROGERS AVE CHICAGO 30 ILL
STEVENS MFG CO
PO BOX 1007 ANNEX MANSFIELD OHIO
STEVENS PAPER MILLS INC
PO BOX 347 WINDSOR CONN
STEVENS PAPER MILLS INC
77 MILL ST WESTFIELD MASS
STEVENS PRODUCTS INC
86 MAIN ST E ORANGE N J
STEWARD MFG CO D M
CHATTANOOGA TENN
STEWART ENGG CO
467 BEAN CREEK RD SANTA CRUZ CALIF
STEWART & STEVENSON SERVICES INC
4516 HARRISBURG BLVD HOUSTON 1 TEXAS
STEWART TRANS-LUX
1111 W SEPULVEDA BLVD TORRANCE CALIF
STEWART WARNER ELECTRONICS DIV
1300 N KOSTNER AVE CHICAGO 51 ILL
STEWART WARNER ALEMITE & INST DIV
1826 DIVERSEY PKWY CHICAGO ILL
STEWART WARNER ELECT
1300 KOSTNER AVE CHICAGO ILL
STODDART AIRCRAFT RADIO CO
6644 SANTA MONICA BLVD HOLLYWOOD 38 CALIF
STOELTING CO C H
424 N HOMAN AVE CHICAGO 24 ILL
STOKES CORP F J
5500 TABOR RD PHILADELPHIA 20 PA
STONE CITY PRODUCTS CO
1206 7 ST BEDFORD IND
STONE PAPER TUBE CO DIV OF STONE STRAW CORP
900 FRANKLIN ST NE WASHINGTON 17 DC
STONE & SMITH INC
5965 ALCOA AVE LOS ANGELES CALIF
STONHARD CO INC
401 N BROAD ST PHILADELPHIA 8 PA
STONITE COIL CORP
RT 130 YARDVILLE N J
STRANDBERG ENGG LABS INC
1001 S ELM ST GREENSBORO N CAROLINA
STRATOCON CORP
BOX 10 MORRISTOWN NJ
STRAT-O-SEAL MFG CO
3039 W FULLERTON AVE CHICAGO 47 ILL
STREETER AMET
GRAYS LAKE ILL
STROBLITE CO INC
75 W 45 ST NEW YORK 36 NY
STROMBERG-CARLSON-SAN DIEGO
SAN DIEGO 12 CALIF
STROMBERG DIV GENERAL TIME CORP
135 S MAIN ST THOMASTON CONN

STRONG ELECTRIC CORP
87 CITY PARK AVE TOLEDO 1 OHIO
STRUTHERS-DUNN INC
LAMBS RD PITMAN NJ
STUCKER & YALE INC
GREEN ST MARBLEHEAD MASS
STUDEBAKER HYDRAULIC PRODUCTS CO
2511 ST CHARLES ROAD BELLWOOD ILLINOIS
STUDIO TV PRODUCTS SALES
356 W 40TH ST NEW 18 NY
STUECK INC W WHITNEY
BOX 335EI OLD SAYBROOK CONN
STURRUP INC
50 SILVER ST MIDDLETOWN CONN
STURTEVANT CO P A
ADDISON ILL
STYROFORMICS
17 HAWKINS ST SOMERVILLE MASS
SUBMINIATURE INST CORP
3236 KANSAS AVE RIVERSIDE CALIF
SUCKLE ELECTRONICS CO
22 & HAYES AVE CAMDEN 5 N J
SULLIVAN LTD H W
70 STATE ST WESTBURY NY
SUMMERS & MILLS INC
1511 LEVEE ST DALLAS TEX
SUMMIT COIL CO
4 CLAREMONT RD BERNARDSVILLE NJ
SUMMIT INDUSTRIES INC
2104 W ROSECRANS AVE GARDENA CALIF
SUNAIR DYNAMICS CORP
4415 E TENTH LANE HIALEAH FLA
SUNAIR ELECT INC
3101 S W 3RD AVE FT LAUDERDALE FLA
SUNBANK ELECTRONICS INC
2516 N ONTARIO ST BURBANK CALIF
SUN CHEMICAL CORP
750 3RD AVE NEW YORK N Y
SUNCOAST INSTRUMENTS DIV MILTON ROY CO
6301 49TH ST ST PETERSBURG FLA
SUNDSTRAND CORP
2531 11 ST ROCKFORD ILL
SUNDSTRAND DENVER
2480 W 70TH AVE DENVER COLO
SUN ELECTRIC CORP
HARLEM & AVONDALE AVE CHICAGO ILL
SUN ENG INC OF ST PETERSBURG
2399 26 AVE ST PETERSBURG FLA
SNYVL DEV CTR SPRY PHOENIX CO SPRY RAND CORP
294 COMMERCIAL ST SUNNYVALE CALIF
SUNSHINE SCIENTIFIC INSTRUMENT
1810 GRANT AVE PHILADELPHIA 15 PENNA
SUPA INSULATIONS INC
RTE 301 A NORTH ROCKY MOUNT NC
SUPEREX ELECTRONICS CORP
4-6-RADFORD PL YONKERS NY
SUPERIOR ELECTRIC CO
383 MIDDLE ST BRISTOL CONN
SUPERIOR ELECTRONICS CORP
208 PIAGET AVE CLIFTON N J
SUPERIOR ELECT CO
1011 S FIFTH ST MINN MINN
SUPERIOR FLUX & MFG CO
1536 ST CLAIR AVE CLEVELAND OHIO
SUPERIOR INSULATED WIRE CO
WASHBURNS LANE STONY POINT N Y
SUPERIOR RESISTOR & ELECTRONICS CORP
333 W SUPERIOR PL BOX 274 FRANKFORT IND
SUPERIOR SPINNING & STAMPING CO
4057 63 FITCH RD TOLEDO 13 OHIO
SUPERIOR STEATITE & CERAMIC CORP
83 91 W FOREST ST ENGLEWOOD NJ
SUPERIOR TUBE CO
BOX 191 NORRISTOWN PA
SUPERIOR TUBE CO
WAPAKONETA OHIO
SUPREME ELECTRONICS CORP
1714 CARROLLTON AVE GREENWOOD MISS
SUPREME TRANFORMER CORP
PO BOX 237 HERRIN ILL
OXFORD ELECTRIC CORP DIV SUPREME TRANSFORMER
4308 W ARMITAGE CHICAGO ILL
SURFACE COMBUSTION CORP
2375 DORR ST TOLEDO OHIO
SURFACE CONDUCTION INC
PARAMOUNT BLDG 1501 BROADWAY NEW YORK N Y
SUPRENANT MFG CO
172 STERLING ST CLINTON MASS
SUTO-CONTROL LABORATORIES INC
5251 W IMPERIAL HWY LOS ANGELES 45 CALIF
SWEDLOW PLASTICS CO
394 N MERIDIAN RD YOUNGSTOWN OHIO
SWEET MFG CO
84 DUNHAM ST ATTLEBORO MASS
SWIFT TEXTILE METALLIZING & LAMINATING CORP
10 LOVE LANE HARTFORD 1 CONN
SWING O LITE INC
15 MOONACHIE RD HACKENSACK N J
SWITCHCRAFT INC
5555 N ELSTON AVENUE CHICAGO ILL
SYLVANIA ELECTRIC PROD INC
FULLERTON CALIF
SYLVANIA ELECTRIC PRODUCTS INC
MICROWAVE DEVICE DIVISION
EAST 3RD ST WILLIAMSPORT PENNSYLVANIA
SYLVANIA ELECTRONIC SYSTEMS
PO BOX 941 SANTA CRUZ CALIF
SYLVANIA ELECTRIC PRODUCTS
ESTES ST IPSWICH MASS
SYLVANIA ELECTRIC PRODS INC
DATA SYSTEMS OPERATIONS
189 B ST NEEDHAM MASS
SYLVANIA ELECTRIC PRODUCTS
60 BOSTON ST SALEM MASS
SYLVANIA ELECTRIC PRODS INC WALTHAM LABS
100 FIRST AVE WALTHAM MASS

SYLVANIA ELECTRIC PRODS INC
BUFFALO OPER ELECTR SYSTEMS
175 GREAT ARROW BUFFALO NY
SYLVANIA ELECTRIC PRODUCTS INC
SENECA FALLS NY
SYLVANIA ELECTRIC PRODUCTS INC
EMPORIUM PENNA
SYLVANIA ELECTRIC PRODS INC
COMPUTER PROD PLANT
PO BOX 360 MUNCY PA
SYLVANIA ELECTRIC PRODUCTS INC
CHEM & METALLURGICL DIV
TOWANDA PA
SYLVANIA ELECTRIC PROD INC PARTS DIV
12 2ND AVE WARREN PA
SYNATRONICS INC
PO BOX 2566 ORLANDO FLA
SYNCOR PRODUCTS CO
30 EASTERN AVE BOX 51 MALDEN 48 MASS
SYNCRO CORP ELECT DIV
MEUSSE ARGONNE AVE HICKSVILLE OHIO
SYNTHANE CORP
MONTGOMERY AVE OAKS PA
SYNTORQUE INC
PO BOX 75 BEARSVILLE STA WOODSTOCK N Y
SYNTRON CO
263 LEXINGTON AVE HOMER CITY PA
SYNTRONIC INSTRUMENTS INC
100 INDUSTRIAL RD ADDISON ILL
SYSTEMATICS OF MO INC
2222 OLIVE ST ST LOUIS MO
SYSTEMS DEVELOPMENT INC
307 WATER ST BINGHAMTON NY
SYSTEMS INC
2400 DIVERSIFIED WAY ORLAND FLA
SYSTRON DONNER CORP
CONCORD CALIF

T

TAAG DESIGNS INC
55 WILLOUGHBY ST BROOKLYN 1 N Y
TABER INSTRUMENT CORP
107 GOUNDRY ST NORTH TONAWANDA N Y
TABET MFG CO
1336 BALLENTINE BLVD NORFOLK 12 VA
TABLE & TICKET CO
1021 W ADAMS ST CHICAGO 7 ILL
TAFFET ELECTRONICS INC
27-05 BROOKLYN-QUEENS EXP W WOODSIDE 77 NY
TAFT PEIRCE MFG CO
32 MECHANIC AVE WOONSOCKET RI
TAKK CORP
P O BOX 346 NEWARK OHIO
TALK-A-PHONE CO
5013 NORTH KEDZIE CHICAGO ILL
TALKING DEVICES CO
4447 IRVING PARK RD CHICAGO 41 ILL
TALKMASTER INC
534 LAUREL ST SAN CARLOS CALIF
TALLER COOPER DIV AMER ELECTRNCS
75 FRONT ST BROOKLYN 1 NY
TALLY CORP
NEWBURY PARK CALIF
TALLY REGISTER CORP
1310 MERCER SEATTLE 9 WASH
TA MFG CORP
4607 ALGER ST LOS ANGELES 39 CALIF
TAMAR ELECTRONICS INC
2045 ROSECRANS AVE GARDENA AVE
TANDBERG OF AMERICA INC
8 THIRD AVE PELHAM N Y
TANSITOR ELECTRONICS INC
WEST RD BENNINGTON VT
TAP A LINE MFG CO
71 S W 5TH ST POMPANO BEACH FLA
TAPCO GROUP THOMPSON RAMO WOOLDRIDGE INC
23555 EUCLID AVE CLEVELAND 17 OHIO
TAPE ATHON
523 S HINDRY INGLEWOOD CALIF
TAPE CABLE CORP
790 LINDEN AVE ROCHESTER 10 N Y
TAPECODE
142 N HAWTHORNE AVE LANGHORNE PENNA
TARC ELECTRONICS INC
48 URBAN AVE WESTBURY L I N Y
TAURUS CORP
ACADEMY HILL LAMBERTVILLE NJ
TAYLOR EMMETT CONTROLS INC
449 E TURKEY FOOT LAKE RD AKRON OHIO
TAYLOR FIBRE CO
BOX 471 NORRISTOWN PA
TAYLOR FIBRE CO
1400 ARROW HWY LA VERNE CALIF
TAYLOR INSTRUMENT CO INC
557 E TALLMADGE AVE AKRON 10 OHIO
TAYLOR INSTRUMENTS COMPANIES
95 AMES ST ROCHESTER 1 N Y
TAYLOR WINFIELD CORP
1052 MAHONING AVE N W WARREN OHIO
TEALE MACHINE CO INC
1425 UNIVERSITY AVE ROCHESTER 7 NY
TECH ART PLASTICS CO
111 RINGEDALE AVE MORRISTOWN NJ
TECH PANEL CO INC
PO BOX 293 37 MILFORD ST BINGHAMTON NY
TECH-MASTER CORP
75 FRONT ST BROOKLYN 1 N Y
TECHNIBILT CORP
905 AIRWAY GLENDALE CALIF
TECHNICAL APPARATUS BUILDERS
109 LIBERTY ST NEW YORK 6 N Y
TECHNICAL APPLIANCE CORP
SHERBURNE NY
TECHNICAL ASSOCIATES
140 W PROVIDENCIA AVE BURBANK CALIF
TECHNICAL ASSOCIATES OF NEW ORLEANS INC
511 S CARROLLTON AVE NEW ORLEANS LA
TECHNICAL CERAMICS & LAVA CORP
85 5TH AVE PATERSON NJ
TECHNICAL DEVELOPMENT CO
305 S CHESTER PK GLENOLDEN PA
TECHNICAL DEVICES CO
11242 PLAYA COURT CULVER CITY CALIF
TECHNICAL LABS
BERGEN & EDSALL BLVD PALISADES PK N J
THE TECHNICAL MATERIEL CORPORATION
700 FENIMORE RD MAMARONECK N Y
TECHNICAL MEASUREMENT CORP
411 WASHINGTON AVE NORTH HAVEN CONN
TECHNICAL OIL TOOL CORP
1057 N LA BREA LOS ANGELES 38 CALIF
TECHNICAL PRODUCTS CO INSTRUMENT DIV
6670 LEXINGTON AVE LOS ANGELES 38 CALIF
TECHNICAL SERVICE CORP
917-19 S THIRD LOUISVILLE 3 KY
TECHNICAL WIRE PRODUCTS INC
129 DERMODY ST CRANFORD NJ
TECHNI CAST CORP
11455 CHECK AVE LYNWOOD CALIF
TECHNIC INC
88 SPECTACLE ST CRANSTON R I
TECHNICRAFT CO
1156 COMMONWEALTH AVE BOSTON 34 MASS
TECHICRAFT DIV
THOMASTON CONN
TECHNIQUE ASSOCIATES
1413 N CORNELL AVE INDIANAPOLIS 2 IND
TECHNIQUES INC
40 JAY STREET ENGLEWOOD N J
TECHNIT SALES CO
48 BROWN AVE SPRINGFIELD N J
TECHNOGRAPH PRINTED ELECTRONICS INC
920 NORTHWEST BLVD WINSTON-SALEM N C
TECHNOLOGY INSTRUMENT CORP
ACTON MASS
TECH-OHM RESISTOR CORP
36-11 33 ST LONG ISLAND CITY 6 N Y
TECH PANEL CO INC
PO BOX 293 37 MILFORD STREET BINGHAMTON NY
TECHRON CORP
20 SIMMONS ST BOSTON 20 MASS
TECT INC
LIVINGSTON & PEGASUS ST NORTHVALE N J
TECHTROMATIC
N WALPOLE NJ
TED MFG CORP
11415 JOHNSON DR SHAWNEE KANSAS
TEKTRON ELECT GENERAL CEMENT CO
400 S WYMAN ST ROCKFORD ILL
TEKTRONIX INC
PO BOX 500 BEAVERTON OREGON
TELCO ELECTRONICS MFG COMPANY
400 S WYMAN ST ROCKFORD ILL
TELCON METALS TELCON WORKS
MANOR ROYAL CRAWLEY SUSSEX ENGLAND
TELE BROADCASTERS OF CALIF INC
758 E COLORADO ST PASADENA CALIF
TELE-COIL CO INC
2733 SAUNDERS ST CAMDEN 5 NJ
TELE COMMUNICATIONS CORP
50 DRUMM ST SAN FRAN CALIF
TELECHROME MFG CORP
28 RANICK DR AMITYVILLE LI NY
TELECOMPUTING CORP
12838 SATICOY ST N HOLLYWOOD CALIF
TELECOMPUTING SERVICES INC
8949 RESEDA BLVD NORTHRIDGE CALIF
TELECOMTROL CORPORATION
20 DILLER AVE NEWTON N J
TELECTRO INDUSTRIES CORP
35-18 37 ST LONG ISLAND CITY 1 N Y
TELECTRON CO
4050 SW 14TH AVE FT LAUDERDALE FLA
TELECTROSONIC CORP
3516 37TH ST LONG ISLAND CITY N Y
TELE-DYNAMICS
5000 PARKSIDE AVE PHILA 31 PA
TELEDYNE PRECISION INC
3155 WEST EL SEGUNDO HAWTHORNE CALIF
TELEGRAPH CONDENSER CO
N ACTON LONDON W 3 ENGLAND
TELEGRAPH CONSTRUCTION & MAINTENANCE CO LTD
MERCURY HOUSE THEOBALDS RD LONDON WC 1 ENG
TELEMARINE COMMUNICATIONS CO
140 W BROADWAY NEW YORK 13 N Y
TELEMATED MOTION PICTURES
70 E 45 ST NEW YORK 17 N Y
TELEMETERING CORP OF AMER
3110 GODDARD WAY SAN DIEGO CALIF
TELEMETER MAGNETICS INC
9937 JEFFERSON BLVD CULVER CITY CALIF
TELEPHONICS CORP
PARK AVE HUNTINGTON L I N Y
TELEPIX CORP
1515 N WESTERN HOLLYWOOD 27 CAL
TELEPROMPTER CO
300 W 43RD ST NEW YORK N Y
TELERAD DIV OF THE LIONEL CORP
1440 BROADWAY NEW YORK 18 NY
TELERAD MFG CORP
FLEMINGTON N J
TELE-SIGNAL CORP
198 MILLER PLACE HICKSVILLE LI N Y
TELETEST INSTRUMENT CORP
136-10 31 RD FLUSHING 54 N Y
TELE-TONE CO OF AMERICA
1668 WEBSTER AVE NEW YORK 57 NY
TELETRAY ELECT SYSTEMS INC
5462 3RD ST N E WASH D C
TELETRONIC LABS INC
1835 W ROSECRANS AVE GARDENA CALIF
TELETRONICS CORP
12786 WESTERN AVE GARDEN GROVE CALIF
TELETRONIX ENG CO
4688 EAGLE ROCK BLVD LOS ANGELES CALIF
TELETYPE CORP
5555 W TOUHY AVE SKOKIE ILL
TELETYPE CORP
4400 W 65TH ST LITTLE ROCK ARK
TELEVISON LABS INC
333 MILL STREET WAUCONDA ILL
TELEVISION SPECIALTY CO DIV F M E
1055 STEWART AVE GARDEN CITY LI NY
TELEVISION UTILITIES CORP DIV NORD
300 DENTON AVE NEW HYDE PARK L I N Y
TELEVISION ZOOMAR CORP
500 FIFTH AVE NEW YORK N Y
TELEWAVE LABS INC DIV POLARAD ELECT
43 20 34TH ST LONG ISLAND CITY N Y
TELEX
1633 EUSTIS ST ST PAUL 1 MINN
TELEX/AEMCO DIV OF TELEX INC
10 STATE ST MANKATO MINN
TELEX INC
1633 EUSTIS ST ST PAUL MINN
TELEX INC COMM ACC DIV
1633 EUSTIS AVE ST PAUL MINN
TEL-INSTRUMENT ELECTRONICS CORP
728 GARDEN ST CARLSTADT N J
TELKOR INC
BOX 186 ELYRIA OHIO
TEL-LABS INC
1050 2 ST MANCHESTER N H
TELONIC ENGINEERING CORP
773 BROADWAY LAGUNA BEACH CALIF
TELONIC INDUSTRIES INC
60 N FIRST AVE BEECH GROVE IND
TELVISION LABS INC
333 MILL ST WAUCONDA ILL
TEMCO ELECTRONICS DIV TEMCO AIRCRAFT CORP
P O BOX 6191 DALLAS 22 TEX
TEMESCAL METALLURGICAL CORP
2850 7TH ST BERKELEY CALIF
TEMPCO TV PROD CO
21341 ROSCOE BLVD CANOGA PK CALIF
TEMPEL STEEL CO
1939 BRYN MAWR AVE CHICAGO 26 ILL
TEMPERATURE ENGG CORP
1600 UNION LANDING ROAD RIVERTON N J
TEMPIL CORP
132 W 22 ST NEW YORK 11 N Y
TEMPLET INDUSTRIES INC
701 ATKINS AVE BROOKLYN N Y
TEMPO INSTRUMENT INC
BETHPAGE RD PLAINVIEW NY
TENATRONICS LTD
1011 POWER AVE CLEVELAND 14 OHIO
TEN BOSCH INC M
PLEASANTVILLE NY
TENNALAB
417 S 10 ST QUINCY ILL
TENNA MFG CO
7580 GARFIELD BLVD CLEVELAND 25 OHIO
TENNEY ENGG INC
1090 SPRINGFIELD RD UNION N J
TENSITRON INC
PIN HILL HARVARD MASS
TENSOLITE INSULATED WIRE CO INC
W MAIN ST TARRYTOWN N Y
TENSOR ELECT DEVELOP CO
1873 EASTERN PKWY BROOKLYN 33 NY
TEPRO ELECTRIC CORP
5 ST PAUL ST ROCHESTER 4 NY
TEPRO OF FLORIDA INC
375 PATRICIA AVENUE DUNEDIN FLORIDA
TERADO CO
1068 RAYMOND AVE ST PAUL MINN
TERRY CO GEORGE A
356 S ELMWOOD AVE BUFFALO 1 NY
TEVCO INSULATED WIRE
108 E PROSPECT AVE BURBANK CALIF
TEXAS CAPACITOR CO DIV K-C-K CORP
4310 LANGLEY RD HOUSTON 16 TEXAS
TEXAS CRYSTALS
1000 CRYSTAL DR FORT MYERS FLA
TEXAS INSTRUMENTS INC METALS & CONTROLS
300 N MAIN ST VERSAILLES KY
TEXAS ENST INC SEMICONDUCTOR COM DIV
DALLAS TEXAS
TEXAS INSTRUMENTS INCORPORATED
6000 LEMMON AVE DALLAS 9 TEXAS
TEXAS INSTRUMENT SEMICON-COMPONENTS DIV
135000 CENTRAL EXPRESSWAY DALLAS TEX
TEXTRAN CORP
PO BOX 9207 AUSTIN 17 TEXAS
TEXTRON ELECTG GENERAL CEMENT CO
400 S WYMAN ST ROCKFORD ILL
TEXTRONIX ENG CO
4688 EAGLE ROCK BLVD LOS ANG CALIF
THEMROLYNE CORP
6112 HUFF ST DUBUQUE IOWA
THERMADOR ELECTRICAL MFG CO
715 S RAYMOND AVE ALAHMBRA CALIF
THERMAL DYNAMICS CORP
LEBANON NH
THERMAL WIRE OF AMERICA
KEELERS BAY SOUTH HERO VT
THERMATRON DIV WILCOX & GIBBS
214 W 39TH ST NEW YORK N Y
THERMAX WIRE CORP
304 E 45TH ST NEW YORK 17 N Y
THERMECH ENGG CORP
1773 LINCOLN AVE ANAHEIM CALIF
THERMOCAL DIV OF JAMIESON LABORATORIES
7900 HASKELL AVE VAN NUYS CALIFORNIA
THERM-O-DISC INC
MAIN ST RD MANSFIELD OHIO

THERMO ELECTRIC CO
109 5 ST SADDLE BROOK N J
THERMOSEN INC
375 FAIRFIELD AVE STAMFORD CONN
THETA INSTRUMENT CORP
520 VICTOR STREET SADDLE BROOK NJ
THIAKOL CHEMICAL CORP NATL ELECTRONICS DIV
1713 KALARAMA RD NW WASHINGTON 9 DC
THOMAS & BETTS CO INC
36 BUTLER ST ELIZABETH 1 N J
THOMAS ELECTRONICS INC
118 9TH ST PASSAIC N J
THOMAS INSTRUMENT CO
BOX 41 OSWEGO RD PHOENIX N Y
THOMAS MOLD & DIE CO
249 W HENRY ST WOOSTER OHIO
THOMAS & SKINNER INC
1120 E 23 ST INDIANAPOLIS 7 IND
THOMAS & SONS INC WILLIAM
SLOCUM AVE RIDGEFIELD NJ
THOMPSON CLOCK CO H C
BRISTOL CONN
THOMPSON LIGHTNING PROTECTION INC
616 41ST AVE MINN 12 MINN
THOMPSON MACHINE & TOOL CORP
PO BOX 12289 ST PETERSBURG FLA
THOR CERAMICS INC
225 BELLEVILLE AVE BLOOMFIELD N J
THORDARSON MEISSNER MFG
7TH & BELLMONT MT CARMEL ILL
THORSEN CORP L S
BOX 60 ELLSWORTH MAINE
THWING ALBERT INSTRUMENT CO
5351 PULASKI AVE PHILA 44 PA
TIBBETTS INDUSTRIES INC
COLCORD AVE CAMDEN ME
TICKLE ENGG WORKS ARTHUR
21 DELAVAN ST BROOKLYN 31 N Y
TIMBER-TOP INC
38 BROOKLYN AVE FREEPORT 6 NY
TIME ELECTRONIC SALES
373 BROADWAY NEW YORK 13 N Y
TIME-O-MATIC INC
PO BOX 859 1108 BAHLS ST DANVILLE ILL
TIMES WIRE & CABLE DIV THE INTL SILVER CO
358 HALL AVE WALLINGFORD CONN
TINNERMAN PRODUCTS INC
DEPT 16 P O BOX 6688 CLEVELAND 1 OHIO
TIPPTRONIC INC
P O BOX 306 CHARGIN FALLS OHIO
TI TAL INC
2001 MAIN ST SANTA MONICA CALIF
TITAN METAL MFG CO DIV CERRO DE PASCO CORP
BELLEFONTE PA
TITANIUM ALLOY MFG DIV NATL LEAD CO
111 BROADWAY NEW YORK 6 N Y
TITANIUM ALLOY MFG DV NATL LEAD CO
HYDE PARK BLVD NIAGARA FALLS N Y
TITCHENER CO E H
67 CLINTON ST BINGHAMTON NY
TITEFLEX INC
HENDEE ST SPRINGFIELD MASS
TKM ELECTRIC CORP
820 LINDEN AVE ROCHESTER 10 N Y
TOLEDO COMMUTATOR CO
1101 S CHESTNUT ST OWASSO MICH
TOLEDO SCALE DIV TOLEDO SCALE CORP
1027 TELEGRAPH RD TOLEDO 12 OHIO
TOMAN & CO E
8700 W 47 ST LYONS ILL
TOMORROW INC
7 W JACKSON HAYWARD CALIF
TOPATRON INC
942 E OJAI AVE OJAI CALIF
TOPATRON INC
11601 ANABEL AVE GARDEN GROVE CALIF
TOPPER MFG CO INC
1100 SHAMES DRIVE WESTBURY LI NY
TOPP INDUSTRIES INC
8907 WILSHIRE BLVD BEVERLY HILLS CALIF
TOPPING ELECTRONICS LTD F V
94 LAIRD AVE TORONTO 17 ONTARIO CANADA
TORK TIME CONTROLS INC
1 GROVE ST MT VERNON NY
TORNGREN CO C W
236 PEARL ST SOMERVILLE 45 MASS
TOROTEL INC
5512 E 110 ST KANSAS CITY 34 MO
TOROTRON CORP
256 E 3RD ST MOUNT VERNON N Y
TORQ ENGINEERED PRODUCTS INC
32 W MONROE BEDFORD OHIO
TORQUE CONTROLS INC
825 E BROADWAY SAN GABRIEL CALIF
TORRES ENGG CO INC
5 CAROLINE ST S HACKENSACK NJ
TORRINGTON CO THE SPECIALTIES DIV
59 FIELD ST TORRINGTON CONN
TORRINGTON MFG CO SPECIALTY BLOWER DIV
100 FRANKLIN DR TORRINGTON CONN
TORSION BALANCE CO
35 MONHEGAN ST CLIFTON N J
TORWICO ELECTRONICS INC
ROUTE 70 LAKEWOOD NJ
TOUCH-PLATE MFG CORP
PO BOX 1970 LONG BEACH 1 CALIF
TOWACO ELECTRONICS
PINE BROOK RD TOWACO NJ
TOWER COMMUNICATIONS CO
2700 HAWKEYE DRIVE SIOUX CITY IOWA
TOWER CONSTRUCTION CO
2700 HAWKEYE DR SIOUX CITY 2 IOWA
TOWNSEND CO
PO BOX 71 ELLWOOD CITY PA
TOWNSEND CO CHERRY RIVET DIV
1224 E DELHI RD SANTA ANA CALIF
TOWNSEND MFG CO H P
BROOK ST W HARTFORD 10 CONN

TRACERLAB INC
2030 WRIGHT AVE RICHMOND CALIF
TRACERLAB INC
1601 TRAPELO RD WALTHAM 54 MASS
TRADE WINDS MFG CO
5718 N 25 AVE OMAHA NEBR
TRAK ELECTRONICS COMPANY INC
59 DANBURY ROAD ROUTE 7 WILTON CONN
TRANCDA CHEMICAL CORP
312-326 ASH ST READING MASS
TRANE CO
CAMERON & 2 ST LA CROSSE WISC
TRANSCO PRODUCTS INC
12210 NEBRASKA AVE LOS ANGELES 25 CALIF
TRANSCRIBER CO
98 COUNTY ST ATTLEBORO MASS
TRANSELECTRIC MFG CO
PO BOX 97 OXFORD PA
TRANS ELECTRONICS DIV BURTON MFG CO
8910 WINNETKA AVE NORTHRIDGE CALIF
TRANSFORMER & ELECTRONIC SPECIALTIES
3824 28 TERRACE ST PHILA 28 PA
TRANSFORMER DESIGN INC OF MILWAUKEE
7377 N 76TH ST MILWAUKEE 18 WISC
TRANSFORMER ENGINEERS
1039 E VALLEY BLVD SAN GABRIEL CALIF
TRANSFORMER TECHNICIANS INC
2608 N CICERO AVE CHICAGO 39 ILL
TRANSFORMERS MFG INC
NORRIDGE ILL
TRANSFORMERS INC
200 STAGE RD VESTAL NY
TRANSICOIL CORP
CHURCH RD WORCHESTER PA
TRANSISTOR DEVICES INC
40 FACTORY ST CEDAR GROVE NJ
TRANSISTOR ELECTRONICS CO
3357 REPUBLIC AVE MINNEAPOLIS 26 MINN
TRANSITEL INTERNATIONAL CORP
615 WINTERS AVE PARAMUS N J
TRANSITOR ELECTRONICS INC
WEST RD BENNINGTON VT
TRANSITRON ELECTRONIC CORP
WAKEFIELD MASS
TRANSLINE ELECT COMMUNICATIONS CO
503 MCCARTER HWY NEWARK N J
TRANS LUX CORP
162 13TH ST BROOKLYN N Y
TRANS LUX CORP
625 MADISON AVE NEW YORK 22 N Y
TRANS-LUX CORP
W SEPULVEDA BLVD TORRANCE CAL
TRANS-SIL CORP
55 HONECK ST ENGLEWOOD NJ
TRANSONIC INC
808 16 ST BAKERSFIELD CALIF
TRANSONIC INC
700 16TH ST BAKERSFIELD CALIF
TRANS-SONICS INC
P O BOX 328 LEXINGTON 73 MASS
TRAN SONICS
MIDDLESEX TURNPIKE BURLINGTON MASS
TRANSVAL ENGG
10401 W JEFFERSON CULVER CITY CALIF
TRANSVISION INC
460 NORTH AVE NEW ROCHELLE NY
TRASONIC INC
808 SIXTEENTH ST BOX 39 BAKERSFIELD CALIF
TRENT INC
211 LEVERINGTON AVE PHILA PA
TRENTON TRANSFORMER CORP
P O BOX 568 822 E STATE ST TRENTON N J
TREPAC CORP OF AMERICA
30 W HAMILTON AVE ENGLEWOOD N J
TRESCO INC
3824 TERRACE ST PHILADELPHIA 28 PA
TRG INC
2 AERIAL WAY SYOSSETT LI N Y
TRG INCORPORATED
400 BORDER ST EAST BOSTON 28 MASS
TRIAD TRANSFORMER CORP
4055 REDWOOD AVE VENICE CALIF
TRI ACRE ELECTRONICS
EAST PINE ST PLAISTOW N H
TRIANGLE MACHIEN
7700 MARBLE AVE CLEVELAND OHIO
TRICON MFG CO
8008 WALLACE ST CHICAGO 20 ILL
TRICONIX INC
BEAR HILL WALTHAM MASS
TRICRAFT PRODUCTS CORP
1124 W NEWPORT AVE CHICAGO 22 ILL
TRI-DEX ELECTRONICS
P O BOX 1207 LINDSAY CALIF
TRI-EX TOWER CORP
127 E INYO ST TULARE CALIF
TRI-KRIS CO
WALNUT & HATFIELD STS LANSDALE PA
TRILSCH INC JOHN D
P O BOX 14201 HOUSTON 21 TEXAS
TRIMETAL WORKS INC
1600 BANNARD ST RIVERTON NJ
TRIMOUNT INSTRUMENT DIV GENERAL CONTROLS CO
8080 MCCORMICK BLVD SKOKIE ILLINOIS
TRIMM INC
400 W LAKE ST LIBERTYVILLE ILL
TRIMOUNT PLASTIC CO
INDUSTRIAL PARK NEW BEDFORD MASS
TRINDL PRODUCTS LTD
1807-11 S CLARK ST CHICAGO 16 ILL
TRINITY EQUIPMENT CORP
CORTLAND NY
TRIO LABS INC
PLAINVIEW LI NY
TRIO MFG CO
GRIGGSVILLE ILL
TRION INC
1000 ISLAND AVE MCKEES ROCKS PA

TRIONICS CORP
4600 BELTLINE HWY MADISON WISC
TRIPLETT ELECTRICAL INSTRUMENT CO
HARMON RD BLUFFTON OHIO
TRIPLETT ELECTRICAL INSTRUMENT CO
BLUFFTON OHIO
TRIPLEX RUBBER & SUPPLY CO
5819 ARMOUR HOUSTON TEXAS
TRI-POINT PLASTICS INC
175 I U WILLETS RD ALBERTSON L I N Y
TRI-R INSTRUMENTS
144-13 JAMAICA AVE JAMAICA 35 N Y
TRI-TEC
11780 W PICO BLVD LOS ANGELES 64 CALIF
TRITON MFG CO
4000 TOWNE ST E HADDAM CONN
TRI-TRONICS CO
2607 ST CHARLES RD BELLWOOD 13 ILL
TRONEX INC
G STREET MILLVILLE NJ
TRONIC COIL WINDING CO INC
58 WESLEY ST WATERBURY CONN
TROPICAL SCREW PRODUCTS
3275 N W 28TH ST MIAMI FLA
TROTT ELECTRONICS INC
412 SMITH ST ROCHESTER 6 N Y
TRU BEAM PROD
4141 BROADWAY OAKLAND CALIF
TRU-CONNECTOR CORP
416 UNION ST LYNN MASS
TRUTONE ELECTRONICS INC
14660 RAYMER ST VAN NUYS CALIF
T T ELECTRONICS INC
P O BOX 180 CULVER CITY CALIF
TUBULAR RIVET & STUD CO
WESTON AVE WOLLASTON 70 MASS
TUCK MFG CO
19 ELLIS AVE W BRIDGEWATER MASS
TUCOR INC
59 DANBURY RD WILTON CONN
TUNG SOL ELECTRIC INC
ONE SUMMER AVE NEWARK 4 NJ
TUNG SOL ELECT
545 ARLINGTON AVE ORANGE N J
TURBO JET PRODUCTS INC
424 S SAN GABRIEL BLVD SAN GABRIEL CALIF
TURBO MACHINE CO
LANSDALE PA
TURNER CO
909 17 ST N E CEDAR RAPIDS IOWA
TUTTLE ELECTRIC PRODUCTS INC
KIRKLAND ILL
TV DEVELOPMENT CORP
469 JERICHO TURNPIKE MINEREA NY
TV UTILITIES CORP DIV NORD PHOTOCOPY CO
300 DENTON AVE NEW HYDE PARK NY
TWEEZER WELD CORP
4820 PARK BLVD PINELLAS PARK FLA
TYCO INCORP
585 BOYLSTON ST BOSTON MASS

U

U B S CHEMICAL CORP
491 MAIN ST CAMBRIDGE 42 MASS
U S CAPACITOR CORPORATION
8917 MELROSE AVE LOS ANGELES 69 CALIF
U S CHEMICAL MILLING CORP
1700 ROSECRANS AVE MANHATTAN BEACH CALIF
U S COMPONENTS
1320 ZEREGA AVE NY 62 NY
U S CONTROLS INC
161 GRAND ST NEW YORK N Y
US CONTROLS INC
410 4TH AVE BROOKLYN 15 N Y
U S DIELECTRIC INC
181 GREENWOOD ST WORCESTER 6 MASS
U S DYNAMICS CORP
1250 COLUMBUS AVE BOSTON MASS
US ELECTRICAL MOTORS INC
200 E SLAUSON AVE LOS ANGELES 54 CALIF
U S ELECTRICAL MOTORS INC
MILFORD CONN
THE U S ELECTRIC MOTOR CO
CADIZ OHIO
U S ELECTRONICS CORP
278 WARREN ST LYNDHURST N J
U S ELECTRONICS CORP
800 SLATERS LANE ALEXANDRIA VA
U S ENG CO
5873 RODEO RD LOS ANG CALIF
U S GEAR CORP
81 BAY STATE RD WAKEFIELD MASS
U S GRAPHITE CO DIV WICKLES CORP
1621 HOLLAND AVE SAGINAW MICH
U S INSTRUMENT CORP
PO BOX 1288 CHARLOTTESVILLE VA
U S PLASTIC MOLDING CORP
150 CARLTON ST WALLINGFORD CONN
U S PLYWOOD CORP
55 W 44 ST NEW YORK 36 N Y
U S RADIUM CORP
5420 VINELAND AVE N HOLLYWOOD CALIF
U S RADIUM CORP
BLOOMSBURG PENNA
U S RECORDING CO
1347 S CAPITOL ST WASHINGTON 5 D C
U S RELAY ELECTRONICS
717 N CONEY AZUSA CALIF
U S RUBBER CO
1230 AVE OF THE AMERICAS NEW YORK 20 N Y

ELECTRONIC MANUFACTURERS—A TO Z

U S SCIENCE CORP
5221 W 102ND ST LOS ANGELES 45 CALIF
US SEMICONDUCTOR PRODUCTS
3540 W OSBORN RD PO BOX 11098 PHOENIX ARIZ
U S STEEL AMER STEEL & WIRE DIV
767 MILLBURY ST WORCESTER MASS
U S STEEL CORP
525 WILLIAM PENN PL PITTSBURGH 30 PA
U S TAXIMETER CORP
516 W 54 ST NEW YORK 19 N Y
U S TESTING CO
1415 PARK AVE HOBOKEN N J
US TIME CORP
WATERBURY 20 CONN
US TRANSISTOR CORP
149 EILEEN WAY SYOSSET NY
UCINITE CO DIV UNITED CARR FASTENER CORP
459 WATERTOWN ST NEWTONVILLE 60 MASS
ULANET CO GEORGE
413 MARKET ST NEWARK 5 NJ
ULTRA ELECTROFORMING MFG CO
110 CEDAR AVE PITMAN 15 NJ
ULTRASONIC ENGG CO
618 LAKE ST MAYWOOD ILL
ULTRASONIC DEVICES INC
695 RAHWAY AVE UNION NJ
ULTRASONIC INDUSTRIES INC
AMES COURT PLAINVIEW L I N Y
ULTRASONIC MACHINING CO
1015 ASBURY AVE ASBURY PARK NJ
ULTRAUDIO DIV OBERLINE INC
PO BOX 921 BEVERLY HILLS CALIF
ULTRAUDIO PRODUCTS
6573 ST MONICA BLVD LOS ANGELES CALIF
ULTRA-VIOLET PRODUCTS INC
5114 WALNUT GROVE AVE SAN GABRIEL CALIF
ULTRONIX INC
111 E 20TH AVE SAN MATEO CALIF
UN AIR ELECTRONICS INC
3101 SW 3RD AVE FT LAUDERDALE FLA
UNBRAKO SOCKET SCREW CO LTD
BURNABY RD COVENTRY ENGLAND
UNDERWOOD CORP CANOGA DIV
736 BEAL ST WALTON BEACH FLA
UNDERWOOD ELECTRIC & MFG CO INC
148 SO 8TH AVE MAYWOOD ILL
UNDYNAMICS DIV
472 PAUL AVE ST LOUIS MO
UNGAR ELECT TOOLS INC
1475 E EL SEGUNDO BLVD HAWTHORNE CALIF
UNGAR ELECTRIC TOOLS INC
4101 REDWOOD AVE LOS ANGELES 66 CALIF
UNHERSOLL PRODUCTS
1000 W 120TH ST CHICAGO 43 ILL
UNHOLTZ DICKIE CORP
2994 WHITNEY AVE HAMDEN CONN
UNI SEAL INC
NORTH AVE & MAPLE ST GARWOOD N J
UNIFORM TUBES INC
LEVEL RD COLLEGEVILLE 2 PA
UNIMAX SWITCH MAXSON ELECT CORP
IVES RD WALLINGFORD CONN
UNION CARBIDE CONSUMER PRODUCTS CO
270 PARK AVE NEW YORK 17 N Y
UNION CARBIDE CORP SILICONES DIV
P O BOX 180 SISTERVILLE W VA
UNION CARBIDE UNION CARBIDE CONSUMER PROD CO
501 GAGE ST BENNINGTON VT
UNION CARBIDE CONSUMER PROD CO
BOX 749 CHARLOTTE N C
UNION CARBIDE METALS CO
270 PARK AVE NEW YORK N Y
UNION CARBIDE PLASTICS CO
270 PARK AVE NEW YORK NY
UNION CITY FILAMENT CORP
540 39TH ST UNION CITY N J
UNION SWITCH & SIGNAL DIV
1789 1807 BRADDOCK AVE
SWISSVALE P O PITTSBURGH PENNA
UNION ULTRA-SONICS CORP
576 LAWRENCE ST LOWELL MASS
UNIQUE WIRE WEAVING CO INC
762 RAMSEY AVE HILLSIDE N J
UNISON ELECTRONICS
1634 MARION ST GRAND HAVEN MICH
UNISTRUT PRODS CO
933 W WASHINGTON BLVD CHICAGO 7 ILL
UNIT PROCESS ASSEMBLIES INC
53-15 37TH AVE WOODSIDE 77 NY
UNITED AIRCRAFT PRODUCTS INC
50 E 42ND ST NEW YORK 17 N Y
UNITED AIRCRAFT PRODUCTS INC
137 W 157TH ST GARDENA CALIF
UNITED AIRCRAFT PROD INC
FOREST OHIO
UNITED AUDIO PRODUCTS INC
202 E 19 ST NEW YORK 3 N Y
UNITED CARBON PRODUCTS CO
1310 N MADISON ST BAY CITY MICH
UNITED CONDENSER CORP
3400 PARK AVE NEW YORK N Y
UNITED CONTROL CORP OVERLAKE INDUSTRIAL PK
PO BOX 3104 SEATTLE 14 WASH
UNITED DATA CONTROL INC
380 N HALSTEAD ST PASADENA CALIF
UNITED ELECTRIC CONTROLS CO
85 SCHOOL ST WATERTOWN 72 MASS
UNITED ELECTRODYNAMICS
200 ALLENDALE RD PASADENA CALIF
UNITED ELECTRONIC MFG CORP
542 39 ST UNION CITY NJ
UNITED ELECTRONICS
42 SPRING ST NEWARK N J
UNITED MFG CO DIV UMC ELECTRONICS
41 HAIG ST HAMDEN 14 CONN
UNITED MINERAL & CHEMICAL CORP
16 HUDSON ST NEW YORK 13 N Y

UNITED SENSOR & CONTROL CORP
BOX 127 GLASTONBURY CONN
UNITED SHOE MACHINERY CORP
SHELTON CONN
UNITED STATES GASKET CO
P O BOX 93 CAMDEN N J
UNITED TESTING LABS
573 MONTEREY PASS RD MONTEREY PARK CALIF
UNITED TRANSFORMER CORP
150 VARICK ST NEW YORK 13 N Y
UNITED TRANSFORMER CORP PACIFIC DIV
4008 JEFFERSON BLVD LOS ANG CALIF
UNITED WIRE & SUPPLY CORP
1497 ELMWOOD AVE PROVIDENCE 7 R I
UNIVERSAL CIRCUIT CONTROLS
3610 OAKTON ST SKOKIE ILL
UNIVERSAL CONDENSER CO
3435 N KIMBALL AVE CHICAGO ILL
UNIVERSAL DRAFTING MACHINE CORP
7960 LORAIN AVE CLEVELAND 2 OHIO
UNIVERSAL ELECTRIC CO
300 E MAIN ST OWOSSO MICH
UNIVERSAL ELECTRONICS CO
1720 22 ST SANTA MONICA CALIF
UNIVERSAL INDUSTRIAL EQUIPMENT CORP
1625 PATERSON PLANK RD SECAUCUS N J
UNIVERSAL MATCH CO UNDYNAMICS DIV
472 PAUL AVE ST LOUIS 35 MO
UNIV MATCH CORP ARMA DIV AVNC & ELECT DEPT
4407 COOK AVE ST LOUIS 13 MISSOURI
UNIVERSAL MFG CO INC
1168 GROVE ST IRVINGTON 11 N J
UNIVERSAL MICROPHONE CO
BOX 55 INGLEWOOD CALIF
UNIVERSAL MOTOR CO
1552 HARRISON ST OSHKOSH WISC
UNIVERSAL PRODUCTS ENGG CO
4100 TAYLOR AVE RACINE WISC
UNIVERSAL RELAY CORP
42 WHITE ST NEW YORK 13 NY
UNIVERSAL SCIENTIFIC CO INC
1102 SHELBY ST VINCENNES IND
UNIVERSAL SHELLAC & SUPPLY CO
540 IRVING AVE BROOKLYN NY
UNIVERSAL SYNAMICS CORP
130 LOS AGUAJES AVE SANTA BARBARA CALIF
UNIVERSAL TOROID COIL WINDING INC
171 COIT STREET IRVINGTON 11 NJ
UNIVERSAL TRANSISTOR PROD CORP
380 OAK ST COPIAGUE N Y
UNIVERSITY LOUDSPEAKERS INC
80 S KENSICO AVE WHITE PLAINS NY
UNIVOX CORP
4301 W JEFFERSON BLVD LOS ANGELES CALIF
UNIVOX CORP
102 WARREN ST NEW YORK 7 N Y
UNIWAVE INC
109 MARINE ST FARMINGDALE N Y
UNMANCO INCORP
712 S FEDERAL SR CHICAGO ILL
UTAH RADIO CORP
1124 E FRANKLIN ST HUNTINGTON IND
UTILITIES SERVICE CO
PO BOX 627 ALLENTOWN PA
UTILITY BODY CO
1530 WOOD ST OAKLAND CALIF
UTILITY METAL PRODUCTS CO INC
117 ELLIOTT ST BEVERLY MASS
UTRAD CORP DIV LITTON IND
305 N BRIANT ST HUNTINGTON IND

V

VACAP CORP
1905 SUMMIT AVE UNION CITY N J
VACO PRODUCTS CO
317 E ONTARIO ST CHICAGO 11 ILL
VACTRONIC LAB EQUIPMENT INC
21 MONNOUTH CT E NORTHPORT N Y
VACUDENT MFG CO
975 E 5 ST SALT LAKE CITY UTAH
VACUUM APPARATUS CO
906 INDUSTRIAL AVE PALO ALTO CALIF
VACUUM SPEC INC
34 LINDEN ST SOMERVILLE MASS
VALCO AMPHFIERS INC
4701 GRAND AVE CHICAGO ILL
VALCOR ENG CORP
365 CARNEGIE AVE KENILWORTH N J
VALOR ELECTRONICS CO
13214 CRENSHAW BLVD GARDENIA CALIF
VALPEY CRYSTAL CORP
1244 HIGHALND ST HOLLISTON MASS
VALUE ENG PROD INC
890 MONTEREY PASS RD MONTEREY PARK CALIF
VALVERDE LABS
252 LAFAYETTE ST NEW YORK 12 N Y
VANGUARD ELECTRONICS CO
3384 MOTRO AVE LOS ANGELES 34 CALIF
VANGUARD ELECTRONIC LABS
190 48 99TH AVE HOLLIS N Y
VANISTOR MFG DIV WESTON ELEC INST CORP
UNION N J
VANITY FAIR ELECTRONICS
50 S 4ST BROOKLYN N Y
VANTON PUMP & EQUIPMENT CORP
201 SWEETLAND AVE HILLSIDE 5 N J
VAP AIR DIV VAPOR CORP
6444 HOWARD ST CHICAGO ILL
VARD INC
2981 E COLORADO PASADENA 8 CALIF

VARE INDUSTRIES
128 W FIRST AVE ROSELLE N J
VAREFLEX CORP
512 W COURT ST ROME N Y
VARI CORP
2925 CEDAR AVE MINN MINN
VARI L CO
207 GREENWICH AVE STAMFORD CONN
VARIAN ASSOC
611 HANSEN WAY PALO ALTO CALIF
VAR-LAC-OID CHEMICAL CO
116 BROAD ST NEW YORK 4 N Y
VARO INC
402 E GUTIERREZ ST SANTA BARBARA CALIF
VARO MFG CO
2201 WALNUT ST GARLAND TEXAS
VECTOR ELECTRONIC CO
1100 FLOWER ST GLENDALE 1 CALIF
VECTOR MFG CO
KEYSTONE RD SOUTHAMPTON PA
VECTOR MANUFACTURING CO
5416 LAWNDALE HOUSTON 23 TEXAS
VECTROL ENGG INC
P O BOX 1089 STAMFORD CONN
VECTRON INC
1611 TRAPELO RD WALTHAM 54 MASS
VEEDER ROOT INC
5 MAPLE ST DANVERS MASS
VEET INDUSTRIES
25753 GROSBECK HWY E DETROIT MICH
VENNER ELECTRONICS LTD
KINGSTON BY-PASS NEW MALDEN SURREY ENGLAND
VERCO INC
1430 130TH N E BELLEVUE WASH
VERITRON WEST INC
5353 STROHM AVE N HOLLYWOOD CALIF
VERMALINE PRODUCTS CO
PO BOX 1 FRANKLIN LAKES NJ
VERSA-TRONICS
BOX 223 WHEELING ILL
VIBRA SEAL CORP
2832 E GRAND BLVD DETROIT 11 MICH
VIBRATION ENGINEERING PLANT
781 WHALLEY AVE NEW HAVEN CONN
VIBRO MFG CO INC
6117 ROOSEVELT AVE WOODSIDE 77 NY
VICKERS INC ELECTRIC PRODUCTS DIV
1887 LOCUST ST ST LOUIS 3 MO
VICTOR ADDING MACHINE CO
3900 N ROCKWELL ST CHICAGO 18 ILL
VICTOR ELECTRIC WIRE CABEL CORP
618 MAIN ST WARWICK R I
VICTOR RF MICROWAVE CO
36 W WATER ST WAKEFIELD MASS
VICTOREEN INSTRUMENT CO TULLAMORE DIV
5857 WEST 95 TH ST OAKLAWN ILL
VICTOREEN INSTRUMENT CO
5806 HOUGH AVE CLEVELAND OHIO
VICTORY ENGG CO
124-28 SPRINGFIELD AVE SPRINGFIELD NJ
VICTORY MICA MFG CO INC
1313 39TH ST BROOKLYN N Y
VIDAIRE ELECTRONICS MFG CORP
365 BABYLON TURNPIKE ROOSEVELT N Y
VIDEO ACCESSORY MFG CO
P O BOX 223 TULSA 1 OKLA
VIDEO INDUSTRIES CO
242 MADISON AVE PORT CHESTER N Y
VIDEO DIV OF DEVENCO
161 EAST CALIFORNIA BLVD PASADENA CALIF
VIDEON CORP
3456 E 10TH LANE HIALEAH FLA
VIEWLEX INC
HOLBROOK N Y
VIKING INDUSTRIES INC
21343 ROSCOE BLVD CANOGA PARK CALIF
VIKING INSTRUMENTS INC
EAST HADDAM CONN
VIKING TOOL & DIE CO
9600 ARDICH AVE SOUTH MINNEAPOLIS MINN
VINCO ELECTRONICS CORP
65 WALLACE ST NEW HAVEN CONN
VINCO ELECTRONICS CORP
65 WALLACE ST NEW HAVEN CONN
VINSON ENGG & SALES CORP
8044 WOODLEY AVE VAN NUYS CALIF
VINSON MFG INC
8044 WOODLEY AVE NUYS CALIF
VIRGINIA ELECTRONICS CO
RIVER RD WASHINGTON D C
VIRGINIA PLAK COMPANY
270 MADISON AVE NEW YORK 16 N Y
VITRAMON INC
111 MAIN ST STEPNEY CONN
VITRO CHEMICAL CO
261 MADISON AVE NEW YOKR N Y
VITRO ELECTRONICS DIV OF VITRO CORP OF AM
919 JESUP-BLAIR DR SILVER SPRING MARYLAND
VITROSEAL CORP
RACE & VINE STRS RIDGWAY PA
V-M CORP
305 TERRIROTIAL BOX 659 BENTON HARBOR MICH
VOAK ENG CO
129 EAST A ST UPLAND CALIF
VOCALINE CO OF AMERICA
COULTER ST OLD SAYBROOK CONN
VOI SHAN INDUSTRIES
739 EAST WALNUT ST PASADENA CALIF
VOLK RADIOCHEMICAL CO
8260 ELMWOOD SKOKIE ILL
VOLKERT STAMPINGS INC
222-34 96 AVE QUEENS VILLAGE 29 N Y
VOLTARC TUBES INC
44 CROSS ST NORWALK CONN
VOLTRON PRODUCTS
1020 S ARROYO PARKWAY PASADENA CALIF
VONRAC INC
19217 E FOOTHILL BLVD GLENDORA CALIF

VDRAC CO
147 MEADOW RD RUTHERFORD N J
VDRON ELECTRDNICS CDRP
1230 E MERMAID LANE PHILA 18 PA
VOTRON PRDDUCTS
1020 ARROYO PARKWAY PASADENA CALIF
VUE TRDNICS INC DV OF PRESCOTT CD
920 CITRUS AVE LDS ANGELES 38 CALIF
VULCAN ELECTRIC CO
88 HOLTEN ST DANVERS MASS
VULCAN-TV MAST & TOWER CO INC
PO BOX 6537 BIRMINGHAM 7 ALA

W

WAAGE ELECTRIC INC
720 COLFAX AVE KENILWORTH N J
WABASH METAL PRODUCTS CD
1569 MORRIS ST WABASH IND
WABASSO PRODUCTS INC
WABASSO FLA
WABER ELECTRONICS INC
HANCOCK & SOMERSET STS PHILA 33 PA
WACLINE INC
35 S ST CLAIR ST DAYTON OHIO
WADDELL DYNAMICS INC
5015 WEEKS AVE SAN DIEGO CALIF
WADE ELECTRIC PRODUCTS CO
BOX 271 STURGIS MICH
WAHLGREN MAGNETICS
1900 WALKER AVE MONROVIA CALIF
WAIMET ALLOYS CO
5320 OAKMAN BLVD DEARBORN 2 MICH
WALCD ELECT CO INC
60 FRANKLIN ST E ORANGE N J
WALD ELECTRONICS
3395 RESERVOIR OVAL NEW YORK N Y
WALDES KOHINOOR INC
47 16 AUSTEL PL LONG ISLAND CITY N Y
WALDOM ELECTRONICS INC
4625 W 53 ST CHICAGO 32 ILL
WALES STRIPPIT INC UNIT OF HOUDAILLE IND INC
AKRON N Y
WALES STRIPPIT INC
AKRON NEW YORK
WALKER CO GEDRGE
118 AMSTERDAM AVE PASSAIC NJ
WALKIRT CO
10321 S LA CIENAGA BLVD LOS ANGELES 45 CAL
WALLINGFORD STEEL CO
VALLEY ST WALLINGFORD CONN
WALLIN OPTICAL SYSTEMS INC
18670 VENTURA BLVD TARZANA CALIF
WALL MFG CO P
ERIE ST GROVE CITY PA
WALLSON ASSOC INC
35 E RUNYON ST NEWARK N J
WALSCO ELECTRONICS MFG CO
100 W GREEN ST ROCKFORD ILL
WALTER J HYATT CO
PO BOX 943 BEVERLY HILLS CALIF
WALTHAM ELECTRONICS CORP
751 MAIN ST WALTHAM MASS
WALTHAM HOROLOGICAL CORP
395 LYNNWAY LYNN MASS
WALTHAM SCREW CO
77 RUMFORD AVE WALTMAM 54 MASS
WANG LABS INC
12 HURON DRIVE NATICK MASS
WARD LEONARD ELECTRIC CO
MT VERNON N Y
WARD PRODUCTS CORP
EDSON ST AMSTERDAM N Y
WARE MARINE PRODUCTS INC
6763 S W 81ST ST MIAMI FLA
WARMINSTER FIBERGLASS CO
WARMINSTER PA
WARNER ELECTRIC BRAKE & CLUTCH CD
INDUSTRIAL DIV BELOIT WISC
WARNER & SWASEY CO
32 16 DOWNING ST FLUSHING N Y
WARREN COMPONENTS DIV EL-TRONICS INC
S IRVINE ST WARREN PA
WARREN MFG CO
NEWTOWN RD LITTLETON MASS
WARREN WIRE CO
POWNAL VT
WARRICK CO CHARLES F
1964 W 11 MILE RD BERKLEY MICH
WARSAW CDIL CO
RD 25 WEST WARSAW IND
WARWICK MANUFACTURING CDRP
27TH & DEBORAH STS ZION ILL
WARWICK MFG CORP
7300 N LEIGH AVE CHICAGO ILL
WASHINGTON PORCELAIN CO
WASHINGTON N J
WASHINGTON SCIENTIFIC INDUST
13111 WAYZATA BLVD MINN MINN
WASHINGTON TECHNOLOGICAL ASSOC INC
979 ROLLINS AVE ROCKVILLE MD
WATERBURY COS INC
835 S MAIN ST P O BOX 1032 WATERBURY CONN
WATERBURY PRESSED METAL CO
300 CHASE AVE WATERBURY 14 CONN
WATERMAN PRODUCTS CO
2445 EMERALD ST PHILADELPHIA 25 PA
WATERS CONLEY CO INC
ROCHESTER MINN
THE WATERS CORP
18 S W 14TH ST ROCHESTER MINN
WATERS MFG INC
BOSTON POST RD WAYLAND MASS

WATLOW ELECTRIC MFG CD
12001 LARKLAND RD ST LDUIS MD
WATSDN MFG CD
63 TAYLOR ST JAMESTOWN NY
WAVEFORMS INC
333 6 AVE NEW YORK N Y
WAVEGUIDE INC
851 W 18 ST COSTA MESA CALIF
WAVELINE INC
P O BOX 718 CALDWELL N J
WAYNE GEORGE CORP
322 NEEDHAM ST NEWTON MASS
WAYNE KERR CORP
1633 RACE ST PHILA 3 PA
WEATHERS INDUSTRIES DIV ADVANCE INDS
66 E GLOUCESTER PIKE BARRINGTON NJ
WEBBER ENGINEERING CORP
P O BDX 217 INDIANAPOLIS IND
WEBBER MANUFACTURING CO INC
PO BOX 217 INDIANAPOLIS 6 IND
WEBCOR ELECTRONICS
2431 WOLCOTT CHICAGD ILL
WEBCOR ELECTRONICS
3912 W MCLEAN AVE CHICAGD 47 ILL
WEBCOR ELECTRONICS
1516 WABASH CHICAGO ILL
WEBCOR INC
5610 BLOOMINGDALE AVE CHICAGO ILL
WEBCDR INC-ELECTRONICS DIV
816 N KEDZIE CHICAGO 51 ILL
WEBER AIRCRAFT CORP
2820 ONTARIO ST BURBANK CALIF
WEBER ELECT DIV
3050 CALIF ST BURBANK CALIF
WEBSTER MFG
317 POEBLING RD S SAN FRANCISCO CALIF
WECKESSER
5701 NORTHWEST HWY CHICAGO ILL
WEDGELOCK CORP OF CALIF
11323 HARTLAND ST N HOLLYWOOD CALIF
WEIDNHOFF CORP
ALGONA IOWA
WEIGHING & CONTROL DIAGONAL TRANS-WIGH
KING OF PRUSSIA PA
WEINSCHEL ENGG
10503 METROPOLITAN AVE KENSINGTON MD
WEKSLER INSTRUMENTS CORP
195 E MERRICK RD FREEPORT L I N Y
WELCH SCIENTIFIC CO W M
1515 SEDGWICK ST CHICAGO ILL
WELDEX DIVISION
23361 TELEGRAPH SOUTHFIELD MICH
WELDMATIC DIV UNITEK CORP
950 ROYAL OAKS DRIVE MONROVIA CALIF
WELLCOR INC
1218 N WELLS ST CHICAGD ILL
WELLER ELECTRIC CORP
601 STDNES CRDSSING RD EASTON PENNA
WELLMAN BRONZE & ALUMINUM CO
801 ANDRE ST BAY CITY MICH
WELLS GARDNER ELECT CORP
2701 KILDARE AVE CHICAGO ILL
WELLS INDUSTRIES CORP
6880 TROOST AVE N HOLLYWOOD CALIF
WELSH CO INC WM H
224 INDIANA AVE CHICAGO ILL
WELTRONIC CD
19500 W 8 MILE RD DETRDIT 19 MICH
WELWYN CANADA LTD
125 BRYDGES ST LONDON CANADA
WELWYN ELECTRIC LIMITED
BEDLINGTON NORTHUMBERLAND ENGLAND
WEN PRODUCTS INC
5810 NORTHWEST HIGHWAY CHICAGO 31 ILL
WERNER CO INC R D
GREENVILLE PA
WERNER CO R D
295 5 AVE NEW YORK 16 N Y
WESCHE ELECTRIC CO B A
9027 SHELL RD CINCINNATI 36 OHIO
WESCD ELECTRIC & MFG CD
27 OLIVE ST GREENFIELD MASS
WEST COAST ELECTRICAL MFG CORP
233 W 116 LOS ANGELES CALIF
WEST COAST RESEARCH CORP
210 SEPULVEDA BLVD LOS ANG CALIF
WEST INSTRUMENT CDRP
4363 MONTROSE AVE CHICAGO ILL
WESTBERG MFG CO
144 S COOMBS ST PO BOX 239 NAPA CALIF
WESTERN APPARATUS CO DIV COMPTOMETER CORP
5600 W JARVIS AVE CHICAGD 48 ILL
WESTERN APPARATUS
2001 GREENLEAF EVANSTDN ILL
WESTERN ARC WELDING INC
749 KOHLER ST LOS ANG CALIF
WESTERN COATING CO
BOX 598 OAKRIDGE STA ROYAL OAK MICH
WESTERN COIL & ELECTRICAL CO
215 STATE ST RACINE WISC
WESTERN DESIGN DIV U S INDUSTRIES INC
SANTA BARBARA AIRPORT GOLETA CALIF
WESTERN DESIGN & ELECT
6312 HOLLISTER AVE SANTA BARBARA CALIF
WESTERN DEVELOPMENT LABS PHILCO CORP
918 INDUSTRIAL PALO ALTO CALIF
WESTERN DEVICES INC
600 W FLORENCE AVE INGLEWOOD 1 CALIF
WESTERN DIV PENN CONTROLS INC
BOX 553 COSTA MESA CALIF
WESTERN ELECTRD ACOUSTIC LAB INC
2222 SO BARRINGTON LOS ANGELES 49 CALIF
WESTERN ELECTRONIC PRODUCTS CO
2420 NORTH LAKE AVE ALTADENA CALIF
WESTERN ELECTRONICS CO
717 DEXTER AVE SEATTLE WASH
WESTERN ELECT KANSAS CITY PLANT
777 N 50 HIGHWAY SUMMIT MO

WESTERN ELECTRIC CD
6655 WEST REND OKLAHOMA CIYT OKLA
WESTERN ELECTRIC
3300 LEXINGTON RD WINSTON-SALEM NC
WESTERN ELECTRODYNAMICS
PO BOX 98 CDLORADO SPRINGS CDLD
WESTERN FELT WORKS
402 OGDEN AVE CHICAGO ILL
WESTERN GEAR CORP ELECTRD PRODUCTS DIV
132 W COLORADO ST PASADENA 1 CALIF
WESTERN GEAR CDRP
P O BOX 126 BELMONT CALIF
WESTERN GEAR CORP ELECTRO PRODUCTS DIV
132 W COLDRADO BLVD PASADENA CALIF
WESTERN GOLD & PLATINUM CO
525 HARBOR BLVD BELMONT CALIF
WESTERN INSTRUMENT CO
826 VICTDRY BLVD BURBANK CALIF
WESTERN INSULATED WIRE CO
E 30TH ST AT SANTE FE LOS ANGELES CALIF
WESTERN INTAGLIO INC
4801 W JEFFERSON LOS ANGELES CALIF
WESTERN INTL CO
45 VESEY ST NEW YORK 7 N Y
WESTERN RADIATION LAB
1107 W 24 ST LOS ANGELES 7 CALIF
WESTERN RUBBER CO
GOSHEN 6 INDIANA
WESTERN SKY INDUSTRIES
21300 CLOUD WAY HAYWARD CALIF
WESTERN TRANSISTOR CORP
13021 BUDLONG AVE GARDENA CALIF
WESTFIELD METAL PRODUCTS CO
1035 LOWER UNION ST WESTFIELD MASS
WESTGATE LAB INC
P O BDX 63 YELLOW SPRING OHIO
WESTINGHOUSE ELECT CORP APPARATUS DIV
BLOOMINGTDN IND
WESTINGHOUSE ELECTRIC CD DIV AIR ARM DIV
PO BOX 746 FRIENDSHIP INTL AP BALTIMORE MD
WESTINGHOUSE ELEC CDRP TV RADIO DIVISION
METUCHEN N J
WESTINGHOUSE ELEC CORP ELEC TUBE DIV
ELMIRA NY
WESTINGHOUSE ELECTRIC CDRP STANDARD CONTROL
BEAVER PENNA
WESTINGHOUSE ELECTRIC CORP
MATERIALS MFG DEPT BLAIRSVILLE PENNA
WESTINGHOUSE ELECTRIC CORP BENOLITE MICARTA
MANOR PENNA
WESTINGHOUSE ELECTRIC CORP TRANSFORMER DIV
SHARON PA
WESTINGHOUSE ELECTRIC CORP MICARTA DIV
HAMPTON SC
WESTINGHOUSE ELECTRIC CORP
SEMICONDUCTOR DEPT YOUNGWOOD PA
WESTLAB INC
590 TUCHAHOE RD YONKERS N Y
WESTLAKE PLASTICS CO
133 LENNI RD LENNI MILLS PA
WESTLINE PRODUCTS DIV WESTERN LITHOGRAPH CO
600 E 2 ST LOS ANGELES 54 CALIF
WESTREX CO DIV OF LITTON SYS INC
540 W 58 ST NEW YDKR N Y
WESTREX CO RECORDING EQUIP DIV LITTON SYS IN
335 N MAPLE DR BEVERLY HILLS CALIF
WESTRONICS INC
3605 MCCART FT WORTH TEXAS
WESTWOOD CABLE CORP
3440 OVERLAND AVE LOS ANGELES CALIF
WESTWOOD CABLE CORP
3416 S ORANGE DR LOS ANG CALIF
WHARFEDALE DIV BRITISH INDUSTRIES CORP
80 SHORE RD PORT WASHINGTON N Y
WHEELABRATOR CORP
1471 BYRKITTST MISHAWAKA IND
WHEELER ELECTRONIC CDRP SUB SPERRY RAND CORP
150 AURDR A ST WESTERBURY CONN
WHITAKER CABLE CORP
1301 BURLINGTON ST KANSAS CITY MO
WHITE AVIONICS CORP
TERMINAL ROAD PLAINVIEW LI NY
WHITE DENTAL MFG CO SS INDUSTRIAL DIV
10 E 40 ST NEW YORK 16 N Y
WHITEFORD LAB
258 BROAD ST LYNN 9 MASS
WHITEHALL ELECTRONICS CORP
1645 HENNEPIN AVE MINN MINN
WHITEHEAD METALS INC
303 W 10TH ST NEW YDRK 14 NY
WHITE INSTRUMENT LABS
BOX 9006 AUSTIN 17 TEXAS
WHITE MFG CO
2926 UNIVERSITY AVE ST PAUL MINN
WHITE & SDN JAMES L
374 VERONA AVE NEWARK 4 N J
WHITEWATER ELECTRONICS INC
136 MAIN ST WHITEWATER WISC
WHITING & DAVIS CO
23 E BACON ST PLAINVILLE MASS
WHITNEY METAL TDOL CO
110 FORBES ST ROCKFDRD ILL
WHITSO INC
9330 BYRON ST SCHILLER PARK ILL
WHITTAKER CONTROLS & GUIDANCE
16217 LINDBERGH ST VAN NUYS CALIF
WIANCKO ENG CO
255 HALSTEAD PASADENA CALIF
WICKES ENGG & CONSTRUCTION CD
12TH ST & FERRY AVE CAMDEN 4 N J
WIEGAND CO EDWIN L
7500 THOMAS BLVD PITTSBURGH 8 PA
WIEGAND MFG CO
882 BALFOUR ST VALLEY STREAM L I N Y
WILBRECHT ELECTRONICS
GRIGGS MIDWAY BDG
1821 UNIVER AVE ST PAUL MINN

ELECTRONIC MANUFACTURERS—A TO Z

WILCO CORP
4030 TENTH ST IND IND
WILCOLATOR CO
1001 NEWARK AVE ELIZABETH N J
WILCOX PRODUCTS CO
3455 DAKOTA AVE MINNEAPOLIS 16 MINN
WILDER MFG CO
MECHANIC ST & ERIE R R PORT JERVIS N Y
WILEY ELECTRONIC PROD CO
2045 W CHERYL DR PHOENIX ARIZONA
WILKINSON CO
1660 9TH ST SANTA MONICA CALIF
WILKS PRECISION INST CO INC
4821 BETHESDA AVE BETHESDA MD
WILLIAMS & CO J H DIV UNITED GREENFIELD CORP
400 VULCAN ST BUFFALO 7 N Y
WILLIAMS & CO C K
2001 LYNCH AVE E ST LOUIS ILL
WILLIAMS & CO C K
640 N 13 ST EASTON PA
WILLIAMS SHIP RADIO CO
4366 MENTONE ST SAN DIEGO 7 CALIF
WILLSON CAMERA CO INC
1395 LAWRENCE RD HAVERTOWN PENNA
WILMINGTON FIBRE SPECIALTY CO
NEW CASTLE DELA
WILRITE PRODUCTS INC
3835 W 150TH ST CLEVELAND OHIO
WILSON & CO G C
1915 8 AVE HUNTINGTON W VA
WILSONS OF CLEVELAND
6502 N W 16TH ST FORT LAUDERDALE FLA
WILTON TOOL MFG CO
9525 IRVING PK SCHILLER PK ILL
WILTRON CO
717 LOMA VERDE AVE PALO ALTO CALIF
WINATIC CORP
50 STAGE RD VESTAL NY
WINCHARGER CORP
E 7 & DIVISION ST SIOUX CITY 2 IOWA
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WINCHESTER ELECT INC
NEW MILFORD CONN
WIND TURBINE CO
E MARKET ST & P RR WEST CHESTER PA
WINDSOR ELECTRONICS INC
999 N MAIN ST GLEN ELLYN ILL
WINEGARD CO
3000 KIRKWOOD BURLINGTON IOWA
WINKLER LABS
5225 N 20 ST PHOENIX ARIZ
J H WINN INC
620 WASHINGTON ST WINCHESTER MASS
WINPOWER MFG CO
1207 FIRST AVE E NEWTON IOWA
WINSTROM
353 FLORENCE RD FLORENCE MASS
WINTERBURN MFG CO
11 WHITTEMORE ST PUTNAM CONN
WINTRONICS INC
213 HAWTHORNE BLVD HAWTHORNE CALIF
WINZELER MFG & TOOL CO
7355 W WILSON AVE CHICAGO ILL
WINZEN RESEARCH INC
8401 LYNDALE AVE SO MINNEAPOLIS MINN
WIRE CO OF AMER SUB WARREN WIRE CO
POWNAL VERMONT
WIRE CO OF AMER SUB WARREN WIRE CO
400 DAVID LOVE PLACE GOLETA CALIF
WIRECRAFT PRODUCTS INC
RT 9 W BROOKFIELD MASS
WISCONSIN PORCELAIN CO
121 LINCOLN ST SUN PRAIRIE WISC
WITTEK MFG CO
4305 W 24TH PL CHICAGO ILL
WOLLAM AIRCRAFT & MARINE PRODUCTS CO
222 S MILL ST CELINA OHIO
N WOOD COUNTER LAB INC
1525 E 53 ST CHICAGO 15 ILL
WOOD ELEC CORP
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WOODBURY GLASS CO
34 BURNSIDE AVE E HARTFORD 8 CONN
WOODLAND ELECTRONICS CO INC
503 MC CARTER HWY NEWARK 2 NJ
WOODWELDING INC
355 N NEWPORT BLVD NEWPORT BEACH CALIF
WOODWORTH METAL FAB DIV
182 BROAD AVE BINGHAMTON N Y
WORKMAN ELECT PROD INC
BOX 5397 PACKINGHOUSE RD SARASOTA FLA
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119 FLORIDA ST FARMINGDALE LI N Y
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RANKIN ILL
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WEST WARREN MASS
WRIGHT ELECTRONICS INC
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WRIGHT EQUIPMENT CORP
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WRIGHT MACHINERY CO DIV SPERRY RAND CORP
BOX 2211 DURHAM N C
WRIGHT METALCOATERS INC
255 WEST ST S HACKENSACK N J
WRIGHT ZIMMERMAN INC
NEW BRIGHTON ST PAUL 12 MINN
WUERTH PRODUCTS CORP
1949 MOFFETT ST HOLLYWOOD FLA
WURLITZER CO
CORINTH MISS
WURLITZER CO
NORTH TONAWANDA N Y
WYBAR ELECTRONICS INC
PO BOX 388 AUBURN NY
WYCO METAL PRODUCTS
6918 BECK AVE HOLLYWOOD CALIF
WYE INDUSTRIES
6 GEN DEVINE WAY BOSTON MASS
WYETH ENG INC
9911 WALDEN PKWY CHICAGO ILL
WYLE MANUFACTURING DIV OF WYLE LABS
133 CENTER ST EL SEGUNDO CALIF
WYMAN GORDON CO
105 MADISON ST WORCHESTER MASS
WYRCO PROJECTS INC
FORSYTHE AVE OWEGO NY
WYZENBEEK & STAFF INC
223 N CALIFORNIA AVE CHICAGO 12 ILL

X

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48-41 VAN DAM ST LI CITY 1 N Y
XCELITE INC
THORN-BANK STS ORCHARD PARK NY
X PANDO CORP
43 15 36TH ST LONG ISLAND CITY N Y
X RAY MFG CORP OF AMERICA
LAKE SUCESS PARK GREAT NECK N Y
X TRON ELECT INC
890 71ST AVE OAKLAND CALIF

Y

YARDNEY ELECTRIC CORP
40 LEONARD ST NEW YORK N Y
YARNALL WARING CO
102 E MERMAID LANE PHILA PA
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744 BROAD ST NEWARK 2 N J
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1 RESEARCH DRIVE STAMFORD CONN
YOUNG BROTHERS CO
1831 COLUMBUS RD CLEVELAND 13 OHIO
YOUNG SPRING & WIRE CORP GONSET DIV
801 S MAIN ST BURBANK CALIF

Z

ZACHARIAS CO ROBERT
519 S OAKLEY BLVD CHICAGO 12 ILL
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Product Finding Index

Here's How To Use This Index:

- **Find the product in the alphabetical list below.**

Products are listed by their basic description (i.e. a wheatstone bridge will be found listed as "bridge, wheatstone"). Cross-referencing is also provided where a product may be known by a number of different names—for instance, volume control; resistor, variable; and potentiometer will be found listed separately in alphabetical order but all indicating page L98 where their manufacturers are listed

REPRINTS ARE AVAILABLE . . .

A limited number of copies of the following articles from back issues of ELECTRONIC INDUSTRIES are available, free of charge. For copies write, Reader Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila. 39, Pa.

JANUARY 1962 Issue

"Using Magnetostrictive Delay Lines," (three parts), 12 pp.
"Junction Transistor Analysis for Circuitry," (two parts), 8 pp.
"Inexpensive Remote Pickup Receivers," 3 pp.
"Nodes & Tables Lighten Trouble Shooting," 4 pp.
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"1962 Summary of Vacuum Tube Voltmeters," 8 pp.

FEBRUARY 1962 Issue

"Survey of Low-Noise Microwave Amplifiers," 5 pp.
"A Spectrum Analyzer from General Lab Instruments," 3 pp.
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"1962—Survey of Transistor Test Equipment Specifications," 4 pp.

MARCH 1962 Issue

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"Designing Flip-Flop Counting Circuits," 3 pp.
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PRODUCTS & MANUFACTURERS

This is a comprehensive listing of equipment, test and measuring instruments, and components manufactured by the electronic industries. Also listed are supplementary items such as cabinets, chemicals, hardware, raw materials and services related to the electronic field. Names and addresses of manufacturers are given for over 1,500 product categories. Companies making these products or offering services in the field are arranged alphabetically. Addresses of the companies are contained in the alphabetical listing of manufacturers at the beginning of the directory. Numbers printed at the right of each column indicate the products each firm manufactures.

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WESTLAKE PLASTICS CO	2
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BARNETT INST CO	16
BASLER ELECTRIC CO	14
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MUCKLE MFG CO	18
MUIRHEAD & CO LTD	12
MUIRHEAD INSTRUMENTS INC	12
NICAD DIV GOULD NATIONAL BATTERIES INC	4-5
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ONAN DV OF STUDEBAKER PACKARD CORP	14
OPAD ELECTRIC CO	14-15-16
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PIONEER GEN-E-MOTOR CORP	14
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TIPPTRONIC INC	14
TRACERLAB INC WALTHAM	6
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VAP AIR DIV VAPOR CORP	14
VERCO INC	16
WATERMAN PRODUCTS CO	14
WESTERN COIL & ELECTRICAL CO	13
WICKES ENGG & CONSTRUCTION CO	15
WINPOWER MFG CO	14
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Capacitors, button	2
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Capacitors, composition	4
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Capacitors, electrolytic dry	6
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AIRBORNE ACCESSORIES CORP	1-9-12-13-14-15-18-20-28
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AJAX CONDENSER CO	1-6-9-13-15-16-18-19-22-28
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CORNELL-DUBILIER ELECTRIC CORP	1-8-9-12-13-15-16-17-18-20-23
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CORSON ELECTRIC MFG CORP	9-13-15-17-18-20-23-27
DALE ELECTRONICS INC DIV OF LIONEL CORP	3-12-13-28
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KEMET CO DIV UNION CARBIDE CORP	26
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PRECISION CAPACITORS INC	1-9-12-13-15-16-18-19-20-22-24-27
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RADIATION RESEARCH CORP WESTBURY	9-15-18-27
RADIO CONDENSER CO LTD	9-9-15-15-18-18-20-22-22-26
RADIO CORP OF AMERICA SOMERVILLE	26
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RADIO MATERIALS CO DIV PR MALLORY & CO INC	3-5-13-19-22-28
RISCO	14
SAFE-T-MIKE CORP	6
SAN FERNANDO ELECTRIC MFG CO	1-3-7-8-9-12-13-15-16-17-18-19-20-22-24-27
SANGAMO ELECTRIC CO	1-2-4-5-6-7-8-9-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-29
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STANDARD PRESSED STEEL CO	6-7-26
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Capacitors, glass trimmer	4
Capacitors, high temperature	5
Capacitors, mica trimmer	6
Capacitors, minature	7
Capacitors, oil filled	8
Capacitors, piston	9
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AIR O TRONICS ENG CO 2
ALL STAR PRODUCTS INC 1
ARCO ELECT INC 10
ATLEE CORP 4
AUTOMATION COMPONENTS INC 2
BARKER & WILLIAMSON INC 14
BENDIX CORP SEMICONDUCTORS DIV 12
BIRD & SONS LTD SYDNEY S 1-6-14
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COLUMBUS ELECTRONICS CORP 3
COMPONENT RESEARCH CO INC 1-2-4-5-7-8-9-10
CONTINENTAL DEVICE CORP 12
CONTINENTAL ELECTRONIC MFG CO 8-14
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DIEHL MFG CO 28
DITTMORE FREIMUTH CORP 1
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ELPAC INC 7-8-10-11
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GENERAL ELECTRIC CO CAPACITOR DEPT 7-8-10-12
GENERAL INSTRUMENT CORP 1-8-12-14
GENERAL INSTRUMENT CORP F W SOCKLES DIV 1
GENERAL RADIO CO 1
GENISTROM INC 7-8-10-13
GLADDING MCBEAM & CO 2
GOMBOS INC CO JOHN 1
HAMMARLUND MFG CO INC 1-14
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JENNINGS RADIO MFG CORP 15
JFD ELECTRONIC CORP 2-3-4-5-7-9-10-11-13-14
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JOHNSON CO E F 1-7-9-11-13-14
LAPP INSULATOR CO RADIO SPECIALTIES DIV 3-14
LA POINTE INDUSTRIES INC 1
LEEDS & NORTHRUP CO 1
MAIDA DEVELOPMENT CO 2
MEASUREMENTS DIV MC GRAW-EDISON CO 1
M E C INC 7
METAL SPECIALTY PRODUCTS CORP 1
MICROMOLD PRODUCTS CORP 10
MILLEN MFG CO JAMES 1-2
MILLER CO J W 1-6
MUIRHEAD & CO LTD 1
MUIRHEAD INSTRUMENTS INC 1
NATL RADIO CO INC 1-14
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PRECISION CAPACITORS INC 10
RADIO COND CO SUB THOMPSON RAMO WOOLDRIDGE 1- 5- 7-11-13-14
RADIO CONDENSER CO LTD 1-7-10-11
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RADIO FREQUENCY CO 14
SARKES TARZIAN INC 1-7
SICKLES F W DIV GIC 1
TAFFET ELECTRONICS INC 1
TELECHROME MFG CORP 1-2-4-7-9-14
TELEGRAPH CONDENSER CO 2
TRANSITRON ELECTRONIC CORP 12
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Sockets transistor	25
Sockets, tube	26
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LANSDALE ELECTROMETER CO	8
LA ROSE & ASSOC INC W T	20
LAVOIE LABS INC	8-13
LINK DIV GENERAL PRECISION INC	8
LIVINGSTON ELECT CORP	1
MADIGAN CORP	3-10-12
MANSON LABORATORIES INC	5-7-8-10-12-13-17-19-20
MANUFACTURERS ENGG & EQUIP CORP	14
MARCONI INSTRUMENTS	1-3-4-6-8-10-13-14
MAXSON INSTRUMENTS	5
MEASUREMENTS DIV MC GRAW-EDISON CO	1-2-3-8-10-12-13-18-19-20
MELABS	3-5-10-14-22
MENLO PARK ENGG	14-19-20
METAL SPECIALTY PRODUCTS CORP	1-10-17-21
M F ELECTRONICS CORP	1
MICRO STATE ELECTRONICS CORP	4
MODEL ENGG & MFG INC	1-3-5-7-8-9-10-12-19-20-21-22
MONTRONICS INC	4-22
MOTOROLA COMMUNICATIONS & ELECT INC	10
MUIRHEAD & CO LTD	1-10
MUIRHEAD INSTRUMENTS INC	1
NAVIGATION COMPUTER CORP	8
NEW LONDON INST CO INC	3-6-10-20
NORRMAN LABORATORIES ERNST	1-10-17-22
NORTHEAST ELECT CORP	1
NORTHEASTERN ENG INC	3-10-14-19-20
NORTHERN RADIO CO	3-10-13-22
NUCLEAR-ELECTRONICS CORP	3-5-10-19-20
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PARABAM INC	1-8-13-21
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PHILMON LABS INC	8-22
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PLANETRONICS INC	5
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POLARAD ELECTRONICS CORP	3-4-5-6-8-14
POLYTECHNIC RESEARCH & DEVELOPMENT CO	5
PRD ELECTRONICS INC	5
PRECISE ELECTRONICS & DEVELOPMENT CORP	1-10
PRECISION APPARATUS CO	23
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PROBESCOPE CO INC	14
PULSE ENG INC	8
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RADIAPHONE CD	1
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RADIATION INC PRODUCTION DIV	5-8-10
RADIO CITY PROD CO	23
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RADIO CORP OF AMER DEFENSE ELECT PROD	10-15
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REEVES INSTRUMENT CORP	6
REMANCO INC	5-6-8-9-10-21
REPUBLIC ELECT INDUST CORP	1
RESEARCH INDUSTRIAL LAB OF ELECTRONICS	8
RESE ENGG INC	8
RIVERBANK LABS ENGG DEPT	1
R M S ASSOCIATES INC	9
RMS ENG INC	22
ROBERTSON INSTRUMENT CO	2
ROHDE & SCHWARZ	1-3-6-10-11-14-18-19-20
RON ELECTRONICS CORP	12
R S ELECTRONICS CORP	3
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SOUTHWESTERN INDUSTRIAL ELECT CD	23
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SPECTRAN ELECTRONICS CORP	1
SPENCER-KENNEDY LABS INC	8
SPERRY MICROWAVE ELECT INC	5-6
SPIVEY INC JAMES S	23
STODDART AIRCRAFT RADIO CD	8
SULLIVAN LTD H W	23
SUMMERS & MILLS INC	10
SYSTEMS INC	1-3-12-17-21
SYSTRON DONNER CORP	1
TAFFET ELECTRONICS INC	1-10-17-21
TEKTRONIX INC	8-13-17-21
TELECHROME MFG CORP	2-5-6-8-12-13-15-18-21
TELECTRO INDUSTRIES CORP	10
TELEVISION UTILITIES CORP DIV NORD	18
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Meters, flux	5
Meters, Frequency	6
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BARNES DEVELOPMENT CO	2
BARNETT INSTRUMENT CO	10-16-17-20
BARRY ELECTRONICS CORP	8
BASSETT INC REX	6
BECKMAN INST INC BERKELEY DIV	4-6-10-11-16-21
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BIDDLE CO JAMES G	6-10-11
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ELECTRONIC COUNTERS INC	6
ELECTRONIC DEVELOPMENT LABS	4-17
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ELECTRONICS OF CLEARFIELD INC	16
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ENGELHARD INDUSTRIES	17
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Test Equipment—Meters
Test Equipment—Meters, RF
Test Equipment—Meters. Audio

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JACKSON ELECTRICAL INSTRUMENT CO 16
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KEITHLEY INSTRUMENTS INC 10-16-17-22
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METER MAKERS INC 20
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NORTH ATLANTIC INDUST INC 11-16-18-21
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NUCLEAR-CHICAGO CORP 1
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NUCLIDE ANALYSIS ASSOC 1-4-16-17
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PHILCO CORP SIERRA ELECTRONIC DIV 16
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POLYTRONICS CO 10
PRD ELECTRONICS INC 6
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QUAN TECH LAB INC 8
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RANGERTONE INC 6
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SIVERS LAB 6
SMITH FLORENCE INC REDMOND 8-10-16-17-20-21
SMITH & FLORENCE INC SEATTLE 1-4-8-10-17-20-21
THE SOLARTRON ELECTRONIC GROUP LTD 14-21
SPECTRO MAGNETIC INDUST 5
STERLING MFG CO 4-8-17
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SUNSHINE SCIENTIFIC INSTRUMENT 8-10-14-16-17-18-20
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TEKTRONIX INC 2
TELECHROME MFG CORP 6
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TRICONIX INC 12
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TRIPLET ELECTRICAL INST CO 4-8-10-16-17-18-20
TRIPLETT ELECTRICAL INSTRUMENT CO 4-8-9-10-14-16-17-18-20
TRIPLETT ELECTRICAL INSTRUMENT CO 4-8-10-14-16-17-18-20
VARO MFG CO 6
VENNER ELECTRONICS LTD 21
VERCO INC 4-6-10-17
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ALCO ELECTRONIC PRODUCTS INC 6
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AMERICAN ASTRO-SYSTEMS 1-2-3-4-5-6-7-8-9-10-11-12-13
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ARF PRODUCTS INC 5
ASSEMBLY PRODUCTS INC 1-7-10-12
BACH-SIMPSON LTD 1-12
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BECKMAN INST INC BERKELEY DIV 9
BENCO TELEVISION ASSOC LTD 4-10-12
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BRUNO NEW YORK INDUST CORP 10
BUDELMAN ELECTRONICS CORP 5-9
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IDEAL PRECISION METER CO 1-12
INSTRUMENT MASTERS INC 1-12
INTERNATIONAL INSTRUMENTS INC 12
JENNINGS RADIO MFG CORP 12
JONES ELECTRONIC CO INC 10-11
KAY ELECTRIC CO 12
LAMPKIN LABS INC 5-9
LAVOIE LABS INC 5
MARCONI INSTRUMENTS 5-9-10
MEASUREMENTS DIV MC GRAW-EDISON CO 4-5-6-9-12
MELABS 9
METAL SPECIALTY PRODUCTS CORP 6-9
MILLEN MFG CO JAMES 6-9-11
MILLIVAC INSTRUMENTS INC 12
MOBIL ELECTRONICS MFG CO 4-10
MODEL ENGG & MFG INC 7-10-12
MOTOROLA COMMUNICATIONS & ELECT INC 12
NEW LONDON INST CO INC 5
NORTHEAST ELECT CORP 10
ORION ELECTRONICS CORP 7-12
PACO ELECTRONICS CO INC 6-12
PHILCO CORP SIERRA ELECTRONIC DIV 10
PHILMORE MFG CO INC 4
PLAS TRON CORP 4-10
POLYTECHNIC RESEARCH & DEVELOPMENT CO 11
PRD ELECTRONICS INC 11
PROJECTS UNLIMITED INC 11
RADAR MEASUREMENTS CORP 10-11-13
RAILWAY COMMUNICATIONS INC 13
RAWSON ELECTRICAL INSTRUMENT CO 12
REMANCO INC 9-10
SECO ELECTRONICS INC 10-11
SENSITIVE RESCH INSTRUMENTS CORP 1-12
SERCO ELECT RESEARCH CORP 11
SERVICE INSTRUMENT CORP 12
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 12
SMITH ELECTRONIC INC 4
SPERRY MICROWAVE ELECT INC 2-4-9-10-11-13
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VITRO ELECTRONICS DIV OF VITRO CORP OF AM 4-8
WACLINE INC 1-12
WAVELINE INC 2-9-11-13
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AUDIO PRECISION AIDS INC 1
BALLANTINE LABS INC 2
BARKER & WILLIAMSON INC 3
BORG-WARNER CONTROLS 1-2
CLOUGH BRENGLE CO 2
DAVEN CO 2-3
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ELECTRONIC INSTRUMENT CO INC 1
GENERAL RADIO CO 3
HEATH CO SUB OF DAYSTROM INC 3-4
HEWLETT PACKARD CO 3
HICKOK ELECTRICAL INSTRUMENT CO 1
HOYT ELECTRICAL INSTRUMENT WORKS 1
IDEAL PRECISION METER CO 2-5
INDUSTRIAL ACOUSTICE CO 1-2
INTERNATIONAL INSTRUMENTS INC 2
INTL INSTRUMENT INC 2
ITI ELECTRONICS INC 1
KAY ELECTRIC CO 6
LANGEVIN DIV OF SONOTEC INCORP 1-2-5
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MILLIVAC INSTRUMENTS INC 1
NORTH ATLANTIC INDUST INC 3-4
NORTHEAST ELECT CORP 1
NORTHERN RADIO MFG CO 2
ORION ELECTRONICS CORP 1
PACE ELECTRICAL INSTRUMENTS CO 2
QUALITONE CO 1
QUAN TECH LAB INC 3-6
RADIO CORP OF AMERICA ELECTRN TUBE DIV 1
ROBINS INDUSTRIES CORP 2
SCOTT INC H H 2
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 1-2
SUN ELECTRIC CORP 2
THETA INSTRUMENT CORP 1
TRIPLETT ELECTRICAL INSTRUMENT CO 2
WACLINE INC 1-2
WAVEFORMS INC 1

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- Calorimeters 2
- Gaussmeters 3
- Magnetometers 4
- Metets, acceleration 5
- Meters, cable testing 6
- Meters, counting rate 7
- Meters, deflection 8
- Meters, deviation 9
- Meters, elapsed time 10
- Meters, electronic micrometer 11
- Meters, events-per-unit time 12
- Meters, flutter 13
- Meters, goniometer 14
- Meters, humidity 15
- Meters, infrared 16
- Meters, photoelectric 17
- Meters, pyrometer 18
- Meters, rate 19
- Meters, ratio 20
- Meters, tachometer 21
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AMERICAN GYRO DIV TAMAR ELECT INC 22
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BACH-SIMPSON LTD 10-21-28-30
BALLANTINE LABS INC 30
BARNES DEVELOPMENT CO 9
BARNETT INST CO 28
BEARING INSPECTION INC 26
BECKMAN INST INC BERKELEY DIV 10-12-20
BELL INC F W 3
BERGEN LABS INC 10
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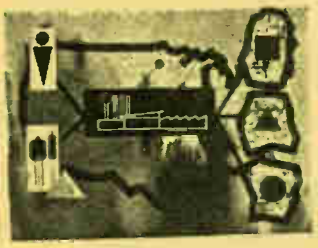

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BURT UNDERWOOD
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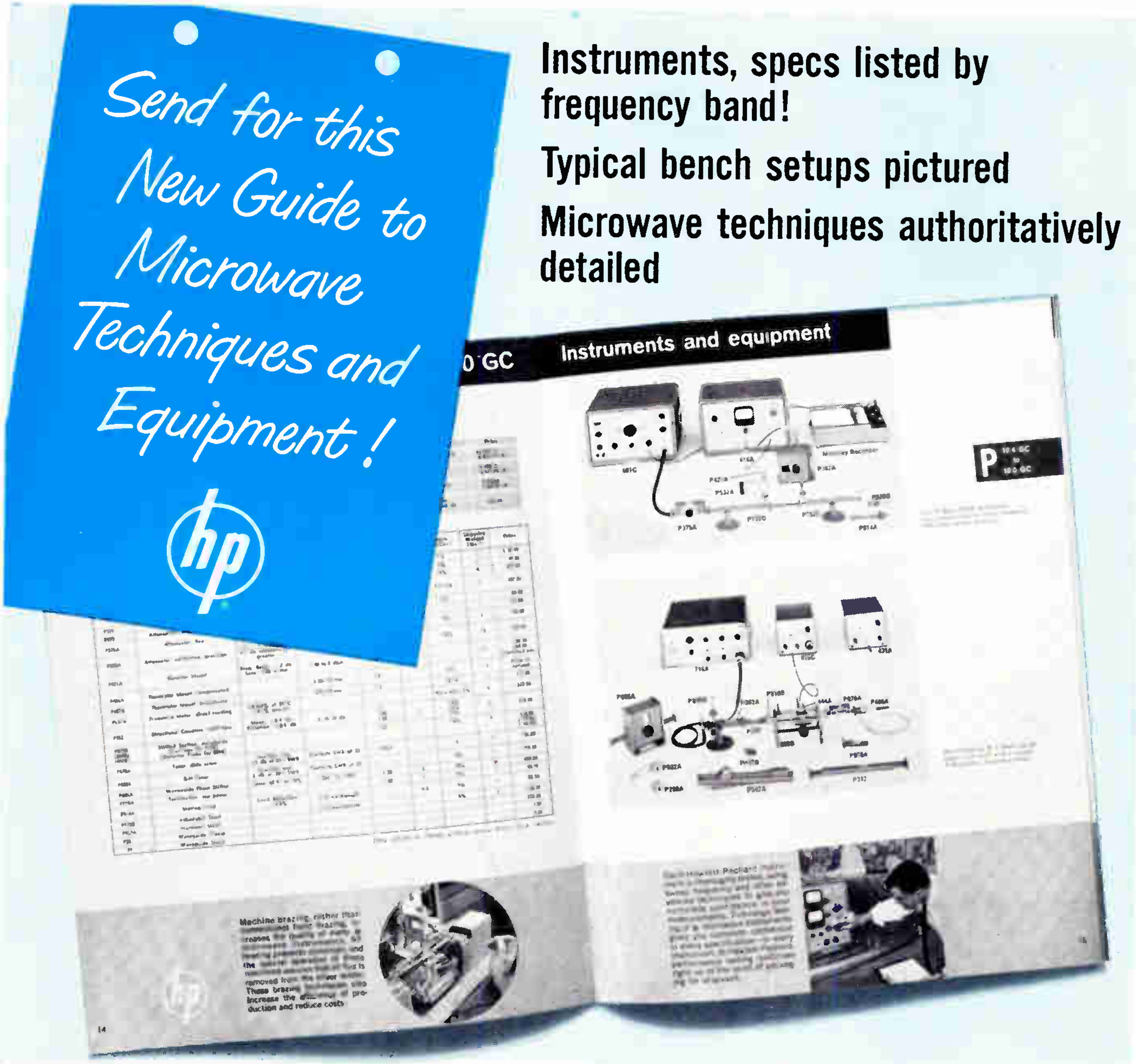

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