ELECTRONIC INDUSTRIES

FEBRUARY 1964

Magnetism – a Staff Report

Lasers: State-of-the-Art

High Speed Operational Amplifiers

DALE RELIABILITY

TOTAL CAPABILITY IN PRECISION RESISTANCE

Need metal films fast? Rely on DALE capability

Dale Metal Film Resistors are yours – fast – with three coating choices. Sizes from 1/10 to 2 watts let you meet a broad range of requirements within MIL-R-10509. Check the chart at right for proof of Dale's capability to supply parts that meet every electrical and environmental requirement of the Mil. Spec. – especially the low TC's difficult to obtain elsewhere (25 p.p.m. is standard with us). The same special metal alloy used in Dale ultra-high reliability wirewounds for the *Minuteman* Program is vacuum deposited on Dale Metal Film Resistors. Following film stabilization at elevated temperatures, terminating bands are deposited under vacuum to insure optimum film-to-lead contact and low noise. Matched coating and encapsulating materials, including undercoat applied immediately after film deposition, protect precise value and assure product homogeneity. Weldable leads, EIA color banding and reel packaging available. From design through delivery – Dale Metal Film Resistors are your most reliable choice.

SPECIALS – ASK US

Special constructions, non-helixed units, special mountings, networks – just name it and we'll go to work.

Write for Catalog A

GENERAL SPECIFICATIONS – TYPE MF*

DALE TYPE	MIL TYPE	125° C RATING	RESISTANCE RANGE	DIMENSIONS (L. x D.)
MF-1/10	RN-55	1/8 watt	100 ohms to 200K ohms	.250 x .093
MF-1/8	RN-60	1/8 watt	49.9 ohms to 550K ohms	.406 x .140
MF-1/4	RN-65	1/4 watt	49.9 ohms to 1 Megohm	.593 x .203
MFS-1/2	RN-70	1/2 watt	49.9 ohms to 2 Megohms	.750 x .250
MF-1	RN-75	1 watt	49.9 ohms to 6 Megohms	1.093 x .375
MF-2	NA	2 watts	99.8 ohms to 15 Megohms	2.250 x .375

Tolerance: ±1% standard; ±.5%, ±.25%, ±.1% available.

ENVIRONMENTAL SPECIFICATIONS*

	DALE T.C. CODE	APPLICABLE CHAR. OF MIL-R-10509E
Dale MF Resistors are manufactured to the environmental specifications of MIL-R-10509E. Characteristic D, C, or E apply depending on T.C. Code specified at purchase.	T-1 (100 P.P.M./°C)	D
	T-2 (50 P.P.M./°C)	C
	T-9 (25 P.P.M./°C)	E

*Specifications for MFF and MFH are similar, but vary dimensionally.

DALE ELECTRONICS, INC.
1304 28th Avenue, Columbus, Nebraska
A subsidiary of THE LIONEL CORPORATION
Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

Circle 98 on Inquiry Card

ELECTRONIC INDUSTRIES

". . . The STATE-OF-THE-ART Magazine for Electronic Engineers"

EDITORIAL:

JOHNSON'S RECORD IS PROMISING

A CLOSE, HARD LOOK at the military spending plans of the Johnson Administration reveals that contract pessimism in the electronic industries is unwarranted.

True, President Johnson has called upon all federal departments and agencies to exercise economy in fiscal 1965. But such talk has become almost a ritual for Washington politicians in odd-numbered years. It is the even-numbered years (election years) that count. Both the White House and the Congress are well aware of this. Economies proposed in non-election years are usually forgotten.

Actually, the overall outlook for defense spending is still bright.

President Johnson's 30-year Washington record shows that he has consistently supported heavy defense programs. In his first campaign in the early 1930s, for a seat in the U.S. House of Representatives, he supported FDR and big federal spending. He then successfully repeated the formula in running for the U.S. Senate, and eventually for the Vice Presidency. Nothing in his record suggests any disposition to reverse the upward trend in federal defense expenditures.

Congress is not likely to vote for a smaller defense budget, either. This is an election year. One-third of the Senate and all 435 seats in the House of Representatives are involved in this election. The incumbent candidates will now promise—and vote for—programs that will create employment and new business in their home areas.

Talk of cuts in defense spending is therefore without foundation, although spending in the electronics area may not increase as much as some in our industry had hoped. Far-sighted managements know that certain government programs are being ended; others are being trimmed, and that some of their existing plans may have to be scrapped. Wise management is preparing and planning now to meet the coming shifts in defense spending.

Government economies, in any case, do not necessarily spell bad news for defense contractors. Cutbacks actually have their good side. For example:

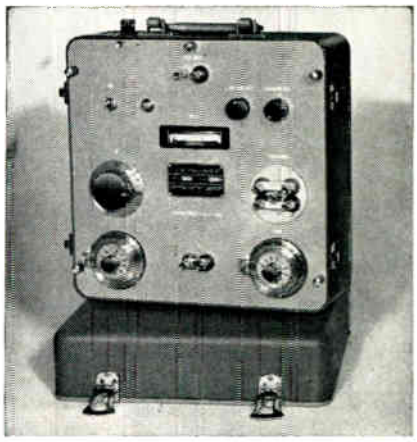
- Although Dyna-Soar project is now dead, Asset project (space re-entry experiments via unmanned spacecraft, plus manned space laboratory work) is on the move, with new engineering ideas, and new products, being investigated.
- The closing down of government installations, particularly shipyards and ordnance plants, means that government must rely more on private industry.
- The Johnson economy move is forcing the government to prepare to aid industries, companies and geographical areas hurt by shifts in spending. The Pentagon is actively extending assistance to firms, through its office of economic adjustment. President Johnson has appointed a committee, headed by Walter Heller, his chief economic adviser, to explore the effects of defense spending cuts.

Keep in mind, too, that while the White House proposes federal budgets, it is the Congress that appropriates the funds, now approaching $102 billion. A so-called "economy" budget can be fattened up by an election-minded Congress. And this has often happened in recent years.

Congressman Johnson was a strong New Dealer. Senate leader Johnson was a middle-of-the-roader. Vice President Johnson was strongly aerospace/defense minded. We have yet to see whether President Johnson's broad new responsibilities have modified his past views.

President Johnson is not proposing a balanced budget. Far from it. Nor is he suggesting that the long-range trend of constantly-rising federal expenditures be reversed. What he is saying, in effect, is simply: "I promised Harry Byrd (Chairman of the Senate Finance Committee) that I would make an honest effort to hold down the new budget, so that taxes could be cut. So, some spending cuts are inevitable. But there will also be new programs. Alert defense contractors and sub-contractors should be aware of this.—We are simply undergoing another period of transition."

New Bridge Design For Safe, Accurate, Easy Measurement of 'Lytic Capacitors



The Sprague Model 1W2A Capacitance Bridge introduces new, improved technical refinements as well as restyling for added attractiveness and ease of operation. Built *by* capacitor engineers *for* capacitor users, it incorporates the best features of bridges used for many years in Sprague laboratories and production facilities.

Precision Measurements over Entire Range from 0 to 120,000 μF

The internal generator of the 1W2A Bridge is a line-driven frequency converter, and detection is obtained from an internal tuned transistor amplifier-null detector, whose sensitivity increases as the balance point is approached. It has provision for 2-terminal, 3-terminal, and 4-terminal capacitance measurements, which are essential for accurate measurement . . . ±1% of reading + 10μμF . . . of medium, low, and high capacitance values, respectively.

No Damage to Capacitors

The model 1W2A Capacitance Bridge will not cause degradation or failure in electrolytic or low-voltage ceramic capacitors during test, as is the case in many conventional bridges and test circuits. The 120 cycle A-C voltage, applied to capacitors under test from a built-in source, never exceeds *0.5 volt!* It is usually unnecessary to apply d-c polarizing voltage to electrolytic capacitors because of this safe, low voltage.

Complete Specifications Available

For complete technical data on this precision instrument, write for Engineering Bulletin 90,010A to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Circle 67 on Inquiry Card

February 1964, Vol. 23, No. 2

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine for Electronic Engineers

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

COVER

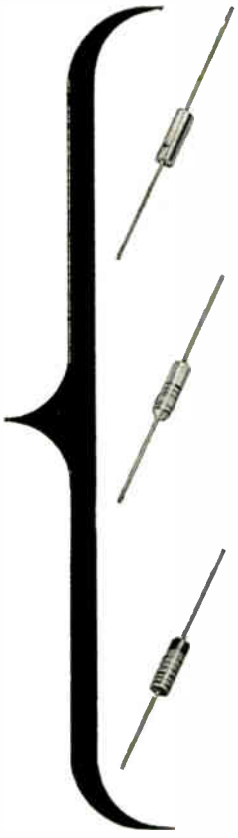
Our cover designer set out to show graphically the interaction between magnetic fields. Magnets of varying sizes and shapes were positioned under a sheet of paper on which were sprinkled iron filings. This striking presentation is the result.

BPA NBP

DEPARTMENTS

All from Sprague...for "cordwood" packaging!

ULTRA-MINIATURE SOLID TANTALUM CAPACITORS



Type 172D in glass-to-metal hermetically-sealed cases. Performance characteristics identical to Sprague's famous Type 150D capacitors . . . including superior high frequency performance, lower leakage current values, lower dissipation factor limits, and higher permissible ripple currents as compared to customary industry specifications. **Engineering Bulletin 3523**

Type 154D in molded cases. Another Sprague innovation to cut your costs. Offers nearly all the high performance characteristics of metal-clad capacitors. For selected applications in digital computing equipment and other commercial and industrial electronic gear where you do not need the humidity protection of higher-priced, hermetically-sealed types. **Engineering Bulletin 3530**

Type 165D in polyester-film tubes. Sealed with epoxy resin. Because of thin wall of tube casing, Type 165D gives you the highest capacitance of any solid tantalum capacitor anywhere! Recommended for use in encapsulated blocks or hermetically-sealed metal-encased sub-assemblies to assure protection from moisture. **Engineering Bulletin 3535**

...PLUS...

TYPE 206P Epoxy-Coated PACER® polyester film CAPACITORS Engineering Bulletin 2067	**TYPE 252C** Molded-Case CERA-MITE® ceramic CAPACITORS Engineering Bulletin 6151	**TYPE 262C, 263C** Molded-Case MONOLYTHIC® layer-built ceramic CAPACITORS Engineering Bulletin 6250	**TYPE 903Z** Epoxy-Coated INDISTOR* induction-resistance DELAY NETWORKS Engineering Bulletin 45,001 *Trademark	**TYPE 416E, 418E** Molded-Case FILMISTOR® metal film RESISTORS Engineering Bulletin 7025B
TYPE 405E, 411E Molded-Case FILMISTOR® deposited-carbon RESISTORS Engineering Bulletin 7000B	**TYPE 239E** Vitreous-Enamel BLUE JACKET® power wirewound RESISTORS Engineering Bulletin 7410D	**TYPE 219E** Silicone-Encapsulated ACRASIL® precision power wirewound RESISTORS Engineering Bulletin 7450	**TYPE 5000Z** CONNECTORS and ISOLATORS ("shorts and opens") Engineering Bulletin 94,000	**TYPE 7000Z** Shielded Radio Frequency INDUCTORS Engineering Bulletin 41,800

The Sprague components shown here are available in the two basic sizes (.090"D. x .250"L. and .138"D. x .390"L.) you need for the accepted high-density technique known as "cordwood" packaging. If you wish, they can be furnished on lead tape for automatic insertion on printed wiring boards. And with standardized sizes, these components can be installed with the same machines, permitting more efficient use of insertion equipment.

For complete technical data, write for Engineering Bulletins listed above. Address: Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
TRANSISTORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
MICROCIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
INTERFERENCE FILTERS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

48C-139-63

SPRAGUE®
THE MARK OF RELIABILITY

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ELECTRONIC INDUSTRIES HIGHLIGHTS

MAGNETICS RESEARCH TURNS UP NEW DESIGNS, APPLICATIONS 30

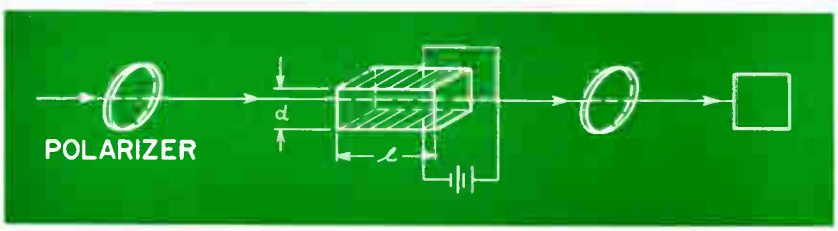
Out of the extensive research in magnetics have come such developments as superconducting solenoids and magnetic thin films. Magnetics is finding increased usage in research labs, space vehicles, power generators, computers and metalforming machines, among others. In many applications they are expected to supplant active components, including semiconductors.

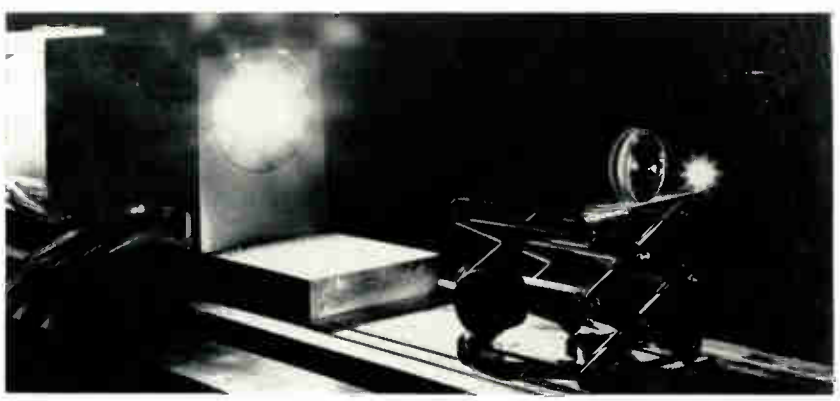
INCREASING ROLE FOR WOMEN IN ELECTRONIC ENGINEERING 46

Women in engineering, though fairly commonplace in Europe and Asia, are still an oddity in American social lattice. By tradition, men have looked on women as housekeepers and needle pushers. Now, individual effort and societies are putting women in their rightful places in modern industry, from the assembly line to the executive suite.

MODULATOR CRYSTALS FOR LASERS 83

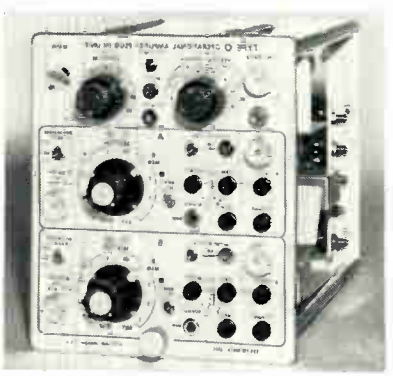
An optical communications system based on the laser would be highly directive and have wide bandwidth. But a first requirement is a method of modulating the beam. A promising approach lies in the use of the Pockel's effect, passing the light through a crystal on which a varying electric field is applied.





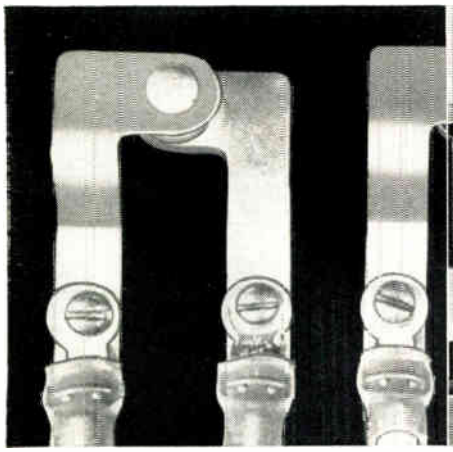
THE LASER FIELD . . . WHERE WE STAND TODAY 68

The past, present and future of lasers are discussed in this article by the man who developed the first laser in 1960. Dr. Maiman discusses the various types of lasers, their properties, problems, and present and future uses. He also comments on likely and unlikely predictions which have been made for lasers.

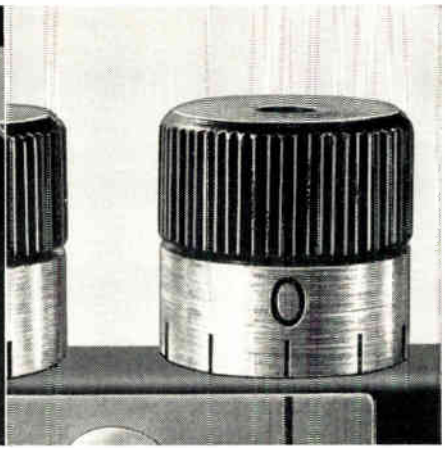


UNDERSTANDING HIGH-SPEED OPERATIONAL AMPLIFIERS 106

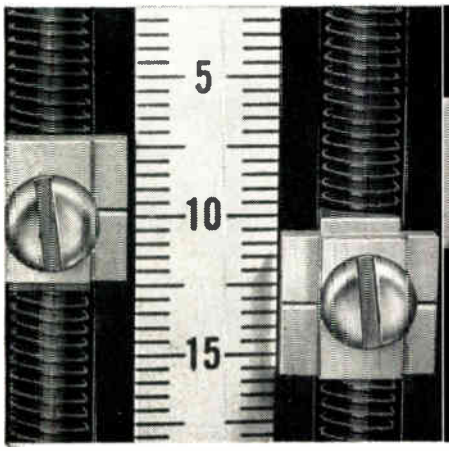
Operational amplifiers are important in measurements and R&D work. Capable of simulating a variety of circuits, they can be used to add, subtract, differentiate, integrate or amplify either linearly or with controlled nonlinear coefficients, under signal conditions. Here is a chance to learn how they work.



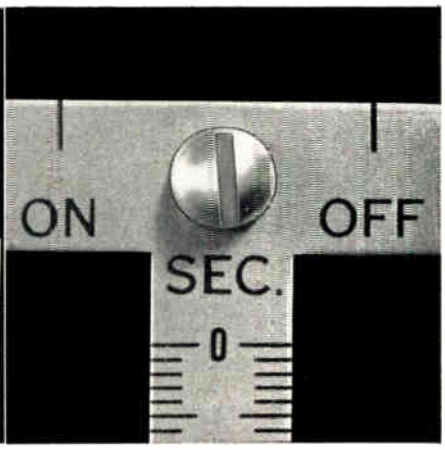
Six 10 ampere, heavy duty contacts handle up to 30 amps. inrush



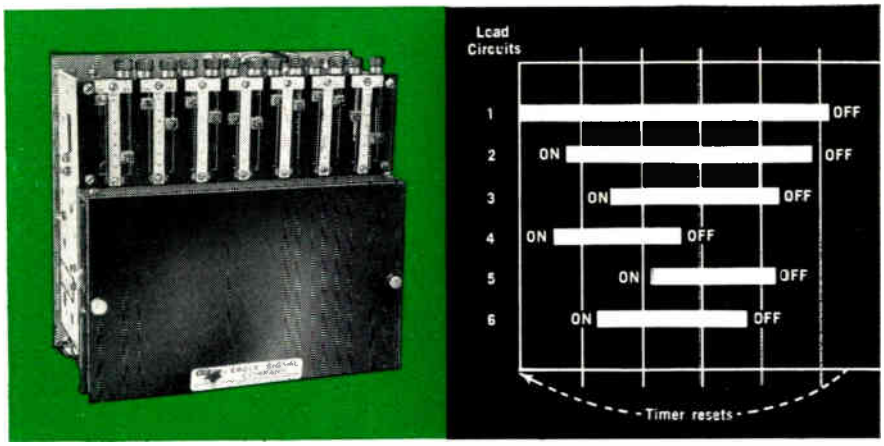
Vernier adjustment for time settings of ⅓ of 1% of full scale



ON and OFF time set points indicated on scale for each circuit



Time scales from 5 seconds to 60 hours available



Simplified control of multi-function processes using solenoid valves, motors or any electrically energized device is possible with the MULTIFLEX. Up to six circuits can be programmed in any order.

SIX TIMERS IN ONE

The Multiflex combines, in a sirgle instrument, a multiplicity of timing functions. Large and small budget engineers alike will appreciate the direct approach of using one accurate synchronous motor for the timing of multiple intervals, and in the same instrument, having versatility for making time settings. Learn more about the Multiflex by writing today.

Ask for Eagle Signal Bulletin 130

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736 FEDERAL ST. · DAVENPORT, IA. · U.S.A.

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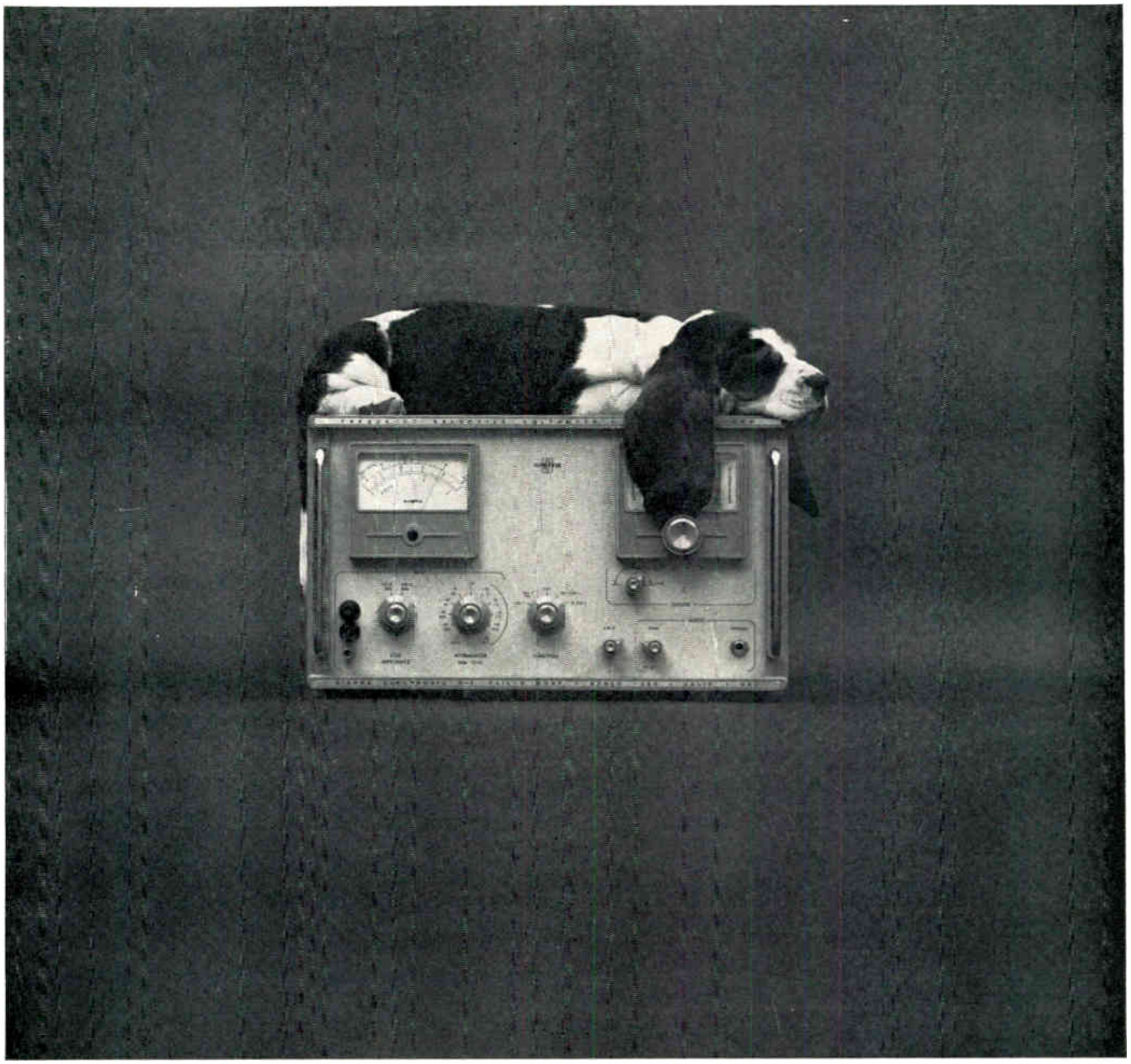


Sierra is a Warm Voltmeter

This is the frequency selective voltmeter that took "voltmeter" out of the language of telephone company maintenance engineers. To them, it's a "Sierra." You'll find them keeping their Sierras warm through constant use: tracking down fugitive harmonics; tracing out complex wave forms; performing the numerous check-out functions required to keep complex carrier equipment humming.

Telephone people have been using Sierras since 1947, the year the line was born. Some have been using the same instrument for 16 years. One of the early '47's came in recently with its first request for service! The same kind of lasting power is being built into this year's models.

Today Sierra means more than voltmeters. It could be the assurance of power levels measured on an r-f calorimeter that sets industry standards for accuracy. Or the security of a transistor passed through quality control after a thoroughgoing physical in a power transistor tester. More than a half-hundred meanings of the word Sierra can be found in the pages of the Quick Reference Catalog.

There's a Sierra Electronic Division to define, too. It's the builder of precision electronic test instruments, backed by the engineering resources of Philco Corporation and the Ford Motor Company. And it's a reputation, backed by 16 solid years of performance, for building superb products from soundly conceived designs . . . without compromise.

The Quick Reference Catalog presents basic information on the products of Sierra Electronic Division of Philco. Ask for your free copy by writing to the address below.

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF Ford Motor Company

Sierra Electronic Division/ 3879 Bohannon Drive/ Menlo Park, California

PRODUCTS FOR EVALUATION

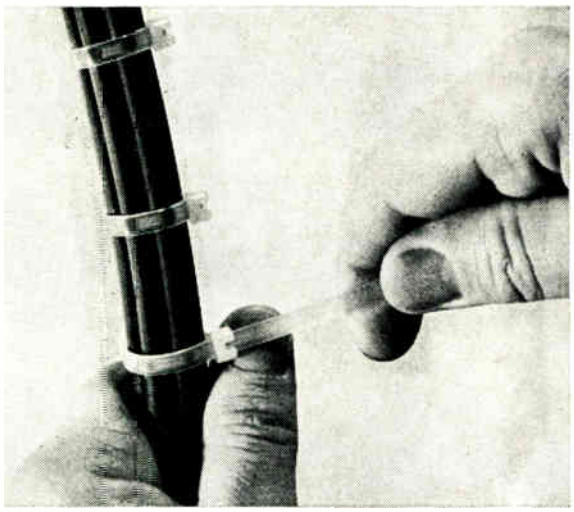
T&B ENGINEERED

CONNECTION SYSTEMS AND CABLING TECHNIQUES

Product samples available on letterhead request.

NEW SELF-TYING TY-RAP™ CABLE TIE

IT ALMOST TIES ITSELF – INSTALLED COST CUT UP TO 60%.



Now harnessing fabrication is easier, neater, and quicker with new TY-RAP cable ties. Training time reduced 75% — 46 sizes of clamps can be eliminated from inventory. Substantial improvement of appearance of wiring in equipment are some of the advantages over string or tape ties. Meets MIL-S-23190 (WEP) and other applicable MIL specs.

The nylon TY-RAP cable tie bundles anything from 3/16" to 4" diameter. The complete line of TY-RAP products includes color-coded ties, clamps, mounting brackets and identification plates. Hand and air power tools are available for high-speed production.

Write for illustrated brochure T-35 and self-tying TY-RAP sample.

Circle 5 on Inquiry Card

FLEXIBLE HIGH-DENSITY WIRING SYSTEM

NEW STA-KON® SERIES '53' SOLID TAPER PIN SYSTEM

The STA-KON TAPER PIN SYSTEM gives you a flexible building block principle using standard components which permits customized high-density connections.

The STA-KON TAPER PIN SYSTEM is designed to offer you improved reliability at lower installed costs. The system utilizes two components: a *solid* taper pin which affords longer life for a self-wiping, self-locking connection, a solderless dual crimp makes the wire and solid pin an integral unit with high pull-out strength; and a molded diallyl phthalate block which has negligible moisture absorption for a warp-free life. Molded barriers on the block provide an excellent creepage path.

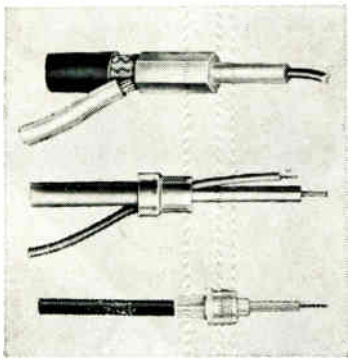
The STA-KON Series "53" accommodates a wire range from #26 to #14 AWG. Blocks available are 10, 20, 30 single and common receptacles. Fewer tools are required.

Write for technical bulletin T30-256.

Circle 6 on Inquiry Card

SOLDERLESS COAXIAL GROUNDING CONNECTORS & R. F. ADAPTERS

NEW COMPRESSION TECHNIQUE REDUCES NOISE



A permanent hex-compression method for reliable grounding termination and insulation of shielded and coaxial cable at lower installed costs. Provides a noise-free, solderless, secure connection without damage to insulation or measurable change in impedance. Mechanically, the bond is stronger than the braid.

T & B has designed a line of R. F. Adapters which are pre-matched to fit widely used coaxial cables to specified R. F. Connectors. They provide a complete, secure, threaded joint in addition to the advantages of the hex-compression. These adapters lower inventory and tool requirements which make them particularly attractive to users of coaxial cable.

A wide selection of sizes in several connector styles are available for the complete range of shielded cable. Standard and special types for every need — non-insulated, flared, self-insulated, half-length and special high temperature, to 500°F, inner and outer sleeves. T & B flag type for special applications is also available. Hand and power tools are available.

Write for complete technical information.

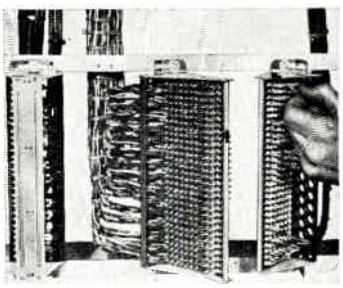
Circle 7 on Inquiry Card

The Thomas & Betts Co., Incorporated • Elizabeth 1, New Jersey
In Canada, Thomas & Betts Ltd • Montreal

T&B ENGINEERED **THOMAS & BETTS**

CONNECTO-BLOK™ WIRING SYSTEM

NEW BLOCK AVAILABLE FOR SNAP-ON TERMINALS OR WIRE WRAP



The Connecto-Blok is a flexible wiring system for audio, video, control, and high-density circuits. This terminal block saves on board assembly, rewiring costs and space. The Connecto-Blok provides greater reliability than a soldered terminal board plus the flexibility of a multi-pin type connector in one compact device.

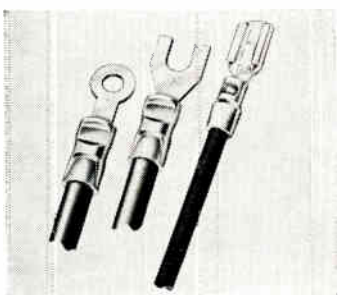
Matching .110 terminals accommodate No. 24 — No. 18 AWG stranded wire. Flash-over — up to 4200 volts, pin-to-pin. Mounting arrangement accommodates a heavy concentration of plug-in connections — 4800 or more — in rack space height of only 10½". Savings in wiring costs of 20% have been reported — 40% savings have been recorded through the use of high-speed strip terminal attaching machines.

Write for technical bulletin T-21-225A.

Circle 8 on Inquiry Card

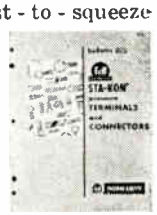
STA-KON® SOLDERLESS TERMINALS AND CONNECTORS

NEW WT-145A HAND TOOL – THE ONLY TOOL THAT CONFORMS TO MIL SPECS. AND INSTALLS INSULATED TERMINALS, SPLICES AND END CAPS ON NO. 26 – NO. 10 WIRE.



An extensive line of insulated and non-insulated tin-plated copper terminals, dis-connects, end caps, wire joints and special terminals. Available with Teflon®, Nylon® and PVC insulation. Wire range from #26 to 250 mcm. Stud sizes #0 to ¾". High-temperature (2000°F.) terminals are also available. Meet MIL-T-7928 and are UL and CSA listed where applicable.

The STA-KON WT-145A is the only tool that conforms to military specifications for installing insulated (TYPE II) Class I terminals, per MIL-T-7928, MS-25036-1A. It replaces 3 tools. It is the smallest, lightest, most economical and easiest - to - squeeze tool. Weighs only 24 ozs. and can be held easily with one hand.



Write for complete technical information.

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MIL TYPE SPLICES AND MULTI-SPLICES

NEW TECHNIQUE SAVES SPACE . . . ELIMINATES TERMINAL STRIPS

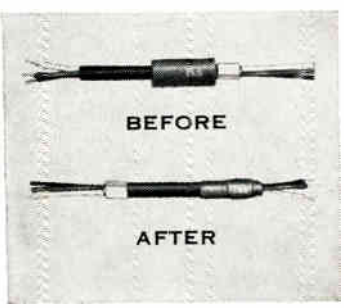
This line meets MIL-T-7928. It has found wide acceptance in the electronic and aerospace industries. Permits splicing of multi-conductors anywhere in the wire bundle. It is a compact, self-contained junction, completely insulated, provides extended flex protection. Inspection window gives reliability check. These connectors operate over a wide temperature range. The insulation material is nylon (Zytel®). When compared to other methods the multi-splice system offers weight and space savings, reduced installation costs, less noise interference and elimination of moisture and fungus traps. The line accommodates wire sizes from No. 10 to No. 26. All sizes can be installed with only one tool — WT-145A. SEE STA-KON solderless terminals for tool features.

Write for complete technical information.

Circle 10 on Inquiry Card

NEW IRRADIATED HEAT SHRINKABLE INSULATORS

QUICK, CLEAN, MOISTURE-TIGHT INSULATION IN SECONDS.



T&B'S color-coded heat-shrinkable insulators are made or irradiated polyolefin tube which shrinks at 275°F. and immediately conforms to the shape of the product being insulated. Ideal for insulating terminals, taper pins, splices, connectors and components. The calibrated shrinking of the insulator provides a tight fit and gives excellent strain relief at flex points.

The tubing is available in lengths from ½" to $3\frac{31}{32}$" and from .125" to .625" dia. (shrink ID .063 to .312). Dielectric strength of 1000 volts/mil., and a tensile strength of 3000 psi.

A special low-cost heat gun is available which supplies fast heat evenly distributed in seconds.

Write today for complete technical information.

Circle 11 on Inquiry Card

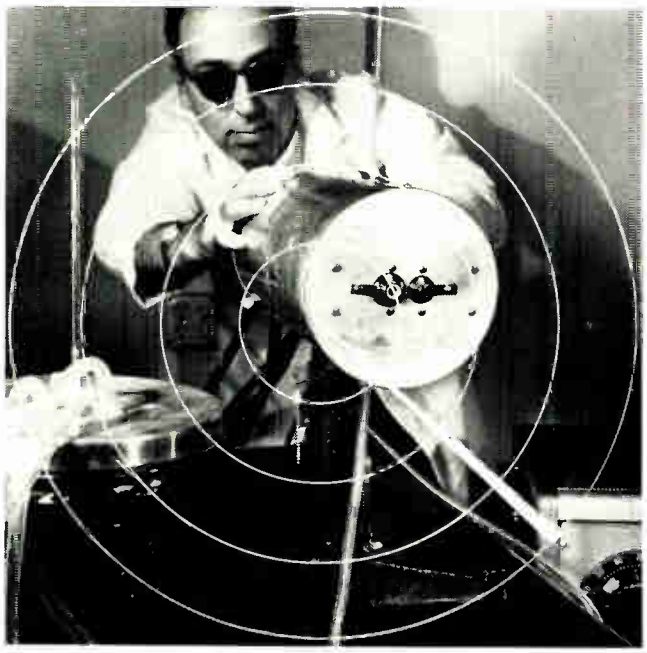
The Thomas & Betts Co., Incorporated • Elizabeth 1, New Jersey
In Canada, Thomas & Betts Ltd • Montreal

T&B ENGINEERED THOMAS & BETTS

ELECTRONIC INDUSTRIES

RADARSCOPE

Analyzing current developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries



NEODYMIUM GLASS-ROD AMPLIFIER

Gun-like laser unit from Electro-Optical Systems, Inc., uses laser coupled to neodymium glass rod to amplify beam at low input levels. Device can produce output gain of 7 db from input signal as low as a few watts. Development could result in laser type of accurate and improved surveillance system for ground-based and airborne uses.

ELECTROMECHANICAL TRANSDUCER converts motion into frequency-modulated signals. Power use is less than a half microwatt, according to developer Federal Electric Corp. The threshold is infinite. Accuracies of better than 3.2 seconds of arc in angle measure are reported. This is important in missile guidance systems. Federal claims device is useful wherever extremely accurate and direct conversion of sound waves to fm signals is needed.

NEW SCANNING ELECTRON MICROSCOPE, is the latest tool of microelectronics research. Westinghouse developed the device based on a concept conceived at Cambridge University. Researchers at Westinghouse say it "marks major advance in the use of non-thermal effects af electron beams to solid-state technology." The instrument allows new technique for the making and inspecting of tiny, complex, semiconductor devices. Key to the scope's value is a delicately focused beam that is scanned across semiconductor surface. It is similar to the sweep of a TV picture. The 0.5 micron beam scans a sequence of 1,000 lines across the specimen about 20 1,000" square.

TRACTABLE-BERNOULLI-SEQUENCE GENERATOR has been designed by an engineer at University of Michigan. It is used for input of errors—noise or static—into a message transmission in new electronic gear being tested. It is designed mainly for use with radio gear that sends data in bits or digital sequences. Designer says it is stable and reliable. It can produce random noise with no pattern. The unit is made of plug-in digital modules connected in a prescribed way. Any error rate caused by noise up to 10% of signal can be injected with the sequence generator, with proper units and wiring.

ULTRASONIC RADAR FOR THE BLIND is now in a two-year test and pilot production program at Ultra Electronics Ltd. in London, England. The device consists of a flashlight-type probe which emits an ultrasonic beam. By FM—a unique application in this field, says the firm—the "bounce-back" from objects in front of the blind person is arranged as a series of pure tones in speech waveband transmitted on a miniature earphone. Claims are that with the guide, blind persons have walked two miles through thick snow. They have been able to detect different noises reflected from trees, bushes, posts, walls, moving objects, curtains and clothing. They were able also to calculate distances.

WIDE-ANGLE IR DETECTOR for spacecraft sensors has been produced by Servo Corporation of America. The new 70-degree unit is designed for high accuracy detection of temperature variations. The device can withstand thermal ranges beyond 100°C for a long time without error. It can be used with cameras and telescopes; it is useful with any highly-refined types of military, industrial and medical gear.

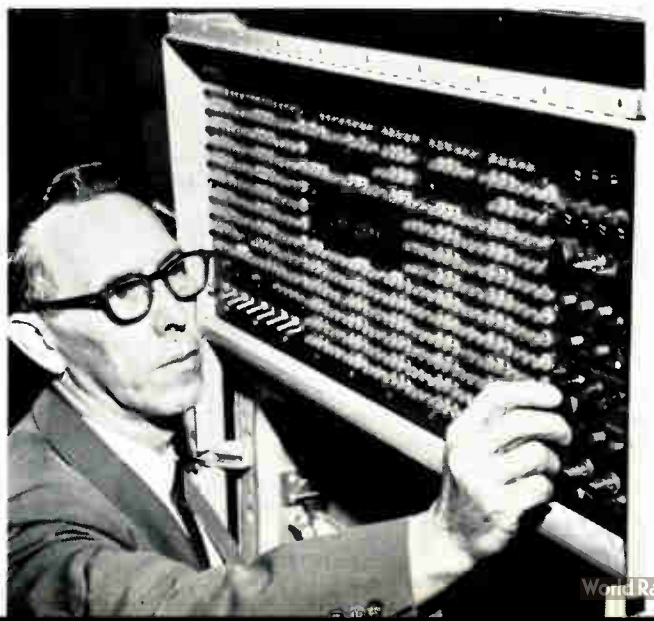
LIFE SCIENCES LABORATORY has been organized at Westinghouse to carry out research in the scientific *interface* among physical and biological sciences. Lloyd B. Kramer was named to head the new research group. Dr. W. E. Shoupp, vice-president of research, said that "the relationship of living things to their environment is being modified and adapted to man's control at a faster rate." Certain phenomena familiar to researchers in physical sciences are being applied in novel ways by those in life sciences. There will be three main research groups. They are astrobiotics, bio-technology, and radiation and physical biology. For NASA, astrobiotics group is studying effects of high-energy particles on living tissue. Aim—determine cosmic ray hazards for spacemen.

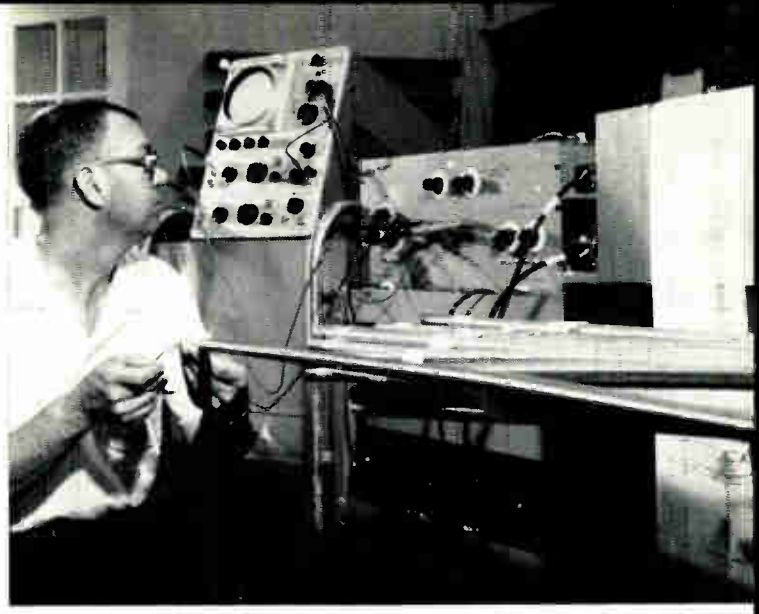
5-MICRON HOLES IN WIRE have been drilled by a Raytheon laser system recently shown. Peak power, pulse length, and power density were cited as major factors in size and shape of holes in the 2-mil hair-like wire. When focussed energy was not precise, the fine wire vaporized or melted. Laser burst tends to concentrate more in center of spot than at edge. This produces greater level of penetration at center of spot making a slightly conical hole. With thick metals, conical cross-section was minimized with beam focused at center of sample's thickness. Consistent and reproducible holes were drilled in varied metals when off-axis radiation was controlled properly.

TINY SEMICONDUCTOR LASER is being studied for advance data by engineers at the University of Illinois. Among many lasers developed and tested over the past three years, though not really put to any good use yet (say the engineers) this is one of the latest. Dr. Nick Holonyak, Jr., research team head, has a working model of the tiny laser. He developed the first junction diode laser to work in the visible region of the spectrum. The tiny laser measures 1/100" long, 1/50" wide, and 1/200" high. Hundreds can fit into a thimble. This speck can reach any wavelength between 8400 and 6400 Å. It is "remarkably efficient, compared to ruby or gas lasers, in turning electrical energy into light." The current in the tiny laser can run up and down at kilomegacycle rates. Dr. Holonyak is now concentrating on improving the design, and collecting basic data in order to understand lasers better.

NEW UNIVAC SYSTEM FOR THE NAVY

Maintenance and control panel of new UNIVAC CP-642B, first large-scale general purpose military computer with magnetic thin-film memory. Developed for the Navy, the system's panel includes lamps to display internal status report, and manual operation controls. Unit repeats sets in 667 nsec.; has 16 input and output channels.





EDDY CURRENT TUBING TESTER

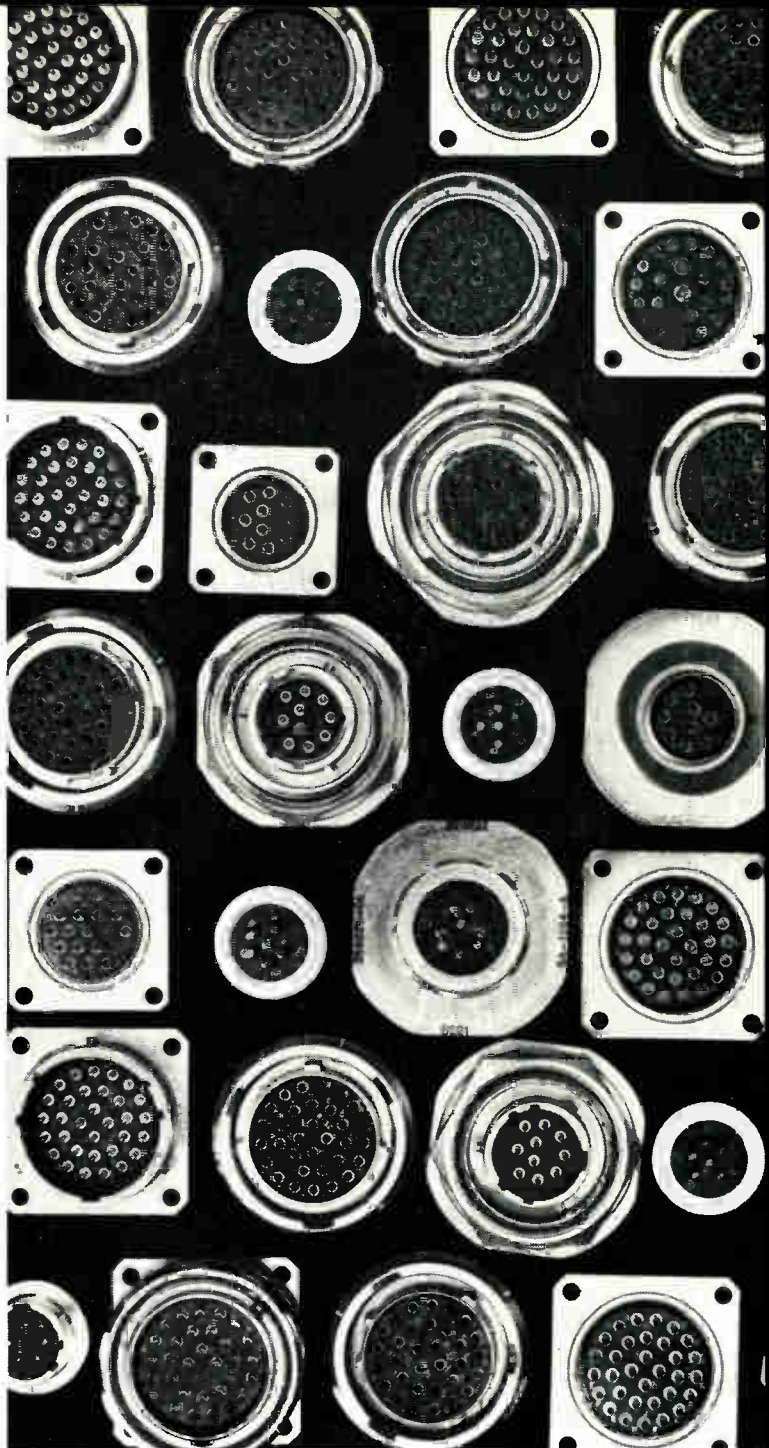
GE engineer M. S. Barger, Hanford Laboratories, demonstrates use of new tester that uses highly accurate eddy currents to test tubing for nuclear reactors. Tubing is tested in support of corrosion propagation studies, burst testing and identification of defects. Test gear includes eddy current tester (center) and chart recorder.

BASIC RESEARCH FACILITY has been established in Switzerland by the SCM Corp. The new laboratories are aimed at improving states of the art and at expanding long-range product planning. Emerson E. Mead, SCM President, said that most theory and lab work will be confidential. But, the laboratories will study the future of microelectronics. They will also look in on ways to achieve optimum development and uses for lasers.

COOPERATIVE STUDY AND RESEARCH is receiving support from industry and colleges as the trend moves across the U. S. One group devoted to such activity is the Midwest Electronics Research Center (MERC). The group has a Visiting Industrial Associate Program in which industrial engineers and scientists are invited to join "in progress" research programs at the University of Illinois. MERC helps to stimulate basic research by university staff members on problems of interest to industry.

1,000,000 GAUSS PULSED MAGNETIC FIELD with superconducting coil has been reached, says the Army's Mobility Command's Engineer R&D Laboratories. The field is believed to be the highest ever reached using such a coil. The coil was made by Materials Research Corp. from a design by an USAERDL engineer. Made from MRC's niobium tin, the coil is about one inch long by one and three-quarters wide. It has a three-quarter inch center bore. It must be used at liquid helium levels. During test runs the coil was undamaged. It can be pulsed repeatedly once each minute. Project goal is light weight, effective mobile electric power equipment for the Army.

(More RADARSCOPE on Page 13)



When we first introduced our Pancake, we only had one model.

Now we have a stack of them.

And it's a pretty big stack. As soon as our customers saw the first one, they immediately wanted other connector types made up in the low profile Pancake configuration.

So, since introducing our Pancake (actually it's our Junior Tri-Lock) connector last year, we've expanded our line to 31 different types and sizes. Wall mounting receptacles. Cable connecting plugs. Box mounting receptacles. Hermetic seal receptacles. Straight plugs. Jam nut receptacles. Through-bulkhead receptacles. And our engineers are hard at work on still more variations, such as crimp contacts and high density insert arrangements.

All are about half the size and weight of our standard Pygmy® connectors and they retain the same mounting dimensions (except in the jam nut receptacle style) so you can adapt the Pancake to your present equipment.

For complete information on our expanding Pancake line, drop us a note in Sidney, New York.

Scintilla Division

THE Bendix CORPORATION

Circle 12 on Inquiry Card

RADARSCOPE

SPACE RADAR ACCURACY GUIDE has been presented by engineer George R. Cooper, Purdue University. Now used on small earth targets, radar is being touted to locate earth and other planets from outer space. But—measure must be precise. On earth, reflected blip is always a smear; target has moved in time lapse. This wavelength smear—many random frequencies—rules out space precision. Cooper offers a way to figure radar accuracy in presence of smears. His formula would be useful to space designers in coping with the randomness problem by matching system accuracies.

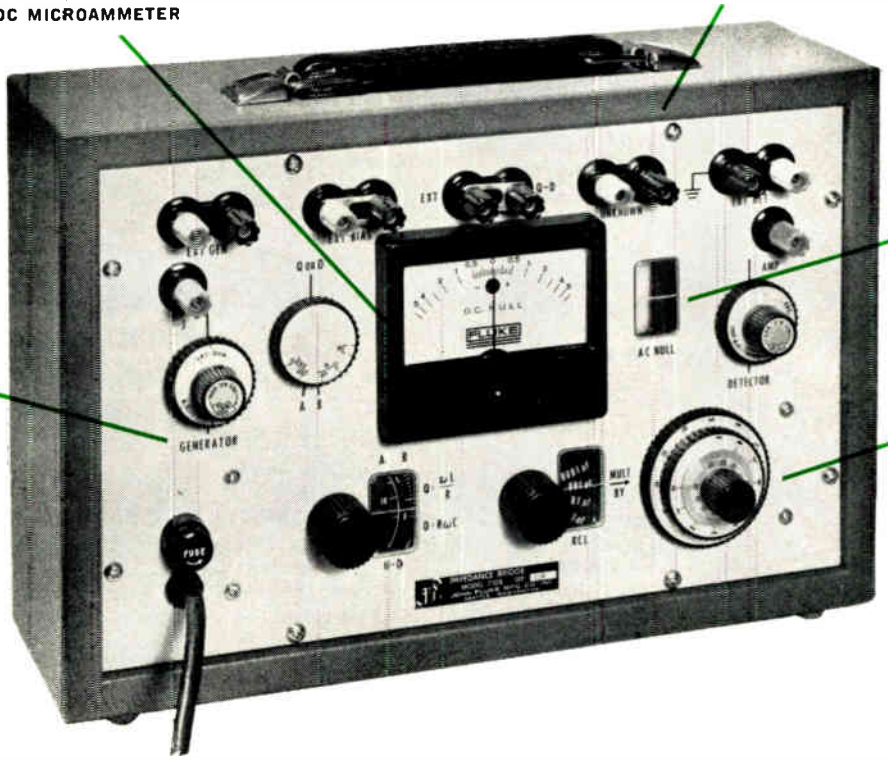
COLD CATHODE DIODE TEST, fast and less costly, has been designed by the Army. The automatic system measures voltage breakdown, energy transfer, and transfer time. Parameters are observed all at the same time; results are tape recorded. System can be used as an operating tool in R&D, and in production. It has advantages over standard methods.

SUPERPOWER LASER SPECTROSCOPY of atomic absorption, announced by ITT, may add greatly to laser state-of-the-art. New gigawatt pulse output laser evaporates samples for analysis. ITT scientists say the focused beam can vaporize any known substance. Spectroscopy now can be used to analyze refractory materials which defy standard means. In function, a hollow-cathode lamp generates spectral lines of the substance. Light shines through prism and image dissector that measures spectral line intensity. Laser beam is focused on sample. A portion of sample is vaporized in light path. Vapor selects and absorbs spectral lines.

(More RADARSCOPE on Page 15)

Outstanding accuracy, wide frequency range

One compact instrument measures resistance to 0.1%, capacitance to 0.2%, inductance to 0.3% — up to 20 KC



FLUKE MODEL 710B IMPEDANCE BRIDGE

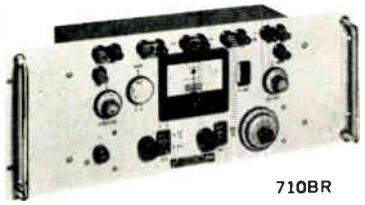
BRIEF SPECIFICATIONS

RESISTANCE
Range: 0.1 milliohm to 12 megohms in 8 ranges, 0.1 milliohm per dial division on the lowest range
Accuracy: ±(0.1% + 1 dial division)

CAPACITANCE
Range: 0.1 micro-microfarad to 1200 microfarads in 7 ranges, 0.1 micro-microfarad per dial division on the lowest range
Accuracy: ±(0.2% + 1 dial division)

INDUCTANCE
Range: 0.1 microhenry to 1200 henrys in 7 ranges, 0.1 microhenry per dial division on the lowest range
Accuracy: ±(0.3% + 1 dial division)

FREQUENCY RANGE: DC to 20 KC with optional RC networks to tune AC generator-detector frequencies from 100 cps to 20 KC



710BR

SIZE
Cabinet model, 13" long x 9½" wide x 6" deep
Rack model, 7" high x 19" wide x 4" deep

PRICE, f.o.b. factory
Cabinet model (710B) $485
Rack model (710BR) $505

Prices and specifications subject to change without notice

Unique versatility, for multiple applications

For laboratory use, the improved Fluke Model 710B provides a single instrument for the measurement of resistance, capacitance, inductance, storage factor and dissipation factor.

For receiving, permits inspection quality control.

For production, permits rapid checking of components.

Special applications include measurement of remote capacitance, incremental inductance and electrolytic capacitors with DC voltages applied.

Unique speed and ease of operation

Four-arm network of bridge standards, with fourth terminal brought out, provides a means of extending the range of dissipation factor and permits measurement in both parallel and series.

Binding post arrangement provides for (1) applying bias and polarizing voltages to the unknown; (2) for operation with external Q-D rheostat, and (3) with either external generator and detector or with internal generator and detector plug-in frequency determining circuits.

Simplified control grouping gives easiest possible balance for reading.

On request, complete Model 710B specifications and latest FLUKE Catalog Digest. Be sure your file is up-to-date on the full line of FLUKE differential voltmeters, power supplies, other precision instruments, components, and Montronics standard frequency equipment. Contact John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, Wash. 98133. PR 6-1171; TWX, 206-879-1864; TLX, 852; Cable, FLUKE.

FLUKE

MINIATURE RESISTANCE THERMOMETER measures up to 1100°C. Electronic thermometer unit, tested by VersiTherm Inc., may have wide use in metals, chemicals, petroleum, food and aerospace fields. Use would be mostly in process control systems. Device is designed for use where space is limited. It has great value where repeatable, high-accuracy measure is needed over wide temperature range from 100° to 1100°C. VersiTherm says thermometer is hand-crafted to almost any degree of accuracy. Ceramic-encased, the device has fast response of less than one second. Platinum elements are fully annealed and strain-free.

HIGH-RESOLUTION ELECTRON MICROSCOPY advance has resulted in photos of elements no larger than 2.35 Å. This high resolution has been reached by researchers of Hitachi, Ltd., and the Perkin-Elmer Corp. It is important to research in structure studies. This high-resolution advance can lead to new knowledge about spacing of atoms in crystals and make-up of cancer cells.

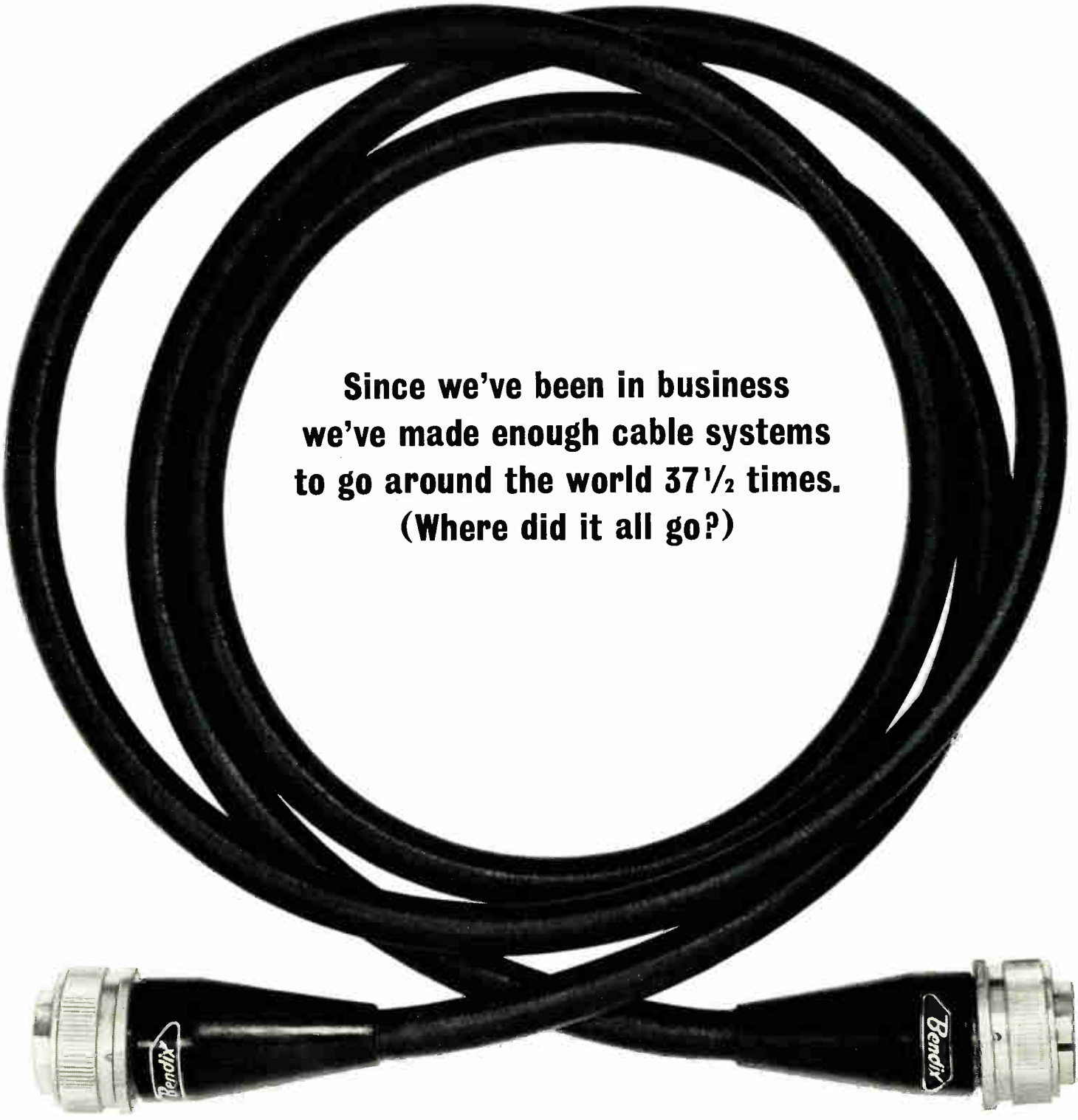
AIR FORCE RESEARCH shows that components with faults do change temperature. They can be found with IR techniques. IR patterns do characterize the operating condition of a resistive circuit. Infrared patterns are observable by various sensing and processing methods except in low power circuits. Choice of sensing and processing methods depend on planned use. Only key parts need be observed. A search for hot spots alone is not enough for maximum fault finding. The important factor is temperature difference (component minus ambient).

MORE USEFUL COMPUTER LANGUAGES were urged by Dr. Richard W. Hamming, Bell Telephone Laboratories. At a Scientific Data System User's meeting, he told EDP men to "think big even with a small computer. Our biggest mistake is our failure to think big, to see single problems as part of a larger pattern." With 20 years behind him in computers, Dr. Hamming recalled "how much I painfully learned is obsolete. I advise you not to specialize in getting the last bit out of a machine by using machine language. Put your efforts into perfecting more useful languages, such as our present FORTRAN." The program is often better, he said. Gained knowledege can be applied to other problems, and to improving the state-of-the-art of EDP language. Present day FORTRAN is one-tenth its onetime size with no loss of speed.

WELDABLE PRINTED CIRCUIT BOARDS for operation to 300°C result from plating nickel conductors on Fotoceram glass-ceramic substrates. Weldable boards can be used in semiconductor and microcircuit analysis in missile and space systems. Welding tests using varied techniques have been evaluated with no degrading of circuit runs or bond strength, says developer, Corning Electronics. Testing included exposures to 250°C using 260° solder. Gold plating of conductors is possible. Fotoceram substrates have zero water absorption and resist oils and solvents. They are non-flammable. They also have a flexural strength of 20,000 psi.

A LITTLE LAB REPORT

This stack of papers and books, nearly five feet tall, bound in 18 volumes and containing 13,200 pages, is one single report on antenna research on the Titan III space booster. All this scientific paperwork was about antenna experiments done by Lockheed-Georgia's Antenna Laboratory, Marietta, Ga. Job took six months.



We know where some of it is. Our cable assemblies are circling the Earth in satellites, we see a lot of it every time we're around an airplane and some pretty important ships in the Navy have a good many feet of cable in their weapons systems stamped Bendix Scintilla. And the other thousands of miles of cable must be used somewhere since we get the same customers coming back time after time for more cable.

They have good reason to come back. We make the best darned cable systems you can buy anywhere. We design any kind of assemblies you could possibly need. We deliver on time and at a fair price. We'll be glad to send one of our engineers out to your place to help you solve any unusual cable problem. And, if you still aren't so sure about us, we offer to send you more information. Just write us in Sidney, New York.

Scintilla Division

THE Bendix CORPORATION

Circle 21 on Inquiry Card

Circle 22 on Inquiry Card →

no amount of testing can ever take the place of this proof of superiority—

not one catastrophic failure in over ten billion Allen-Bradley Hot Molded Resistors now in service

ALLEN-BRADLEY HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances.

■ What more positive proof of complete reliability can there be—certainly no "testing program" could produce an equivalent answer. Similarly, many years of large volume production has demonstrated to our customers the "uniformity" of Allen-Bradley hot molded resistors—not only from order to order but from one year to the next. This uniformity has been the same for at least 25 years! Such remarkable performance—exclusive with Allen-Bradley composition resistors—is the result of the unique hot molding process—perfected and used *only* by Allen-Bradley. It produces such uniformity in resistors that their long term performance can be accurately predicted. A convenient conscience may permit spouting claims—but the actual quality of performance of Allen-Bradley composition resistors is supported by the billions of these resistors now in service.

Specify Allen-Bradley hot molded resistors for your equipment and you are automatically assured of the ultimate in resistor reliability! Please write for Technical Bulletin 5050: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

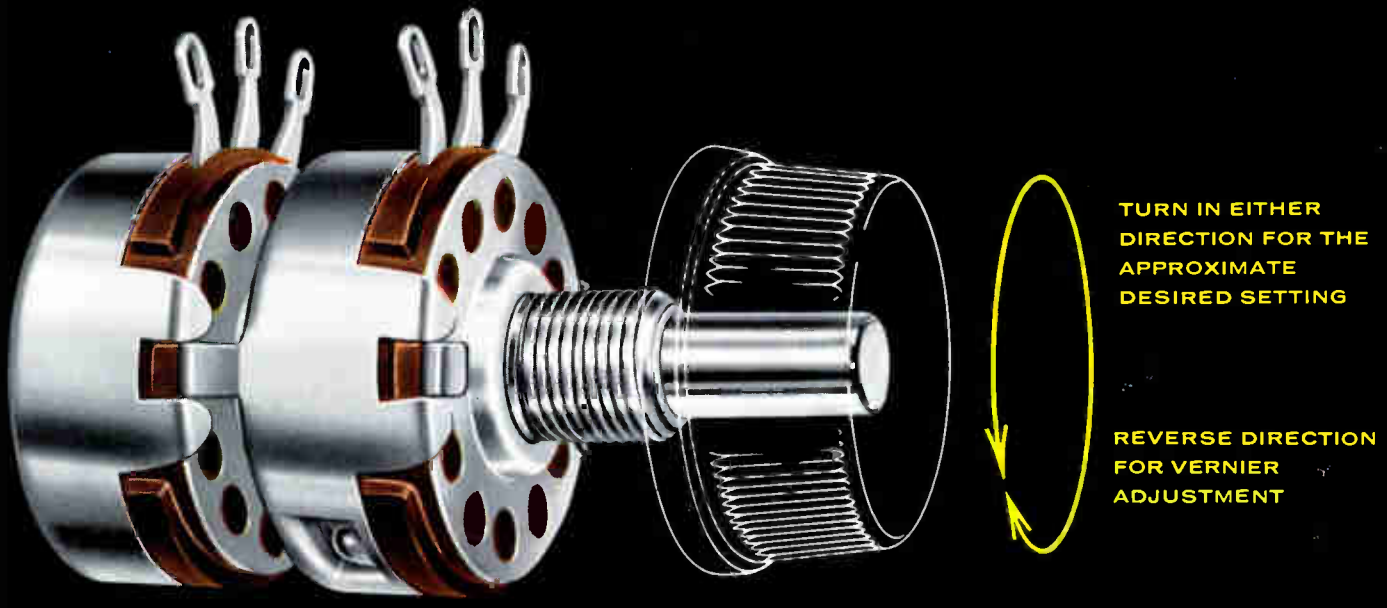
27-63-E

A-B QUALITY

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

new Allen-Bradley Type JJV Hot Molded Variable Resistors with "built-in" vernier



TYPE JJV VERNIER CONTROL
Shown Twice Actual Size

TURN ONE KNOB—you obtain both the approximate setting and the fine resistance adjustments . . . *in the panel space of only one control.* A unique coupling arrangement allows the approximate setting to "idle" when the operator is making the vernier adjustment. More than 12% of total rotation is available for the independent vernier adjustment, thus providing up to 20 times better resolution than is obtainable with a single element control.

VERSATILE—All standard tapers and resistances are available to satisfy virtually any control requirement. Can be used as a rheostat or as a modified potentiometer in a three or four terminal circuit. A triple control, having two units locked together with the third unit providing the vernier adjustment, is available where true potentiometer circuitry is required.

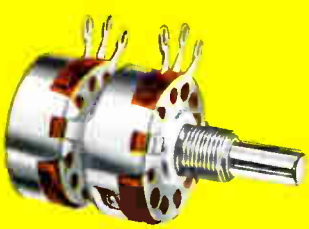
FAMOUS TYPE J PERFORMANCE—The exclusive hot molded resistance element with its built-in stability is a guarantee of long operating life and having a low initial noise level, which is further improved with use. The control is always smooth and during adjustment is completely free of sudden changes or "steps."

Try this new Type JJV control—surprise yourself with the vernier resistance adjustment that is obtainable over a wide range. Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY TYPE J HOT MOLDED VARIABLE RESISTORS


Type J
with encapsulation


Type JS
with line switch


Type JJ
standard dual unit


Type JJJ
standard triple unit

29-63-E

A-B QUALITY

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

COMING EVENTS

FEBRUARY

Feb. 19-21: Int'l Solid-State Circuits Conf., IEEE, Univ. of Pa.; Sheraton Hotel, Philadelphia, Pa.

MARCH

Mar. 2 - 6: 15th Conf. on Analytical Chemistry & Applied Spectroscopy; Penn Sheraton Hotel, Pittsburgh, Pa.

Mar. 16-20: Western Metal & Tool Expos. and Conf., American Soc. of Tool & Mfg. Engineers and ASM; Pan Pacific Auditorium, Los Angeles, Calif.

Mar. 23-26: IEEE Int'l Conv.; Coliseum and New York Hilton, New York, N. Y.

Mar. 31-April 2: ASM Gulf Coast Metal-Working Exh. & Conf., ASM; Shamrock-Hilton Hotel, Houston, Tex.

'64 Highlights

IEEE Int'l Conv., Mar. 23-26, Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show and Conv.; Aug. 25-28, IEEE WEMA; Sports Arena, Los Angeles, Calif.

Nat'l Electronics Conf., Oct. 19-21, IEEE, et al; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.

APRIL

Apr. 1-2: 5th Symp. on Eng. Aspects of Magnetohydrodynamics, IEEE, AIAA, MIT; MIT, Cambridge, Mass.

Apr. 6-9: Int'l Conf. on Nonlinear Magnetics, IEEE; Shoreham Hotel, Washington, D. C.

Apr. 14 - 16: American Power Conf., IEEE, et al; Sherman Hotel, Chicago, Ill.

Apr. 19-25: Int'l Conf. & Exhib. on Aerospace Electro-Tech., IEEE, et al; Westward-Ho Hotel, Phoenix, Ariz.

Apr. 21 - 23: Spring Joint Computer Conf., AFIPS (IEEE-ACM); Sheraton-Park Hotel, Washington, D. C.

Apr. 21-23: 12th Industrial Electrical Expos.; Great Western Exhibit Ctr., Los Angeles, Calif.

Apr. 22-24: Southwestern IEEE Conf. & Elec. Show, IEEE; Dallas Memorial Audit., Dallas, Tex.

Apr. 28-30: 12th Annual Conf. on Electromagnetic Relays, NARM; Oklahoma State Univ., Stillwater, Okla.

MAY

May 4 - 6: Packaging Industry Conf., IEEE; Nassau Inn, Princeton, N. J.

May 4-8: Annual Mtg. and Welding Exp., AWS; Hotel Sheraton-Cadillac, Detroit, Mich.

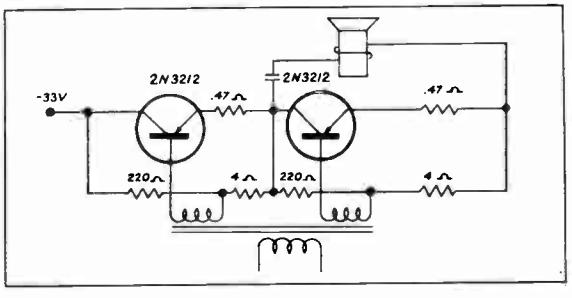
May 5-6: 5th Nat'l Symp. on Human Factors in Electronics, PTG-HFE; San Diego, Calif.

FOUR NEW HOT LITTLE NUMBERS

FROM DELCO

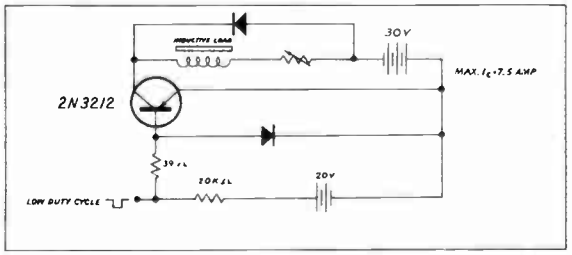
2N3212 2N3213 2N3214 2N3215

Now from Delco Radio come four remarkable new miniature Nu-Base† transistors for people who need high current, high voltage and fast switching in a very small package.



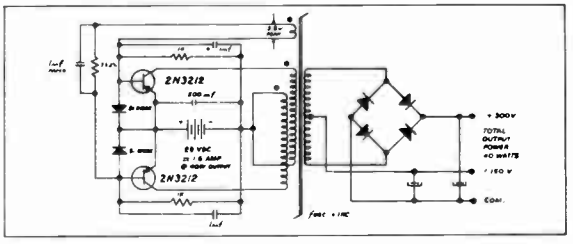
Miniature Class AB audio power amplifier: Maximum RMS power output 18 watts at 200 cps

Each of these devices is rated at 5 amperes, maximum continuous collector current. Ranging from 30 to 80 volts, their VCEO ratings make them especially useful where high voltages and high currents are encountered. In addition, their relatively low saturation resistance and high speed give them excellent efficiency and reliability for switching applications.



Miniature Solenoid Driver: Excellent high current gain of 2N3212 enables intermittent operation of solenoids at high currents such as 7.5 amperes. Duty cycles of 1 millisecond at 15 millisecond repetition rates are typical.

†Delco's name for drift field non-uniform diffused base construction.



Miniature converter in which 2N3212 high gain, high current and fast switching speed characteristics provide a 40-watt output at an efficiency of over 87 percent.

The Delco Nu-Base construction features a husky element with built-in protection from current "hot spots" to assure freedom from secondary breakdown over the operating range.

These units will dissipate over 5 watts at 71°C case temperature, operate over a range of −65°C to 110°C and lend themselves easily to automatic insertion—all this in a TO-37 package.

The shortest distance between you and more detailed information is a call or letter to one of our sales offices or your Delco semiconductor distributor. Right now is as good a time as any.

TYPE	2N3212	2N3213	2N3214	2N3215
Vcbo	100	80	60	40
Vceo @ Ic=20ma	80	60	40	30
h_{FE} @ 3A	30-90	30-90	30-90	25-100
Vce (sat) @ Ic=5A	0.5v	0.5v	0.5v	0.5v
Vce (sus.) @ Ic=3A	80	60	40	30
Conditions for Vce (sus.)	Pulse Width = 1.4ms Duty Cycle = 4% Inductance = 6mh			

Operating temperatures = 110°C max., −65°C min.; max. storage temperature = 125°C.

Union, New Jersey*
324 Chestnut Street
MUrdock 7-3770
AREA CODE 201

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560
AREA CODE 313

Palo Alto, California
201 Town & Country Village
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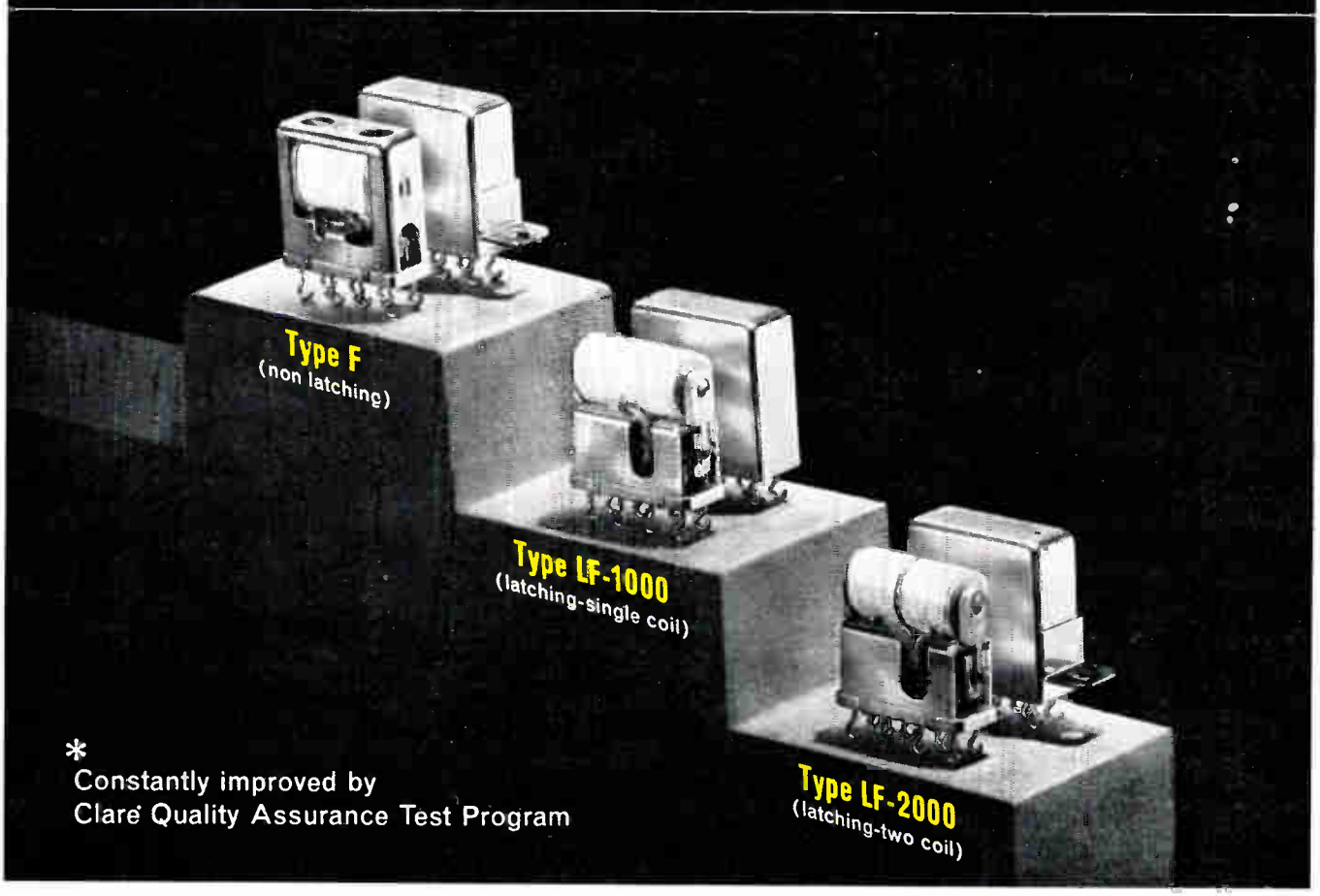
DELCO RADIO
DEPENDABILITY
RELIABILITY
Division of General Motors, Kokomo, Indiana

CLARE

Military-Type Relays

for maximum RELIABILITY* in adverse environment



* Constantly improved by Clare Quality Assurance Test Program

Small, lightweight Clare Military-Type Relays not only meet the rigid specifications of MIL-R-5757D... they actually surpass them. They provide the highest standards of reliability ever obtained from large-volume, production line relays. Yet they are available at competitive prices and for prompt delivery.

How is this possible? The Clare Quality Assurance Test Program continually analyzes sample lots...tests them to failure...to learn the cause of breakdown, whether it be materials, processes or people. If necessary, corrections are then made to produce ever-increasing reliability.

So, whether your requirement is for Type F Relays (for non-polarized, single-side-stable, single coil operation), or Type LF Relays with magnetic latching (for polarized, bi-stable, single or double-coil operation), these relays give assured reliability and maximum contact life at high or low load level . . . under extreme conditions of shock, vibration and temperature.

Send for Reliability Manual 710. Compare actual tests made under Mil Specs and Clare QA program

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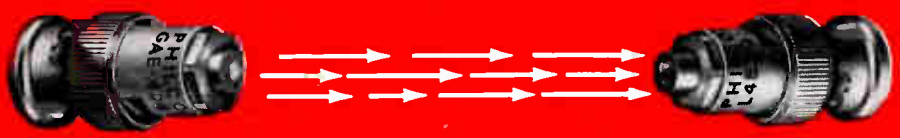
CLARE®

Relays and related control components

TALK WITH LIGHT



LIGHT EMITTER
GAE-404

PHOTOMIXER
L4530

TALK WITH PHILCO SOLID-STATE OPTICAL COMMUNICATIONS SYSTEMS COMPONENTS

Philco, with more than 10 years experience in the field of Electro-Optical Device Development, offers a variety of solid-state devices suitable for use in optical communications systems. Typical is the combination of the Philco GaAs Light Emitting Diode (GAE-404) and the Philco InAs Photomixer Diode (L4530).

These devices are ideal for line-of-sight communications systems featuring high carrier frequency and broad information bandwidth.

The wide bandwidth capability of the GAE-404 also makes ground and airburst fuzing systems and battlefield range finding applications quite feasible. To talk with light, explore the possibilities of these Philco elements for an all-solid-state optical communications system. Ask also about other Philco Infrared Devices. Write to Philco/Lansdale, Special Products Operation, Department EI264.

InAs Photovoltaic Detectors for 1.0 to 3.7 micron Region
- IAU-601 . . . TO-18 Package/Quartz Window. Uncooled.
- IAC-701 . . . Miniature Glass Dewar/Sapphire Window. For 195° K operation

InSb Detectors, Dewar-Packaged for 77° K, for 1.0 to 5.5 micron Region
- ISC-301, ISC-363 . . . Photovoltaic—Detectivity (D) to 15 x 10^9
- ISC-501, ISC-502 . . . Photoconductive.

Ge Photoconductive Detector
- GPC-201 . . . Useful Over Entire 1.5 to 10 micron IR Region.

GaAs Photovoltaic Detector for 0.4 to 0.9 micron Region
- GAU-401 . . . TO-18 Package/Uncooled. Peak Response at 0.85 micron.

Custom Packages / Immersed and Custom-Shaped Elements / Multi-element Devices for Application Flexibility.

GaAs Light-Emitting Diodes
- GAE-402 . . . Emits at 0.9 micron. Radiates 0.1 mw Uncooled. Packaged in UG-88/U type BNC for Maximum Modulation.
- GAE-404 . . . Emits at 0.9 micron. Radiates 0.7 mw Uncooled.

Si, InAs and InSb Photomixer Diodes
- L4500 Series . . . Peak Responses in 0.4 to 5.7 micron Range. Detect Modulation up to 40Gc.

Dewar-Matched Cryostats

Cryostat Type	Compatible IR Detectors
C-100	ISC-301, ISC-501, GPC-201
C-300	ISC-363, ISC-502, IAC-701

SPECIAL PRODUCTS OPERATION

PHILCO®

A SUBSIDIARY OF Ford Motor Company

LANSDALE DIVISION, LANSDALE, PA.

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SOLID-STATE CENTER U.S.A.

Circle 26 on Inquiry Card

WASHINGTON TRENDS

FUND CUTS SHAPE '64 TRENDS—Defense and *peace* funds are being slashed for 1964. Defense Secretary McNamara thinks defense costs for Fiscal Year 1965 (starting July 1, 1964) may be about $1 billion less than the $52 billion that may be spent for FY 1964. With little attention, the budget request of a mere $15 million for the U.S. Arms Control and Disarmament Agency (ACDA) was whittled down to half. The House had voted only $1,669,000. From House-Senate talks came the final allotment of $7,500,000. This amount is still higher than the $6,500,000 voted by Congress for Fiscal Year 1963, and the $2 million for 1962. At the same time, Congress neatly sidestepped the issue of repealing the $10,000,000 annual budget ceiling for ACDA.

CUTTING DEFENSE COSTS—One of President Johnson's greatest allies in cutting defense costs is Rep. Earl Wilson (Rep.-Ind.) Rep. Wilson recently criticized DOD for paying the developer of the AN/ASN Navigational Computer System some $950,000 of the total cost of $1.3 million, yet allowing this developer to claim the equipment as a patented item. He also took the Navy to task for "proposed sole source purchase of a control antenna for a drone airplane." Rep. Wilson asserted that the Navy had or should have made drawings for the AT 948/U antenna for which competitive procurement could cut costs by 69%. He complained that DOD went to a sole source for an altitude indicator that has been bought and stocked by the Navy and Air Force since 1950.

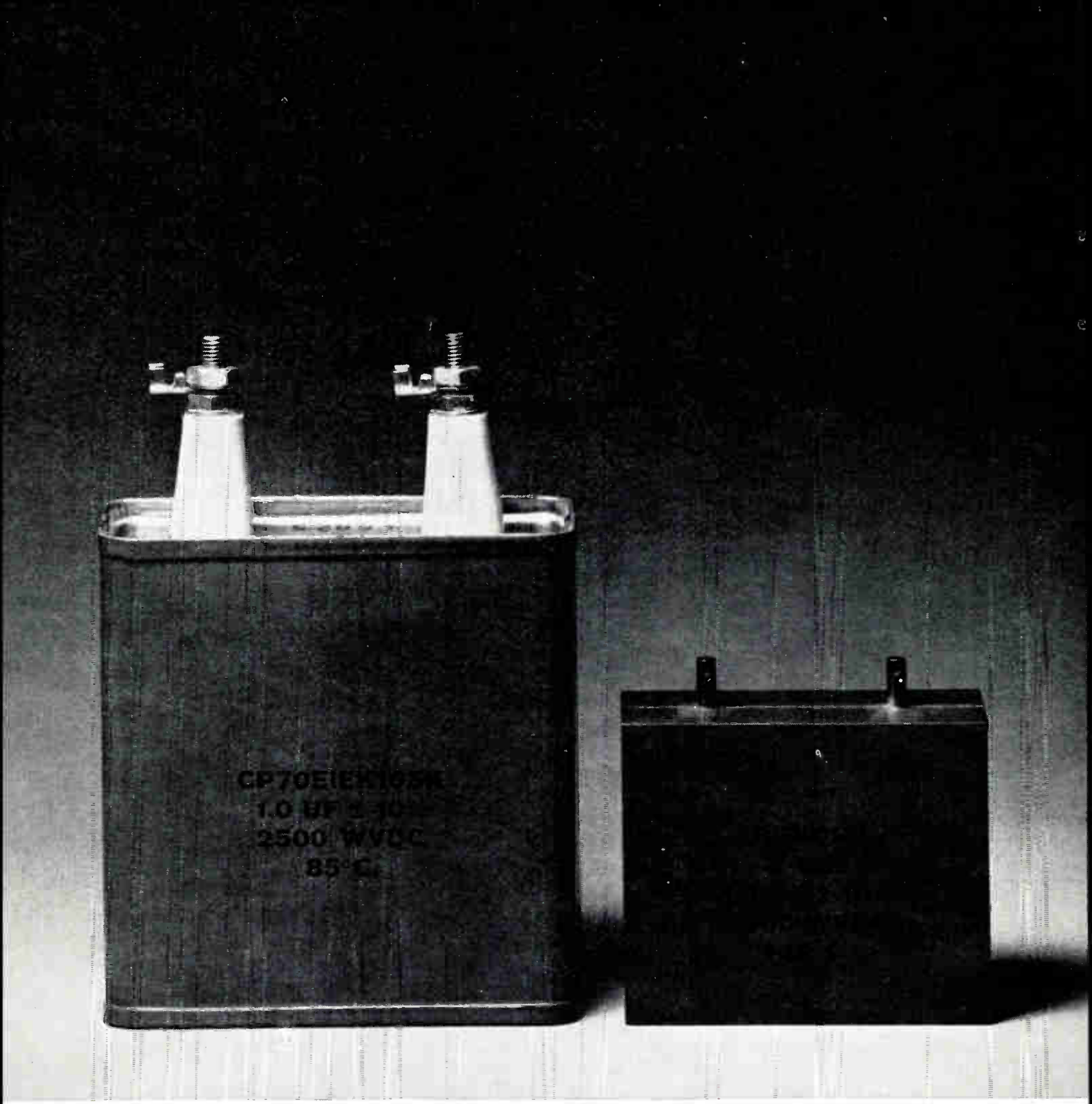
FUND CUTS SLOW NASA PACE—By trimming NASA's fund request for Fiscal year 1964, Congress, among other things, is forcing some contractors to invest more of their own money. Long mindful of the military implications of a civilian NASA, Congress still has throttled down the agency's heavy funding. For FY 1964 NASA asked for $5.7 billion but got only $5.1 billion. This sum is still $1.6 billion more than the $3.5 billion given to NASA in FY 1963. The cut in effect slows down NASA as still the fastest growing agency in Washington. To cope with the cut, Administrator James E. Webb plans to ask President Johnson to put the bite on Congress for a special 200 million supplement. Meanwhile, the President is cutting down and slowing up some NASA projects. One is the joint NASA-AEC Project Rover nuclear-powered rocket. This has been deferred for a saving of about $180 million. Contractors are encouraged to invest own funds.

IS THIS REPORT NECESSARY?—Newest area of DOD cost-cutting is paperwork. One estimate is that DOD plans to save about $2 million yearly by cutting down on reports, papers, documents, and bits, slips and scraps. The main approach is to reduce the flood of reports and audits a contractor must provide. A pilot study soon will involve aircraft production of the T-38 trainer and F-5 fighter. A project in electronics may be selected next. The practice may go over into other contracting if it proves a success. Cost-cutting involves paperwork, also. We may soon be involved in cutting the cost of cost-cutting.

AUTOMATION STUDIES INCREASE—There's a proposal that government, management, and labor work together on the problems of automation. The proposal, by businessmen at a recent AFL-CIO convention, is supported by government men all the way back to the Cabinet. Government support for automation puts labor on the spot. The unions have begun an all-out battle to protect workers from the effects of automation. Some labor-management-government groups have dealt with the problem in the past. Unions have always dissented on any conclusion or ideas.

COMPUTERS IN THE U. S. GOVERNMENT—Federal use of computers will be studied by yet another committee. Bureau of Budget made previous studies and will manage the current six-month investigation. Results will be weighed by the President and Congress in making up policies on use of EDP. The government now spends more than $750,000,000 a year for owning and/or leasing computers. A key matter now is, should the government buy or lease equipment? The trend has been to buy. On the current committee are industry users, educators, and a trade economist.

R&D ON THE LINE AGAIN—More attention and controversy are centering on our annual Federal R&D bill of around $14.5 billion. Congress is still investigating R&D. The new House Select Committee on R&D is now making one of the broader studies. Prime concern is aimed at how to improve procedure, side-step duplication, fill gaps and set priorities. Science people at the recent annual meeting of the American Association for the Advancement of Science were concerned over the Federal probing of R&D. Meanwhile, the House Committee on Science and Astronautics is doing some of its own probing. It's also strengthening its scientific capability.



We have to show you somebody else's capacitor

to illustrate why ours is better.

Both of these high voltage capacitors are designed to operate at 1.0 UF ±10% at 2500 WVDC. The one on the right—which we modestly hasten to inform you we make—uses a reconstituted mica dielectric and can withstand temperatures as high as 125°C. without de-rating. The one on the left must be de-rated to 1600 volts to withstand 85°C.

As if that weren't enough, the Bendix® capacitor is of solid construction to avert impregnant leakage, is less than half the size of other units, is highly shock resistant, and has better electrical characteristics. Circuit density automatically increases when you specify Bendix capacitors. And, they pack more performance into a smaller package.

Why settle for less? You can have both higher temperatures and reduced equipment size with our high voltage capacitors. Write us today in Sidney, New York, for additional information.

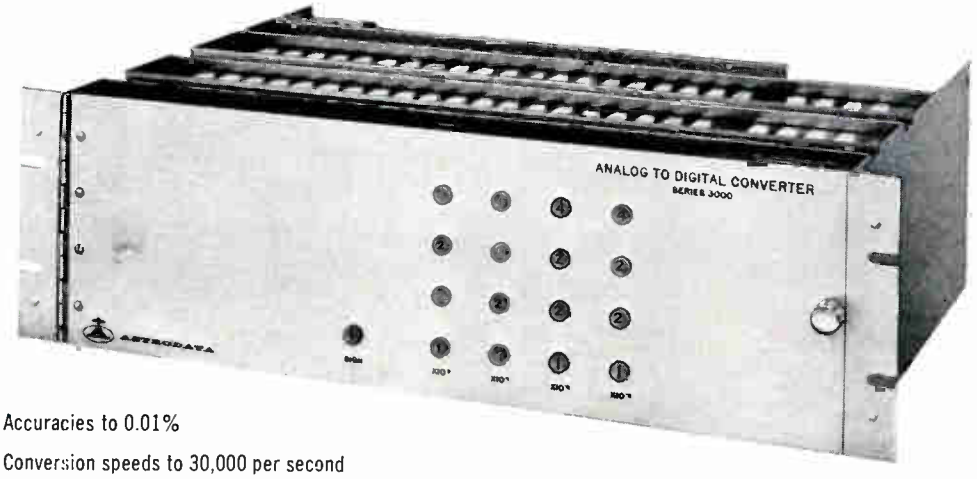
Scintilla Division

THE Bendix CORPORATION

Circle 27 on Inquiry Card

ASTRODATA

MORE THAN 1,000 STANDARD ADC's FROM A LIBRARY OF 13 BASIC CARDS

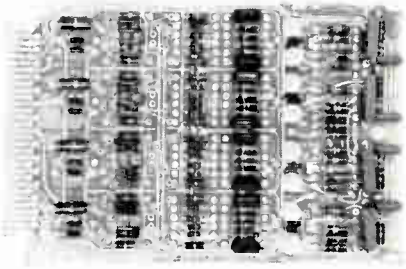


- Accuracies to 0.01%
- Conversion speeds to 30,000 per second

Astrodata low cost Series 3000 Analog-to-Digital Converters meet the requirements of virtually all data acquisition systems with 1088 standard production models. From these you can select the full scale range . . . speed . . . accuracy . . . sample-and-hold . . . resolution . . . output format best suited to your specific system.

Designed for easy integration into existing or new data acquisition systems, standard features include individually buffered data output lines . . . adjustable output logic levels (clamped) . . . wiring installed for future addition of input amplifier or sample-and-hold circuits . . . front panel readout of data (including polarity) . . . and isothermal environment of converter network and reference voltage diode to assure maximum accuracy over wide temperature range.

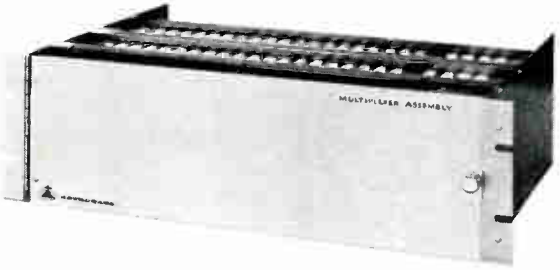
Series 3000 ADC's ideal for use with time-multiplexed input data



HIGH LEVEL MULTIPLEXERS

Model 155-83 low cost, high-level-input multiplexer module has been developed for high speed analog switching applications.

Inputs per card	6 one-wire or 4 two-wire
Input Voltage	5 volts
Switching Time	<5 μsec
Crosstalk	0.01%
Input Impedance	1000 megohms/number of switches in multiplexer group



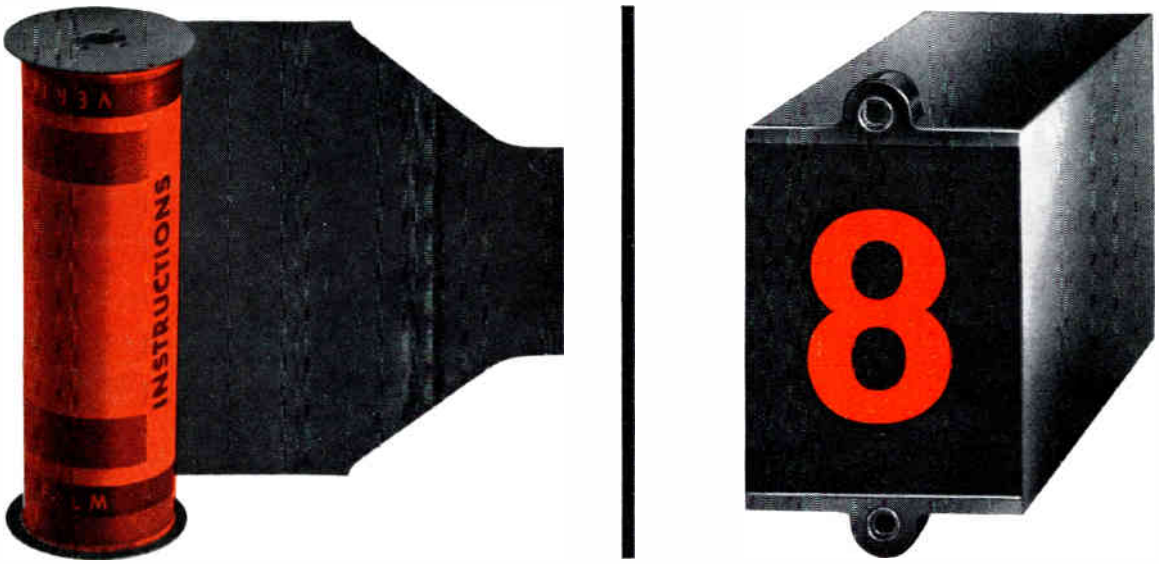
MULTIPLEXER ASSEMBLIES

Series 950 multiplexer assemblies consist of cards, shown at left, for single ended channels in multiples of 6 or differential channels in multiples of 4. Power supply and output buffer amplifier are included. Channel identification data can be furnished in binary or BCD form. The multiplexer channels can be addressed directly by computers or advanced sequentially to meet the requirements of specific systems applications.

17

Contact your nearest Astrodata representative today for a demonstration or write for technical literature giving complete specifications.

ASTRODATA INC.
240 E. Palais Road • Anaheim, California



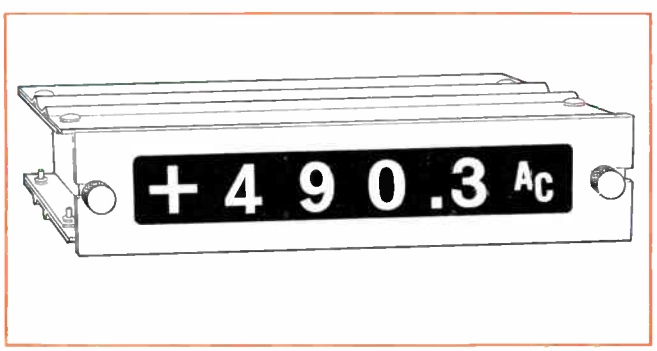
ANYTHING YOU CAN PUT ON FILM...YOU CAN DISPLAY ON THIS IEE READOUT (EVEN COLORS)

NUMBERS, LETTERS, WORDS, SYMBOLS, COLORS • There is literally no limitation to the display versatility of IEE readouts. As miniature rear-projectors, they operate by back-lighting display symbols arranged on film and projecting the selected message on a non-glare viewing screen. Each IEE readout contains 12 lamps for 12 separate messages which may be displayed individually or in combination. You may specify virtually any type or combination of messages that are photographically reproducible: numerals, letters, digits with polarity or decimal points, words and multi-digits, mode/word indications, multiple words, colors for emphasis, and any symbols.

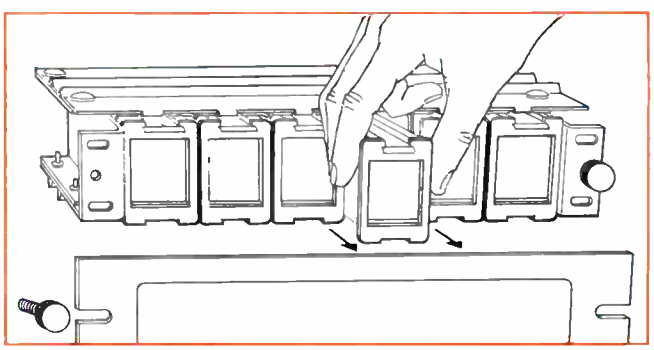
SINGLE-PLANE PRESENTATION FOR VISUAL CRISPNESS • IEE readouts combine the advantages of a new high-brightness lens system and the all-important single-plane presentation for visual clarity. The result is unmistakable readability—at wide angles, long distances, in bright light—without filters, screens, or shades of any kind.

UNLIMITED UNIT LIFE • IEE readouts contain no moving parts; hence, cannot wear out. The conventional MS or commercial lamps used in these readouts provide up to 30,000 hours of operation per lamp and are as easily replaceable as a flashlight bulb.

CLICK, IT'S IN; CLICK, IT'S OUT For quick, easy lamp replacement or complete message exchange, specify IEE Series 220 front plug-in readouts. These miniature rear-projection readouts (5/8" maximum character height) plug in and out to provide front panel accessibility, permit permanent wiring and eliminate flexible cables.



Typical assembly shows six Series 220 readouts with common viewing screen. Display inserts with individual screens or with bezels also available.



Individual Series 220 readout insert clicks out for lamp replacement or exchange of insert for new message displays. Permanently wired base remains in assembly.

IEE one-plane rear-projection readouts are available in several sizes offering maximum character heights from 5/8" to 3 3/8". Your inquiry will bring the comprehensive new "Readout Display Selector Guide" which includes specifications and other technical information on the entire IEE line of readout devices.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

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Representatives in Principal Cities

MARKETING

Facts and Figures Round-Up

ELECTRONIC INSTRUMENTS HIT $562 MILLION SALES IN 1962

Factory sales and shipments for electronic instruments of all kinds for 1962 hit $562 million. Figure for 1961 was about $507 million.

Test, measuring and analyzing equipment for electronic and electrical circuits were valued at $409 million in 1962. (Annual Survey of Manufacturers puts this last figure at $466 million.)

Industrial process instruments accounted for some $108 million. Selected laboratory analytical instruments were put roughly at $34 million.

These figures are based on a report on Selected Instruments and Related Products 1962, issued recently by the Department of Commerce, and data from other sources.

In the test and measuring class, oscilloscopes and plug-ins brought about $84 million. Voltmeters and similar measuring gear accounted for $65 million, while generators, including audio, sweep and RF, generated some $43 million.

Largest groupings in industrial process instruments were for temperature measuring and control at $38 million. Gear for testing physical properties went for $20.6 million.

The $34 million for electronic analytical instruments included spectrometers and electron microscopes. The DOC reports that its figures represent net billing prices, f.o.b. factory after discounts and allowances. This is excluding freight charges and excise taxes.

The figure for test, measuring and analyzing equipment for 1961 is nearly $390 million. (ASM says $422 million.) Oscilloscopes were at $66 million in 1961.

DANISH BATTERY FIRM SEES GROWING CONSUMER MARKET

The world's oldest dry cell manufacturer, Hellesen of Copenhagen, predicts that before long each family will have at least three transistor radios. A Hellesen spokesman said this would include one large radio, a small one for children, and a portable for the beach. A fourth may be fitted into the family car.

Newer items becoming battery operated are shavers, tape recorders, and some TV sets, as well as radios. More transistorized devices will be used as time goes on, widening the battery market still further.

The Hellesen factories make 138 battery types, from 1.5v to 300v, and from 1.5g to 10Kg. Their latest design is a "steel battery," completely encased in thin steel as a safeguard.

JAPAN, BRITAIN SHOW GAINS IN EXPORTS TO U. S.

Japan and Great Britain accounted for more than 68% of total exports of electronic hardware to the U. S. in 1962.

All imports of electronic gear and parts into this country was around $270 million. Of this figure, Japanese and English exports to the U. S. topped $188 million. Broken down — Japan chalked up some $159 million in exports to the U. S., and Britain about $29 million.

Japan sent over mostly TV receivers, transistor radios, radio - phonographs, sound recorders, amplifiers and capacitors. From Great Britain we got phonograph parts, tape decks, radio testing instruments, high frequency and electronic control equipment. Both nations had heavy traffic in electron tubes and parts. They also showed significant gains over 1961 in most of the hardware exported to the U. S.

Total gains for such exports over 1961 for both nations was an average of 31%. U. S. electronic exports to the United Kingdom in 1962 set a record of nearly $36 million. This is 52% above 1961.

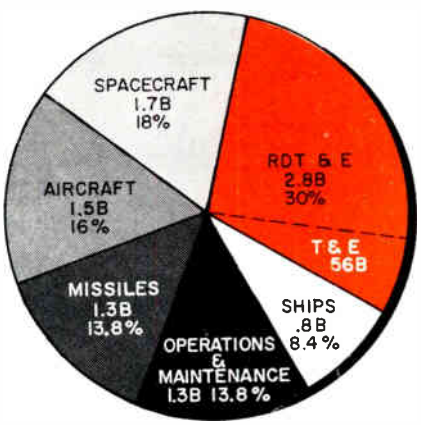
Sales to the U. S. accounted for more than half of the total in Japanese electronic exports in 1962. Their total electronic export in 1961 was $248 million. In 1962 it was $303 million, up 22%. U. S. exports in electronic gear also registered a 22% rise from $613 million in 1961 to more than $750 million in 1962. U. S. exports around the world in 1963 are set at about $1 billion. In 1964 this figure is expected to go beyond $1.3 billion.

As electronic development and trade grow, so will exports and imports. As U. S. exports grow by giant strides, so exports to the U. S. from Japan, Britain and others are expected to increase steadily. Total imports into the U. S. for 1963 are estimated at $340 million. This may go over $500 million in 1964.

Electronic industrial potential and output of Japan and Britain are growing. And at this moment, the U. S. is the best customer of both countries.

MILITARY AND SPACE ELECTRONIC EXPENDITURES

(In Billions of Dollars)
for fiscal 1965



The pie chart above indicates projected estimates for the 1965 Fiscal Year based on data from the Department of Defense and other U. S. agencies. Total outlay for major defense and space electronics may be around $9.4 billion. The chart shows dollars/percents of the major categories.

NAM SEEKS FCC APPROVAL FOR IN-PLANT SW RADIOS

The National Association of Manufacturers' Communications Committee has asked FCC approval for certain bands to be used by in-plant radio systems.

The FCC has proposed allowing industrial firms to use 30 frequencies in the 72 to 76 mc range. This would be mostly for short-range personnel messages to strengthen safety programs.

Workers and foremen could carry small radios into areas where excess noise and obstructions prevent visual and audio contact. Such radios could be used to direct machine devices such as cranes and locomotives.

SALES PROSPECTS RISING IN NEW FRENCH MARKET

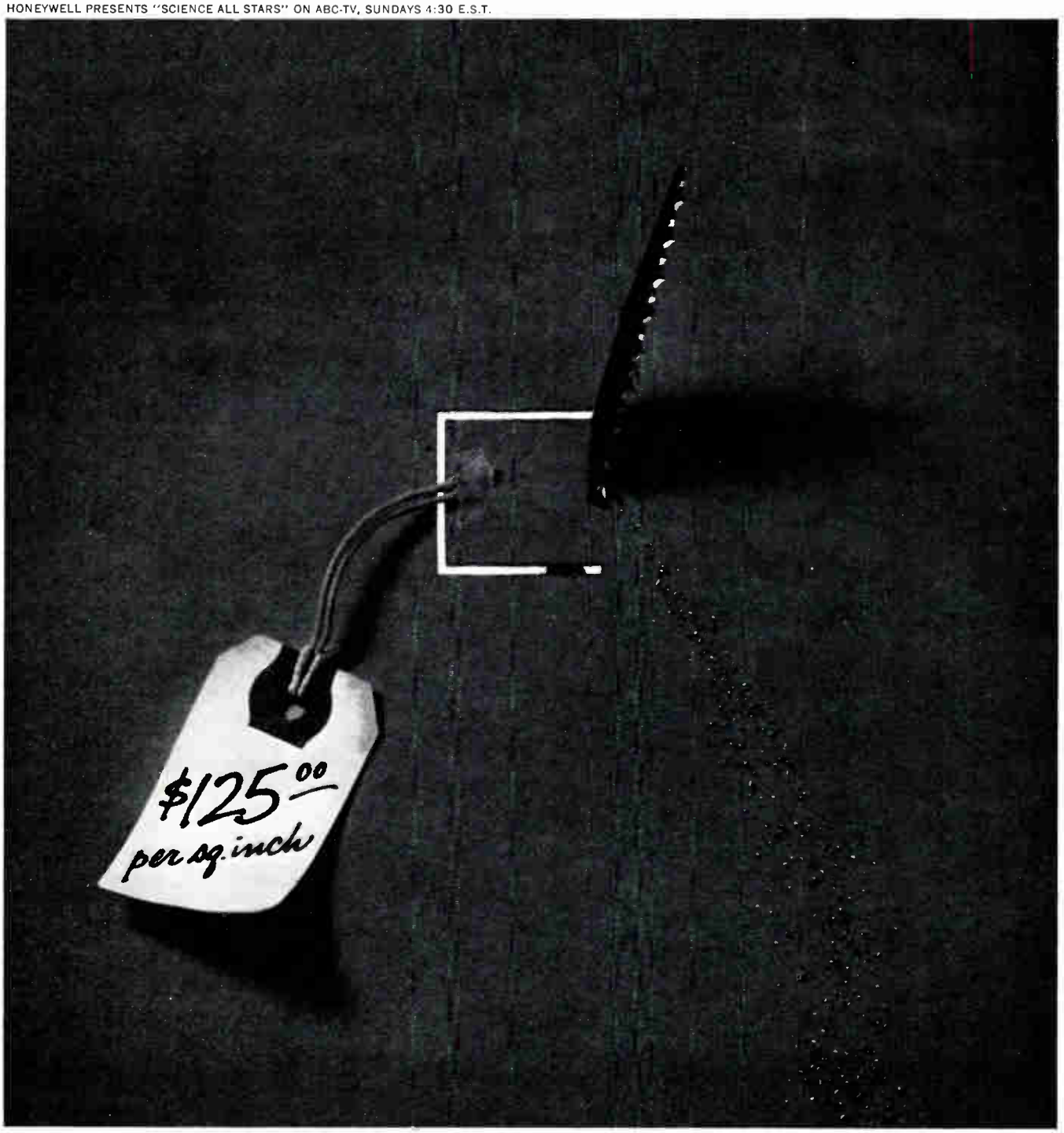
France is a thriving marketplace for a wide variety of U. S. products, reports the U. S. consumer goods trade mission sent to France by the Department of Commerce.

"With strong and rising demands for foreign goods, prospects favor" a rise in French purchases from the United States. The mission reports that U. S. firms will have to strengthen sales efforts in this growing and highly competitive market in order to achieve expansion.

The trade group, called the Consumer Goods Mission, took about 700 business proposals from U. S. firms to France. Interviews with more than 400 French businessmen revealed interest in a great variety of U. S. goods.

Proposals covered electronic and electrical goods, as well as industrial products, pharmaceuticals and chemicals, automotive supplies, accessories and components. There were also requests for licensing deals and joint-venture proposals.

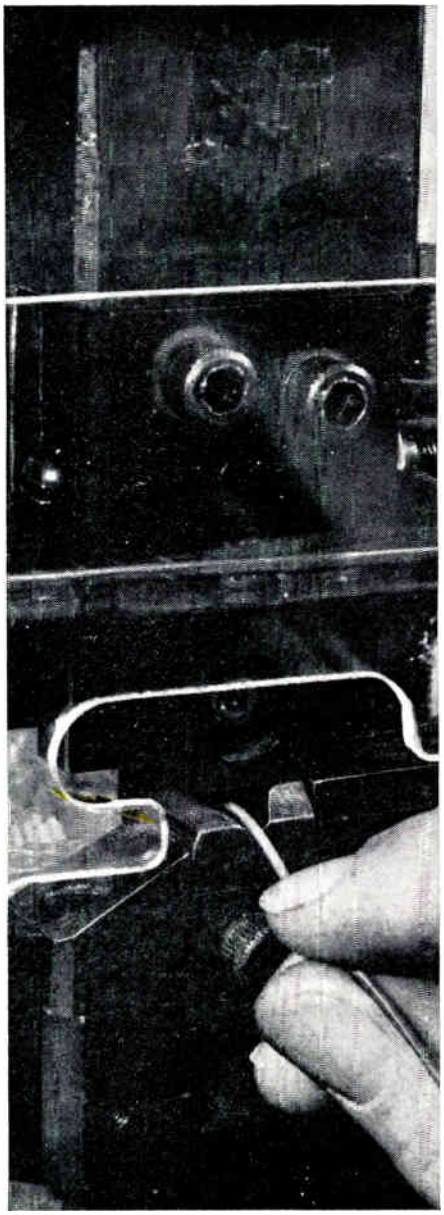
HONEYWELL PRESENTS "SCIENCE ALL STARS" ON ABC-TV, SUNDAYS 4:30 E.S.T.

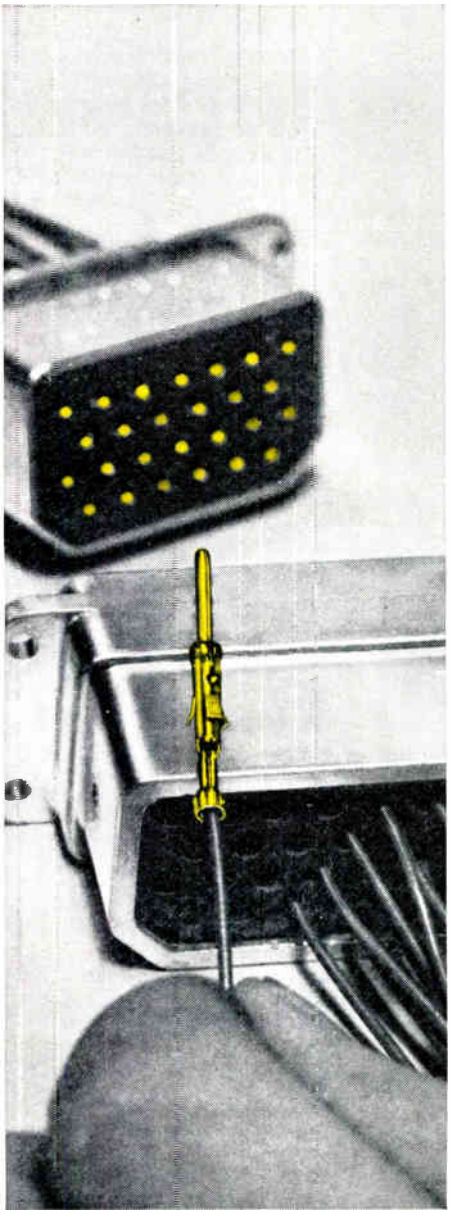


Fight today's high cost of panel space with Honeywell miniature meters

Panel space nowadays is expensive. (Our estimate of $125 per sq. inch is probably conservative.) You can beat this panel "squeeze", however, with miniature meters by Honeywell. Our line is the broadest in the business. We have Ruggedized (HS1) and Edgewise (MCE1) meters. A handsome medallion-shaped meter called the Medalist (MM1). A new square-shaped meter (MS1) with uncluttered, easy-to-read concave dial face. All are smaller than 1¾ inches. Available in any practical range. Write Honeywell, Precision Meter Division, Manchester, New Hampshire, for more details.

Honeywell





Psss fffft fini

Psss-fffft—that's the sound of our automachine crimping AMP-INCERT★ pin and socket contacts. It's that fast! And that's why we offer the lowest total applied cost in the industry.

You get maximum production levels without sacrificing quality. And you get maximum reliability, too. Because contacts are crimped with consistent pressures, terminations are always the same. Gold over nickel plating provides top resistance to corrosion. External retention springs facilitate quick assembly and firm seating in the connector block. Cantilever-beam engagement springs minimize surface wear.

Just figure out your production requirements. There are a number of automatic application machines that provide high speed terminations all ready for snap-in assembly. And their speed permits extreme flexibility in production matters . . . contacts can be crimped to leads or harnesses any time, anywhere. And actual insertion can be done in any volume or sequence you desire.

Automatic machines are available in portable and bench mounted types. Power is pneumatic or fully electric. They terminate formed contacts fed in strip form, or tape mounted screw-machined contacts. Either way you get maximum reliability for a wide range of wire sizes.

Increased production. Lower cost. Maximum reliability. That's what you get. If you want further proof, write us today for complete information and test data.

★Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

A-MP★ products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

General Electric Co. engineers remove a superconducting coil from liquid helium after the coil had attained a magnetic field of 101,000 gauss. Power source consisted of six ordinary auto storage batteries.

Careful attention to quality and uniformity has led to improved materials. Here, samples are being studied on a Modified Hay Bridge to determine magnetic performance of high permeability alloys. Photo was taken at the Electrical Laboratory of Magnetic Metals Co.

MAGNETICS RESEARCH TURNS UP NEW DESIGNS, APPLICATIONS

Needle - shaped particles of Columbian Carbon Co.'s Mapico Red #516M iron oxide are shown in this X 25,000 blow-up. Used in ferrite production, this oxide has about 90% of its particles less than 0.75 micron (right).

Engineer (below) works on a Westinghouse superconducting magnet. This magnet has a field rating of 50,000 gauss. Its rated current is 12.70 amps.

THE VERY OLD FIELD OF MAGNETICS is undergoing a change. Research done in the past decade is paying off for the electronic industry. Rapid advances are being made in many fields of application ranging from magnetic metalforming to digital computers—from electromagnetic weighing to medical research.

Superconducting magnets, thought impossible a few years ago, are being sold. Film memories, thought impractical a few years ago, are also on the market today and could conceivably be a "best seller." Also, magnetic materials with a degree of impurity unheard of a short time ago are now a reality. And, it is interesting to note that magnetic devices are replacing semiconductors in some applications. These and other developments are discussed here.

* * *

Out of the extensive research in magnetics have come such developments as superconducting solenoids and magnetic thin films. Magnetics is finding increased usage in research labs, space vehicles, power generators, computers and metalforming machines, among others. In many applications they are expected to supplant active components, including semiconductors.

Perhaps the most important recent development in the magnetics field is the superconducting magnet. Development of this magnet has made possible small volume, high density fields without the need of high power and large cooling systems.

Superconductivity, briefly, is the complete absence of measurable electrical resistance in certain materials at temperatures at least as low as 18°K. There are two parameters which affect superconductivity. These are temperature and magnetic field.

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART FEATURE

A material's "critical temperature" is the temperature below which the material is superconductive. The "critical field strength" of a material is the strength at which a magnetic field will cause a superconducting material to return to its "normal" resistive state. The type of material and the current being carried determine the field strength at which this will occur. The relationship between temperature and critical field can be shown by the parabola

$$H_c = H_o[1-(T/T_c)^2]$$

where:

H_c = critical field at the temperature T (°K)

T_c = superconducting transition temperature at zero magnetic field

H_o = critical field for the material at 0°K.

A transition from superconducting to normal state can also be triggered by exceeding a "critical current." This current is a function of temperature and magnetic field.

Classes of Superconductors

There are two classes of superconductors — the "ideal" or "soft" class and the "non-ideal" or "hard" class. The "soft" class consists of pure elements such as mercury, tin and lead. These are characterized by a sharp transition from the superconducting to the normal state at some critical temperature. Most of the early work on superconductivity was carried out using these materials.

The "hard" class of superconductors consists of alloys and compounds. The alloys are, in general, ductile and easily handled while the compounds are brittle and have fixed properties that are hard to alter.

The most significant difference between the hard and soft types is the manner in which the magnetization goes to zero as the applied field reaches a critical value. In the soft superconductor the current is carried in only a thin surface layer. The hard type is thought to be made of discrete, quasi-ideal filaments which are separated by zones of normal conductors. Thus, high fields can penetrate it. All high-field-strength superconducting magnets are wound from the hard type.

Alloys and Compounds

The most commonly used alloy at this time is niobium-zirconium with niobium-titanium, titanium-tantalum and vanadium-titanium showing promise. Of the compounds, Nb_3Sn and V_3Ga have received much attention. Other attractive compounds are Nb_3Al and V_3Sn.

Generally, in a given alloy system, if the composition is varied a change in critical current and critical field results. The current density in a system can also be affected by the heat treatment and amount of cold work given the material during the fabrication process. Cold-worked materials with high internal stresses usually show higher current carrying capacities than annealed materials.

The compound Nb_3Sn remains superconducting up to 18°K and V_3Ga to 17°K. Experiments at 4.2°K show that Nb_3Sn remains superconducting in fields of 185,000 gauss. (This is the limit of experimental equipment, not the material.) Further experiments show that it can carry a current density of over 10^5

By SMEDLEY B. RUTH
Associate Editor
ELECTRONIC INDUSTRIES

amps/cm² in a field of 100,000 gauss. It is felt that V_3Ga should be superconducting in magnetic fields approaching 300,000 gauss.

Nb_3Sn is limited by its mechanical hardness; but, it has been put in a usable form by placing niobium and tin powder into a niobium tube, drawing the tube into wire, winding a coil, and then sintering the coil to make Nb_3Sn. This process is difficult, especially for larger coils. Another method is to put Nb_3Sn on a substrate, either by deposition of the compound or by plating tin on niobium. Either method appears to hold good promise for magnet applications.

It is expected that new binary and ternary alloy systems will soon be discovered which will accept higher current densities than today's materials. Higher critical fields will also be realized.

This 19-lb. superconducting magnet can duplicate the performance of a 600-lb. conventional Alnico V permanent magnet. It was designed and produced by The Arnold Engineering Co., Marengo, Ill., a subsidiary of Allegheny Ludlum Steel Corp.

Advantages

The very large power needs of normal high field magnets are due mainly to the electrical resistance of the coils. Thus, one of the main advantages of the superconducting magnet becomes evident. As the superconducting magnet material exhibits zero resistivity, it needs little power to operate. The only power expended is that needed to keep the magnet at superconducting temperatures. Fields of over 100,000 have been reported using only six auto batteries as the source. Comparable fields created by normal means needed about 2Mw of power.

This same lack of resistance means that with a low power source, current can be started in a superconductor, and when the power source is removed, the current will continue to flow indefinitely.

Weight is also an advantage. A typical superconducting magnet might weigh 200 lbs. By comparison, present day methods of producing high magnetic fields, within a comparable working volume, would weigh over 6 tons.

Cost is a feature of the superconducting magnet. Increased demand has brought the superconducting coil to a point where initial and operating costs are modest when compared to other normal high field magnets.

Applications

Why all the excitement over these magnets? The excitement stems from the large number of potential uses that these magnets have. Generally, fields above 20,000 gauss had been restricted to lab use. This had been necessary because of the size of the available magnets and the power needed to operate them. The superconducting magnet has changed this. Higher fields are now available and the weight and power needs are much less.

Avco SC600 superconducting magnet is lifted from its —450°F liquid helium bath after a test run. Coil is wound with niobium-zirconium and multiple insulation. Coil ID is six inches.

Almost every field of science could be affected. At present the main areas of use are for R&D and to provide the high-field uniformity that is important

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to high-gain, broad-bandwidth, high-frequency and high-sensitivity maser operation.

In the laboratory it is expected that they will be used for medical and biological research, magneto-chemistry, particle accelerators, bubble chambers and for the study of the magnetic properties of materials.

For space it is possible that these magnets will be used in MHD power generation and propulsion. They may also be used to shield space vehicles against radiation.

On rocket engines, they may be used to direct the hot, ionized gases for steering, to divert the gases to prevent nozzle burnout and possibly to control burning rate of the fuel.

Cryogenic motors, generators, frictionless bearings, gyroscopes, switches and transformers may all make use of the superconducting magnet.

The magnets are being studied for possible medical-surgical use. They may be used to withdraw a particle from the eye or body via the same path it entered. Removing these particles often does more damage than when they entered. Normal magnets available today are either too weak or too bulky to maneuver.

Other potential uses are for thermonuclear fusion containment, traveling wave tubes, IR detectors, energy storage and metal forming.

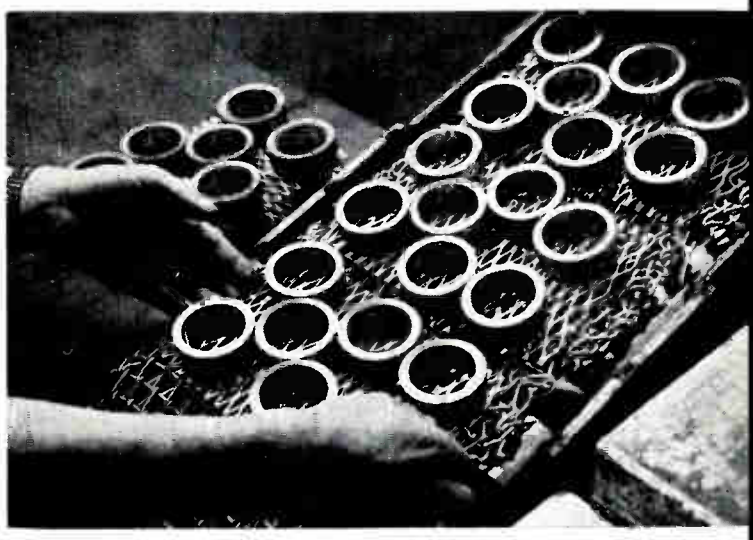
Potential uses are almost unlimited. Present advantages are those which will be realized as research fallout. Meanwhile, research continues to furnish improved materials, protective circuitry, and higher fields. This year should provide more than one breakthrough in superconducting magnets. One of these could be provided by a 50,000 gauss magnet with a 10 in. bore which Avco-Everett is building for AEC. It is for a large bubble chamber. Another project which bears watching is a large saddle-shaped coil which Avco is making for use in a MHD power generation program.

Thin Film Memories

An essential part of any digital computer is its memory capability. Ferrite cores are one of the oldest memory types still in use. Not only are they still in use, but they are the mainstay of many computer memory systems. This is due to their significant and steady improvement over the years. But, it is felt by many that magnetic thin films will soon be the dominating computer memory system.

The use of magnetic thin films for memories has been delayed by several factors. These are:

1. The inability to control fabrication parameters (especially in large bit plane capacities).



Magnetic strip from 0.5 to 14 mils thick is wound into a toroid to form the heart of a Magnetics, Inc., tape wound core. Cores are then loaded onto a conveyor belt for annealing at 1100 C.

2. An inadequate knowledge of the properties of the films.
3. Difficulties in making connections to and interconnections between the film memory elements.
4. A low output signal.
5. In large units, the stack noise that is generated.

Magnetic thin film memories showed enough promise, however, to warrant much effort being spent to overcome these disadvantages. As a result, several companies appear to have solved many or all of the problems. A few companies have tested experimental memories and have reported them more than satisfactory. Several other companies have film memories in production. At least two companies, Burroughs and Univac, are using film memories in computers.

The reason for this interest in magnetic film memories is evident. They are capable of high speeds and short access times—almost a must in the current computer speed race. They are inexpensive to operate and test. They can be produced in volume and lend themselves to high-density packaging. They can be made, in thicknesses measured in Angstrom units, by several methods—evaporation, supttering, vapor deposition or electro-deposition. And, they can be operated in either a destructive or nondestructive readout mode.

Even superconductors are entering into thin film memory designs. RCA last year announced an experimental thin-film superconductive all-electronic memory which can store 16,384 bits of information in an area only two inches square and 120 millionths of an inch thick.

The unit consists of a glass plate which bears several thin layers of tin, lead, and silicon oxide

deposited by evaporation to create a sandwich. Between the oxide layers (insulators) are two conducting grids made of 128 hair-thin strips of lead, and deposited at right angles to each other to form a fine wire screen pattern. Beneath the grids and the insulators is a thin film. Memory capacity is determined by the 16,384 intersections in the screen.

In addition to the thin film memory there is another that deserves mention.

A BIAX memory, made by Philco, operates in 100 nsec. and stores 50,000 bits of information in 1,024 words. Called the 10-megacycle BIAX memory, it is now available for delivery. It is believed to be the fastest large memory available.

Features it has in common with other BIAX memories are non-volatile storage, true non-destructive read out and low power consumption.

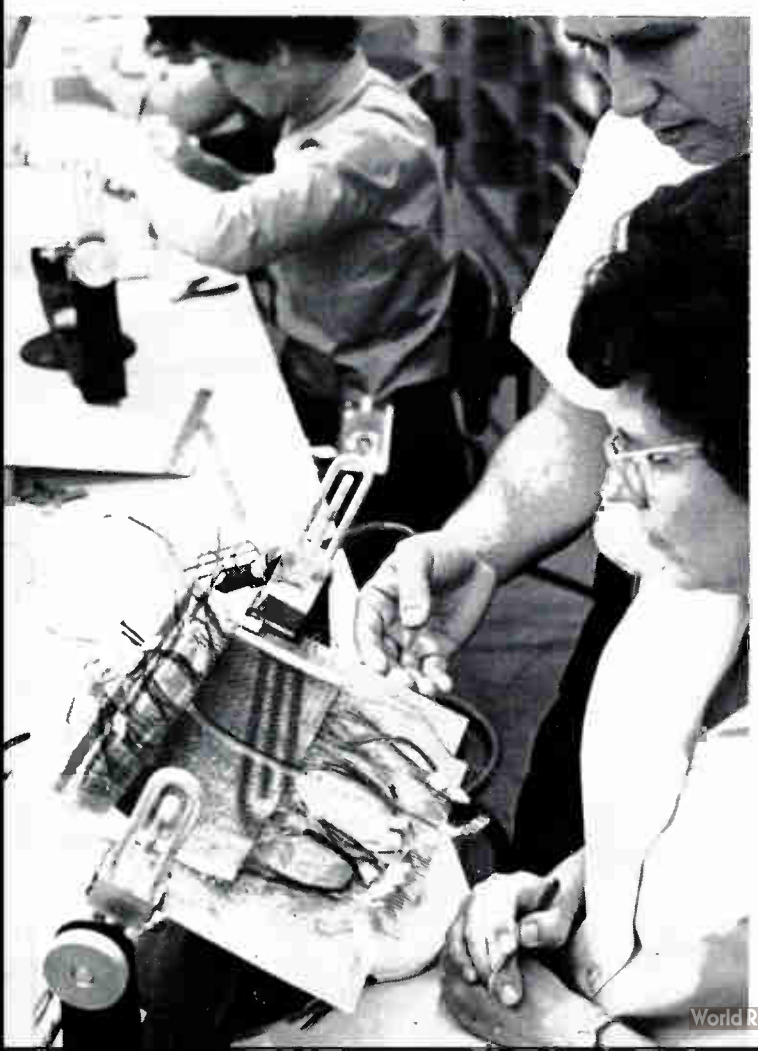
Semiconductors Replaced

There is a revival of interest in the "all magnetic" computer concept. A number of computer people feel that if it were not for the invention of the transistor, all computers would now probably be magnetic. An example of the all magnetic computer concept is the Burroughs D210 computer which uses predominantly magnetic circuit methods.

The value of a magnetic computer is emphasized by the space age. Magnetics are very resistant to radiation, have a long life expectancy and allow a reduction in the number of components needed to build a computer. The radiation resistant feature would eliminate the need for weighty shielding in a space vehicle.

Sperry Gyroscope Co. is working on a radiation-tolerant computer for the USAF. It is to be immune to neutron radiation as high as 10^{17} to 10^{21} NVT and temperature up to 900°F. Sperry scientists have discarded semiconductors in favor of magnetics. They claim that magnetics can do what semiconductors can do, and are much better on some counts.

Memory arrays, composed of thousands of Biax ferrite magnetic elements which store information, undergo quality checks at Philco Corporation's Aeronutronic Division plant in Santa Ana, Calif. The tiny elements are woven together to form the arrays, which are later assembled into Biax memories, the latest model of which operates at 100 nanoseconds.



Other Applications

Magnets and magnetic theory are being used for an increasing number of applications. Shielding, weighing, hardness gaging, controlling weld pressure, materials handling and delaying signals are just a few of the uses to which magnetic principles have been put.

Another interesting and comparatively recent use of magnetics is that of metal forming. Magnetic metalforming machines are being used to force hard-to-work metals into complicated shapes. Most of the practical uses of magnetic forming thus far have been in the field of swaging; but, magnetic forming can also be used to coin, shear and form flat stock.

Obvious advantages are that this process will not mar, scratch or damage work surface. These machines will operate through thermal or electric insulating coatings. They generate a force equal to a pressure wave of 50,000 psi. They are fast, are easily automated and need minimum maintenance. Work is done by discharging a capacitor through a coil over a period of 10-20 μsecs, producing fields with flux densities of over 300,000 gauss.

Then there is the permanent magnet system which can be turned "on" and "off." The Westinghouse "Flux Transfer Principle" allows a permanent magnet's poles to be switched end-for-end. This in effect turns the magnetism on and off. And it remembers its direction of greatest magnetic pull indefinitely. It needs no applied energy to create a strong magnetic field.

Magnetic Materials

Most magnetic alloys, although of the same basic composition as years ago, have been improved. Gen-

(*Continued on page 37*)

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OUTPUT: 200 voltamperes 50 cps to 1 kc. Beyond 1 kc, see plot.

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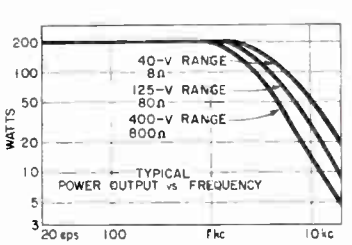
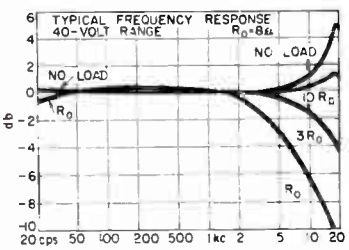
0-4	0-12.5	0-40	0-125	0-400	volts, rms
0-5	0-5	0-5	0-1.6	0-0.5	amps, rms

Output transformer will pass dc equal to rated ac.
Harmonic Distortion: 1% from 100 cps to 10 kc, 2% from 50 to 100 cps.
Hum: Better than 50 db below maximum output.

AMPLIFIER:
Input: 10 kilohms.
Sensitivity: Approximately 2 volts needed for full output.

POWER REQUIREMENTS: 105 to 125 or 210 to 250 volts, 50-60 cps, 70 to 500 watts (depending on load).





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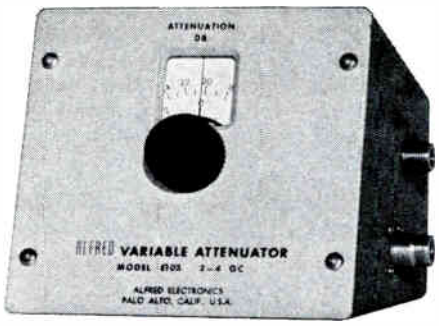

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SPECIFICATIONS

Model	E101	E103	E105
Frequency Range Gc	1 to 2	2 to 4	4 to 8
Insertion Loss (at 0 db setting)	5 db	5 db	5 db
Frequency Response (at 0 db setting)	±¾ db	±¾ db	±¾ db
Frequency Response (at 60 db setting)	±1½ db	±1½ db	±2 db
Calibration accuracy at center frequency	±0.2 db or ±2%, whichever is greater		
Impedance	50Ω	50Ω	50Ω
Connectors	Type N female		
Price	$400	$450	$480

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erally, the basic ingredients are still iron, cobalt and nickel, but they are mixed in different proportions. Other materials such as silicon, vanadium and molybdenum are mixed with the basic materials to obtain certain wanted magnetic or physical properties.

Much research is being done in an attempt to obtain better materials. A major area of study is that of control. The ability to control materials during manufacturing is still a problem. And all phases of the melting and refining operations must be strictly controlled if high quality material is to be produced.

New processing methods are being developed and more attention is being paid to the quality of the raw materials selected. Through careful attention to quality and uniformity, and improved manufacturing methods, magnetic materials have attained new highs in purity and thus in magnetic properties.

Impurities can now be controlled to parts in one million. As a result, hysteresis losses, which are controlled mainly by controlling impurities, are lowered. Lowering the amount of impurities present also serves to increase permeability. In short, performance levels of the materials rise as the impurities are removed and this is accomplished through improved processing methods.

MAGNETIC RELAYS STAY ON PLATEAU

Electromagnetic relays for electronic applications have been somewhat stabilized in the 100-million-dollar-a-year range.

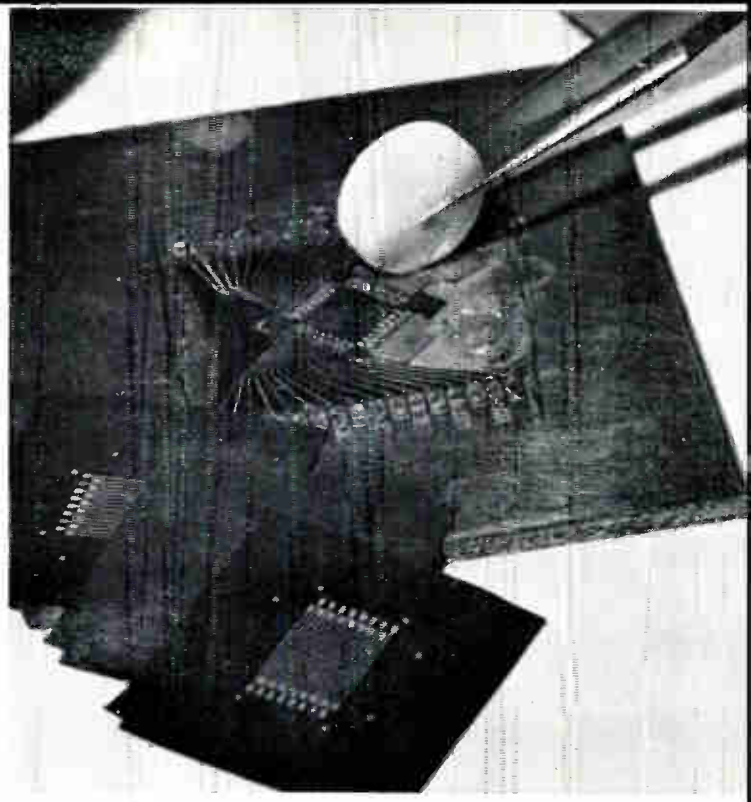
Total sales for 1961 and 1962 were about $97 million for each year. For 1963, such relays sold for an estimated $100 million. They will probably do the same for 1964.

Development of methods for orienting the grains in soft magnetic materials has led to lower coercivity and higher permeability. This orientation can be done by cold rolling and, later, annealing of the material.

The rare earths are receiving a great deal of attention in a number of labs throughout the country, but they are expensive and have low Curie temperatures.

Some companies will make materials to order instead of by selection. These companies now feel that they are fitted to the task of developing an alloy to meet a customer's needs. Many of these companies are now working very hard to get their lab work into production.

Many new uses are being found for ferrites. Although not as useful at low frequencies as ferromagnetic materials, they are replacing them in many high frequency applications. Big advantages of ferrites are their low eddy-current and hysteresis losses and for some uses, the fact that they can be made to show a square hysteresis loop. Another growing use of ferrites is in magnetic amplifiers where they



Diamond-shaped unit above is a computer memory made by RCA. Dwarfed by an aspirin, it can store up to 256 bits of information permanently, or of processing up to 10 million bits per second. It is made of thin laminated sheets of ferrite. In the foreground are typical sheets in an unfinished form.

are successfully competing with vacuum tubes.

The anti-ferromagnetics are also receiving much attention as materials for use at very high frequencies. Of particular interest is the part that spin waves (oscillations of the precessing magnetic movements in the material) play in anti-ferromagnets. How these waves are generated is studied.

The amount of research being done in the magnetic materials area should result in the discovery of many new and better magnetic materials and alloys. The big problems will be to make them economically feasible, to get them into production and to have them accepted by the users.

Acknowledgements

We would like to thank the following for their contributions to this article:

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F. W. Bell, Inc.	Columbus, Ohio
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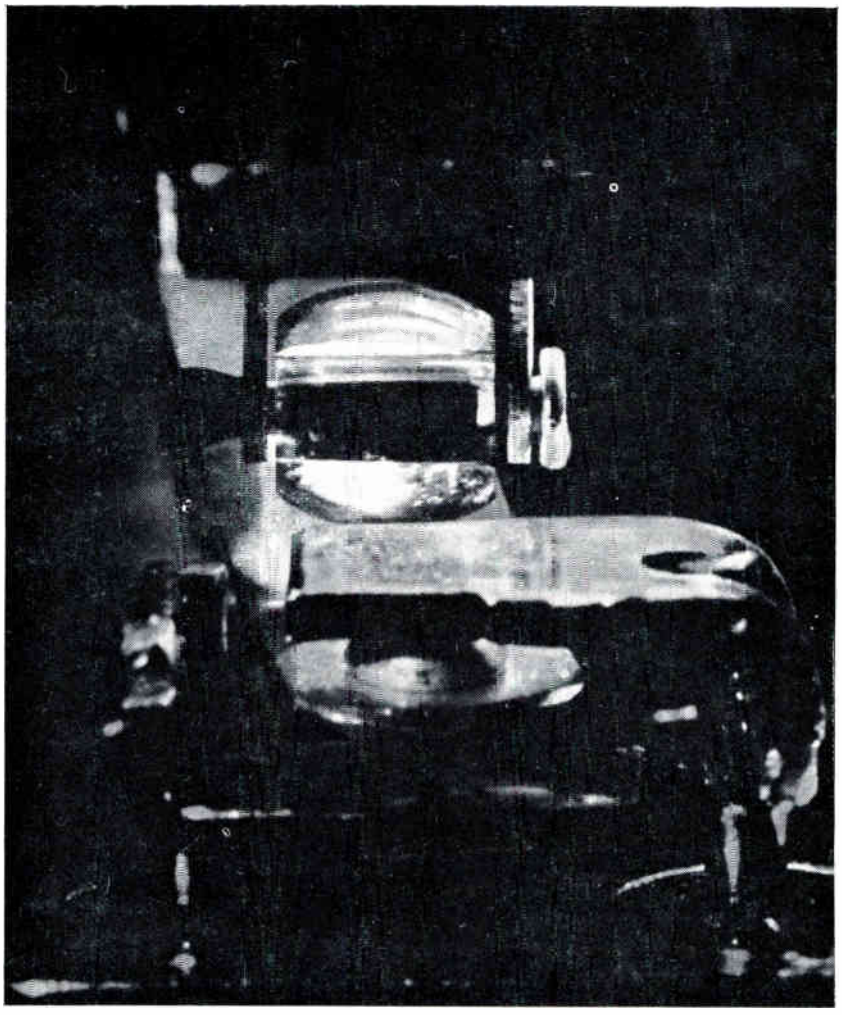
Columbian Carbon Co., Inc.	New York, N.Y.
Wilbur B. Driver Co.	Newark, N.Y.
Forster/Hoover Electronics, Inc.	Ann Arbor, Mich.
The Franklin Institute	Phila., Pa.
General Ceramics, Div. of Indiana General Corp.	Keasbey, N.J.
General Dynamics Corp., General Atomic Div.	San Diego, Calif.
General Electric	Schenectady, N.Y.
G-L Electronics	Westville, N.J.
Leyman Corp., Magnetics Div.	Cincinnati, Ohio
Magne-Head Div./General Instrument Corp.	Hawthorne, Calif.
Magnetic Metals Co.	Camden, N.J.
Magnetic Shield Div., Perfection Mica Co.	Chicago, Ill.
Magnetics, Inc	Butler, Pa.
Magnion, Inc.	Cambridge, Mass.
Minnesota Mining and Manufacturing Co.	St. Paul, Minn.
Philco Corp.	Blue Bell, Pa.
Radio Frequency Laboratories	Boonton, N.J.
Sperry Gyroscope Co., Div. of Sperry Rand Corp.	Great Neck, N.Y.
Stackpole Carbon Co.	St. Marys, Pa.
Univac, Div. of Sperry Rand Corp.	Blue Bell, Pa.
Varian Associates	Palo Alto, Calif.
Westinghouse Electric Corp.	Pittsburgh, Pa.
C. K. Williams & Co., div. of Chas. Pfizer & Co., Inc.	New York, N.Y.



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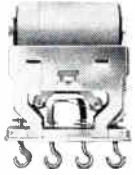

How do Relays Operate?

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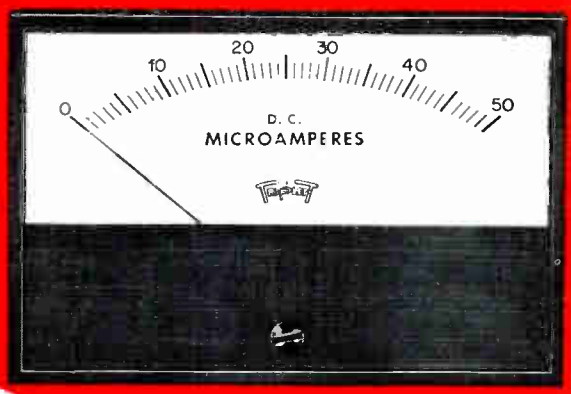

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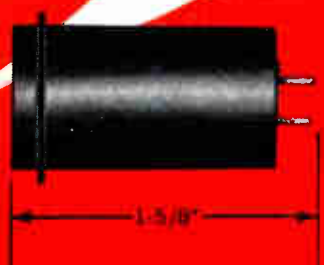

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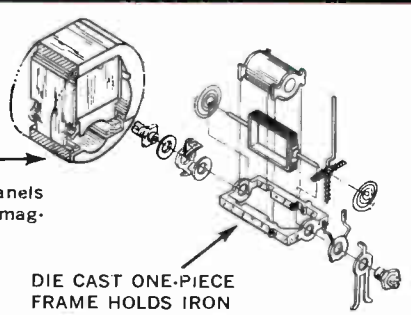

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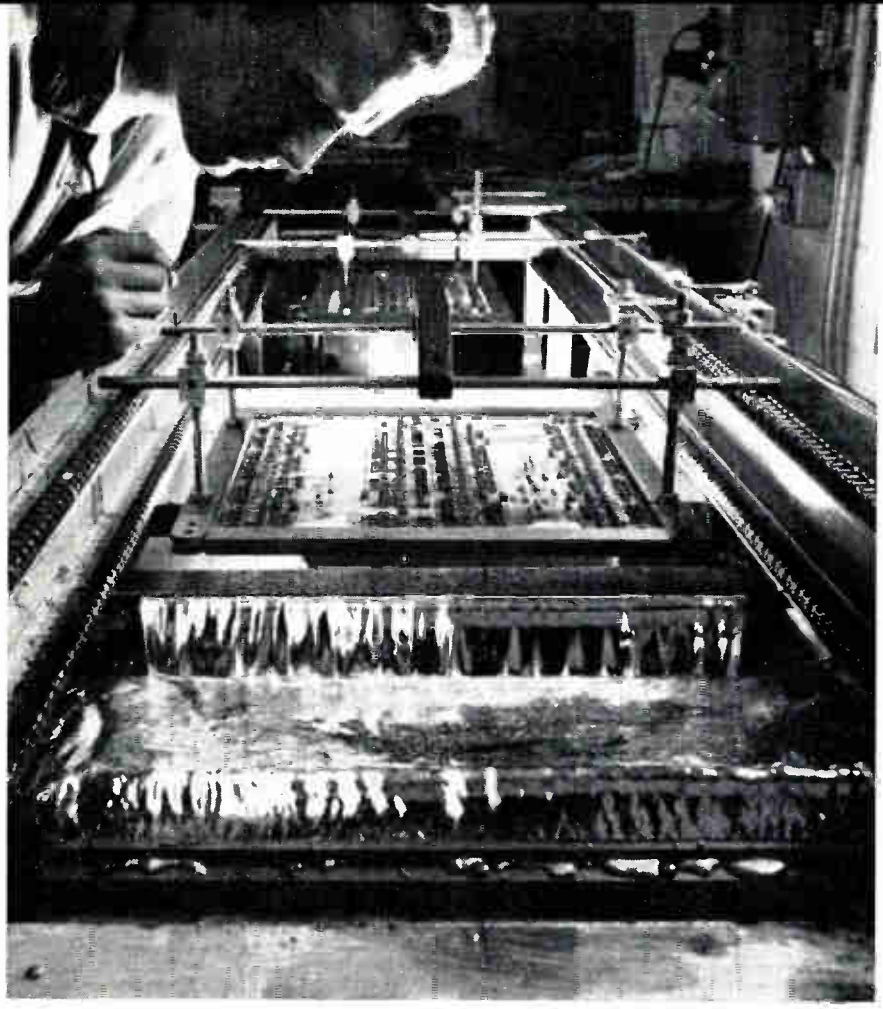

ELECTRONIC SNAPSHOTS

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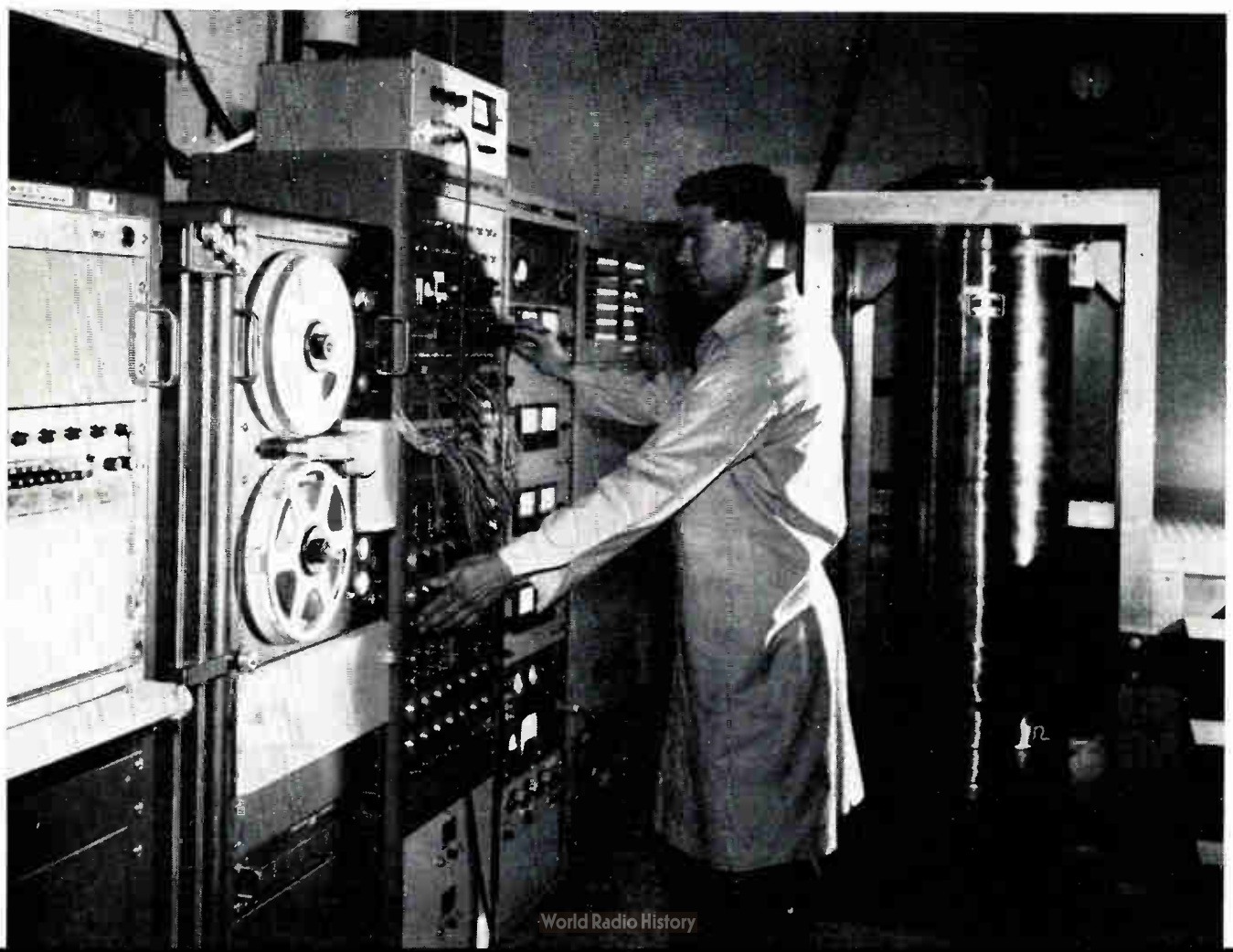
HOT BATH

Assembler checks printed circuit card as it moves down conveyer for a liquid solder bath. The card passes over molten, flowing solder which adheres to the component leads on the bottom of the card. Card is used in General Precision Inc.'s LPG-21 computer produced in Burbank, Calif.

TEST STAND FOR SUPERCONDUCTING MAGNETS

Engineer checks test stand at Avco-Everett Research Laboratory, Everett, Mass. Stand is one of two used to test large diameter superconducting magnets. Both stands consist of a nested set of liquid-helium and nitrogen dewars, with inside diameters of 14 and 24 inches respectively



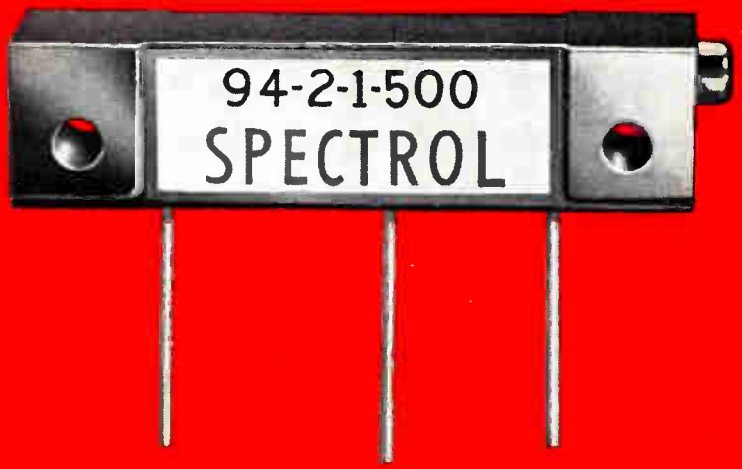
SUB-ZERO

Data Acquisition Units
and Microwave Relay Units
in the Air Force Flight Test Center
Data Acquisition and Transmission System
must withstand severe
environmental conditions.
Temperatures at remote mountainous sites
vary annually from −30°F to +130°F.
System was designed and implemented
by Motorola Inc., Scottsdale, Ariz.,
under contract to the Air Force.

MONITORING SYSTEM

Compact sensors of Executone-Gulton
Physio-logical Monitoring System
permit measurements to be made painlessly.
Blood pressure is measured
by a small harness on one finger
while a tiny sensor in the patient's nostril
monitors respiration rate.
Transducers and instrumentation
for the system were developed
by Gulton Industries, Metuchen, N. J.
Executone Inc., Long Island City, N. Y.,
installs and maintains the system.

WHAT'S NEW IN TRIMMERS?



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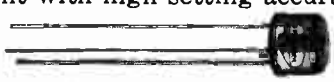
HERE'S ONE: Model 94 rectangular. Available with insulated stranded leads, printed circuit pins, or solder hooks.

ACTUAL SIZE

HERE'S THE OTHER: Model 82 round. Packaged in a TO-9 transistor type case (volume only 0.02 cu. in.). Standard terminal spacing for solid-state circuit card use. Convenient single-turn adjustment with high setting accuracy.



ACTUAL SIZE

CONCLUSION: Spectrol Model 94 low cost rectangular trimmer with ½ watt power rating is best in its class. Competitively priced, too. The Model 82 round trimmer, a Spectrol original, is the *only* one in its class in both performance and price.

SPECIFICATIONS	MODEL 82	MODEL 94
Standard Resistance Range . .	50Ω to 10K	50Ω to 10K
Standard Resistance Tolerance	± 10%	± 10%
Power Rating	½ Watt at 50°C	½ Watt at 50°C
Operating Temperature Range	−65 to +105°C	−65 to +105°C
Number of Turns	1	22 ± 5
End Stops	Fixed	Idler clutch
Case Dimensions-inches	¼H x 11/32 Dia.	1¼L x 5/16H x 9/32D
Unit Prices		
1-9	$4.00	$3.15
500	$2.63	$1.94

Call your nearest Spectrol distributor for immediate off-the-shelf delivery at factory prices, or write for complete specifications.

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
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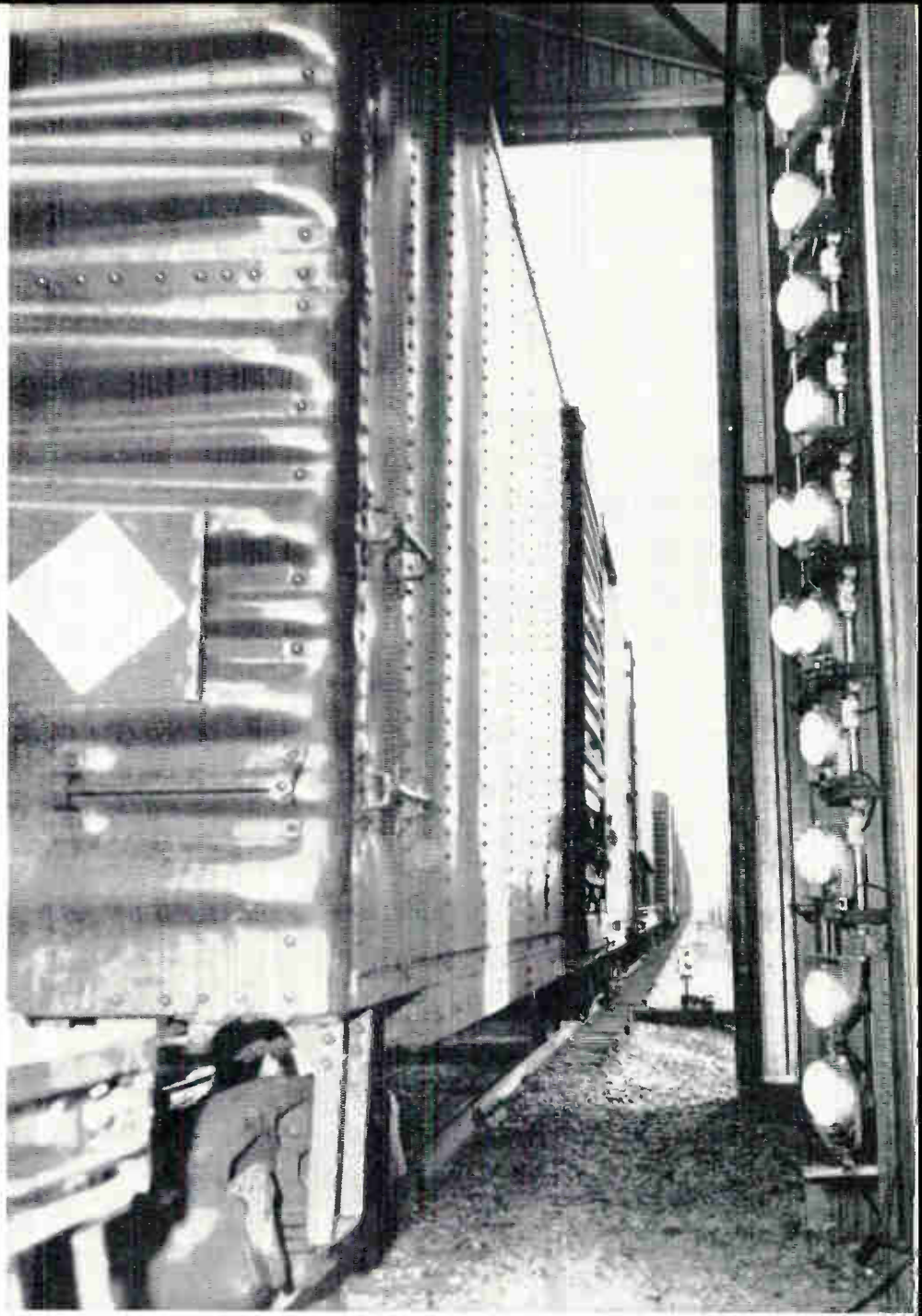
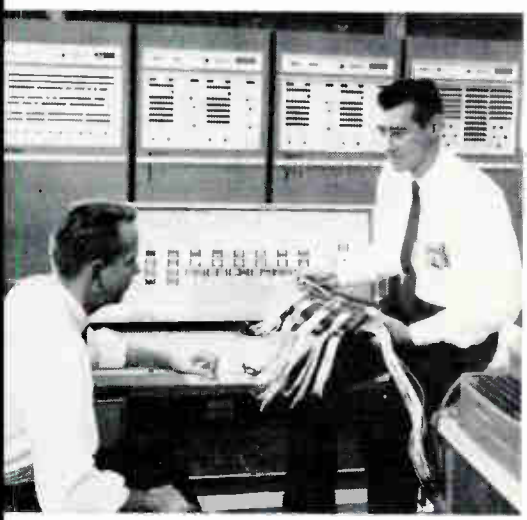
SNAPSHOTS . . . (Concluded)



REPORTING SYSTEM

Floodlights illuminate side of train in a narrow vertical band—the area being scanned—in A. B. Dick Co.'s Videograph Railroad Car Reporting System. Trains traveling up to 35 mph activate a camera-type scanner (behind lights) that generates a signal which is transmitted through coaxial cable to an electrostatic printer. The printer contains a modified CRT that images the entire train on a roll of paper tape giving a permanent pictorial record of each car and its identification marks.



"SCRATCH PAD"

Burroughs Corp. engineers examine thin film "scratch pad" memory used in D825 electronic modular data processor. Computer was designed and developed at Burroughs Laboratories, Paoli, Pa. Modular design allows easy expansion of a basic system to include up to 4 computers, 16 memories and 10 control modules. Thirty-four D825 systems have been ordered by the Air Force for the back-up interceptor control (BUIC) system.

'IMPLANTATION'

Photograph illustrates a new method of implanting chronic, multiple electrodes in the heads of smaller animals such as this rat. The electrodes are implanted in the animals' brains for various psychological tests. Connections are made to inexpensive strip connectors made by the Amphenol Connector Div., Amphenol-Borg Electronics, Corp.

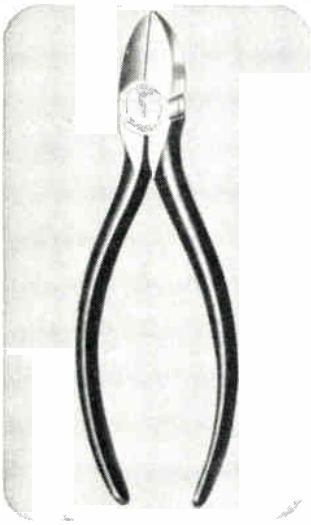
KLEIN PLIERS *Speed up electronic wiring*

When the crystal set was a seven-day wonder, Klein long nose pliers were used to adjust the cat's whisker. Through the era of B and C battery sets, Klein kept pace by providing pliers specially adapted for electronic wiring.

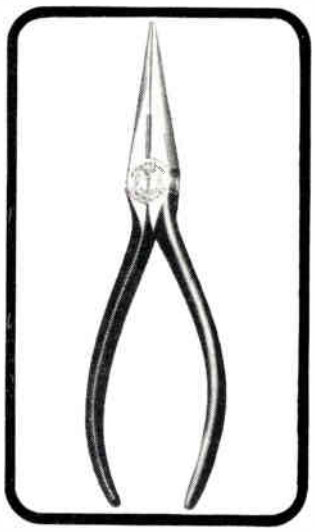
Today, more than 100 different styles and sizes of Klein pliers are available to provide the exact tools needed for any job. Klein engineers have developed a special plier for wiring printed circuits; a high hardness plier for cutting nickel ribbon wire; a transverse end cutting plier for cutting closely in confined spaces; extremely small pliers for wiring midget assemblies—and many others.

Klein has also developed special pliers to do special jobs requested by electronic manufacturers.

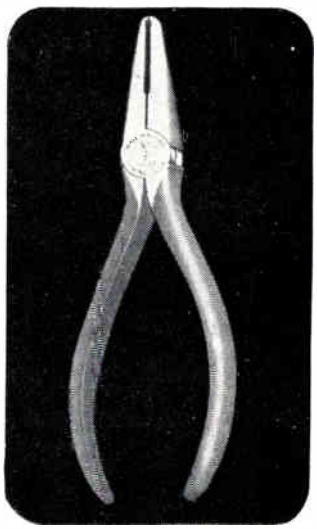
For better work done more quickly and at lower cost, be sure the pliers you use are exactly suited to the job . . . made by Klein, of course, "Since 1857."



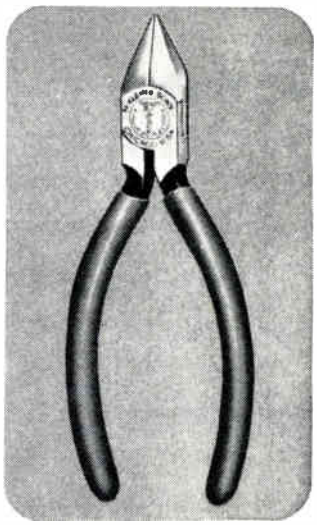
202-5C Oblique Cutting Plier with narrow nose. Available with coil spring. 5½-, and 6-in. sizes.



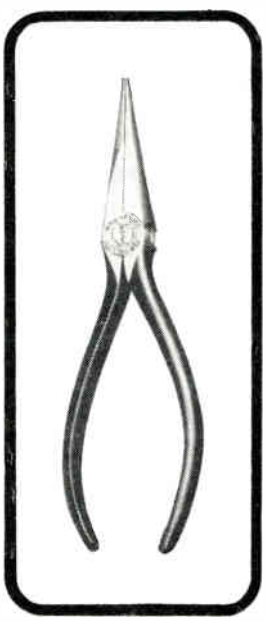
203-5C Long Nose Side Cutting Plier. Available in 5½-, 6½- and 7-in. sizes. Supplied with coil spring.



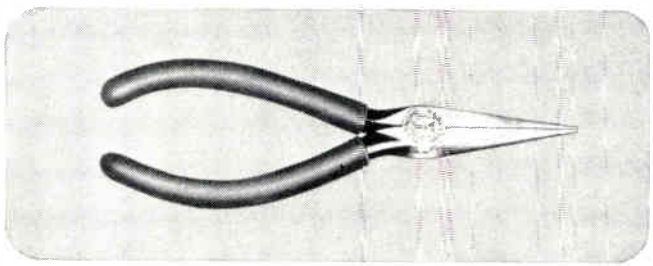
204-6C Transverse End Cutting Plier, 6-in. long. Supplied with coil spring to hold jaws open.



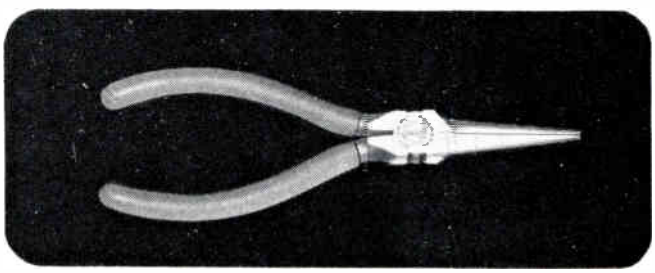
D209-5C Lightweight, Pointed Nose, Flush Cutting Plier. Supplied with coil spring to hold jaws open.



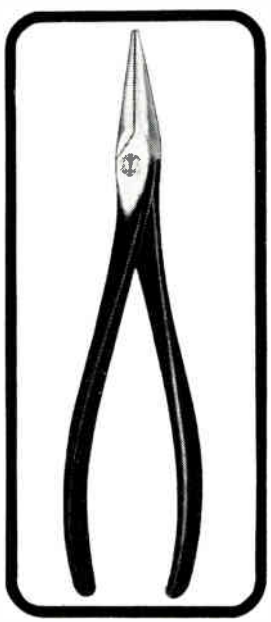
301-5C Long Nose Plier. Available in 5½-, 6½- and 7-in. lengths. Coil spring.



D307-5½C Slim Long Nose Plier for reaching into confined spaces. Yellow plastisol handles. Supplied with coil spring to hold jaws open.



D310-6C Slim Long Nose Plier. Handles are yellow plastisol covered. Supplied with coil spring to keep jaws open.



314-8 8-in. Long Nose Plier. Jaws have knurl.

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Cinch's Mark I series connectors have demonstrated their dependability in a wide range of applications where small size, light weight, and reliability are essential.

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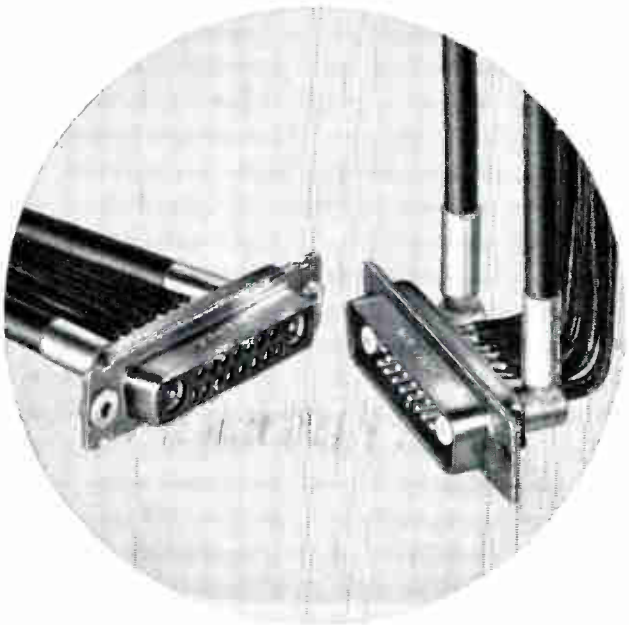
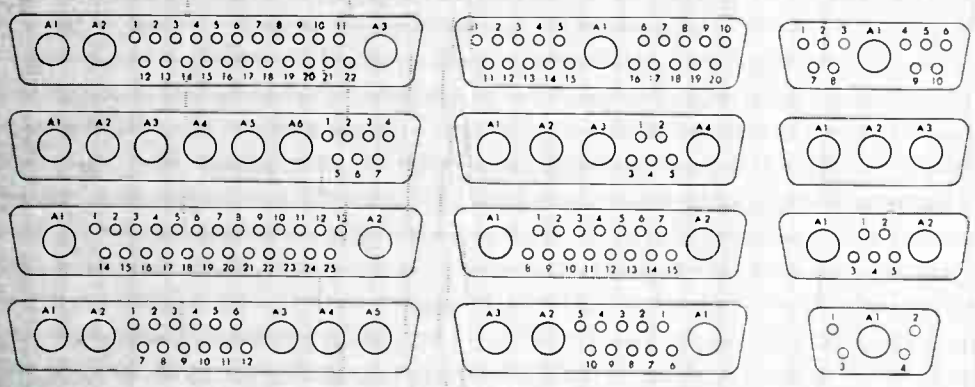
Mark I connectors are now available in twelve combination layouts of #20 contacts with coaxial or high voltage contacts. A choice of straight or right angle solder terminations can be used on the coaxial and high voltage contacts. The #20 contacts permit straight solder terminations only.

In addition to the combination layouts, basic layouts of #20 size contacts only—in groups of 9, 15, 25, 37 or 50 contacts—are also available. For immediate delivery on these standard connectors, call your Cinch Industrial Distributor.

For detailed information on these and other Cinch D-Subminiature connectors, contact your local Cinch Representative or write us direct.

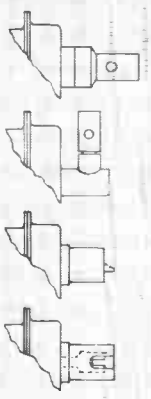


AVAILABLE IN 12 COMBINATION LAYOUTS



ACTUAL SIZE

CHOICE OF 4 TERMINATIONS



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CM-6403

Circle 38 on Inquiry Card

Women in engineering, though fairly commonplace in Europe and Asia, are still an oddity in American social lattice. By tradition, men have looked on women as housekeepers and needle pushers. Now, individual effort and societies are putting women in their rightful places in modern industry, from the assembly line to the executive suite.

INCREASING ROLE FOR WOMEN IN ELECTRONIC ENGINEERING

THE ELECTRONICS BUSINESS is very much a "man's world," but women are becoming more important. A few are already top executives. Many are engineers; many work in offices; and an army of them *man* the production lines. Behind the scenes, women are also the (patient or impatient) wives of electronic engineers and executives who must switch jobs with changing Federal contracts and business conditions.

In recent years, two distinct groups are voicing the needs and abilities of women to serve.

One group is the Society of Women Engineers. It was founded in Philadelphia in 1950 to overcome "professional loneliness," to make known the need for women engineers, and to encourage young women to consider an engineering career. SWE's ranks have grown to nearly 800 members in the U. S. Of these, about 20% are electrical-electronic engineers, according to a survey made in 1960. Yet, the fewer than 5,000 women among the nation's 800,000 engineers represent less than 0.3%.

The other group of women is in the labor unions. They represent several hundred thousand women who work as solderers, assemblers, inspectors and in related jobs. These are the female hand-workers who complement their sisters under the skin, the engineer head-workers in electronic companies.

Women Are People

Most women in business want to be regarded as *people*, not just *women*. From girlhood on, women are aware that they generally are brought up to have a secondary place in a male world. This "male myth" of natural superiority is being challenged more openly by women who see a chance to assert their equality in the laboratory and in the factory—as well as in the home, the office, and the shop.

One of the staunchest advocates of "woman's exciting potential in tomorrow's world" is the French author Simone de Beauvoir. Her book, "The Second Sex," opposes women being treated like a racial minority. She says that women should associate with men on equal levels, intellectually and professionally.

A professional counterpart of Madame de Beauvoir in the United States is Miss Aileen Cavanagh, national president of the Society of Women Engineers. Miss Cavanagh works for Bell Telephone Laboratories on a project concerned with measuring line-of-sight propagation characteristics of microwave energy involving airborne transmitter and receiver.

Miss Cavanagh, as articulate as she is attractive, answered our questions:

Exemplary women scientists and engineers must surely include Elizabeth Zimmerman, research specialist at Philco's Advanced Technology Center in Blue Bell, Pa. Her work has contributed to hf germanium devices, negative resistance diodes, parametric amplifiers and active elements used in microelectronic circuits.

By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

There are nearly 400,000 women in 6,100 U.S. electronic plants, ranging from assemblers to technicians. One of these is Elizabeth Kisselberg, at Western Electric's Oklahoma City plant, standing surrounded by crossbar switches. She averages up to 24,000 perfect solder connections a day.

Aileen Cavanagh, Bell Telephone engineer and president of Society of Women Engineers: "Women engineers work with men engineers the same way that men work with men. It's not a matter of sex, but a matter of engineering. It's not a male or female problem. It's a people problem."

While some women help to research, design and production-plan new products, others are busy putting current products together. In some plants, especially in tubes and semiconductors, women represent more than 50% of total personnel.

Q. How do women engineers work with men engineers?

A. The same way that men engineers work with men engineers. It's not a matter of sex, but a matter of engineering. It's not a male problem or a female problem. It's a people problem.

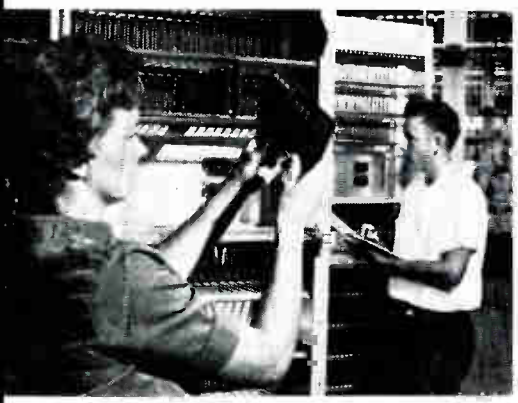
Q. Are there any particular people problems?

A. Some younger engineers have to learn they really don't quite know it all, after all. And, women engineers often need to learn how to handle themselves in a mixed group.

Q. Why do little girls want to become women engineers?

A. Nobody ever told me that engineering wasn't work for little girls. I majored in physics (A.B. Degree, 1951, Boston University, College of Liberal Arts). I looked at the opportunities, and turned to electronics.

Q. Do we need more male engineers or more female engineers?



Most women in electronics are semi-skilled assemblers, machine operators, inspectors, and testers. Some are technicians. Marjorie Gaddy, technician at RCA's West Palm Beach computer center, examines a circuitry module for the firm's 301 line.

Dr. Beatrice A. Hicks and husband, consulting engineer Rodney D. Chipp. Dr. Hicks is President and Director of Engineering of Newark Controls Co. "The problem of so few women engineers goes back to the schools; girls and young women are not being encouraged to take advantage of science-engineering educational opportunities."

Janie Lomax is an engineer on random access communications projects at Martin Company's Orlando (Fla.) plant. She is co-author of a paper on system and propagation data analysis to be presented at the 1964 IEEE Convention in New York. Her MS in mathematics is from Auburn University, 1961; her BS is from Mississippi College.

WOMEN ENGINEERS (Continued)

A. We need more *good* engineers. We need more well trained engineers, given a broader education in basics. As women engineers, we're more sensitive and quickly aware of changes in industry. We feel that a good education, grounded in basics, should help insure future re-education of engineers, of either sex, to adapt to changing needs for engineers.

Q. Can electronic companies depend upon long service from women engineers?

A. A woman engineer may work for about 10 years, marry and raise her family for about another 10 years. Then she may look for work again. We feel she should be well-educated in electrical engineering principles and modern physics, so that she may be retrained to resume work if she wants to, or has to, return to industry.

Q. How many women engineers are married?

A. About half the members of SWE are married. Yet, the other half must continue working because they are unmarried, divorced or widowed. They have to keep on reminding the boss, "Look, we've got to work. We just have no sugar daddy!"

Q. Do women engineers tend to fall back upon marriage as a way of engineering?

A. At times, some may marry out of frustration because their full talents and intelligence may not be put to use on the job. Still others marry for love.

Q. The Russians say some 35% of their engineers are women. Do you believe that women engineers are appreciated more in Russia?

A. Not quite. Apparently, the millions of World War II casualties have caused the Russians to use women workers more extensively. Some engineers visiting Russia report that women engineers there tend to do more general and less critical work (such as in shoe factories). Male engineers get most advanced assignments. So there, too, apparently men have a head start over women. We shouldn't strive to duplicate the Russian percentage of women engineers, but should let our men and women enter engineering as they choose.

Q. What patterns of employment have you found in the U. S.?

A. There's some geographical discrimination against women engineers, mainly in New England where public utilities and engineering partnerships are more conservative. Industries in the rest of the East, Northwest and South are much more receptive to women engineers. So is the Midwest, though women engineers here often earn less than male colleagues. The Far West is most inviting to women engineers who enjoy good employment prospects among defense and aerospace companies.

Female Stronghold

A female stronghold is Hughes Aircraft Co., in California, which employs nearly 100 women in science and engineering. Florine Cain, inspired by an aircraft demonstration at a World War II Bond Rally, became an engineer and helped design the Lockheed X-7 ramjet test missile.

Other exemplary women engineers include Mrs. Helen Neumann who did design and evaluation work on the TM-76B Mace missile flight control system at Martin Marietta Corp. Mrs. Sima Miluschewa was one of five Tiros weather satellite design engineers at RCA Astro-Electronics Division. And, SWE's former national president is Patricia L. Brown, Information Services Supervisor at Texas Instruments, Semiconductor/Components Division.

In recent years women have been suggested to help swell the ranks of engineers. Consensus is that some 80,000 engineering graduates are needed yearly. Only about 37,000 are being graduated each year. However, fewer than 200 women enter the engineering profession annually. Among military men who recognize the need for greater numbers of engineers, including women, is Major General Leighton L. Davis, commander, U. S. Air Force Missile Test Center, Patrick Air Force Base, Florida.

"Academically, there is no valid reason why a woman cannot be as good an engineer as a man—if we men are willing to accept it," says Herbert W. Hartley, president, Northrop Institute of Technology, Inglewood, California. Practically, says Jack Leadbetter, president of Associated Aero Science Laboratories, "The average woman going in for engineering is better than the average man."

Search for Womanpower

To further locate the "latent womanpower now only in token use," the First International Conference of Women Engineers and Scientists will be held this June (1964) at the United Engineering Center in New York. Conference Director, Dr. Beatrice A. Hicks, is president and director of engineering, Newark Controls Co. She says the problem of so few women engineers goes back to the schools; girls and young women are not being encouraged to take advantage of science-engineering educational opportunities.

It's noteworthy that many men now think in terms of "women" whenever they consider computer programmers. However, a woman engineer confesses, "programming is a wonderful short-term starting job. But women engineers shouldn't be stuck with it. After a while it can become desperately boring work."

Of more than 900,000 employees in electronics companies in 1962, about 850,000 worked in manufacturing plants. More than 50,000 worked in research, educational and administrative jobs. Between 40% to 45% of workers in electronics plants are women, reports the Bureau of Labor Statistics. Many a production line is manned by wives, mothers, sisters and sweethearts. In some plants, especially those making tubes and semiconductors, women represent 50% or more of total employees. Most women are semi-skilled, chiefly as assemblers, machine operators or tenders, inspectors and testers, often working on mass-produced items.

Of about 83,000 R.C.A. employees, as of October 1963, women represented about 19,000 hourly and 9,000 salary employees. Of some 140,000 Western Electric employees in 1962, a little over 30% were women. At a typical WE electronics plant, such as the Kansas City Works (Missouri), more than 50% of employees are women. At the WE Allentown Works (Pennsylvania), slightly under 50% of employees are women.

Women Get Dull Line Jobs

Many personnel directors of electronics firms employ women to do precise, repetitive, often boring jobs. In one case, engineer Aileen Cavanagh said, "I had women doing fine bead-stringing for computer memory cores. Men just don't have much experience or interest stringing beads or doing embroidery." Women generally do light assembly work. Men mostly work on certain precision components, power tubes, and assembling large gear.

The Federal Government has been serving women's interests. Congress established The Women's Bureau in the Labor Department in June 1920 and voted the Equal Pay Act in June 1963. This law, which goes into effect June 11, 1964, seeks "to prohibit wage discrimination based on sex." The Labor Department will interpret this law and determine any violations. There may be certain qualifications to permit different pay systems for men and women in the same plant. This remains to be seen. *(Cont.)*

Dorothy P. Vogel (now Mrs. Morris) worked her way up to vice president of Colvin Laboratories, Inc. Graduate of Concordia College and Pace Institute, Mrs. Morris is now with Victory Engineering Corp. (thermistors and varistors). She is U. N. representative of the Society of Women Engineers.

WOMEN ENGINEERS (Concluded)

Yet, this law, seeking "simple justice for women," may discourage some personnel directors from hiring women because of marital, emotional, psychological, or physiological reasons. Says one administrator, "If I can choose between hiring a woman who may or may not stay on the job, I'd sooner hire a man for the same wage. Women leave to marry or raise families.

"Men must work till they're 65—and to support women who marry and raise families. However, we'll still hire women to do monotonous light assembly or inspection work which men can't do too well." The Equal Pay Act should not affect firms, such as Western Electric, which pay according to job classification—not according to sex of worker.

Despite claims that women can fall back on the "safety net of marriage," of 24 million women workers in March 1962: a) Some 13.5 million were living with their husbands; b) About 5 million were widowed, divorced or had husbands absent from home; c) Almost 5.5 million were single. Of these women, about 3.3 million were union members.

Women Staunch Union 'Men'

In the electronic industries some women are militant union members. The first woman labor organizer in the U. S. was a telephone operator, a member of The International Brotherhood of Electrical Workers. More recently, the United Electrical, Radio & Machine Workers of America Women's Committee represented women at eight Canadian General Electric plants. And the International Association of Machinists is acquiring an increasing number of women local and district lodge officers. Typical is Goldie Perkins, IAM Lodge 1626 president, who led the union's drive at Lockheed Electronics Co., Los Angeles.

One personnel director, a married man himself, observes, "Women can be feminine—and tough, too. If they're satisfied on the job, you can't beat 'em. But if they're dissatisfied, you can't hold 'em. They lay it on the line when it comes to pay raises. And they can get pretty worked up, go on strike and picket energetically."

Many thousands of workers in electronics plants are in administrative and other office jobs. These include purchasing, sales, personnel, advertising.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED
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The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila., Pa. 19139

While the Russians may hail Cosmonette Lt. Valentina V. Tereshkova as the first woman astronaut, U. S. industry cites many women leaders. Bureau of Census classified 1,021,000 women as managers, officials and proprietors in 1960—more than twice as many in this group as in 1940.

MAGNETIC TAPE SALES RISING

Current sales of magnetic tape have been estimated from $50 million to $60 million. Total sales of tape by 1965 may be around 125 to 135 million dollars.

Some Are Top Executives

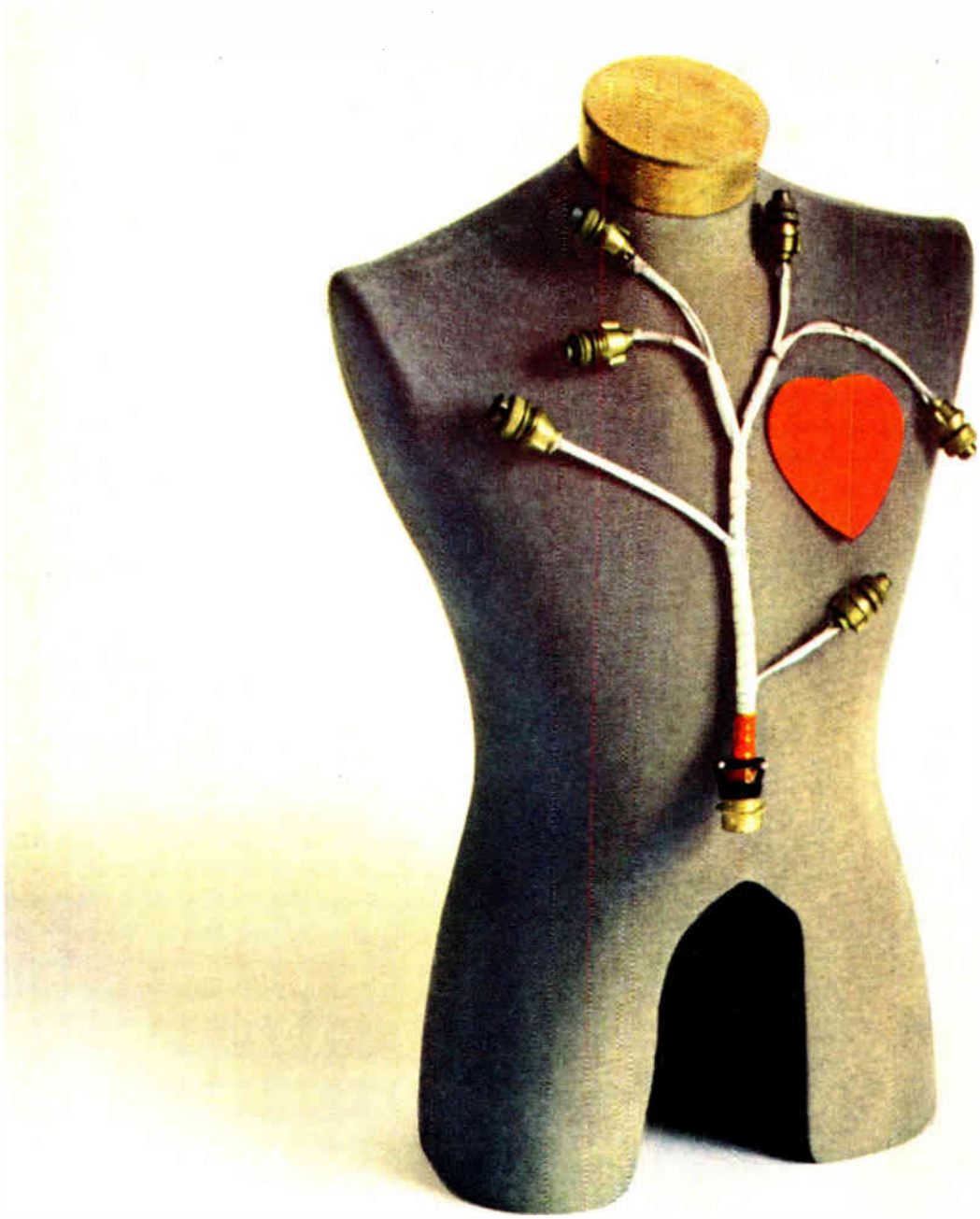
These include Mrs. Olive A. Beech, who heads Beech Aircraft Corp., an aircraft maker and aerospace subcontractor. She's also a member of Defense Secretary McNamara's Defense Committee on Women in the Services.

Miss Dorothy P. Vogel worked her way up from secretary to the president to vice president and general manager of Colvin Laboratories, Inc., an electronics-avionics firm. Mary Alice Reed managed finances at All States Distributing Co., an electronics distributor of Dallas, Texas. Future female business leaders now are training at the University of California's Los Angeles Extension executive development program exclusively for women.

Finally, a word about the wives. Certain larger electronic firms interview wives, as well as their engineer or executive husbands. These firms often may win their man by winning over his wife. Many a wife bears the brunt of resettling the family in another part of the country whenever her husband becomes a "white collar migrant worker."

Sometime ago, AC Spark Plug, the Electronics Div. of General Motors directed their advertising to "The Mrs. Behind the Missile."

PHOTOGRAPHY WITHOUT LENSES may be a coming thing. A new optical system that produces sharp, clear images without lenses has been demonstrated by University of Michigan researchers. Light sources are lasers or mercury arc lamps. The object is illuminated and the optical device shoots a smudgy, unintelligible negative. Light rays not only have intensity, they also have individual phase. Regular photo film is insensitive to light phase. A projector-like device shines a coherent beam through the blurred negative. Interaction between film and light causes light rays to group into patterns similar to those taken by the lensless camera. Original rays were divergent. New rays are convergent, they form an image on the screen or on the print paper.



Tailor-made nerve systems for sale

Your cable assembly may have to fit a 3-inch junction box, or stretch out 2,000 feet on a launch pad.

Maybe you're faced with linking 40,000 volts for 88,000 hours inside a radar system. Or how to keep a cable assembly intact despite high altitudes and contact with fuels and oils. We've already solved these problems at Amphenol. And more.

Like the complex interstage harness assemblies that are the backbone of Minuteman. Like shear-off disconnect assemblies on interceptor missiles. And cost-saving plug-in assemblies for communications systems.

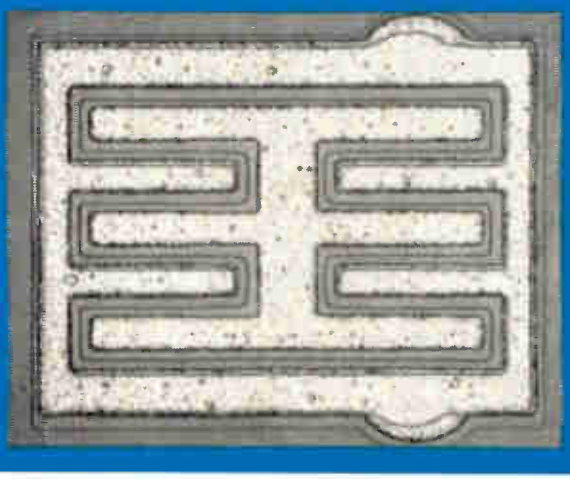
Almost all of today's cable assemblies are tailor-made, specially engineered, individually tested. What makes one different from another?

Your Amphenol Sales Engineer can show you with a 10-minute photo presentation that may be extremely useful if you have a cable assembly or other wired product requirement. Call your Amphenol Sales Engineer. Or, if you prefer, write directly to: Dick Hall, Vice President, Marketing, Amphenol, 1830 South 54th Avenue, Chicago 50, Illinois.

Amphenol®

A DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION

This is why . . . . . .



Sylvania's unique "double H" epitaxial structure is the key to the outstanding performance summarized here. This large-area, low-capacitance design is extremely efficient in current handling—hence the unusually flat beta, high even in the higher-current region. Leakage currents are very low, and speed is excellent, too. Tested in 2N1132B circuitry, the new Sylvania 2N3081 exhibits typical T_{on} of 10 ns, T_{off} of 15 ns, compared to 2N1132B maximum limits of 45 ns and 35 ns. Extremely tight manufacturing controls, plus far advanced epitaxial, planar and photolithographic techniques, are Sylvania strong points that make this design—and performance—possible.

2N3081, 2N1132 family and 2N1131 family available

The prime unit described is Sylvania's 2N3081, a vastly superior core driver. From Sylvania you can also obtain the 2N1132 and 2N1132A and 2N1132B, plus the 2N1131 and 2N1131A. We can also make special units with higher speeds or higher voltages. And you have a choice of packages: TO-51 co-planar, and TO-5 with collector connected to case.

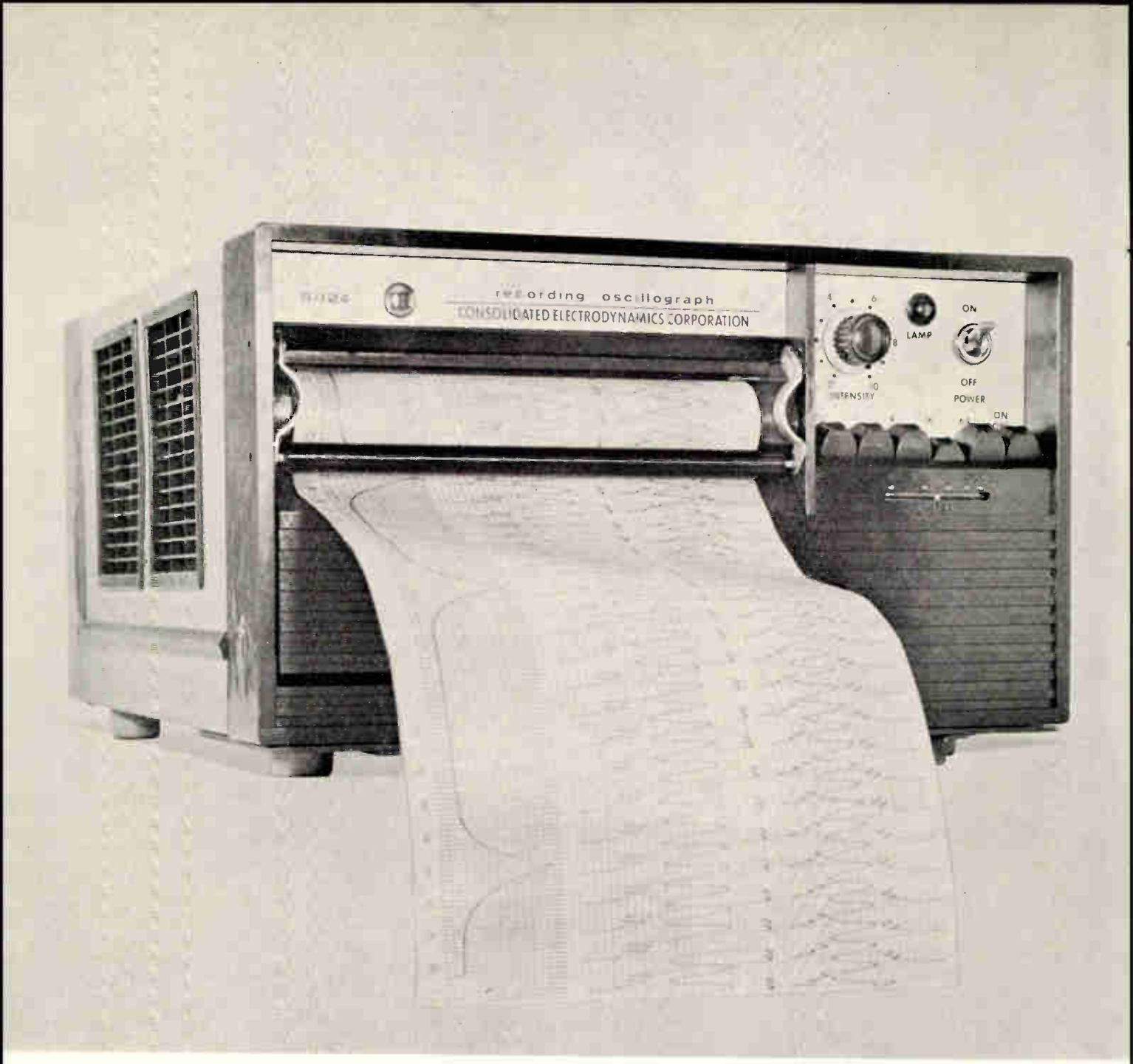
For complete information, see your Sylvania sales engineer or write to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.

SYLVANIA TO-51 CO-PLANAR PACKAGE

ACTUAL SIZE

* Reliable, Welded Closure
* Kovar-Hard Glass Matched Seal
* Only .060" High, .150" Dia.
* Various Lead Configurations

ALSO IN TO-5



Meet the lightweight champ with heavyweight capability

CEC's 5-124 DataGraph Portable Oscillograph

This mighty mite weighs in at only 40 lbs., stands a mere 7⅝" high — yet it can challenge a heavyweight in performance.

The 5-124 is a direct print portable oscillograph of exceptional versatility and reliability. It loads in just 10 seconds, records data from d-c to 8000 cps on 18 channels using standard CEC Series 7-300 Galvanometers. Produces 7"-wide records at speeds up to 50,000 ips by the fast print-out process. A grid line system and trace interruption are standard features. And it comes with five record speeds (¼,1,4,16,64) instantly selected via pushbutton transmission.

Simplicity of design makes the 5-124 virtually maintenance-free. No record magazine is required, eliminating spindle or paper threading. All four modules are readily exposed and accessible by removing the single cover piece.

Optional features for even greater versatility include: trace numbering; a full-record-width electronic flash timing system; heated galvo block; special slow and higher record speeds; a record take-up unit and slide rack mount.

Want more? You'll get it with the 5-124. For complete information, call CEC or write for Bulletin CEC 5124-X19.

CEC

Data Recorders Division

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Circle 42 on Inquiry Card

1952– **RCA introduced the 6146**

RCA DESIGNED:

- Small, sturdy structure
- High efficiency
- High power sensitivity

Early 1963– **RCA announced improved-design 6146A**

RCA ADDED:

- "Dark Heater"
- Controlled power output at reduced heater voltage
- Controlled zero-bias plate current

NOW– **RCA-6146B/8298A with even more improvements**

- Higher plate dissipation and plate current ratings
- Withstands heater overvoltage
- Higher temperature operation
- Higher power output

GET HIGHER POWER OUTPUT IN NEW EQUIPMENT DESIGNS

Now! Use and specify the RCA-6146B/8298A. This new RCA Beam Power Tube at once brings more power in new equipment designs and extended tube life in renewal use. In existing 6146, 6146A and 8298 sockets, RCA-6146B/8298A can give extended life while offering OEM designers increased power capability.

A direct result of RCA's power-tube research, the RCA-6146B/8298A permits higher plate dissipation (35 watts max. CW ICAS) for increased plate current. It also offers all the advantages of improved performance and mechanical stability that only RCA "Dark Heater" technology provides. At normal heater ratings, capabilities are: 85 watts CW output (ICAS) at 60 Mc; 50 watts CW output (ICAS) at 175 Mc.

GET EXTENDED LIFE WHEN REPLACING 6146, 6146A or 8298

In fixed station use, 6.3 volts is the recommended value for the tube's "Dark Heater." In mobile service, the tube operates efficiently over a range of heater voltages from 5 volts to 8 volts.

For further details on the RCA-6146B/8298A, consult your RCA Representative. For a technical bulletin, write: Commercial Engineering, Section B-50-Q, RCA Electronic Components and Devices, Harrison, N.J.

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RCA The Most Trusted Name in Electronics

New types of computer circuits, semiconductor lasers, and cryogenics are a few of the topics to be covered this year. Here is a brief summary of what you can expect at the Solid State Circuits Conference in Phila. on Feb. 19, 20 and 21.

Preview of . . .

1964 INTERNATIONAL SOLID-STATE CIRCUITS CONFERENCE

The formal opening and some of the daytime sessions will be held in the Irvine Auditorium, Univ. of Pennsylvania.

RECENT ADVANCES IN SOLID-STATE CIRCUITRY and applications will be covered in 50 papers—contributed, tutorial, and invited—by over 80 scientists, engineers, and educators at the 1964 International Solid-State Circuits Conference in Philadelphia.

In 38 contributed papers, speakers will cover system realization and interconnection; microwave circuits; device characterization and analysis; linear and digital integrated circuits; optical circuit techniques; transducers and display devices; and memories. Invited and tutorial reports will discuss all-magnetic digital circuits; circuit reliability; redundancy and adaptability; and circuit noise.

Contributed papers will be presented during nine daytime sessions. Two sessions will be devoted to tutorials, and one to invited.

All daytime meetings will be held in the Irvine Auditorium and the University Museum auditorium, both of which are located on the campus of the University of Pennsylvania.

Informal Sessions

Ten topical subject areas have been selected for informal evening discussions which will be held Wednesday and Thursday evenings, Feb. 19 and 20, at the Sheraton Hotel in central Philadelphia.

Over 50 panelists, chosen for the contributions they have made to their field, will participate in these discussions. Discussions will include microwave solid-state techniques, threshold detection circuits, radiation resistance and field-effect transistor applications. Also on the agenda will be integrated digital logic, adaptive and self-repairing circuits, minimum power devices and circuits, optical modulators and detectors, and multi-octave h-f power sources.

At these sessions everyone is encouraged to participate in the discussions.

Formal Opening

This year's keynote address will be delivered by H. B. G. Casimir, Director of Research, Philips Research Laboratories, Eindhoven, Netherlands. Prof. Casimir's topic, "Physical Phenomena and New Devices," will survey discoveries made during academic research that have not only led to new circuit and device developments, but stimulated further study in university, industry, and government laboratories.

Conference Digest

All registrants will receive—at no additional cost—a copy of the conference report book, which features condensations of every paper, including the keynote, tutorial, and invited talks. It is supplemented by over 300 diagrams and photographs.

Post-conference copies of the Digest will be available from the University of Pennsylvania at $5.00 per copy.

Sponsors

The conference is sponsored by the IEEE Professional Technical Group on Circuit Theory, the IEEE Electronic Circuits and Systems Committee, the IEEE Philadelphia Sections, and the University of Pennsylvania.

Technical Program

Speed, reliability, and microminiaturization reign supreme at this year's ISSCC. Highlighting the program will be papers on microwave, digital and integrated circuits, design applications, memories and lasers.

It is interesting to note the increased interest in cryogenics. In a paper by T. C. Kwei of IBM, a thin-film superconducting transformer used as an input device for cryogenic circuits will be described. Other papers will be given on computer memories using cryogenic devices.

Radiation is a problem that must be reckoned with. Failures encountered by space vehicles due to radiation affecting component parts have caused some far-sighted companies to produce radiation-proof components. "The Design of Radiation Resistant Semiconductor Circuits" by D. Landis discusses the effects of nuclear radiation on semiconductor devices. During this presentation, circuit-design examples will be compared with similar non-radiation-resistant circuits.

"Circuit Design for Radiation Resistance" will be the topic for a panel discussion that will be held at the Sheraton Hotel, Wednesday evening at 8:00 PM.

Microwave

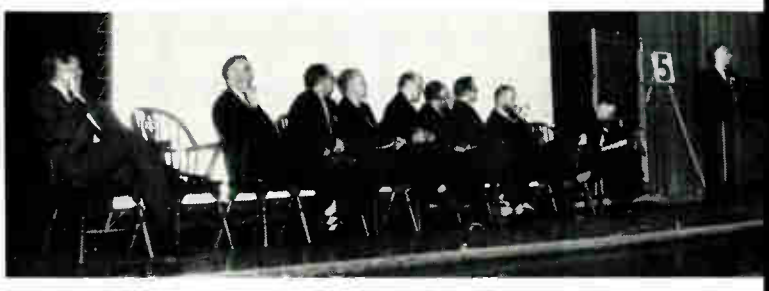
The varactor cartridge, considered as a transformation between the pn junction and the waveguide, will be the subject of a paper by J. G. McCallum of Northern Electric Co., Ltd. The cartridge is to be used as an essential tuning element, rather than a parasitic element.

"High-Power Solid-State Switching" by J. F. White of Microwave Assoc., Inc., will discuss the general theory and analysis of high-power microwave switching. In the paper, theoretical predictions will be compared with experimental results in a 50kw switch and a 1.5mw duplexer.

Magnetic Circuits

Among the relatively new approaches to digital-circuit design are all-magnetic circuits. There is a general feeling that magnetics may replace semiconductors in certain computer applications.

Magnetic circuits may replace semiconductors in space-vehicle computers. A computer in space is subjected to radiation as high as 10^{21} NVT and temperatures up to 900°F. The problems of weight and size prohibit the use of conventional shielding needed for semiconductors. Magnetics are said to offer 100,000 times more resistance to radiation and 1000 times the life expectancy of semiconductors. There is also a 10 to 1 reduction in the number of components needed to build a system. Magnetic circuits would require far less power than their semiconductor counterparts.



At the formal opening, plaques for last year's outstanding papers will be given.

This year, two tutorial papers will be given on all-magnetic digital circuits. The first, "All-Magnetic Digital-Circuit Fundamentals," will be given by E. E. Newhall of Bell Telephone Laboratories. In this paper several basic circuits will be described. Among the topics discussed will be energy gain, flux gain, MMF gain, and energy and conversion efficiency.

The second paper deals with circuit application problems. In this paper, jointly given by T. Baker

and C. Dillon of Sylvania, primary design problems and solutions will be discussed.

Microelectronic Circuits

Microelectronics and integral circuits and packages continue to make lengthy strides. Currently available are thin-film hybrid, integrated, and micromodule circuits, plus discrete components and molecular electronics applied to these circuits.

For integrated circuits, some manufacturers have found it more practical to use a greater number of active components since they require less area in a functional block. Thus integrated circuits may be designed using more active components and less passive ones to achieve a given result.

An example of how a passive element can be replaced will be given in a paper entitled, "An Integrated Charge-Control J-K Flip-Flop." This paper will show how a charge stored in transistors may replace capacitors or other storage elements used in an integrated-circuit binary.

A few of the problems encountered in high-speed emitter-coupled logic are tight component tolerances and inherent parasitic oscillations. In "Integration of Nanosecond Emitter-Coupled Logic," T. E. Gilligan and D. E. Roop of Burroughs will discuss how simple design considerations result in loose component tolerances, and how proper packaging and circuit designs can control inherent parasitic oscillations.

Integrated circuits are not restricted to digital uses. This year four papers will be presented on linear applications for integrated circuits. A paper of considerable interest is "An Integrated Analog Switch." This paper describes how a field-effect transistor, serving as the basic switching element, has been integrated along with associated driving circuitry to form a monolithic multiplex switch. This is of interest because relays have been used in the past to perform this function. Using transistors for analog switches produces a circuit with low offset voltages, high linearity, and switching times below 1μsec.

Lasers

Using lasers to transmit information is still in the elementary stages. This is attributed partly to the problem of modulation.

Modulation, which governs the laser's information-carrying capacity, needs intensive development before the laser's full potential as a communications medium can be achieved. One of the most promising means of modulating data is by use of the semiconductor laser. This laser has shown a capability for short-range data transmission. The development of the semiconductor laser, however, is hampered by a shortage of materials that will lase continuously, thus allowing easy modulation.

Junction lasers differ in many ways. A paper entitled, "A Review of PN Junction Lasers" will discuss properties such as efficiency, wavelength range and tunability, linewidth, mode stabilization and power output.

Reliability

Reliability, both in systems and components, cannot be overstressed. The demands of government and industry for systems that remain on the air with a minimum of down time have become more stringent. In order to prove reliability, most manufacturers are subjecting their components to exhaustive life tests. In order to improve systems reliability, redundant circuits are built into equipment.

Component reliability is stressed in "Reliable Sys-

(*Continued on page* 61)

At the informal session, the audience is invited to participate in the discussion.

Irvine Auditorium is located at 34th and Spruce Streets.

Cramped Like The Fisherman's Genie?

get more design freedom with <u>new</u> Benelex 100A

You'll recall how the fisherman in the Arabian Nights unsealed a bottle, allowing an emerging genie to expand mightily. Benelex 100A—the new electrical laminate—does the same for design ideas. That's because Benelex 100A offers a *combination* of useful qualities suitable for an almost unlimited range of electrical applications. High in dielectric strength, this versatile Masonite cellulose and lignin laminate has the hardness, density and durability to stand up under a wide variety of environmental conditions, yet cuts and shapes like wood. Complete technical information all yours for the asking.

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(*Continued from page 58*)

tems for Reliable Components" by D. S. Peck of Bell Telephone Laboratories. This paper points out that even in the most flexible systems, reliability is eventually limited by the components used. Evidence will be presented which shows that components can be made sufficiently reliable to meet systems needs without added circuit complexity.

"Use of Circuit Redundancy to Increase System Reliability" by J. J. Suran of GE will review the reasons, as well as the proposed techniques, for applying circuit redundancy to increase systems reliability. The impact of integrated electronics on the use of circuit redundancy will be considered.

Noise

The extreme sensitivity of modern devices requires meaningful evaluation and comparison of noise performance. In a paper entitled, "Noise Factors and Fallacies," simple and concise up-to-date methods of evaluation through proper application of noise temperature will be given.

In another paper, "Noise—The More You Pay the Less You Get," the advances in low-noise techniques, which have reduced receiver noise to almost negligible values, will be discussed.

Memories

In the quest for faster memories with reduced physical size, many computer manufacturers are turning to cryogenics and thin films.

Electrical resistance in certain materials drops to zero below characteristic critical temperatures near O°K. The materials are said to be superconducting below these temperatures. By appropriately inducing and suppressing supercurrents in elements of these materials, magnetic flux may be trapped locally, and binary storage devices thereby devised. This is the cryotron—a superconductor. The cryotron is nothing new in electronics. The uses for this superconducting device were pretty well limited because of the helium liquefier refrigeration units need to maintain the low operating temperature. These refrigeration units are ceasing to be a problem. The cryogenic memory offers a highly desirable, fundamentally different but previously unfeasible method of content addressing.

"A Cryotron Multi-Level Logic and Memory Circuit" will be discussed in a paper given by M. L. Cohen, et al. This paper will report on a cryotron oscillator circuit and counter which drives an address tree of an 8-word, non-destructive memory.

● **A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department**

SOLID-STATE CONFERENCE (Concluded)

E. O. Johnson of RCA is this year's Conference Chairman.

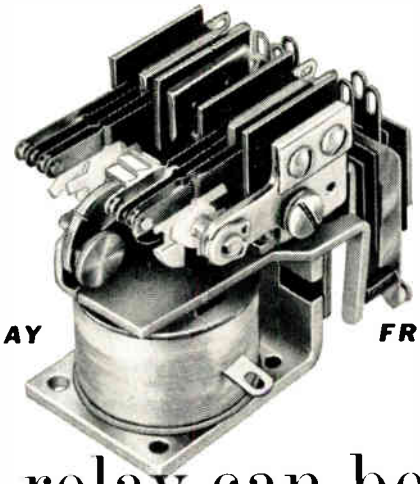
P. B. Myers of Martin Marietta is the program chairman.

Another paper dealing with cryogenics will be given by R. A. Gange of RCA. "The Rytron—a New Cryogenic Device" describes the rytron, which is an electronically variable inductor that can be used in digital applications or parametric amplifiers. The principle of operation, effect of parameters on inductive change, experimental results, and possible logic functions will be described.

Thin magnetic films offer another solution to the high-speed, small-size memory problem. One of the greatest obstacles to thin-film memory development —adequate control of fabrication parameters, particularly in large-bit plane capacities—seems to have been resolved.

In thin-film memories, the film elements, which are deposited on glass substrates, are switched between binary states by domain rotation, as opposed to the domain wall motion mechanism of magnetic cores. With film memories, driving and sensing circuitry and all interlayer insulation can be made by additional depositions, thus making memory geometry very simple.

A paper by A. M. Bates and F. P. D'Ambra of Burroughs will describe a thin-film memory with a 167-nsec. read/write cycle. The matrix-driver and sense-amplifier circuit design for a 6MC, 128-word, 48-bit, linear-select, random-access memory will be given.



A REMARKABLE NEW RELAY **FROM POTTER & BRUMFIELD**

Versatile P&B relay can be made to step, count, sequence, home, switch, read-out

...all with singular reliability

INHERENT RELIABILITY DUE TO RELAY'S INDIRECT ACTION

The GM is a reliable, low cost, impulse/sequencing relay providing a choice of switching elements which make it practical for an extremely wide range of applications.

Contact action, except in the case of auxiliary contacts, takes place during the *drop-out* of the armature. The motive power is the armature's return spring, a constant force providing smooth, dependable results.

As drop-out occurs, a pawl engages a 10 or 12-step ratchet, advancing it one position. This action turns a shaft which results in contacts being opened or closed and/or results in advancing the movable contact arm of a printed circuit board switch.

PRINTED CIRCUIT BOARD CAN BE USED FOR 10 OR 12-STEP SWITCHING

A uni-directional printed circuit board with either 10 or 12 stations can be attached to the basic GM structure. Contacts are rated to 250 milliamps. The movable arm advances one position each time the armature *drops out*.

A pulse of only 20 milliseconds will effect switching.

If sufficient coil power is available, two sets of regular contact arms and two sets of auxiliary contacts may be used in conjunction with the printed circuit board.

Regular cam-activated contacts as well as auxiliary contacts are rated to 3 amperes, 115 volts ac, 60 cycles non-inductive. GM coils may be either ac or dc powered.

LET US HELP YOU WITH YOUR SEQUENCE SWITCHING PROBLEMS

Almost daily we discover new design possibilities with the GM Series. Perhaps this relay will prove to be a reliable, inexpensive solution to your switching problems. Please call us, or get in touch with the P&B representative in your area.

ENGINEERING DATA

GENERAL:

Description: Impulse/sequencing relays. GM=2 Form C contacts. GM with auxiliary contacts=4 Form C contacts.

Expected Life: 500,000 mechanical operations.

Breakdown Voltage: 1000 volts rms between all elements and ground.

Temperature Range: AC: −45°C to +45°C (intermittent duty only). DC: −45°C to +75°C.

Operate: AC: 78% or less of nominal voltage @ +25°C. DC: 75% or less of nominal voltage @ +25°C.

CONTACTS:

Arrangements: GM: Two Form C (ratchet operated). GM with auxiliary contacts: Two Form C (auxiliary), and two Form C (ratchet operated). Special: Modification of GM with 10 or 12-position unidirectional printed circuit stepping switch.

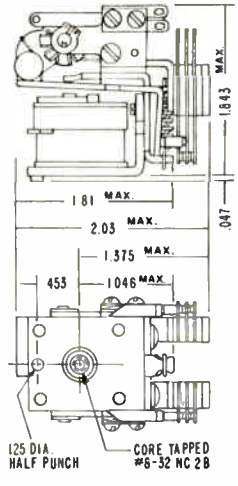
Ratings: GM: to 3 amps 115 volts AC 60 cycle (non-inductive). GM with auxiliary contacts: to 3 amps 115 volts AC 60 cycle (non-inductive). GM with 10 or 12-position printed circuit stepping switch: 250 MA.

COILS:

Voltage: AC: to 230 volts, 60 cps. DC: to 110 volts.

Power: AC: 9 voltamps maximum. DC: 2.5 watts minimum, 4 watts maximum.

Duty: AC: 50% coil duty cycle—5 minutes maximum on, 5 minutes minimum off. DC: Continuous @ 4 watts at 25°C.



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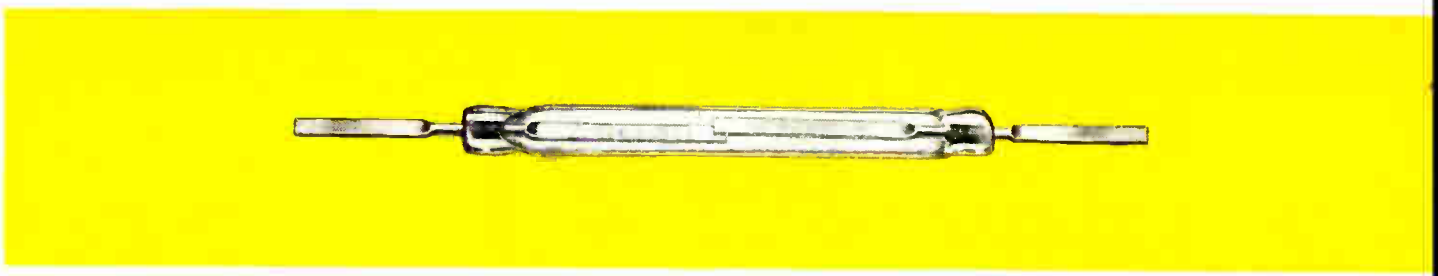


THIS is a Reed Switch! Simple in design...easy, economical to use...and a

highly reliable component, *IF* the quality is right. CLAREED® by Clare has this quality built-in.

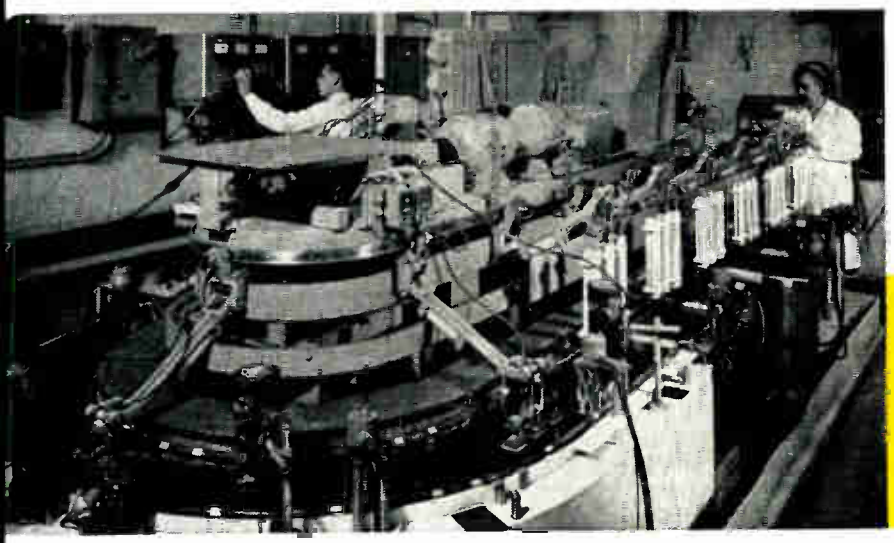
WHY SO? Because Clare cares about continuous quality-controlled manufacturing methods...precision parts and assembly ...and accurate testing of every switch. We know that *every* reed switch has to be *just right*...to be sure that CLAREED relays and control modules measure up to the consistent-performance standards you expect for your control job.

To see what we mean, look at our manufacturing story. Actually, you *can't afford* to overlook it. You'll see why CLAREED relays and control modules are the standard of reed relay reliability.

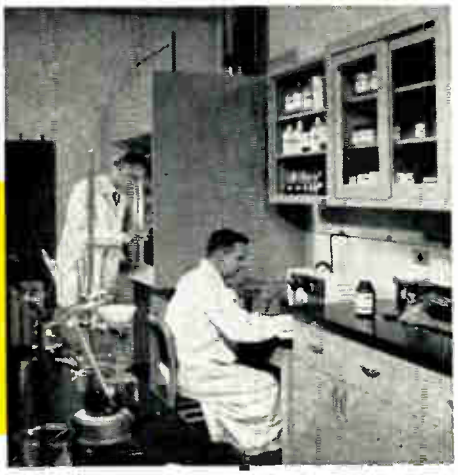
BUT, a good switch is only *half* the story! It takes proven packaging techniques and application know-how to do the right job for you. Clare has the engineering experience to meet all your requirements.

It's easy for you to include Clare reliability in your product or system...specify CLAREED relays and control modules next time...and every time.

Got a question? Need technical data? Ask us! C. P. Clare & Co., Group 2D9, 3101 Pratt Boulevard, Chicago, Illinois 60645.



EXACTING, controlled mass production begins with nickel-iron reeds of carefully-determined metallurgical characteristics. Blades are pre-straightened. Contact areas are flattened to assure precise mating in the "closed" position, then gold-plated (above) for consistent contact resistance.



CONTINUOUS in-process quality control procedures assure careful adherence to standards...resulting in long switch life.

CLEAN parts assure CLAREED cleanliness. Ultra-sonic cleaning removes all contaminants from contact surface.

PRECISION, automatic, clean-room assembly provides consistent, same-characteristic CLAREED switches...every time.

STANDARD quality control subjects switches to statistical physical tests and 100% electrical checks... including hermetic seal checkout, micro-visual inspection and ten automatic electrical tests.

AND *this means you get* *built-in reliability* *when you specify* *CLAREED relays or control modules.*

CLARE®

relays and control components

Say "silicon high voltage single-junction diffused power rectifiers" fast ten times.

(or just say Bendix once.)

Most of your power rectifier requirements can be filled with Bendix® rectifiers. 17 MIL Spec. types and 70 commercial types are available in the JEDEC DO-4 and DO-13 packages.

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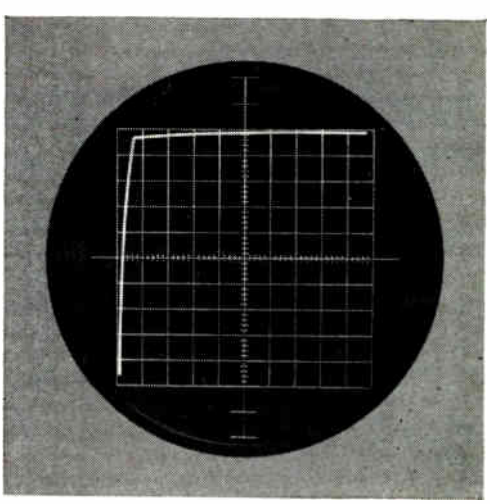
1N3924-1N3927	1000-2500	10
1N3929-1N3932	1000-2500	1
1N2240, 1N2240A	800	5
1N2242, 1N2242A	1000	5
1N2260, 1N2260A	800	10
1N2262, 1N2262A	1000	10
1N3649-1N3650	800-1000	3
1N1124-1N1128	200-600	3
1N1124A, 26A, 28A*	200-600	1
1N1199-1N1206**	50-600	12
1N1341-1N1348	50-600	6
1N1581-1N1587	50-600	3
1N1612-1N1616†	50-600	5
1N1614R-1N1616R††	50-600	5
1N2491-1N2497	50-600	6
1N1130-1N1131	1500	0.3

*Available to MIL-S-19500/104B(Navy)
**Available to MIL-E-1/1108(USAF)
†1N1614,15,16 available to MIL-S-19500/162A(EL)
††Available to MIL-S-19500/162A(EL)

Peak reverse voltage ratings go up to 2500 V and current ratings up to 12 amps. The forward drop is extremely low for greater efficiency because of the single-junction. Nevertheless, the rectifiers exhibit high PRVs with sharp avalanche. Even better, not one unit leaves our plant unless it passes a dynamic sweep test so you can count on reliable operation in your power supply, magnetic amplifier or DC blocking circuit.



For more data on Bendix rectifiers contact your nearest Bendix sales office.

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WHAT'S NEW

". . . the changing STATE-OF-THE-ART in the Electronic Industries"

SEMICONDUCTOR NETWORKS

SERIES 53 IS A HIGH-SPEED CATALOG LINE of digital Solid-Circuits® semiconductor networks. It includes 6 integrated-circuit types: a J-K flip-flop, single- and multiple-logic gates, and clock-driver or buffer. Some of the operating characteristics for these units include:

CIRCUIT	N sec. Propagation Delay (tp)	Fanout	Milliwatt Dissipation (at 3v)
J-K FF (SN 530)	45	10	27
NAND or NOR Gate (SN 531)	25	Term. G 10 Term. Y 4	10
AND or OR Gate (SN 532)	5	5	14
NAND or NOR Gate (SN 533)	25	10	10
AND or OR Gate (SN 534)	5	5	14
Clock Driver/Buffer (SN 535)	25	40 (10/gate)	9

All units operate at −55°C to +125°C.

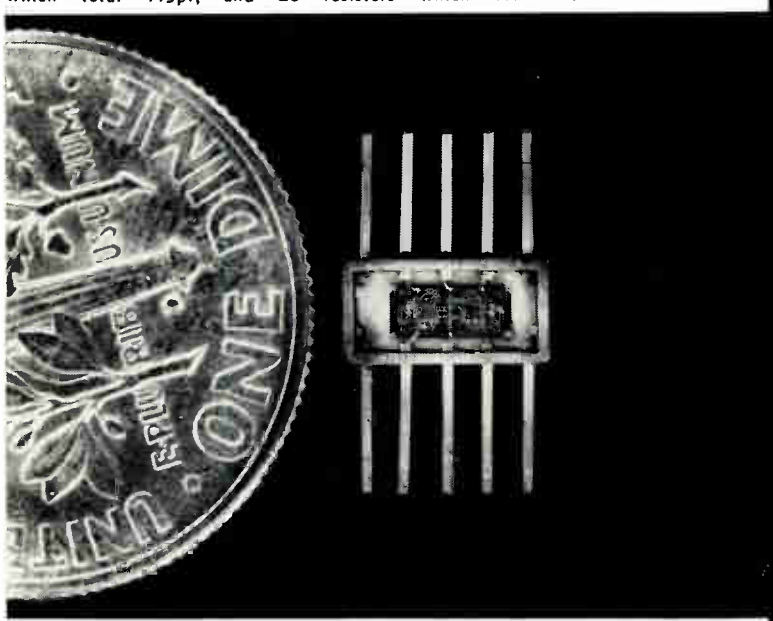
The SN 530 features J-K design, which defines all logic states and does not have an indeterminate condition when "1" is applied to both inputs. The flip-flop can be used as a single-phase shift register or as a counter without additional components.

The AND/OR gate is the basic unit of the series. Operation is similar to diode logic, but input diodes are replaced with pnp transistors and output diodes are replaced with npn transistors. This produces a higher dc input impedance and lower dc output impedance, making fanout possible from a non-inverting AND/OR gate.

The NAND gate has a fan-in of 5 that may be increased to 20 by supplementing with AND gates.

The SN 535 drives 40 logic loads or 16 clock-pulse loads. Using dual-gates and inverters, with a complete J-K FF/shift register, it can often reduce the units needed in a system. Texas Instruments Incorporated, P.O. Box 5012, Dallas, Tex.

The series uses the master-slice technique. A 65 x 150-mil bar contains 28 npn and 10 pnp transistors, 5 capacitors which total 115pf, and 26 resistors which total 70KΩ.



THYRATRON REPLACEMENT

A NEW SOLID-STATE UNIT has been developed to replace certain thyratrons. The assemblies, which replace the 2D21, 2050, and 6011, can be plugged directly into the thyratron sockets.

According to its manufacturer, General Electric Co., Auburn, N. Y., reliability is its most important feature. When properly fabricated and used, the units will not wear out. The unit achieves a more efficient and cooler operation with its lower voltage drop. It has no filament; hence it requires no time delay before anode voltage is applied, and reduces heat load. (*More What's New on Page 67*)

Solid-state units are replacements for gaseous thyratrons. They are less sensitive to vibration than conventional units.

NEW! CLARE Type JDP Relay

Outstanding plug-in relay capabilities at cost well below comparable assemblies!

The CLARE Type JDP Relay assembly provides for direct plug-in mounting of the CLARE Type J Relay with the contact springs and coil terminals serving as plug pins. This complete assembly of relay, mounting socket and clear plastic dust cover is available at much lower cost than comparable relay assemblies. Part numbers and prices include complete assembly at one low price.

And that's not all. The Clare JDP Relay assembly provides a simple, economical plug-in relay with all the advantages of the stable operation and adjustment, the consistent performance and the optimum reliability which have made the CLARE Type J Relay so widely accepted as the ideal component for critical control applications.

Direct plug-in mounting eliminates costly internal wiring, and makes possible cost savings with no sacrifice of Type J Relay quality. There is space-saving, too. Overall height of the JDP assembly when mounted is 20% less than the height of relays with the conventional octal plug.

Type JDP assemblies are available in two sizes. A 28-pin assembly for 24 contact springs and four coil terminals, and a 16-pin assembly for 12 contact springs and four coil terminals. Relay terminals are slotted so relays intended for JDP assembly can also be wired directly into chassis.

All standard Type J Relay features are available in the Type JDP assembly. These include: contact forms A, B, C, D, and E; contacts for low level to 5 ampere switching; double-wound coils; slow operate; slow release; and a-c coil operation.

ELECTRICAL AND MECHANICAL CHARACTERISTICS OF CLARE TYPE J RELAYS

Contact Arrangements	Contact Ratings	Coil Resistance	Nominal Operating Voltages	Operate Time	Release Time
Forms A, B, C, D, E, up to 24 contact springs max	Low level to 5 amps, 500 watts	Up to 21,000 ohms	Up to 300 vdc Up to 220 vac, 50-60 cps	Fast operate: 5 ms mir Delayed operate: 60 ms max	Fast release: 5 ms min Delayed release: 125 ms max

GET COMPLETE INFORMATION including prices, detailed specifications, and standard part numbers. Circle Reader Service Number below, or write C. P. Clare & Co., Group 2D5, 3101 Pratt Blvd., Chicago, Illinois 60645

CLARE® *Relays and related control components*

WHAT'S NEW

REMOTE DATA SYSTEM

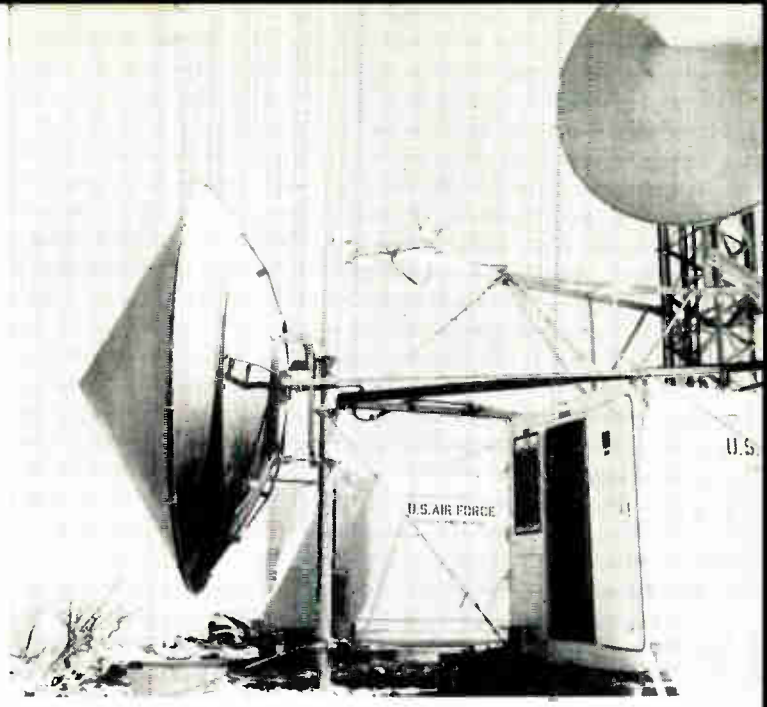
THE RANGE INSTRUMENTATION CAPABILITIES of the Air Force Flight Test Center and the NASA Flight Research Center at Edwards AFB have been extended by a remote data-acquisition and transmission system designed and implemented by Motorola Inc.

The system allows several control centers at Edwards to receive, record, and display flight-test data from test vehicles as they proceed over the flight range. The system also allows continuous two-way UHF communication between Edwards and the flight craft.

Two types of transportable units form the basis of the system. The first is a data-acquisition unit (DAU), which is carried in a helicopter drop-shelter. The unit consists of four telemetry receivers, four UHF communications transceivers, intercoms, and provisions for digitized radar inputs. It also has subcarrier equipment to modulate the data onto the microwave carrier, two-way microwave receivers and transmitters, and control equipment for remote operation and monitoring.

The second unit is a microwave-relay unit (MRU), which is a repeater or relay between DAUs. The unit contains the two-way frequency-diversity microwave receivers, transmitters, and remote-control equipment. The unit is constructed in three sections, any one of which can be transported in a ½ ton truck.

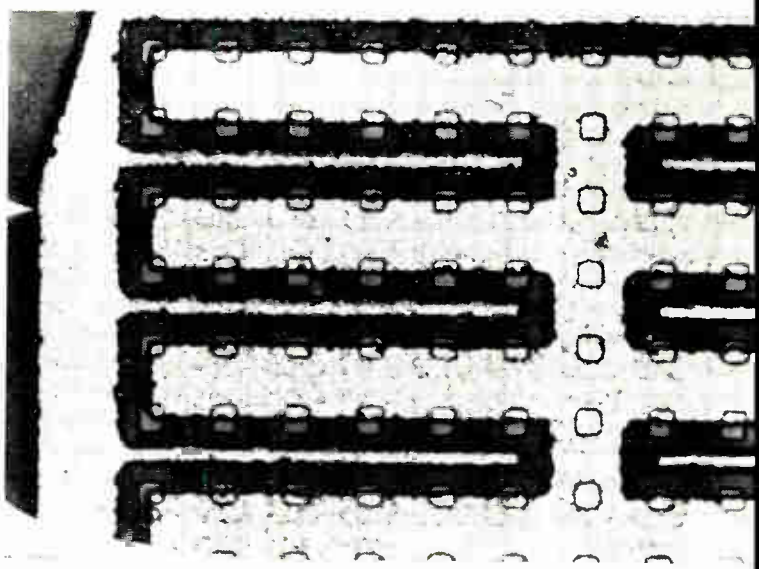
The Microwave-Relay Units (MRU) are used as a repeaters or relays between DAUs. The units may be easily carried on a truck.



Walk-in Craig huts house the Data Acquisition Units (DAU). Each site is equipped with 6- to 10-ft. parabola antennas.

UHF TRANSISTOR

THE TYPE TA-2307 "OVERLAY" UHF TRANSISTOR produces 5w. 500MC with a 7db gain. The heart of this unique transistor is a tiny checkerboard structure, far smaller than the head of a pin. It consists of a mosaic made up of 156 individual microscopic h-f transistors. These units are integrated through use of a new overlay structure and applied on a silicon wafer.



Reducing the emitter-capacitance improves the freq. response.

Applications of the transistor are expected in military and satellite transmitters, lightweight radar, and microwave relay equipment for TV and telephone communications. It was developed under the technical direction of the Army Electronics R&D Laboratories and RCA Electronic Components and Devices Division.

The past, present and future of lasers are discussed here by the scientist who developed the first laser in 1960. Dr. Maiman discusses the various types of lasers, their properties, problems, and present and future uses. He also comments on the likely and unlikely predictions which have been made for lasers.

THE LASER FIELD . . . WHERE WE STAND TODAY.

By Dr. THEODORE H. MAIMAN

President,
Korad Corporation,
A Subsidiary of Union Carbide Corp.
2520 Colorado Ave.
Santa Monica, Calif.

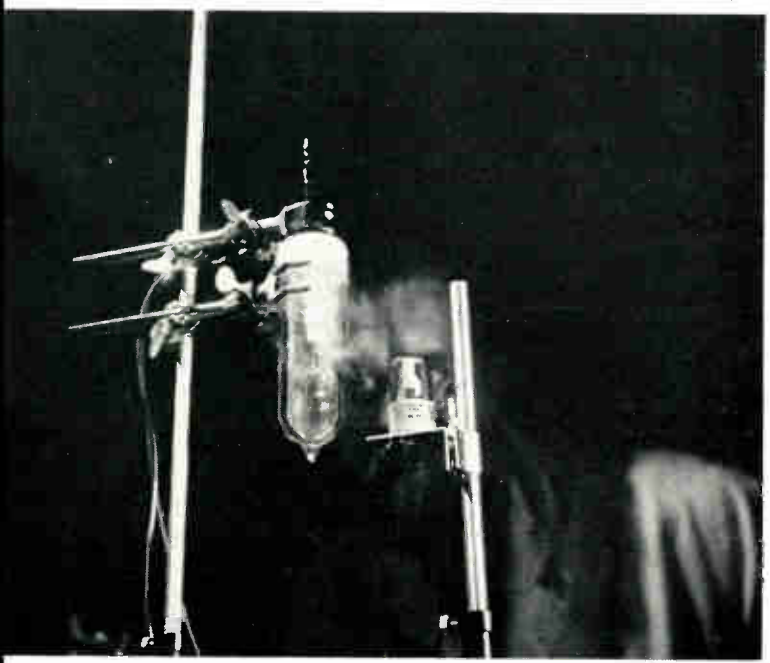
ANNOUNCEMENT OF THE FIRST LASER, 3½ years ago, evoked a rash of predictions as to its potential uses. Like many previous developments, the Laser was more the outcome of scientific curiosity and theory than of practical need. It represented, to a large extent, "a solution seeking a problem," and countless problems were volunteered for its alleged curative powers.

Since then, many "potentialities" have been shown to be less practicable than they seemed at first, while some other, more feasible possibilities have arisen to take their place. Lasers, their past, present and future are discussed in this "must" article.

More than a dozen uses have been found for which Lasers are now known to have—or at least appear to have—distinct advantages over existing devices or methods. These uses now represent the Lasers' greatest potential for near-term realization.

Even so, the Laser remains—although to a much lesser extent—a solution seeking a problem, and

Fig. 1: Engineer tests new semiconductor laser immersed in dewar filled with liquid nitrogen, which is needed for cooling. Photo diode at right measures the laser's light output.



R&D is thus continuing at a rapid pace. Today more than 500 companies, universities and government agencies are actively advancing Laser technology, seeking and testing new uses and searching for new Laser materials. In the aggregate, they are spending an estimated $30 million annually on these efforts.

Among the well-known organizations in the field are Westinghouse, RCA, Raytheon, Perkin-Elmer, MIT's Lincoln Labs., Lear-Siegler, IBM, Hughes Aircraft, G.E., Bell Laboratories and American Optical. This is a field, however, in which small companies can successfully challenge the giants, and major contributions have been made by a number of these lesser known firms—among them, Technical Research Group, Spectra-Physics, Radiation-Stanford, Maser Optics and Korad.

The manufacture and sale of Laser equipment has been expanding rapidly during the past year or more, and several companies now have Lasers available "off the shelf." For the present, most sales are limited to private, educational or government labs., but a few Lasers have recently been sold to industry for experimentation in commercial use. Current prices range from about $500 to around $45,000.

Laser Categories

The Laser field embraces three broad categories: Optically Pumped Solid (and liquid) Lasers, Discharge Excited Gas Lasers and Electron Injection (Semiconductor) Lasers.

There are, to date, some 15 optically pumped solid Laser materials. But, only 4 of these are considered the most useful, from a practical point of

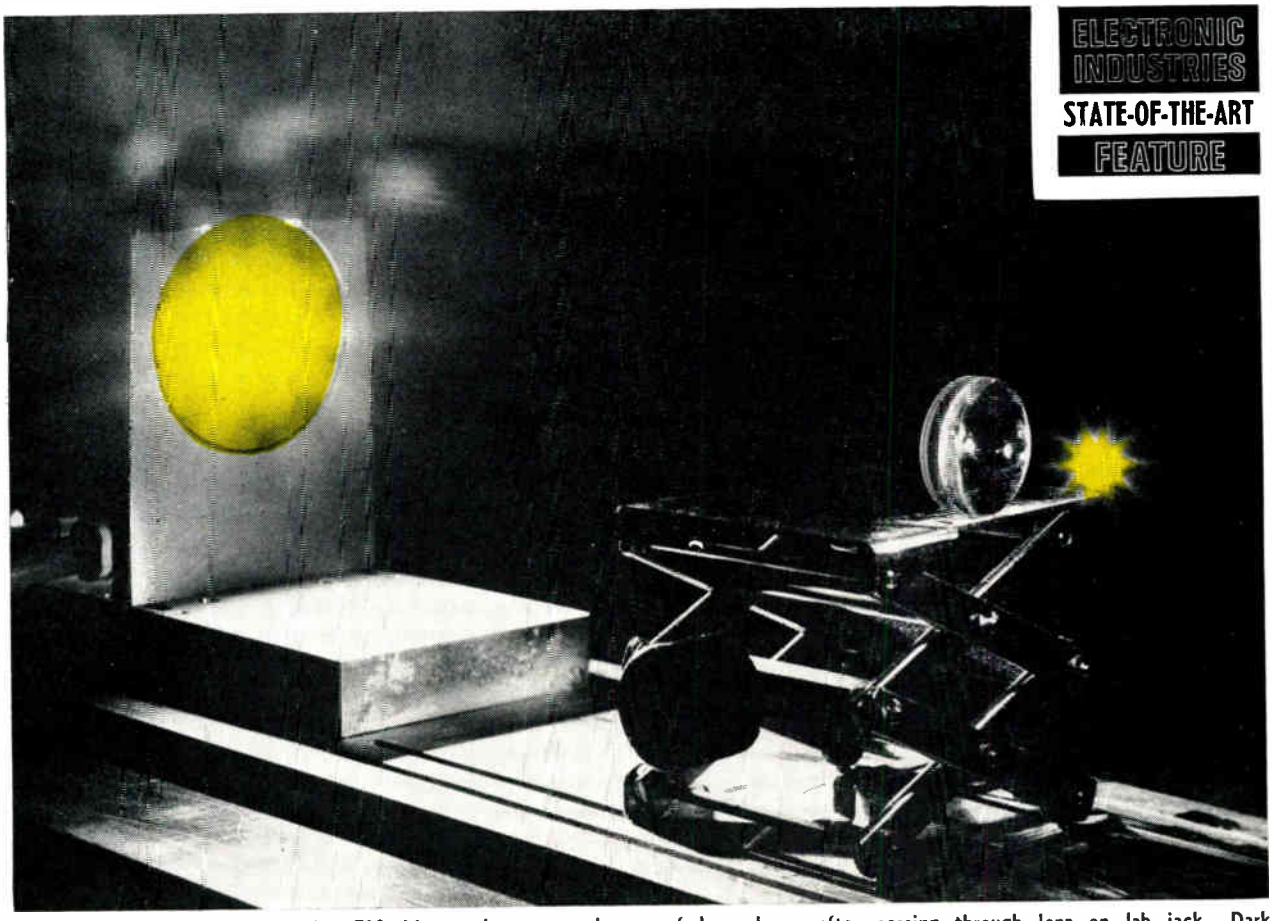


Fig. 2: Korad ruby laser attains 500 Mw peak-power pulse using oscillator-amplifier configuration. Puff of light at right is ionization of air caused by intense concentration of laser beam after passing through lens on lab jack. Dark box from which beam emanates is amplifier unit. The K-1Q laser head itself is in a box behind the amplifier unit.

view: ruby, neodymium-doped glass, neodymium-doped calcium tungstate and dysprosium-doped calcium fluoride.

Ruby — which emits in the deep red, 0.69 microns(μ)—needs a high excitation energy, is generally useful only for pulse applications and is highly durable. At present, some of its potential usefulness is limited by the fact that available material possesses only fair optical quality.

Neodymium-doped glass (1.06 μ) is the second most used solid Laser material, despite its fragility. It needs less excitation energy than ruby, but, like ruby, is primarily useful for pulse applications. Large pieces, with good optical quality, are readily available.

Both the neodymium-doped calcium tungstate (1.06 μ) and the dysprosium-doped calcium fluoride (2.36 μ) need sufficiently low excitation energies to be useful for CW applications. (A 100-watt light bulb, for instance, will pump the latter crystal.) Dysprosium-calcium fluoride, however, needs cryogenic cooling to liquid nitrogen temperatures or less. It is further limited by a valence instability of the dysprosium ion. Both crystals are somewhat fragile. Current optical quality of the neodymium-calcium tungstate is the poorest of all 4 materials. Presently available dysprosium-calcium fluoride crystals possess good optical quality, second only to neodymium-doped glass.

In Laser uses needing optical receivers, overall performance of the system is, of course, determined by the receiver sensitivity. Since photo-tubes generally are more sensitive to short wavelengths in the optical range than to long wavelengths, ruby offers the highest performance of these 4 materials in such uses. The best detector for its wavelength is about 50 times as sensitive as the best detector for the neodymium wavelength, and the discrepancy is even greater between ruby and the dysprosium-calcium fluoride Laser.

Ruby's clear-cut superiority in this area may, however, give way to a new, recently announced solid Laser material which radiates an even shorter wavelength (0.59 μ) than ruby: praseodymium-doped lanthanum trifluoride.

Highest reported Laser pulse energy is 2000 joules, which was obtained with neodymium-doped glass. Ruby ranks second, with 1500 joules. Highest reported peak pulse power is Korad's 500-megawatt giant-pulse ruby Laser. Average powers of the order

of 1 w. reportedly have been obtained from both neodymium-doped calcium tungstate and dysprosium-doped calcium fluoride.

Due to the short wavelength of Laser radiation, beam divergence in all Lasers is small—theoretically of the order of 10^{-4} radians. Gas Lasers, in fact, closely approach this value. Both the solid and the electron injection Lasers, however, exhibit beam angles as much as 2 orders of magnitude larger. This is due to the poor optical quality of Laser materials, aggravated by thermal problems.

All Lasers presently exhibit low efficiency. Least efficient is the gas Laser, which normally runs around 0.01%, e.g., 5 mw of output requires 50 w. of input. The solid Lasers average slightly less than 1% but have attained efficiencies as high as 4%. The electron injection Laser, on the other hand, already has shown efficiencies as high as 25%, and it is expected that this will be increased to 50%.

The gas Laser—announced about 6 mo. after ruby—produces the most coherent beam. As was noted before, its spatial coherence most closely approximates the theoretical divergence of 10^{-4} radians. It also measures up in terms of time coherence. For, whereas the spectral width of gas Lasers is measured in KC, the spectral width of solid Lasers is measured in MC and that of semiconductor Lasers, in GC. This characteristic qualifies gas Lasers for particular use in metrology and doppler radar.

Also, the gas Laser normally operates CW (though it can also be pulsed), and it is therefore good for communications uses.

Gas Lasers also find use in optical instrumentation. They have even been used to facilitate measurement of the optical quality of ruby crystals.

Fig. 3: Scientist uses a microscope and tweezers to aid in putting together a semiconductor (GaAs) laser. Below his right hand, on the block, are several completed GaAs lasers.

A number of gases have been found to lase. Collectively, they cover the widest wavelength span of any of the Laser categories — from 0.3 to 28 μ. Helium-neon is by far the most often used gas because it is, to date, the only gas capable of emitting visible Laser light and, therefore, is the most convenient.

The third category of Lasers—the electron injection, or semiconductor, Laser — was announced in Nov., 1962. As its name implies, it uses electrical current directly for excitation. As noted before, it is much more efficient than the other two types. It is also more compact. Semiconductor Lasers, in fact, normally measure less than 1 mm^3 and often are only barely visible to the naked eye. This Laser has the added advantage of being capable of direct modulation up to frequencies in the GC range.

Gallium arsenide (which operates at 0.84 μ) has been the primary Laser material in this category. Recently, however, Lincoln Labs lased indium arsenide, which emits at 3.1 μ, then lased alloys of indium arsenide and gallium arsenide to reach several intermediate wavelengths. Indium antimonide (5.2 μ) has even more recently been found to lase. The next step, it seems, would be to lase alloys of indium arsenide and indium antimonide, to achieve operation near the atmospheric window which peaks at about 4 μ.

So far, no other type of Laser provides this means—or any other means—of attaining specific frequencies by design.

Gallium arsenide Lasers normally are operated at liquid nitrogen temperatures, and are capable of being pulsed at high repetition rates (1,000 pps). Moreover, they can readily be converted to CW operation by using liquid hydrogen cooling.

The tiny size of the semiconductor Lasers, their ease of modulation and their high efficiency singularly qualify them for possible future use as interconnections in computer systems. They also appear to be feasible for, among other uses, short-range communications.

Near-Term Potentialities

Today, more than 3½ years after the introduction of the Laser, there are more than a dozen answers to the question, "What, if anything, is the Laser good for?" Some of these answers may still be somewhat tentative or qualified, but they are based upon specifice experience rather than theory or speculation.

TRG, Hughes Aircraft and Korad, for example, have begun selling ruby Lasers to industry for experimentation with certain types of welding, since

LASER PROPERTIES

	Wavelength Span (Microns)	Highest Reported Average Power (Watts)	Highest Reported Peak Pulse Power (Watts)	Highest Reported Energy Per Pulse (Joules)	Highest Reported Efficiency (%)
Optically Pumped	0.58–2.7	2	5×10^8	2×10^3	4.0
Gas Discharge	0.3 – 28	10^{-2}	100	10^{-4}	0.1
Electron Injection	0.72–5.2	3	200	10^{-3}	25

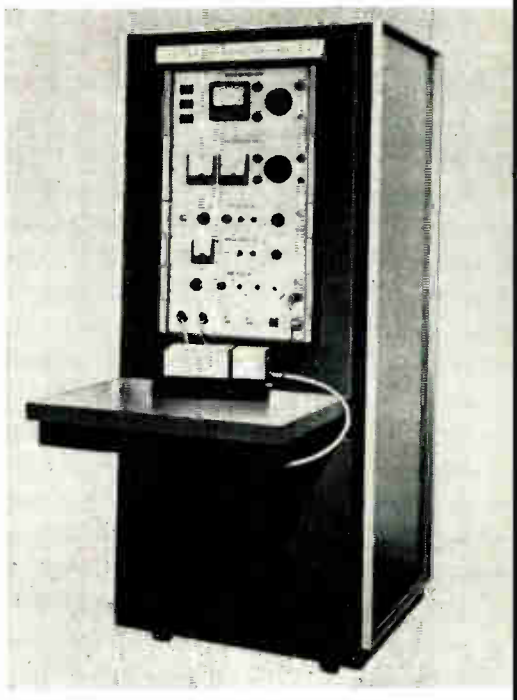


Fig. 4: Korad Corporation's K-1Q Giant Pulse Laser normally has a peak power of 50 Mw, but has been used with an amplifier to attain more than 500 Mw. The Laser head itself is in the box on the shelf; the large instrument contains the capacitor and other needed equipment.

a pulsed beam, operating over a short distance, appears to have the greatest capacity for welding metals in inaccessible locations. One of its advantages is that it does not need the vacuum environment necessary for electron beam welding.

The quality of the Laser weld, the development of the best welding methods and the economic feasibility of Laser welding devices remain to be seen. Their specifications, however, have been developed and proven, and the product currently is available.

Also, the msec. pulsed beam of a ruby Laser is uniquely effective in the welding of detached retinas. Maser Optics has sold several Lasers to medical institutions for further exploration in this use.

Ruby Lasers also appear to have potential as replacements for the standard optical range finder. They provide target range directly, in contrast to the indirect measurement—through angle computations—of the optical range finder; with a total weight of 25 lbs., including battery pack. They are compact and mobile, appear to be economically feasible and they perform a job which microwave radar — because of ground clutter problems — would be unable to perform. The Army is now using one or more Laser range finders in field trials, and RCA reportedly is developing several more for Army use.

Laser uses in optical weather radar have also been tested and now appear to represent another near-future achievement. Laser light's higher reflectivity enables meteorologists to detect clouds and turbulence which are more transparent to microwave radar. Its high frequency (some 10,000 times that of microwaves) provides increased doppler sensitivity.

Cancer research has been performed, on a limited scale, by ruby Lasers, and some scientists seem optimistic over its potential. But, no one is prepared to predict or even hint, at this early stage, that Lasers will be used to cure cancer in humans.

Semiconductor Lasers have shown a capability for short-range data transmission, and this potential seems particularly appropriate to immense radio traffic areas, e.g., missile test ranges. Although this potential has not been proven under field-trial conditions, the ease of modulation of semiconductor Lasers, and the resultant decrease of physical facilities they would need appear to justify their use in short-range, traffic-jammed communications systems.

None of these uses, however, has yet been proven practicable; much trial and error remains to be undergone before they are proven. The same is true of the other, highly specialized uses: Raman and chemical emission spectroscopy, high-speed and Schlieren photography, metrology, and so forth. There is a tendency, in some circles, to leap forward with these evidences of so-far successful experiments as proofs of practical use, but they cannot and should not be so interpreted without much more testing.

Long-Range Applications

The tendency to appraise Lasers as the just-around-the-corner panacea for all our needs in such fields as space and terrestrial communications, satellite tracking, computer systems and micromachining is even more premature. Laser space communications, for example, are not critically needed until a man can be sent millions of miles into space, and until then, microwaves are probably adequate.

Long-range terrestrial Laser communications seem even further in the future, for they must wait until we have perfected some economically feasible form of solid or hollow pipeline in which to carry the Laser beam without effect from the weather.

We do know that Laser light can be used for very long-range, pin-pointed illumination, although no extensive experiments in this use have been reported.

● **A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department**

LASER FIELD (Continued)

As a means of providing light for high-altitude, night reconnaissance photography, Lasers would be superior to normal flashlamps because they could concentrate their illumination (from an altitude, for example, of 90,000 ft.) on a ground area only a few feet in diameter.

Micromachining with Lasers—despite the highly publicized experiments in the cutting of razor blades and diamonds—does not appear to represent a near-term use because we have not even fully explored its capabilities yet. Since this step is only the first in the development of a practical Laser device, this use of Lasers appears to be much further than "just around the corner."

Problems and Goals

One of the most conspicuous problems in the Laser field is that of impatience—impatience to report, or anticipate, "breakthroughs" in Laser development, to find new uses, to pass field trials and to produce commercially feasible instruments. It is an impatience one finds both inside and outside the field, and it is not an unreasonable sentiment in view of the "miracle tool" plaudits that greeted the Laser's birth. (It sometimes also has a rather salutary effect.) We believe that the Laser will, indeed, become a miracle tool, but it is still less than 4 years old and it needs time to mature. Meanwhile, it has a number of serious growing pains to endure.

We are hampered, for instance, by the existing limitation upon attainable frequencies and, therefore, upon the Laser's potential versatility. Probably the most serious remaining gap in the spectrum is that ranging from the ultraviolet to the orange (0.3 to 0.6 μ): this is the region to which photo-tubes are the most sensitive.

We have, so far, achieved only 2 practical, though less-than-perfect, entries to this part of the spectrum. Nitrogen gas has lased at a number of frequencies throughout this region, but nitrogen is only operable in the pulsed mode (most other gases operate CW) and it exhibits low efficiency. We also have passed the powerful beam from giant-pulse Lasers through suitable, non-linear crystals (e.g., potassium dihydrogen phosphate), to produce second harmonics. Coherent radiation at 0.35 μ, for example, has been produced from ruby. This indirect method is both inconvenient and inadequate as a solution to the problem.

Modulation, which governs the Laser's information-carrying capacity, is still in the elementary stages, and needs intensive development before the Laser's full potential as a communications medium can be achieved. Interwoven with this problem is the dearth of available materials which will lase continuously and which can, therefore, be easily modulated. This deficiency is particularly significant among the solid state Lasers.

Increased efficiency also is an ever-present objective. The electron injection Laser—with its near-future potential efficiency of 50%—holds the greatest promise, but its relative incoherence and need for cryogenic cooling still represent serious problems. Increased efficiency of the solid Lasers, as well as reduced beam divergence, would result from improvement in the optical quality of solid Laser materials but, though much progress has been made in this area, much more remains to be done. Increased output power—as well as higher efficiency—are the major problems to be overcome with the gas Lasers.

We also are seeking a means of sweeping a Laser beam very fast over an appreciable segment of arc (20°, for example); this is particularly important if we are to expedite Laser uses in computer systems and surveillance. We are, however, a long way from achieving this goal.

None of these problems seems any more insurmountable that those which beset earlier scientific discoveries. Those earlier problems were not solved in a matter of months or even of a few years, and we do not expect that long-range potentialities will become short-range actualities in the Laser field, either. We do believe that we will overcome the many problems that face us today; that we will develop Laser uses which have not even been envisioned at this point in our progress, and, that Lasers will, in the future, be as fundamental to modern-day technology as microwaves have become. Our goal is to reach that time as quickly, and as reliably, as we can.

LASER USES

Lasers are now known to have—or appear to have—certain distinct advantages over existing devices or techniques in the following applications; these uses seem, therefore, to have the greatest potential, at this time, for near-term achievement.

	TYPE OF LASER
Range-Finding	Solid
Welding (of metals)	Solid
Plasma Diagnostics	Solid or Gas
High-Speed Photography	Solid
Raman Spectroscopy	Solid
Schlieren Photography	Solid
Chemical Emission Spectroscopy	Solid
Retina Welding	Solid
Short-Range Communications	Gas or Semiconductor
Metrology	Gas
Optical Instrumentation	Gas or Semiconductor
Cancer Research	Solid
Optical Weather Radar	Solid or Gas
Narrow-Beam Illumination	Solid or Semiconductor

A HIGH EFFICIENCY LIGHT GENERATOR

The next step in radar and communications design will be toward systems working in the infrared, visible and ultraviolet ranges. "Enetron" is an unusual gas-discharge device which produces high power, pulsed energy from 2,000 to 20,000 Angstroms. Efficiency is comparable to the magnetron.

A NEW NON-COHERENT LIGHT ENERGY SOURCE has been developed. Called the Enetron, it is a source of radiation for the ultraviolet, visible and infrared regions.

The tube is a low-pressure gas discharge tube immersed in a liquid of low viscosity. The liquid permits the tube to withstand very high internal pressures without shattering. The Enetron can have an energy conversion efficiency of over 50%, comparing favorably with the magnetron. It can be used for radar or communications. Communications have been maintained while the beam was pointed in the direction of direct sunlight.

* * *

While superficially, the Enetron system may appear to be just another form of a gaseous discharge tube, the external appearance is, in this case, deceiving. The essential principles of operation result in high power, pulsed energy from low average power input. Operational features of the Enetron include an ability to produce arc discharges which are confined plasmas, capable of higher average power absorption than previously thought obtainable. It produces precise pulses of energy which, in a pulse train, conform in both pulse width and peak power and produce extended trains of pulses at precisely controlled repetition rates from single discharge to more than 10,000 cps.

The basic radiant energy generation tube is backed by a modulation and control circuit which is essential to the proper working of the total system. The device does not use the conventional trigger electrodes or trigger circuits of standard gaseous discharge tubes.

Many of the techniques and formulas that apply to radar are also applicable to the Enetron. Units are available now that cover 2,000 to 20,000 Angstroms. These units have pulse repetition rates up to 1,000 cps. Pulse widths are adjustable in steps of 1, 2 and 3μsec. Other units can be built to suit the needs of the user.

Conventional Communications

An IR transmitter can be built to provide 360° of azimuthal coverage combined with any amount of elevation coverage. Fig. 2 presents one concept for a combined transmitter and receiver. Through its toroidal optics it covers 360° in azimuth and 40° in elevation. An advantage is that it does not require

Fig. 1: An Enetron is mounted in the reflector. Liquid emersent acts as a filter and gives the tube the dark color.

By WILLIAM H. LONG
Manager,
Space Projects Laboratory,
Marshall Laboratories,
Torrance, Calif.

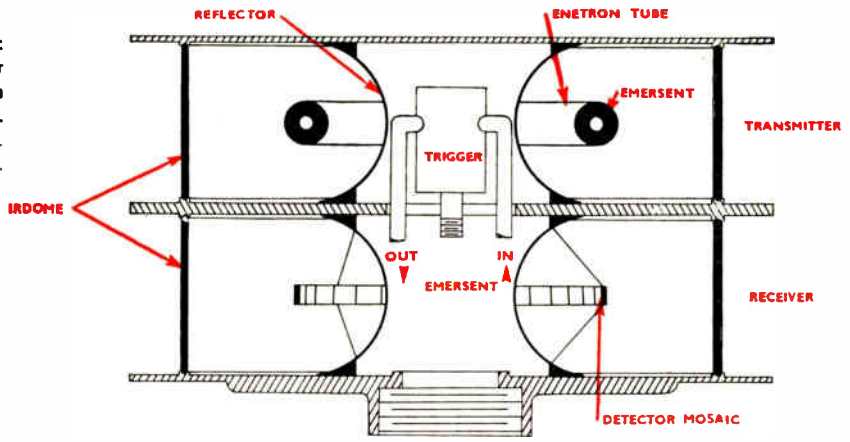


Fig. 2:
The combined Enetron receiver and transmitter antenna is toroidal in shape. The unit is about 12 in. in diameter and 9 in. high.

ENETRON (Concluded)

precise alignment or tracking equipment to establish communications. If the combined transmitter and receiver are located anywhere within the field of radiant energy, communication will be established. Range tests indicate ranges of 100 vacuum range miles with about 250 average watts input. If the data is transmitted by FM of 10KC repetition rate and a transmitter pulse width of 1μsec., direct voice transmission is possible. The system functions in the on-off mode, so that modulation using binary decimal digit information or any other digital modulation can easily be done.

Re-Entry Communications

A possible use is communications through the plasma or ion sheet created by a space vehicle re-entering the atmosphere. While the electrically charged gas particles constitute a veritable solid wall through which conventional r-f energy cannot penetrate, they have little effect at optical frequencies, particularly if pulsed radiant energy is used. The ionized, high temperature gases produce their own characteristic radiation and absorption patterns, leaving transmission holes for "optical" energy to pass.

Space Radar

Because the device is very much like a magnetron in its ability to generate high peak power, pulsed energy from low average power input, it is suited for space radar and guidance. In outer space, where there is no atmospheric absorption, the propagation characteristics are identical with microwave energy. Therefore, all range formulas associated with magnetron energy hold true for this device.

A major advantage of this type of space radar over the more conventional microwave radar lies in the much smaller size of the antennas needed. The transmitter designed for a particular role would be no larger or heavier than a comparable microwave transmitter. The real advantage of the Enetron system is in the receiver. The usual radio frequency components, such as klystrons, i-f strips, etc., are not needed. The receiver consists of an energy detector backed by one or two stages of signal amplification. The detector converts the received energy directly into electrical pulses.

The term Enetron is a registered trademark of Marshall Laboratories.

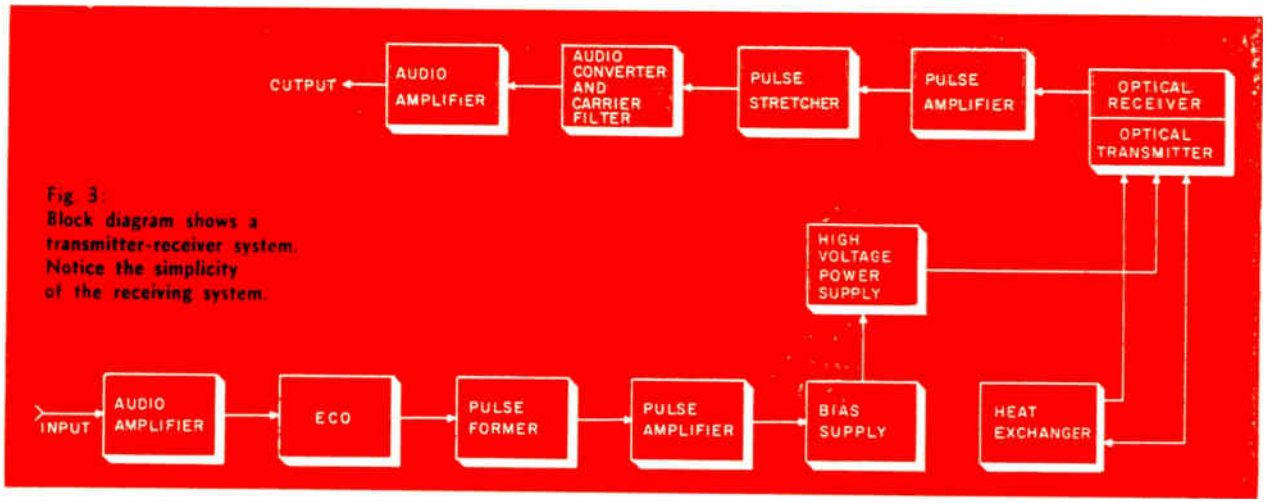


Fig. 3:
Block diagram shows a transmitter-receiver system. Notice the simplicity of the receiving system.

71 MEASURING PHASE STABILITY OF ULTRASONIC DELAY LINES

DIRECT READING PHASE MEASUREMENTS up to 500 KC can be made with available phase meters. Absolute accuracies of 1 to 3°, and better relative accuracies, are obtainable. Outputs from these meters can be used for recording phase as a function of time on several types of direct indicating graphic recorders.

The quartz ultrasonic delay lines in question operate at a center frequency of 30 MC. By using frequency translation methods, phase changes at 30 MC, due to changes in effective delay line length, can be directly reproduced at 100 KC; thus allowing the use of the low frequency instrumentation. Two frequencies, whose difference is the frequency at which the phase measurement is to be made, are needed to compare the input phase with the output phase of the delay line signal. Therefore, 30 MC and 30.1 MC can be chosen as the two frequencies.

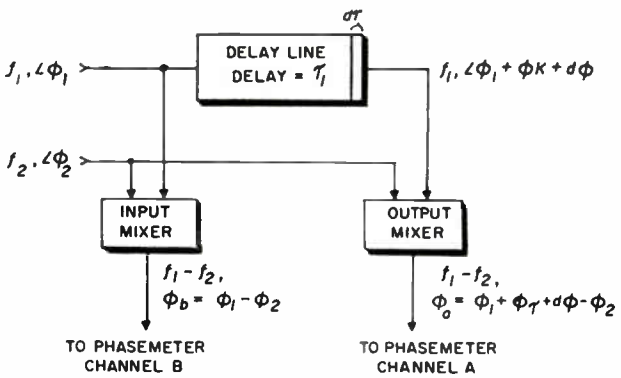


Fig. 1 shows a block diagram of the measurement setup. Frequency f_1 is applied to the delay line and input mixer. The same frequency f_1 at the output, shifted in phase in its passage through the delay line, is applied to the output mixer. Delay line driver and post amplifiers, not shown, may also be included as part of the delay system to be measured. The second frequency, f_2, is applied to both mixers. The amplitude of f_1 fed into each mixer is made much smaller than f_2. The mixers, which are simple h-f diode-capacitor-resistor circuits, detect the envelopes of the beat frequencies of the applied signals. The simple linear phase relationships between the envelopes and input signals are given in Fig. 1. From this it is seen that the phase meter measures:

$$\phi_a - \phi_b = \phi_\tau + d\phi \qquad (1)$$

$\phi\tau$ is a constant phase change for a given input frequency, f_1, and delay line length, τ_1 and is measured to the nearest 360°. If we are interested in measuring only phase stability, and hence small changes of phase, we need consider only the increment $d\phi$ which is given in radians by:

$$d\phi = 2\pi f_1 d\tau + 2\pi\tau_1 df \qquad (2)$$

From Eq. 1 is seen that $\phi_a - \phi_b$ is not a function of either ϕ_1 or ϕ_2* which can have an arbitrary phase relationship with each other. It further follows that ϕ_2 can change at a fairly rapid rate, implying a continuous change or drift in frequency f_2, and not cause a change in $\phi_a - \phi_b$.

However, since $d\phi$ is a function of frequency f_1, and delay, τ_1, a change in either of them will change the phase meter reading. Since $d\tau$** is what is to be determined by this method, it is necessary to prevent f_1 from changing an amount large enough to affect that determination.

It is apparent that f_2 need not be truly stable, but that f_1 should be stable enough so that it has minor effect on the evaluation of $d\tau$. The stability needed of f_1 may be computed as follows:

$$df = \frac{K f_1 d\tau}{\tau_1} \qquad (3)$$

where K is the desired ratio of the changes due to df alone and to $d\tau$ alone in Eq. 2.

As an example, assume the following:

$K = 10^{-1}$
$f_1 = 3 \times 10^7$ cps
$\tau_1 = 10^{-3}$ sec.
$d\tau = 10^{-9}$ sec.

then

$$df = \frac{10^{-1} \times 3 \times 10^7 \times 10^{-9}}{10^{-3}} = 3 \text{ cps}$$

This frequency stability of one part in 10^7 allows $d\tau$ to be found to 10^{-9} seconds with an assurance that the error due to a frequency change will not exceed 10^{-10} seconds. The corresponding measurable variations of phase will be close to 11° and 1.1° respectively, the latter figure being of the order of the stated absolute accuracy of the phase meter.

*A change in ϕ_1 is propagated down the line with some delay. Hence, Eq. 1 is strictly true only for steady state conditions.

**The temperature coefficient of delay of a quartz line is largely a function of the effect of temperature on its elastic moduli, rather than on the linear dimensions of the material.

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APPLYING MODULAR DESIGN TO RECEIVERS

While the modular packaging concept is not new, its application to ground receiver equipment is unique. There were many items to be considered and taken care of in the design.

THE ENDLESS VARIATION IN ELECTRONICS EQUIPMENT emphasizes the need for a more universal form, one that does not require continual hardware redesign.

A partial resolution is obtained by using plug-in, printed wiring assemblies in a modular form. The advantages in this approach have induced much of the industry to accept this "packaging" as standard for computer, data handling, control, audio, and dc uses. This article describes a design concept carried to a conclusion.

* * *

As it is noted that these are all low-frequency uses, it becomes clear that the limitation to this "packaging" is that as the frequency rises, interference and radiation become crippling problems. Therefore, the "endless variation" is still pronounced in equipment designed to operate above 5 MC.

Reduction of r-f radiation requires a metal enclosure. The "tightness" of the enclosure is fixed by the frequencies which can cause malfunction, the radiation field strength, and the sensitivity to interference of the equipment.

In 1962 a Philco program tackled the problem of "modularizing" high-performance receivers in a manner comparable to the accepted plug-in modules used for l-f equipment. A basic rule was that the solution should accommodate any number and kind of modular printed wiring assemblies operating up to 200 MC.

Interlocking Problems

The basic goal was to extend the modular design into the i-f range and in a manner that would bring relief to the problem of interference due to r-f radiation. This broad goal could be achieved only by solution of many interlocking problems, of which the following are typical:

a. R-F radiation must be prevented from leaking through plastic connector blocks or unused connector pinholes.

b. The enclosure must be an all-metal and radiation leak-proof enclosure.

c. Provision must be made for quick access to test and adjustment points, and in a manner that would permit system monitoring during operation.

d. The design must be modular in every practical sense and be compatible with existing l-f modular printed wiring assemblies.

e. Means for temperature control must be provided on an optional "for-use-when-necessary" basis: Cooling when excessive internal temperatures are anticipated and "ovenizing" when temperature sensitive components require constant temperature.

f. A constant ground plane must be provided for the functional components and

g. Low impedance grounding from module to module must be provided.

h. A flexible module thickness must be provided to handle varying thicknesses of modules likely to be encountered in i-f and l-f equipment.

i. The use of space must be economic and based upon the true cost of a cubic foot of ground equipment space.

j. Modules and enclosures must be consistent with currently available components, yet provide for easy transition to the use of future ground equipment components.

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Fig. 1: A partially assembled chassis with mixed frequency modules is typical of the module design.

Fig. 2: A clear view of three i-f modules in place with the spring covers open.

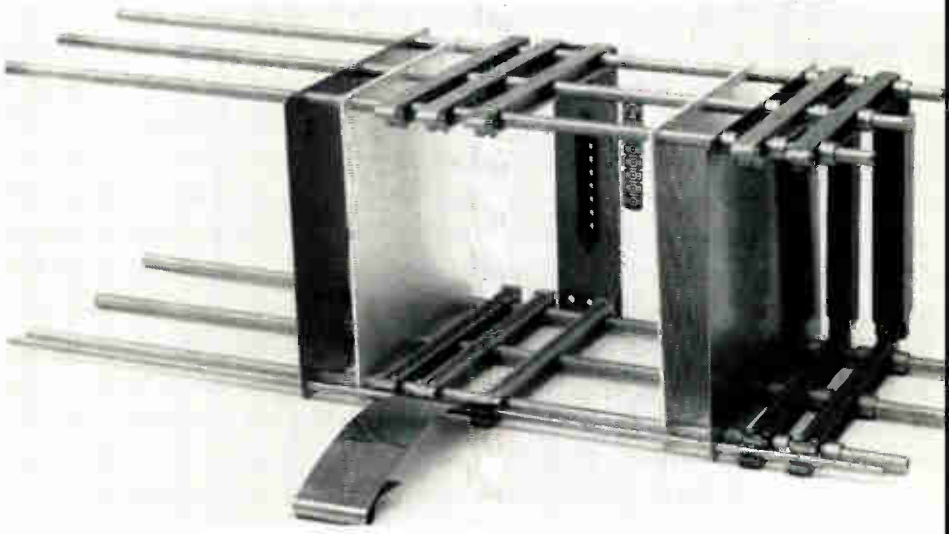

Fig. 3: The exploded view of a module enclosure shows the important hardware parts.

The basic goal has been achieved. The advantages sought at the start of the program are now features of the design. All current receiver equipment uses the design. The design has been designated as Philco Uniflex.

The design is based upon incorporating the "packaging" needs of the "thinnest" functional module into a small number of simple parts which can be stacked to provide a number of adjacent enclosures or cubicles, each of which handles any kind of module having a fixed length and width. Module thickness can vary in increments of $\frac{3}{8}$ in., the most common thickness in receiver equipment being $1\frac{1}{8}$ in.

Each "stack" of modules is referred to as a "basket"—a carryover term from Data Handling equipment. Three such baskets fit into a standard $8\frac{3}{4}$ in. chassis and will accommodate 30 receiver modules such as mixers, multipliers, phase detectors, i-f amplifiers, discriminators, oscillators, etc. All the coaxial and power connections are arranged for easy access along the bottom face of the 3 baskets. Module covers make up the top face of the 3-basket chassis to provide maximum accessibility to insert, remove, or probe a test point on any module. Instruments and controls are mounted to the front panel, and chassis-to-system connectors are located on the back plate of the chassis.

Packaging Features

An engineering model of a typical receiver system chassis is shown in Fig. 1. The chassis cover is removed to show the visible l-f modules and the enclosed i-f modules. Features include the ability to mix the open l-f modules with the enclosed i-f modules, and the ease with which front-panel controls and meters can be integrated into a chassis.

A clearer view of 3 i-f modules in place and spring covers opened is shown in the i-f module portion of a Frequency Selector chassis in Fig. 2. The visible i-f modules are a Balanced Mixer, an X2 Multiplier and an X5 Multiplier. The spring covers are curved to provide continuous metal-to-metal contact around

MODULAR PACKAGING (Concluded)

the edges when closed to prevent r-f leakage. The spring cover is a press-to-close, press-to-open snap type. Cover opens and closes instantly.

Other features can be shown in the expanded and detailed illustrations which follow. Fig. 3[1] shows the hardware parts which combine to secure the features and advantages sought at the start of the program. All parts are our design except the connectors. The module guide is the foundation piece of the design. It is a lightweight die cast aluminum part having most of the physical restraint features needed. It not only provides a means of building up an all-metallic enclosure for i-f modules, but it also handles the l-f modules. The l-f module spacers are selected from a table of options to provide the densest practical spacing between modules.

The snap type of cover provides the quick access needed to reduce maintenance time, while it provides r-f radiation tightness so essential to receivers. Also, the cover carries the module identification along with test and adjust point location markings.

R-F Leakage

The connector shield is a Philco part. It is installed into the connector by a special tool that the outer conductor of the r-f connector pins are grounded to the connector shell; all unused connector pinholes are blocked, and r-f leakage through the plastic connector block is stopped. It is a simple part photo-etched from beryllium-copper spring stock and formed to make intimate contact with the connector shell.

Characteristic of the detailed thought given to eliminate r-f leakage effects is the use of a stainless steel module separator that isolates and decouples adjacent i-f modules. All parts were designed from a product engineering point of view. Essential functional needs were met while providing economy of production, durability, and pleasing appearance.

Fig. 4 shows an exploded view of the parts standard to all i-f modules. An essential and unique feature is the dc power interference filter. It is made to our design and provides a coaxial terminal to introduce power across the grounding plane directly into the filter, leaving no part of the circuit exposed. Thus, eliminating conducted interference.

Fig. 5 shows a 21.5 MC Discriminator assembled, ready to be plugged into a system. This i-f Module is typical of the Uniflex Receiver Library of Modules from which the technical needs for a custom receiver can be met. Some of the numerous advantages that accrue from such a Library are the following:

a. Accumulation of reliability histories (from actual in-use conditions of operation)

b. Logistics simplification

c. Inherent low cost without compromising quality of functional parts

d. Quick delivery capability

e. Versatility to accommodate growth of existing systems

f. Ideal mantainability provisions.

It is possible to list many advantages for modular design. The acceptance attests to its general recognition. The significant point is that the design provides a good means of extending the use of comparable modular design to at least 200 MC.

1. "Uniflex Modular Design Applied to Ground Receiver Equipment," *WDL-TR-E330*, Philco Corporation (Palo Alto, April 1963)

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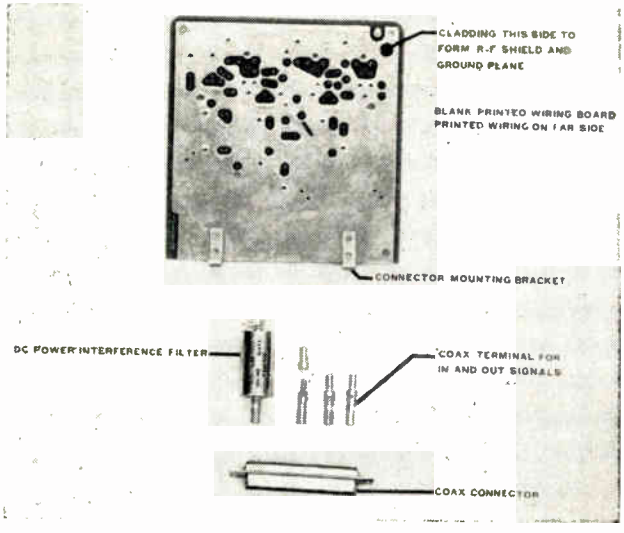
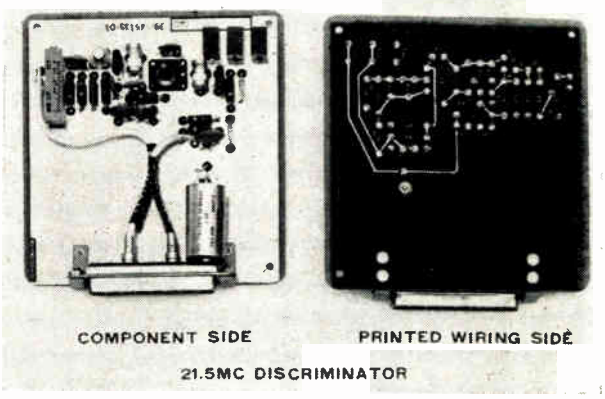


Fig. 4: The parts standard to all i-f modules are indicated.

Fig. 5: Both sides of a typical i-f module show parts layout.



ELECTRONIC INDUSTRIES
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FEATURE

OPTICS TECHNOLOGY— NEW ELECTRONIC DISCIPLINE

The optical spectrum is being absorbed into the electromagnetic spectrum, of which it is rightfully a part. The advent of the laser and the extended use of infrared and ultraviolet has made optics an important area for electronic engineers.

THE OPTICAL SPECTRUM includes infrared, visible light, and ultraviolet wavelengths ranging from about 1 mm (1000 microns) down to 0.001 micron (10 Angstroms).[1]

In a poorly defined region near wavelengths of 1000 microns, the optical spectrum merges with microwave. At an equally vague region around 10 Angstroms, where metal no longer reflects, the optical spectrum blends into the shorter wavelength X-ray spectrum. In time, the optical spectrum may lose its identity and be submerged with little trace in the electromagnetic spectrum of which it is a part.

Optical technology, with historic roots in the development of instruments using mirrors, lenses, and gratings to control visible light, has been invaded by the techniques of the users of the microwave spectrum.[2] Conversely, optical technology, having spread from its base in the visible light region to the infrared (IR) and ultraviolet (UV) regions, may yet provide the microwave spectrum with a most versatile generator depending on coherent light as its primary source.[3]

* * *

Devices

Types of devices can be divided somewhat arbitrarily into the following categories: Optics (Materials and Components), Detectors, Amplifiers, Sources, Display Devices, and Modulators.

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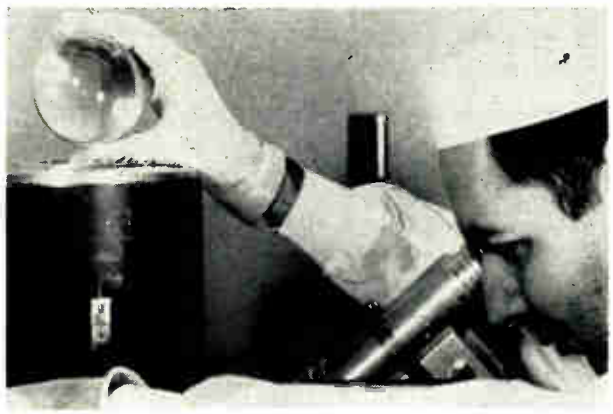
The term "optics," the name of the branch of science dealing with light, also is used to describe the materials and components, such as lenses, filters, prisms, light pipes, gratings and mirrors, used to reflect, refract, and diffract light in optical systems. Lenses for visible light have developed slowly over three centuries, with improvement depending mainly on advances in controlling the glass-making process, in modifying the content of the glass, and in finishing and mounting the lens. Recent small-diameter glass fibers (fiber optics) have given great flexibility to optical system design by making possible conduction of quanta of light along a non-rectilinear path[4] and amplification of light by laser action.[5, 6]

Fig 1: One optic device is checking another. Roundness of ball can be checked within 2 millionths of an inch.



In the IR and UV regions, investigation of materials other than glass is continuing. In the very near infrared (out to 1.2 micron) ordinary glass can be used for most work. Beyond that wavelength, ordinary glass becomes opaque to IR, and other materials, such as lead sulfide (to 3 microns) and fused silica, have been applied. Materials that can transmit IR out to 20 microns and more are available.

New developments will likely extend this range to 100 microns or more. In the UV region, quartz has optical transparency down to wavelengths of about 1850 A. Ordinary glass is transparent down to 3,000 A, and certain special glasses will transmit down to 2200-2500 A. No known substance is optically transparent below 1000 A. Research is underway to develop materials in the 1000-1850 A region.[7] Multi-layer thin-film coatings are now widely used to produce both narrow-band and band-pass filters.

The first optical detector was the human eye. Like all detectors, it has a limited range of response, being sensitive only to wavelengths in the narrow region between about 3800 and 7500 A (0.38 to 0.75 micron). Detecting techniques were first developed for visible light, whose chemical action on silver chloride was discovered in the 18th century. In 1800, Herschel discovered infrared by using a thermometer to detect the energy beyond the end of a visible prismatic spectrum.[8] A half-century ago, the first photoelectric detectors were developed.[9] Luminescent phosphors, essential in cathode-ray tubes (CRT) and TV pick-up tubes, also serve as detectors.

Chemical action has formed the basis for the most popular form of detection, photography. There is great interest in IR and UV sensitive films which may be developed to produce visible light images. Ultraviolet film, which can be developed by heat rather than chemical processing, is receiving careful thought.[10] Finer-grained film having greater resolution is a continuing goal of the film research labs.

In both thermal detectors and photodetectors, the incident radiation changes the electrical properties. In thermal detectors, however, radiation is absorbed and causes heating, thereby causing an electrical change (voltage change in thermocouples and resistance change in bolometers). The photodetectors cause changes in electrical properties without heating. The image tube is usually photoemissive, that is, incident light causes electrons to be emitted from a cathode. Photoconductive materials, such as selenium, decrease resistance in the presence of light. Thallous sulfide and lead sulfide are photoconductive in the IR region. Phosphors are very useful as UV detectors, as many are responsive to UV radiation and emit visible light. Phosphors also emit in the UV or IR region.[11]

Among the light amplifiers, are the image intensifiers and laser amplifiers. Image intensifiers usually depend on the liberation of free electrons from a photocathode by impinging photons. The free electrons are then accelerated and focused on a screen. Multi-stage devices (photomultipliers) are common. Laser amplifiers are potentially important although only small optical carrier amplification has been done by use of two travelling wave lasers in series. Much work remains in light amplification.

The earliest practical electro-optical generator was the filament lamp. Both the arc and the fluorescent lamp were developed before 1900. Other lamps depending on the principle of the electric discharge in metal vapor also developed early.[12] Used as detectors of optical quanta, phosphors are also applied in a great variety of generators, including CRTs and fluorescent lamps.[13]

Some of the common sources are: Fluorescent Lamp, Mercury Vapor Arc, Carbon Arc, Sodium Vapor Lamp, Neon Tube, Xenon Tube, and Tungsten Filament Lamp.

Most of these operate in several portions of the spectrum. Another group of generators, depending mainly on heating, either electrical or gas, may be used to produce IR as well as visible light.

A recent generator is the laser, depending on stimulated emission of radiation from liquids, solids, or gases. Because the radiation produced is coherent, in distinction from other types of generators, the techniques of microwave can be applied. The laser can also concentrate energy in a beam of small diameter, and is thus useful as a heat source.

Data presentation has been concentrated in the visible light region because of the human eye's limit. As greater need arises for presentation to machines, IR and UV may become more common. Photography has been the traditional form of data presentation, but luminescent (CRT), incandescent, and glow discharge displays on consoles have grown in the past two decades. Need for real-time projection displays have spurred work in rapid film processing.

Modulation may be done either by directly modulating the optical carrier, or by modulating the electrical power input to the optical generator.

Direct modulation of the optical carrier is one of the key problems in developing lasers for communication uses. Acoustic, magnetic, or electric effects are used in most of the proposed techniques. The Kerr effect (electro-optical) has long been used in such

devices as the Kerr Cell to provide very high speed shutters.[14]

Incoherent sources are commonly modulated by pulsing the electrical input. Laser action at a gallium arsenide pn junction permits modulating the light output as a function of the electrical signal input to the junction.[15]

Equipments

Equipments use one or more of the devices—optics, detectors, amplifiers, generators, display devices, modulators—discussed above. Equipments can be grouped in the following categories: Communications, Detection and Identification, Navigation and Guidance, Data Processing, and Energy Conversion.

Incoherent light from flares, signal fires, and signal lamps have been used for centuries in communications systems.[16] With the development of telephone, telegraph, and radio, emphasis shifted away from visible light to radio wave systems. Within the past three decades voice-modulated IR carriers have been applied in military communications,[17] and the laser has opened the entire optical range of frequencies. Because of the earth's atmosphere, ground-based systems other than those using pipe or glass fibers as light conductors will experience severe attenuation, although high power line-of-sight or over-the-horizon systems may be feasible. The narrow beams in optical communications systems make them most attractive in space systems. If good modulation schemes can be developed, the great channel capacity of the optical spectrum will be opened for communications.

Detection and Identification equipment categories include: Radars, Passive Trackers, Cameras, Radiometers, Television Equipment, Countermeasures Equipment, Other Physical-Chemical-Biological Detectors and Analyzers.

Both coherent and incoherent wave radars will be used in space vehicle rendezvous, radar mapping, and battlefield surveillance.

Optical trackers like telescopes, theodolites and tracking cameras have been supplemented in recent years by many varieties of IR and UV trackers for missile and other vehicle detection. New types of detectors have evolved as a result of space work. IR and UV trackers have been widely used in ICBM detection both from the ground and from satellites. Military detection devices like the World War II infrared Sniperscope[18] and a large variety of optical rangefinders, periscopes, etc., are standard equipment.

The importance of photo-reconnaissance was re-

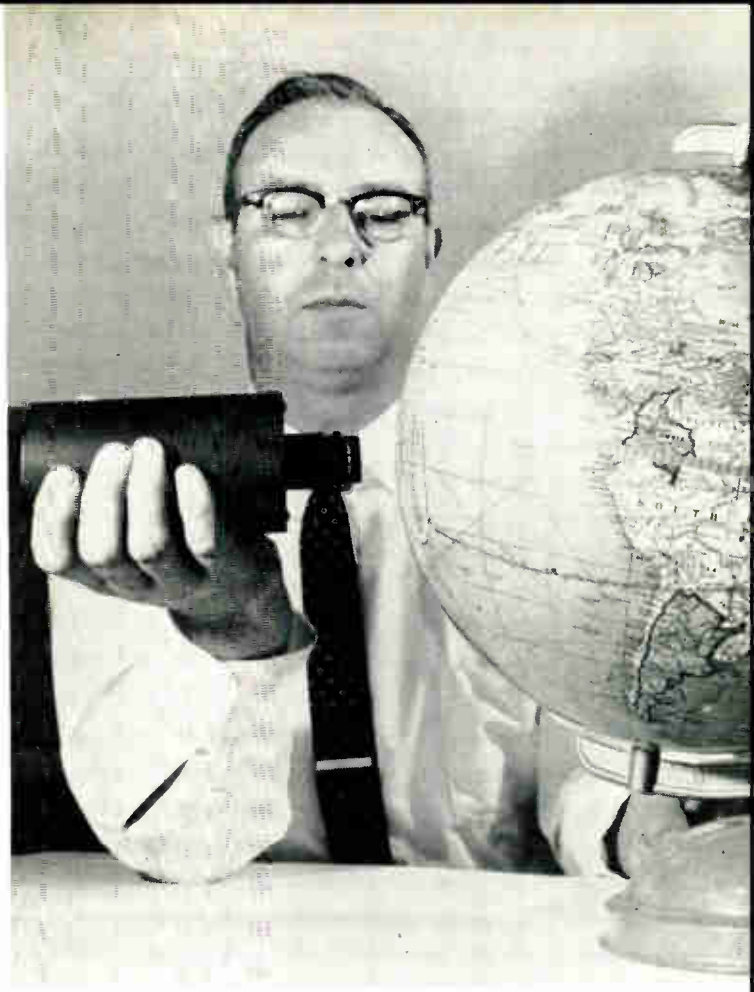


Fig. 2: The "attitude sensor" is a small electronic mirroring device that can correctly position huge orbiting satellites on less power than that needed for a miniature flashlight bulb.

emphasized during the 1962 U.S.-U.S.S.R. showdown in Cuba. It can be surmised that work is continuing on higher resolution equipment.

In addition to those used in trackers, radiometers are in demand for a variety of space, industrial, and military uses. These include sensing flames and heat, detecting flaws in materials, and learning the radiation characteristics of celestial masses.

Television advances will be made in the IR and UV range where vidicons are now available, and in special systems designed around parameters differing greatly from commercial TV. Space applications will have dynamic growth. Industrial TV should increase steadily.

Other physical, biological, and chemical detectors using optical techniques take many forms and include spectrometers, spectrophotometers, ophthalmoscopes, fluoroscopes. Although many of these are used in labs., they will be found more and more in satellites and space vehicles, and production facilities.[19, 20, 21]

Navigation and Guidance included are the following equipments: Horizon Trackers, Docking and Rendezvous Aids, Air Traffic Control Equipment, Celestial Navigation Equipment, and Map-matching Systems. *(Continued on following page)*

OPTICS TECHNOLOGY (Concluded)

Horizon trackers depending on IR-sensing of planetary positions are useful in space vehicles, including the MIDAS early-warning satellite.[22] The market for these and closely associated attitude sensing devices is a rapidly growing one. Docking and rendezvous aids, now mostly in the study stage, will develop as the lunar landing program progresses.

Celestial navigation equipment ranges from the simple sextant used in marine navigation to the star trackers using electronic image intensification devices in space vehicles.

Map-matching guidance systems have not achieved great popularity in the past, but may be useful in second generation space-vehicle terminal guidance. Air traffic control equipment uses radio frequencies, but IR equipment is being considered for all-weather runway surveillance and other special purposes.[23]

Optical Data-Processing equipments include: Image recorders and evaluators, Projection displays, Console displays, Optical computers, and Optical sub-systems for computers.

Image recording and evaluation equipment includes film processing and photogrammetric equipment to support photography. Projection displays have wide commercial and military uses, but console displays are mostly military, with a few industrial and commercial uses (such as computer control consoles).

Optical sub-systems for computers, such as optical readers and certain analog to digital converters, have been widely used for several years. But, the period of widespread use of optical techniques in computers lies ahead. Optical frequencies provide potentially greater bandwidth and higher information handling rates than microwave frequencies and, therefore, will be the basis for faster computers.[24] The optical transistors reduces the transit time of signals over normal transistors. As more work is done on coherent light generators, systems using glass fibers, both as passive conductors and as laser amplifiers, may be expected to develop.

Sustained interest in heating by radiation has resulted in a great variety of heating devices depending upon electricity, fossil fuel, direct solar radiation, and other energy sources.

The laser converts electrical to heat energy which can be directed in a highly concentrated beam. As a result, the laser will be used for welding, machining, and surgery.[25]

Military uses of the laser as an energy converter may include an anti-ICBM system, possibly using solar pumping, to destroy missiles in space. Battlefield uses are also probable.[26]

Conclusion

Optics is one of the most rapidly advancing fields in the physical sciences, and any predictions of the exact directions it will take in the next decade are bound to be grossly inaccurate. Who could have predicted the laser in 1950?

Nevertheless, the lines along which optics technology will develop, assuming no great change in the scientific foundation, are somewhat clearer. Much of the development effort will go toward applying the breakthrough in coherent light generation, the heightened understanding of the relatively neglected IR and UV portions of the spectrum and the higher quality components now available to the familiar problems of communications, navigation and guidance, detection and identification, data processing, and energy conversion.

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MODULATOR CRYSTALS FOR LASERS

An optical communications system based on the laser would be highly directive and have wide bandwidth. But a first requirement is a method of modulating the beam. A promising approach lies in the use of the Pockel's effect, passing the light through a crystal on which a varying electric field is applied.

WITH THE INVENTION OF THE LASER, the first requirement for an optical communication system was realized. Because of its coherence, directionality, large bandwidth, and many other advantages, the laser makes such a system practical.

There are, however, two other minimum needs for communication that have yet to be met for a general optical system: (1) a method of modulating the beam, and (2) a means of both detecting the beam and extracting its information. This article discusses a suitable type of modulator.

* * *

To make effective use of the laser bandwidth, high modulation frequencies must be used. For this reason, modulation systems using mechanical shutters, magnets, and acoustic velocities are discounted. The most promising method for h-f modulation lies in the use of the Pockels effect. There are two possible modes of operation in the effect (Fig. 1)—the longitudinal and transverse modes.

The longitudinal method involves the direction of the beam of polarized light along the axis of a suitable crystal while an electric field is applied in the same direction. The field causes the indices of refraction of the ordinary ray and the extraordinary ray to vary with respect to each other. Because a change in the index of refraction implies a change in ray velocity, one of the rays is retarded with respect to the other. Both rays enter the crystal in phase, but, because of the relative retardation, are out of phase when they leave the crystal. When passed through an analyzer, the two rays are resolved into one ray whose amplitude is less than the amplitude of the incident ray. The application of a modulated voltage then provides an AM beam. Retardation Γ is given by

$$\Gamma = \frac{2\pi}{\lambda} n_o^3 r_{ij} V$$

where n_o is the index of refraction at zero field, r_{ij} is the electro-optic modulus, V is the applied voltage, and λ is the wavelength of the incident light.

If I_o is the incident light intensity, then the modulated intensity I is given by

$$I = I_o \sin^2 (\Gamma - \phi)$$

where ϕ is the orientation angle of the polarizer.

The same discussion applies to the *transverse mode* of operation, with the important exception that the electric field is perpendicular to the direction of light propagation. Phase retardation is then given by

$$\Gamma = 2\pi/\lambda \; n_o^3 \; r_{ij} \; v \; 1/d$$

where $1/d$ is the aspect ratio (length/width). Because the voltage necessary to obtain a given retardation is decreased by this factor, it is advantageous to select a material capable of transverse operation. There are also other needs that must be satisfied, including:

Transparency over the laser frequency range (0.3 to 10 microns).

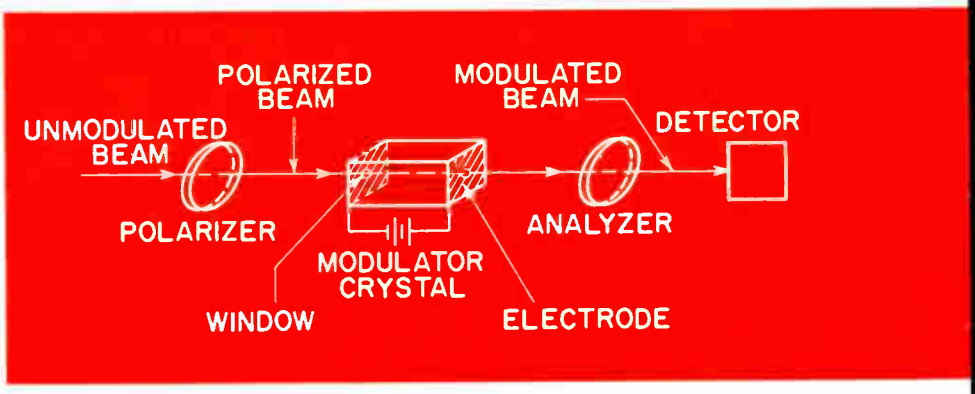
Large electro-optical modulus to obtain a low halfwave retardation voltage.

Low dielectric constant and dielectric loss tangent to minimize dielectric heating, and insensitivity of all constants to temperature changes.

Crystals

Crystals used to date have been ADP and KPD (ammonium and potassium dihydrogen phosphate). These modulators operate only in the longitudinal mode, have severe angular aperture problems, a narrow transmission region (0.5 to 1.4), a high dielec-

By LAURENCE A. MURRAY
Radio Corporation of America
Semiconductor and Materials Div.
Somerville, N. J.



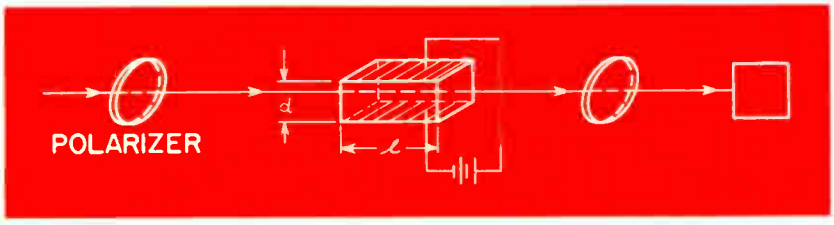


Fig. 1: Longitudinal (above) and transverse (left) modes of operation using the Pockels Effect (amplitude, phase, and frequency modulation may be affected by suitable orientation of the polarizer and analyzer).

Table 1

PROPERTY	CuCl	ADP	KDP
Transmission Range (microns)	0.4 - 20.5	0.4 - 1.3	0.4 - 1.3
Halfwave Retardation (kv) Voltage	6.2	9.6	7.5
Dielectric Constant (E'/Eo)	8	12	20
Dielectric Loss Tangent	0.001 (at 5 GC)	0.005	0.0075

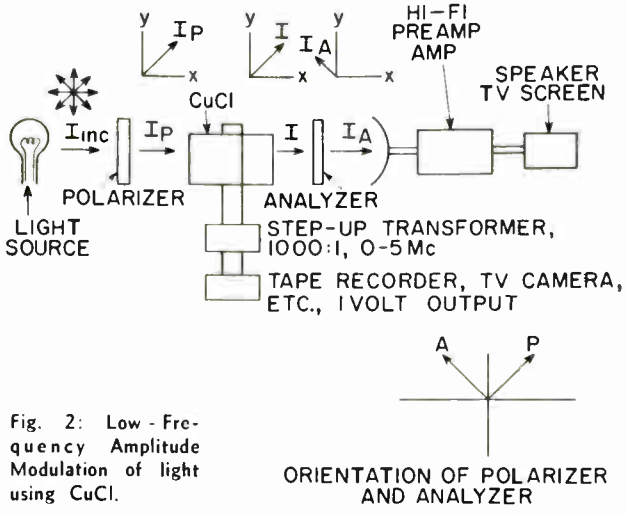
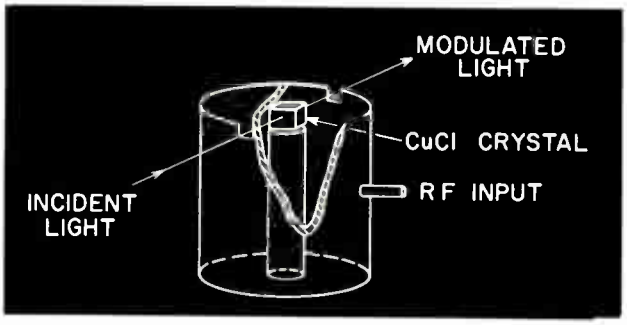


Fig. 2: Low-Frequency Amplitude Modulation of light using CuCl.

ORIENTATION OF POLARIZER AND ANALYZER

Fig. 3: Re-entrant cavity for Light Modulation at Microwave Frequencies. Microwave cavity has a 4 megacycle bandwidth.



tric constant (20), and fair electro-optic coefficients and loss tangents.

To select a crystal which produces a transverse electro-optic effect, it is necessary to examine the crystal symmetry needs for the existence of such an effect. First, it is necessary that the crystal lack a center of symmetry. If such a center existed, there would be no net dipole moment induced in the crystal with the application of a field and therefore no index-of-refraction change in the first order. (The second-order Kerr Effect is possible.) Thus, on these grounds, only 20 of the 32 basic crystal structures are usable.

The next need is that the crystal be isotropic in the voltage-off condition (that is, $r_{41} = r_{52} = r_{63} \neq 0$) with all other moduli being zero. This feature permits transverse operation without any natural birefringence superimposed on the birefringence induced by the field. A survey of the remaining 20 crystal systems shows that materials having the T_d and T (43m and 23) structures can show a transverse electro-optic effect. The T system rarely occurs and contains mainly crystals opaque in the desired transmission range.

Of the crystals having T_d symmetry, the most promising are those having the T_d^2 or zincblende structure. This structure is found in most compound semiconductors. Crystals of III-V compounds fail to meet at least two of the other needs (e.g., transmission in the visible and a large electro-optic effect), as well as the further needs that they be nonconducting and partially ionic. Crystals with large energy gaps (greater than 2ev) are needed. Of the simple compound semiconductors left, ZnS, ZnSe, CuCl,

CuBr, CuI and AgI (and their solid solution mixtures) fall in the II-VI and I-VII classes. ZnS and ZnSe fulfill all the above needs, but a method for large crystal growth is not yet available. AgI is light sensitive, and CuBr and CuI are difficult to prepare in pure form. For these reasons, CuCl is the most attractive crystal and was first developed.

Some of the characteristics of CuCl are:

Transmission: less than 1% absorption from 0.4 to 20.5 microns.

Electro-optic modulus: $r_{41} = 18.7 \times 10^{-8}$ cm/statvolt.

Halfwave retardation voltage: 6.2kv.

Dielectric constant: 8.

tan $\delta \sim 0.01$ to 0.0004 (35 GC to 5 GC range).

In each instance, cuprous chloride is superior to existing Pockels modulators; but, the crystal has its own inherent problem.

CuCl melts at 422°C and crystallizes in a hexagonal (wurtzite) phase, but at 407°C the structure reversibly converts to the desired zincblende form.* In conversion the crystal is badly strained and, because the possible maximum annealing temperature is only 400°C, stress-relief annealing is not effective. Thus, the melt-grown methods suitable for large-volume production (Czochralski, Bridgman, etc.) result in highly strained material, regardless of crystal size. Experiments on vapor-phase depositions below 400°C and low-temperature solution growth result in strain-free crystals, but the crystal size is small.

Even though the crystals are strained, successful experiments have been carried out because the electro-optic effects still occur inefficiently on large-area crystals. More efficient experiments have been made by using strain-free areas or strain-free regions cut from large boules.

Light Modulation With CuCl

With these crystals, modulation of CW incoherent light at 1 GC using a re-entrant microwave cavity having a 4 MC bandwidth (Fig. 3), and modulation of a CW laser beam at 1 KC were done. All crystals tested have successfully modulated incoherent light with signals taken from record players, tape recorders, and the like, with good fidelity. Because the transverse mode is possible, voltage as low as 60v can be used on a crystal with a 10:1 aspect ratio and 10% modulation.

In one of the experiments mentioned, a 1 KC modulation was impressed on a CW laser. Higher frequencies were not possible because the output frequency of the laser used ($CaF_2:Dy^{2+}$) is 2.36μ and a detector having a frequency response much higher than 1 KC is not available. This fact points out the detector problem that still exists.

FERRITE DEVICES SALES RISING

Sales of ferrite devices for 1963 are estimated at roughly $20 million. Applications are increasing, so this market for 1964 may top $24 million.

Summary

Crystals possessing the zincblende structure (T_d^2) have great potential for use as modulators in laser communication systems, and at least one type of crystal is available for exploratory use. One such crystal, CuCl, shows superior properties over the crystals in the KDP family.

At present, experiments with incoherent light and laser beams have shown the system to be quite simple, practical, and promising.

Acknowledgements

The author wishes to thank J. Dailey for suggesting the applicability of CuCl, F. Sterzer for the work on modulation, D. Blattner for making the measurements, and F. L. Vogel for many helpful discussions.

BATTERY-POWERED X-RAY

A mobile X-ray machine that operates on automobile batteries has been introduced by the Keleket Div. of Laboratory For Electronics, Inc., Waltham, Mass. The mobile unit, called the Independent M, is powered by two 12v. batteries. It performs the same fluoroscopic tasks as a stationary unit.

The 24vdc are fed to a special converter where the current is modulated to h-f and fed to the high-voltage transformer. By pulsing the voltage at a given rate, the waveform is almost smooth and approaches constant potential, thereby giving a gain in film quality. Thus the film-darkening effect at a given setting is increased, while the radiation exposure to the patient is decreased.

The Independent M has a voltage range of up to 100kv. It has been used without battery recharging for up to 1,500 radiographic exposures. Recharging the batteries is accomplished by plugging the unit into any 15a wall outlet. The mobility of the 600 lb. system and its self-contained power source makes it ideal for emergency use.

*The transition is not a peculiarity only of CuCl, but is inherent to ZnS, CuBr, etc. In the case of CuI, three separate phase transformations occur. Universality of occurrence suggests that crystals having large electro-optic coefficients are prone to phase transitions. This fact can be qualitatively understood because both effects use a lattice deformation; but, the mechanisms are different.

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Transient Response of Ceramic Filters

February 1963

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Self-Verification-Needs and Methods

March 1963

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An Engineer's Guide to Job Hunting
A Simple Electronic Analog Multiplier
Characteristics of Unipolar Field-Effect Transistors
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Synthesis of an Active Chebyshev Filter
The Node Method of Circuit Analysis

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Circuit Realizability Criteria
Connectors—and Terminations
Disarmament: What Would it Mean to the Electronic Industry?
Function Generation with Active Nonlinear Elements
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June 1963

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Ceramics: A New Dimension in Circuitry
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Microelectronics: In Search of the Ideal Circuit
Microwave Tubes: After Three Decades
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Reliability Trends in Space Electronics
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Testing Without Direct Electrical Connections
The Future of Integrated Circuits
The Future of Semiconductor Devices
The Outlook for Adhesives in Electronics
The Outlook for Thermoelectric Devices
The Search for New Semiconductor Materials
The Status of Microelectronics
Trends in Process Control Computers
Trends in Semiconductor Research
Tubes—Today and Tomorrow
Where Ultrasonic Transducers are Today

July 1963

An Evaluation of Environmental Testing
An Improved Insulation for Space Use
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Industry Opens up New Areas of U.S.
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Project Apollo's Command and Control
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August 1963

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Mathematical Models for Engineers
On the Properties of Negative Immitance
Smoothing-Predicting Sampled Data
U.S. Needs Electronic Capability for Space

October 1963

A Communications System for "Apollo"
Automatic Tracking Antenna Systems
Building Reliability into Space Instruments
Electronics Growth Brings Trouble for Labor
Improved Checkout for IR Detectors
Obtaining High and Ultrahigh Vacuum
Survey of Vacuum Technology
Technical Writing: Superstition and Fact
Time Decoding for Satellite Tracking Systems
Well Regulated Battery-Solar Cell Charging

November 1963

A Survey of High Power Microwave Filters
Control System Compensation
Generating Ultrasonics at Microwave Frequencies
How to . . . Calculate Hard Tube Modulator Fall Time
Microwave Diodes—A Progress Report
Microwaves—A Market in Transition
New Developments in Laser Weapons
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New Shift in Purchasing to Affect Industry
Who is the 'Unemployable' Engineer?

December 1963

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NEW TECH DATA

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Porcelain Capacitor

Data on a porcelain frit capacitor with a temp. coefficient of 0, ±25ppm/°C is available. The VY—O capacitor has axial-radial lead configuration for use where board space is critical. Conforms to Mil-C-11272. Rated at 300 and 500vdc. Operating temp. range —55°C to 125°C. Capacitance from 10-1000pf. Standard tolerances 5 and 10%. Ideal for use in tuned circuits, i-f, delay lines, filters and h-f applications. Vitramon, Inc., P. O. Box 544, Bridgeport, Conn.

Circle 148 on Inquiry Card

Microminiature Transistors

Data is available on a line of low-cost, microminiature alloy transistors. The BCZ13 and BCZ14 are silicon pnp alloy types; the OC 58, 59 and 60 are germanium pnp alloy. All units are in the TO-19 case. The OC 58 and OC 59 are for small-signal applications. Betas are respectively 55 and 80. The OC 60 is for large-signal and power output stages. Rated at 40mw, 7v., and 10ma. The BCZ13 and BCZ14 have Betas of 25 and 55. Max. ratings are 20v., 10ma and 85mw. The collector-base leakage current is 10na, and the saturation voltage is 0.25v. Amperex Electronic Corp., Semiconductor and Receiving Tube Div., Hicksville, L. I., N. Y.

Circle 149 on Inquiry Card

Transformer Catalog

A complete line of constant-voltage transformers is listed and described in this short-form catalog. It lists all specs. and list prices for the sinewave output types, as well as the normal-harmonic output, filament, plate-filament, and adjustable types. Transformers are listed in ratings from 15va to 10kva. Sola Electric Co., div. of Basic Products Corp., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 150 on Inquiry Card

Transistor Uses

This 31-page booklet presents characteristics and applications for a series of silicon-planar transistors. The booklet is in 6 parts. Part 1 gives device characteristics and distributions, covering such topics as collector-base and emitter-base leakage current distributions, breakdown voltage, diode-capacitance vs. reverse-voltage capacitance, leakage-current distribution, and other important characteristics. Part 2 covers differential amplifiers; part 3 describes h-f characteristics. Part 4 discusses noise characteristics and supplements the data with characteristic curves. Part 5 describes a 4-terminal regenerative switch; part 6 pertains to low-level switching. This booklet contains schematics, characteristic curves, and equations. It should be a great aid to design engineers. Sperry Semiconductor Div., So. Norwalk, Conn.

Circle 151 on Inquiry Card

Facilities Brochure

A new 16-page brochure outlining the facilities and capabilities of semi-conductor instrumentation is now available. The brochure discusses the measurement techniques developed in designing a complete line of off-the-shelf test and measurement equipment for semiconductor uses. These include both single-parameter and multi-parameter test units, high-speed Go/No-Go testers, plus optional systems, such as automatic feeders, sorting, oven testing and data logging. Fairchild Semiconductor Instrumentation, 844 Charleston Rd., Palo Alto, Calif.

Circle 152 on Inquiry Card

Power Transistors

Data is available on a family of miniature base (TO-37) power transistors with max. continuous collector current ratings of 5a. Type numbers 2N3212, 13, 14, and 15 are medium power, Nu-Base, pnp, germanium devices. They are used for rapid switching of high-voltage, high-current loads. V_{CEO} ratings range from 30 to 80v., V_{CBO} from 40 to 100v. Delco Radio, div. of General Motors Corp., Kokomo, Ind.

Circle 153 on Inquiry Card

Digital Clock Techniques

Bulletin 1002 describes control modules used as the basic circuitry for digital clocks. The digital clocks can be built with any number of digits from 2 to 7 with a choice of different positions for the decimal point. Low rate counting is performed by Clareed flip-flop modules. High rate counting is done by mercury-wetted contact flip-flops. Included in the bulletin is a timing-mode option selection chart and a diagram illustrating a typical digital-clock application. C. P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill.

Circle 154 on Inquiry Card

Micro Capacitors

Bulletin NPJ-128 gives complete technical specs. for Type P95ZN capacitors. Data includes capacitance ratings available for 200, 400 and 600vdc units. Typical temp. characteristics curves are also provided. Units use a new internal construction process to achieve small size. Aerovox Corp., New Bedford, Mass.

Circle 155 on Inquiry Card

Magnetic Material

Bulletin 363A describes Alnico VIII, which offers a coercive force of 1600 Oersteds and an energy product of 5.00 million (max.). Suited to periodic focusing of TWTs. It provides a low-temp. coefficient that helps overcome operating temp. problems encountered in TWT design. Indiana General Corp., Magnet Div., Valparaiso, Ind.

Circle 156 on Inquiry Card

Vidicons

The WX-4914 and 4915 are highly sensitive vidicon tubes. They allow low-level imaging in vidicon-like devices. The WM-4914 is an all-magnetic vidicon; the WX-4915 uses electrostatic focus and deflection. The tubes can be scanned at normal TV rates or at frame durations of up to 2 min. They have a threshold resolution of 200 lines at 10^{-8} ft.-candles target illumination; a center resolution of 500 TV lines; and a corner resolution of 350 TV lines. More data available from Westinghouse Electronic Tube Div., Elmira, N. Y.

Circle 157 on Inquiry Card

Power Surge Protection

Model 6916A Crowbar protects exotic load devices from increases in power supply output. When voltage level is exceeded, an SCR shorts the power supply within 5μsec. and blows a dc fuse. This model can protect any output from 10 to 60v. with a voltage margin of 1-4v. Max. output current rating of supply being protected is 10a. Additional data from Harrison Laboratories, div. of Hewlett-Packard, 45 Industrial Rd., Berkeley Heights, N. J.

Circle 158 on Inquiry Card

Terminals

Data is available on terminals that correspond in function and performance to all the feedthru and stud terminals specified in Mil-T-55155. The publication cross-references each military terminal style and the corresponding Cambion terminal. It gives manufacturing and testing standards. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.

Circle 159 on Inquiry Card

Output Amplifier

Power outputs to ±30v.; rise and fall times of 15nsec; pulse widths of 50nsec. to 50μsec.; pulse delays to 50nsec.; and waveform aberrations typically less than 2% are features of this output unit. Complete specs. are provided in Technical Bulletin P905. Datapulse Inc., 509 Hindry Ave., Inglewood, Calif.

Circle 160 on Inquiry Card

Silicon Materials

A 12-page illustrated review of silicone and silicon materials and materials systems is available. The publication, "Materials News," abstracts newest product and application information about silicones. Among the subjects covered are an ablative material, an electrical varnish with high bond strength and heat stability, and a clear, tough silicone resin that cures at room temp. Dow Corning, Midland, Mich.

Circle 161 on Inquiry Card

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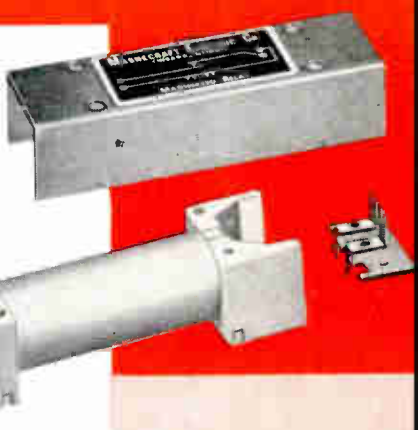

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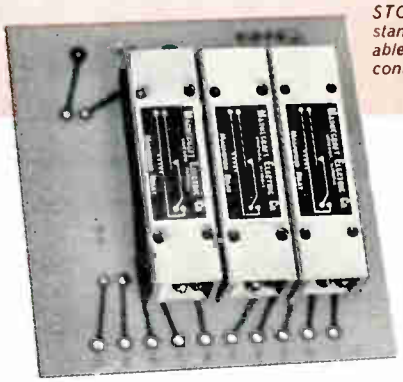

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NEW TECH DATA

Servo Analyzers

Data is available on two servo analyzers. Model 301 is an all solid-state unit that weighs less than 20 lbs. It has inline numerical indicators which provide freq., phase, and attenuation data without interpolation. Model 501 provides automatic data readout in decimal form. It rejects noise and harmonic components of test signals, and provides true fundamental response data. It has a self-check capability. Ling-Temco-Vought, Inc., P.O. Box 5003, Dallas 22, Texas.

Circle 167 on Inquiry Card

Flash X-Ray Equipment

Data is available on a relatively compact, mobile, flash X-ray system with a 600,000v. output. It can be used for ballistic and high-speed impact studies and shock-wave studies in opaque media. The Flexitron Model 760/265 has a modular design pulser and a Model 517 cold-cathode X-ray tube. Its fixed impedance offers many advantages for radiography or other uses such as stop-motion studies, where X-ray output is more important than wave form. Field Emission Corp., McMinnville, Ore.

Circle 168 on Inquiry Card

Training Lab

This 2-color brochure describes the PRD X980 Universal Microwave Training Lab. Discussed are instruments and X-band components, freq. range (8.2-12.4gc), and an introduction to making microwave measurements in the 4 fundamental parameters: VSWR, attenuation, power, and freq. PRD Electronics Inc., 202 Tillary Street, Brooklyn, N. Y.

Circle 169 on Inquiry Card

Digital-Modules Catalog

Catalog T-113, 80 pages, details more than 175 circuits. Data includes logical and schematic diagrams, characteristic curves, electrical specs., and a description of each circuit. It is an ideal reference guide for digital-circuit designers. Engineered Electronics Co., Box 58, Santa Ana, Calif.

Circle 170 on Inquiry Card

Laser Bulletin

A laser bulletin entitled, "Properties of a Laser Resonators Giving Uniphase Wave Fronts," discusses the advantages and disadvantages of several of the resonators producing uniphase wave fronts. Among the resonator configurations examined are the large-radius mirror, confocal, spherical, concave-convexed and hemispherical resonators. Intra-cavity radiation patterns are illustrated and alignment characteristics discussed. Spectra-Physics, Inc., 1255 Terra Bella Ave., Mountain View, Calif.

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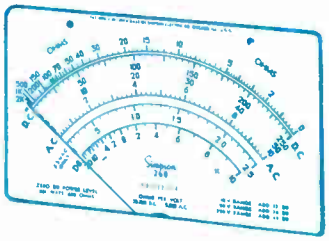
are

2 new 260® VOMs



WITH STANDARD 260 SCALE Series 4...Still Only
$48.95

with 6 new features

Now the world-famous 260® volt-ohm-milliammeter is a better buy than ever before. Call your distributor now for immediate delivery on either of these two new 260's, or on any of the other 50 Simpson testers —the world's largest selection.

- New Self-Shielded Movement
- New Higher Accuracy: 2% DC, 3% AC
- New Ruggedness From Spring-Backed Jewels
- Greater Repeatability
- Increased Linearity and Stability
- *Mirror Scale (260, Series 4M)

SIMPSON INSTRUMENTS STAY ACCURATE

Both new 260's can be used with Simpson's popular "Add-A-Tester" adapters.
Write for Revised Stock Catalog 2064A.

Simpson

SIMPSON ELECTRIC COMPANY 5213 West Kinzie Street, Chicago 44, Ill.
Phone: (312) ESTebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ontario

Representatives in Principal Cities ...See Telephone Yellow Pages

NEW TECH DATA

Power Sources/Instruments

Catalog supplement 131, 8 pages, describes a full range of power sources and solid-state instruments. The bulletin contains photos and specs. for each unit. Some of the units described include: solid-state power supplies; tunnel-diode power source; transistor power supply; magnetically-regulated, dual-output supply; high-current supplies, zener-diode tester; Alpha-Beta tester; and SCR tester. Electronic Research Assoc., Inc., 67 Factory Place, Cedar Grove, N. J.

Circle 162 on Inquiry Card

Miniature Rheostat

Bulletin 203 lists stock values and prices of the new Model C miniature rheostat. Rated 7½w. at 40°C amb., this unit measures ½ in. dia. x 9/16 in. long exclusive of shaft and bushing. Bulletin gives up-to-date dimensions and mounting facilities on this new item. Ohmite Mfg. Co., 3684 Howard St., Skokie, Ill.

Circle 163 on Inquiry Card

Protective Coating

Data is available on HumiSeal Type 1A27, a protective coating for circuitboard and other electronic uses. Type 1A27, a single-component polyurethane coating that dries quickly in air, is fungusproof, humidity-resistant, and comes in a spray can. Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway W., Woodside 77, N. Y.

Circle 164 on Inquiry Card

Analyzer Catalog

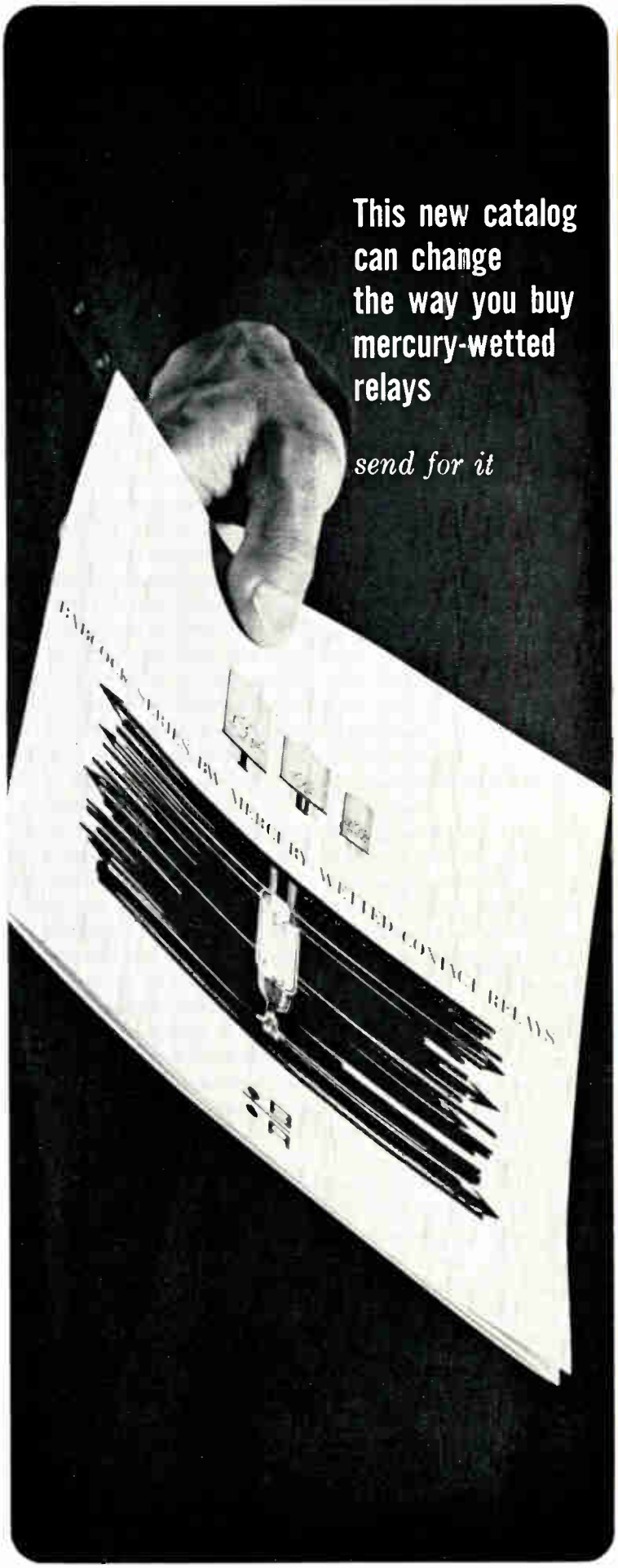
A 16-page catalog covering more than 100 panoramic spectrum analyzers and associated instruments is available. Designated catalog digest J, it details the specs. and applications of each instrument. Specs. for a new line of signal generators covering 60KC-11GC without a gap are given. The analyzers described range from 0.5 CPS to 63GC. A description of each instrument is given, along with detailed specs. Singer Metrics Div., The Singer Co., 915 Pembroke St., Bridgeport, Conn.

Circle 165 on Inquiry Card

Instruments Catalog

A short-form catalog covering recording, testing, digitizing, and sensing instruments is available. Products included are 5 types of strip-chart recorders, count printers, transistor and diode test equipment. Also included are integrated-circuit testers, analog-to-digital converters, multiplexers, pulse generators, precision pressure gages and controllers, geophysical instrumentation, and semiconductor welders. Texas Instruments Incorporated, Industrial Products Group, P. O. Box 66027, Houston, Tex.

Circle 166 on Inquiry Card



A new standard of excellence in mercury-wetted relays

Babcock's new non-bridging, mercury-wetted contact relays are designed for the high speed switching requirements of computer, control, and data processing applications. Operating at speeds as high as 1 millisecond or on power as low as 1.2 milliwatts, these high performance relays have a contact breaking acceleration of 1500 Gs.

Featuring Babcock's new form C mercury switch element, Series BW relays provide billions of trouble-free operations, constant contact characteristics and permanent low contact resistance without erosion, bounce or chatter.

An exclusive Babcock feature offers a wide variety of special adjustments.

Five models are available, each designed to meet specific applications.

Model BW-2: A single switch unit housed in a 1.234" steel container. Available in a wide range of single side stable bi-stable and chopper adjustments

Model BW-3: Similar to the BW-2, but housed in a shorter steel container. Designed for use where mounting space is limited

Model BW-4: A seven pin miniature plug-in relay measuring only .625" (dia.) x 1.891" Recommended for use in military and commercial applications where small size is a critical factor

Model BW-5: Module form designed for printed circuit board applications. Plated steel enclosure can be grounded to provide both mechanical protection and magnetic shielding

Model BW-6: Similar to the BW-5 but housed in an epoxy filled molded nylon enclosure for cooler operation. Recommended for applications where caustics and solvents are involved

Send for complete details.

BABCOCK BR RELAYS

A DIVISION OF BABCOCK ELECTRONICS CORPORATION
3501 HARBOR BLVD., COSTA MESA, CALIF. • 546-2711

Circulators/Isolators

This 20-page catalog presents photos and characteristics of coaxial ferrite circulators and isolators. Components described include port coaxial Y and T circulators, octave-bandwidth isolators, standard and broadband isolators, and miniature and subminiature coaxial isolators. Data contains characteristics curves. Western Microwave Labs. Inc., 1045 Di Giulio Ave, Santa Clara, Calif.

Circle 172 on Inquiry Card

Data Products

Precision air data products are described in a brochure available from the Guidance and Control Systems div. of Litton Industries, 5500 Canoga Ave., Woodland Hills, Calif. Photos, charts and specs. are given for central air data computers, altitude computers, pressure computers, flight-test instrumentation and support equipment.

Circle 173 on Inquiry Card

Transistors

Bulletin C610-25 describes passivated planar-epitaxial medium-power transistors, which are intended for general-purpose use in the current range up to 500ma. They are said to provide lower V_{CE} and more uniform parameter distributions than mesa types. Solid State Products, Inc., 1 Pingree St., Salem, Mass.

Circle 174 on Inquiry Card

Relay

Brochure LI-38 describes type LR ac load-current relay. This relay detects a predetermined percentage of over or under load current in single and 3-phase ac motors, and initiates an alarm when the preset value is reached. The publication contains photos, wiring and dimensional diagrams, electrical ratings, design characteristics, ordering information, and typical applications. Cutler-Hammer Inc., 315 N. 12th St., Milwaukee, Wis.

Circle 175 on Inquiry Card

Crystal-Can Relay

Bulletin GEA-7650 describes the type AV relay. The unit is radiation-hardened for aerospace uses and features electron-beam welded enclosure to header. Included are specs., coil data, mounting forms, and photos. General Electric Co., Schenectady 5, N. Y.

Circle 176 on Inquiry Card

Switch Catalog

Catalog 85, 24 pages, gives complete specs. and ordering data for a broad line of proximity switch systems that detect ferromagnetic metals. Complete electrical data, operating characteristics, dimensions, application suggestions and ordering information are explained. It is a complete spec. manual for equipment designers and plant engineers. Micro Switch, div. of Honeywell, Freeport, Ill.

Circle 177 on Inquiry Card

Arc Suppressors

Bulletin F-103 gives a 1-step approach on how to eliminate arcing caused when inductive load is interrupted. It shows how to determine the arc suppressor to use for specific applications. Includes specs. on 8 stock models. Four of the models are for uses which combine electro-magnetic and solid-state circuitry. These limit reverse voltages in addition to suppressing arcs. Lexex Inc., 123 Webster St., Dayton, Ohio.

Circle 178 on Inquiry Card

Crystal-Case Relays

Bulletin 1078 gives detailed information on Models 903 and 904 general-purpose (2PDT) crystal-case relays. Electrical and environmental data and ordering information are included. Mounting styles are illustrated. Union Switch & Signal Div., Westinghouse Air Brake Co., 1789 Braddock Ave., Pittsburgh, Pa.

Circle 179 on Inquiry Card

Recorder/Reproducer

Bulletin 2810 describes the GL-2810 continuous-loop recorder/reproducer. Unit is designed for data reduction or data monitoring, and storage where machine work load is heavy. It handles continuous magnetic-tape loops at any of 6 tape speeds from 60 ips through 1⅞ ips. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 180 on Inquiry Card

NEW TECH DATA

Fastener Booklet

A comprehensive, well illustrated booklet on bolted connections is offered. This 40-page, pocket-size booklet, illustrated with simple line drawings and written in non-technical language, gives detailed information on the simple mechanics of a nut and bolt connection. It explains why they loosen and suggests how to obtain reliable joints. It covers bolting requirements, methods of preventing nut loosening, and includes a specific glossary of fastener terms. Elastic Stop Nut Corp. of America, Dept. 6316, 2330 Vauxhall Rd., Union, N. J.

Circle 181 on Inquiry Card

Connector/Termination Catalog

Catalog 482-A, 20 pages, allows quick selection of midget environmental connectors and termination accessories. Each shell size, ranging from 12 to 24, is outlined with shell and termination dimensions cross-referenced with dimensional drawings. All connectors described meet or exceed the requirements of Mil-C-26482C. Connector Div., Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.

Circle 182 on Inquiry Card

Patch-Panel Connectors

Data is available on a patch-panel connector, which provides high flexibility by means of pin or socket contacts mounted in either half. Designed as universal connectors for programming digital computers, automatic test equipment, and automatic systems, the units may be equipped with standard interchangeable crimp-removable contact pins or sockets, or with a double socket with both Jac-Pins and standard ends. Hughes Connecting Devices, 50 Superior Ave., Newport Beach, Calif.

Circle 183 on Inquiry Card

Capability Brochure

An 8-page capability brochure on operational voice communications system, voice paging systems, and allied terminal equipment is available. The brochure describes specific areas of capability and reliability in manufacturing operational equipment used at missile or satellite tracking stations and launch sites. Also included are detailed descriptions of these systems and their specs. Remanco, Inc., 1805 Colorado Ave., Santa Monica, Calif.

Circle 184 on Inquiry Card

Connectors

Catalog data describes the REMI (removable re-entrancy miniature crimp type), MI (miniature) and SMI (subminiature) connector series. They have bathtub type shells and mounting plates which protect against pin damage and certain environmental conditions. The shells meet Mil MS-17775. A selection of 7 polarization positions is available. Polarization pins are stainless steel, nonmagnetic. U.S. Components, Inc., 1320 Zerega Ave., Bronx, N. Y.

Circle 185 on Inquiry Card

Magnetic Preamplifiers

Solid-state, self-balancing magnetic preamplifiers are covered in this catalog available from Lumen Electronics, a div. of Esterline Angus Instrument Co., Inc., P. O. B. 905, Joliet, Ill. Four types of preamplifiers, typical applications, and specs. are given. Features include: input impedance from 1Ω to 50kΩ; constant current or voltage output regardless of extreme load impedance changes; no maintenance; and null stability of ±1% max. input.

Circle 186 on Inquiry Card

CAREER NEWS FROM HUGHES

Aerospace Divisions in Culver City, California

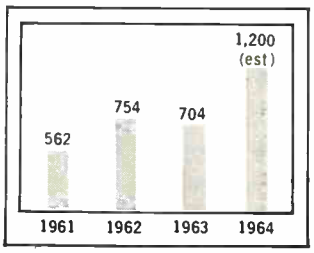
NEW AND CONTINUING PROGRAMS AND PROJECTS

F-111B PHOENIX Missile System
SURVEYOR Lunar Landing Vehicle
SYNCOM Synchronous Communications Satellite
POLARIS Guidance
TOW Anti-tank Missile
VATE Automatic Checkout System
FALCON Missiles
ARPAT
HARD POINT DEFENSE

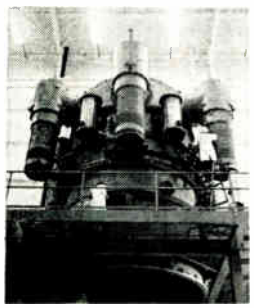
These examples of Hughes Aerospace activities are representative of *more than* 230 major product and service capabilities ranging from aerospace vehicles to ASW systems.

GROWTH OF THE ENGINEERING STAFF

Of the over 9,000 employees of these divisions, 3,000 are Members of the Technical Staff. Average length of experience is 11.0 years. Average age is 33 years.

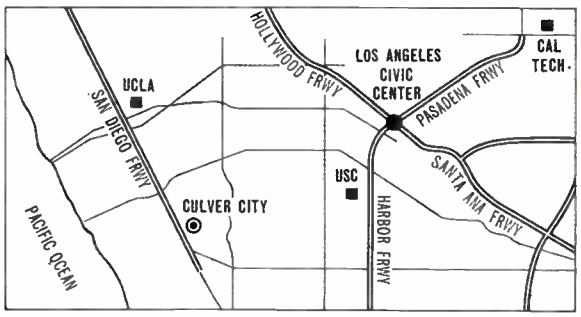


OUTSTANDING TECHNICAL FACILITIES



This giant environmental test chamber at Hughes new Space Simulation Laboratory is just one of a complete range of facilities maintained by the company for the Technical Staff. Hughes physical plant and professional atmosphere, unexcelled in industry, encourage individual achievement.

HUGHES/CULVER CITY & LOS ANGELES



Hughes Aerospace Divisions at Culver City offer engineers and scientists a unique combination of urban and suburban advantages. The plant is immediately adjacent to a major freeway. Los Angeles Civic Center is about a half-hour distant. Beach communities are just minutes away. Attractive residential neighborhoods are nearby. UCLA, USC and Cal Tech offer outstanding educational facilities.

IMPORTANT OPPORTUNITIES, steady growth, advanced facilities, fine living conditions—these are the advantages which Hughes Aerospace Divisions can offer you at Culver City.

Requirements include an accredited degree in E.E. or M.E. and specialized experience which can be related to development of aerospace vehicles. U.S. citizenship required.

For immediate consideration please airmail your resume *today*. We promise you a reply within one week.

MR. ROBERT A. MARTIN
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City, 86, California

Creating a new world with electronics

HUGHES
HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS
An equal opportunity employer

NEW TECH DATA

What is a Computer?

This 30-page book presents the fundamentals of process-control computers. The scope has been limited to the basic background data need to "talk the language" and understand what a computer is; what it can do; and how it does it. Westinghouse Computer System Div., Box 898, Pittsburgh 30, Pa.

Circle 207 on Inquiry Card

Application Notes

An applications engineering Publication, No. 91-19A-21, entitled "Operation of the Hughes Tonotron Tube: Extending Storage Time," is available. Applicable to Tonotron and half-tone Typtron® storage tubes, the notes discuss various techniques for extending viewing time. Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.

Circle 208 on Inquiry Card

Magnetic Shields

Bulletin F-1 describes Shieldmu 30, a high-permeability allow which provides high-shielding efficiency at low induction. Available in tape or foil form. Widths from ¼ to 15-⅜ in. Thicknesses from 0.001, 0.002, 0.004, and 0.006 in. Requests on company letterhead to Special Product Sales, Magnetic Materials Co., Camden 1, N. J.

Klystron Replacement

A 5-page report describes the TK-99, which serves an electrical replacement for 2K25. TK-99 is a plug-in unit. The data describes the design problems solved and the improvements offered by the new unit. A cutaway drawing of the 2K25 and TK-99 are given. The Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 209 on Inquiry Card

Computer Tape

Data is available on a computer tape that has very low friction. The tape, GT-708, will not build up a static charge as it slides against itself. It offers a minimum amount of drag during operation. It has a Mylar® base to which graphite particles are adhered. These particles are oriented on the tape's surface. G. T. Schjeldahl Co., Northfield, Minn.

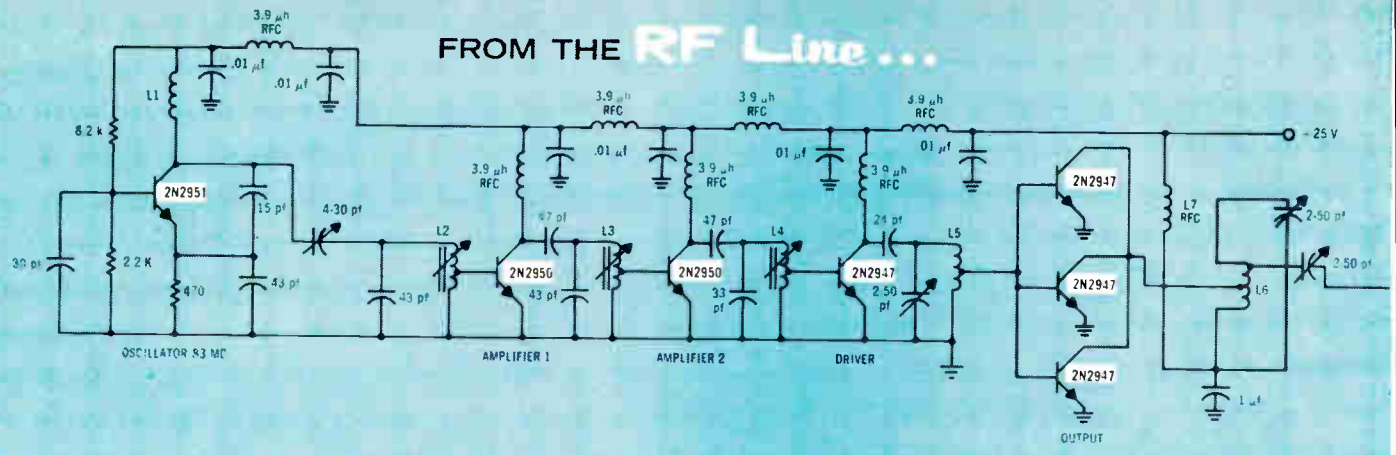
Circle 210 on Inquiry Card

Encapsulated Inductor

Data on a complete line of center-tapped encapsulated inductors for printed-circuit applications is now available. Units can be had with inductive values from 2.40mh to 30.4h. All units are vacuum encapsulated. The toroidal packaging concept uses from 2 to 8 pin terminals. Sangamo Electric Co., Springfield, Ill.

Circle 211 on Inquiry Card

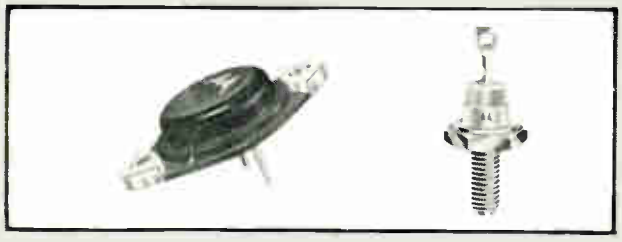
FROM THE RF Line...



L1 = 4T #22, ¼" I.D.
L2 = 4T #16, ¼" I.D. Tapped ½ T
L3 = 4T #16, ¼" I.D. Tapped ½ T
L4 = 4T #18, ⅜" I.D. Tapped ¾ T
L5 = 3T #14, ½" I.D. Tapped 1 T
L6 = 3T #10, ⅞" I.D. Tapped ¾ T
L7 = 16T #24, ¼" I.D.
L8 = 13T #16, ½" I.D. Tapped 3 T

NEW MOTOROLA VARACTORS PUSH WITH 15 WATTS OUT

USING SILICON TRANSISTORS to provide 40W @ 80 mc . .



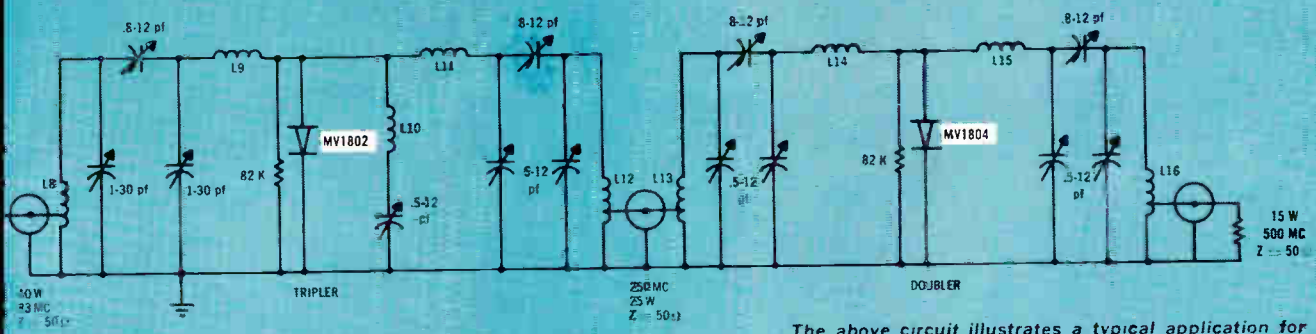
Now you can get a complete semiconductor complement for your VHF/UHF telemetry and data-link applications using a combination of Motorola's silicon high-power, high-frequency RF transistors and the recently introduced silicon varactor multiplier diodes.

MOTOROLA SILICON HIGH-POWER TRANSISTORS

		PERFORMANCE SPECIFICATIONS				ABSOLUTE MAXIMUM RATINGS		
Type	Package	Power Output	Power Gain @ Power Output (db) min	Collector Efficiency (%) min	Pulse Breakdown V_{CES} (V) min	V_{CB} (Vdc)	I_C max (Adc)	P_D 25°C Case
2N2947	TO-3	15 W @ 50 mc	7	60	90	60	1.5	25 W
2N2948	TO-3	15 W @ 30 mc	7	60	80	40	1.5	25 W
2N2950	STUD	3.5 W @ 50 mc	10	43	85	60	0.7	6 W
2N2951	TO-5	0.6 W @ 50 mc	7.8	35	—	60	0.5	2 W

MOTOROLA

BOX 955 • PHOENIX, ARIZONA 85001



The above circuit illustrates a typical application for Motorola silicon RF transistors and varactor diodes, and is not intended to be a final design.

L9 = 5T #16, 3/8" I.D.
L10 = 8T #16, 3/4" I.D
L11 = 6T #16, 3/4" I.D.
L12 = 4T #16, 3/8" I.D. 1/8" Tapped 1 T

L13 = 6T #16, 1/8" I.D.
L14 = 5T #16, 1/4" I.D.
L15 = 4T #16, 3 16" I.D.
L16 = 4T #16, 3 16" I.D. Tapped 1 T

POWER/FREQUENCY HORIZONS

PUT AT 500+MC!

. and POWER VARACTORS with efficiencies as high as 75%

Motorola silicon high-power varactor diodes are 100% tested for in-circuit efficiency at specified input power levels . . . designed for meeting high-frequency requirements up to and beyond 500mc where high power outputs are desired.

Look to Motorola for continued leadership in high-power, high-frequency RF silicon devices. These units are immediately available through your Motorola Semiconductor District Office or Distributor . . . available at production prices!

MOTOROLA SILICON HIGH-POWER VARACTORS

		PERFORMANCE SPECIFICATIONS AS TRIPLER			ELECTRICAL SPECIFICATIONS @ 25°C			ABSOLUTE MAXIMUM RATINGS	
Type	Package	Frequency	Input Power	Efficiency (%) min.	Breakdown Voltage (10 μA) min	Q min (6 Vdc @ 50 mc)	C_j max (6 Vdc @ 50 mc)	T_j	R.F. P_{in}
MV1802	DO-4	50-150 mc	50 W	65	250 Vdc	75	50 pf	175°C	100 W
MV1804	DO-4	150-450 mc	30 W	50	150 Vdc	150	35 pf	175°C	40 W

Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA INC.

Circle 55 on Inquiry Card

BUSS: 1914-1964, Fifty years of Pioneering....

Relay Brochure

This brochure describes a line of balanced armature relays which operate in the 5 to 15a. range. These relays are all standard units. The 5a. model is available in 2, 4, or 6 PDT configurations. The 10a. model in 2 or 4 PDT; the 15a. unit in 4 PDT. The brochure, in color, contains photos and characteristics. Leach Corp., Relay Div., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle 253 on Inquiry Card

Glass Laminate

This data describes Textolite® thin-glass laminates used for multi-layer circuitry. The new laminates, grades 11558 and 11622, are available in thicknesses down to 0.002 in. unclad, 0.004 in. with 1 oz. copper on one side and 0.0065 with 1 oz. copper on both sides. Laminated Products Dept., Section DJC, General Electric Co. Coshocton, Ohio.

Circle 254 on Inquiry Card

Liquids Brochure

This brochure describes inert fluorochemical liquids. Data covers radiation resistance, surface properties, chemical stability, heat transfer properties, high-temp. characteristics, mechanical design, and electrical properties. 3M Co., Dept. G3-580, 2501 Hudson Rd., St. Paul 19, Minn.

Circle 255 on Inquiry Card

Synchro Evaluation

Technical Bulletin 107 discusses several different methods for testing synchros and resolvers. It discusses the use of the ratio divider in combination with a precision angular divider, and a phase-angle voltmeter to test synchro and resolver components. Details on loading errors are given. Several block diagrams illustrate the test methods described. North Atlantic Industries, Inc., Terminal Dr., Plainview, N. Y.

Circle 256 on Inquiry Card

Alpha-Numerical Guide

A booklet listing some 100 types of silicon controlled rectifiers and switches is available. The booklet lists type number, 8 major ratings, package illustrations, and corresponding references. Transitron Electronic Corp., Wakefield, Mass.

Circle 257 on Inquiry Card

Wirewound Resistors

Data is available on a line of precision wire-wound resistors for high-stability uses. Series O can be used in digital voltmeters, analog computers, A-to-D converters, and in special laboratory instruments. Resistance change/yr., 0.003% max. Wattage ratings from 0.15 to 2.50w.; max. resistance ranges from 560K to 20.0 Meg. Kelvin Sales Co., 5919 Noble Ave., Van Nuys, Calif.

Circle 258 on Inquiry Card

Laminated Plastic

General descriptions and properties of industrial laminated plastic mechanical and electrical/electronic grades are detailed in this 12-page catalog. It contains complete specs. and uses for 36 industrial laminates and engraving stock. Formica Corp., Dept 3J161, 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle 259 on Inquiry Card

Environmental Parts Catalog

A comprehensive, illustrated catalog of the most frequently ordered environmental equipment replacement parts is available from Tenney Engineering, Inc., Union, N. J. Many of the items, which range from gaskets to valves, compressors, and control instruments are interchangeable on existing equipment.

Circle 260 on Inquiry Card

Molding Compounds

Electrical, mechanical, and molding characteristics of epoxy molding compounds are described in Bulletin #5. The bulletin gives a comprehensive description of a new epoxy formulation which is said to be substantially more stable than previous epoxy compounds. The bulletin discusses how properties and how they are measured. Epoxy Products Inc., 133 Coit St., Irvington, N. J.

Circle 261 on Inquiry Card

NEW TECH DATA

Capacitor Reliability Charts

These charts show glass-dielectric capacitor failure rates in %/1000 hrs. at various voltage and temp. stresses. The chart is on 1 sheet. One side shows plots for 90% confidence, while the other side shows plots for 60%. The sheet entitled, "Failure Rate for Corning CYFR Capacitors," is available from Corning Electronic Components, Corning Glass Works, Raleigh, N. C.

Circle 262 on Inquiry Card

Constant Modules Alloy

Bulletin T-31 provides data on thermal treatments for control of thermo-elastic coefficient; physical and magnetic properties; corrosion resistance; and procedures for pickling of NI-SPAN-C alloy 902. This high-strength iron-nickel-chromium alloy is used in aneroid capsules, weighing springs, and other precision instruments. Huntington Alloy Products Div., The International Nickel Co., Inc., Huntington, W. Va.

Circle 263 on Inquiry Card

Data-Transmission System

This pamphlet describes the 25A data-transmission system which provides 200 bps data transmission. The system versatility allows its use with card-transfer, tape-to-tape, data-acquisition, and printing-telegraph systems. The publication includes complete performance figures, circuit description and block diagrams. Lenkurt Electric Co., Inc., Dept. A134, 1105 County Rd., San Carlos, Calif.

Circle 264 on Inquiry Card

Instruments Catalog

A full line of vibration measuring instruments is described in this 8-page booklet. Included are performance capabilities and physical characteristics for various vibration pickups, probes, and signal converters. Vibration meters complete the equipment requirements for a vibration-measuring system. They give direct readings in terms of acceleration, velocity, and displacement. MB Electronics, div. of Textron Electronics, Inc., 781 Whalley Ave., New Haven, Conn.

Circle 265 on Inquiry Card

Wave/Pulse Generator

This data sheet gives photos and specs. on the Model PSG-1 square-wave generator and Model PG-10 HF Pulse Generator. PSG1 has a freq. range of 1 cps to 1MC. Pulse widths are 0.1μ sec. to 0.3 sec. Rise and fall time, 0.02μsec. The PG-10 has a 5nsec. rise time. Freq. range 1-20MC. General Applied Science Labs, Inc., Merrick and Stewart Aves., Westbury, L. I., N. Y.

Circle 266 on Inquiry Card

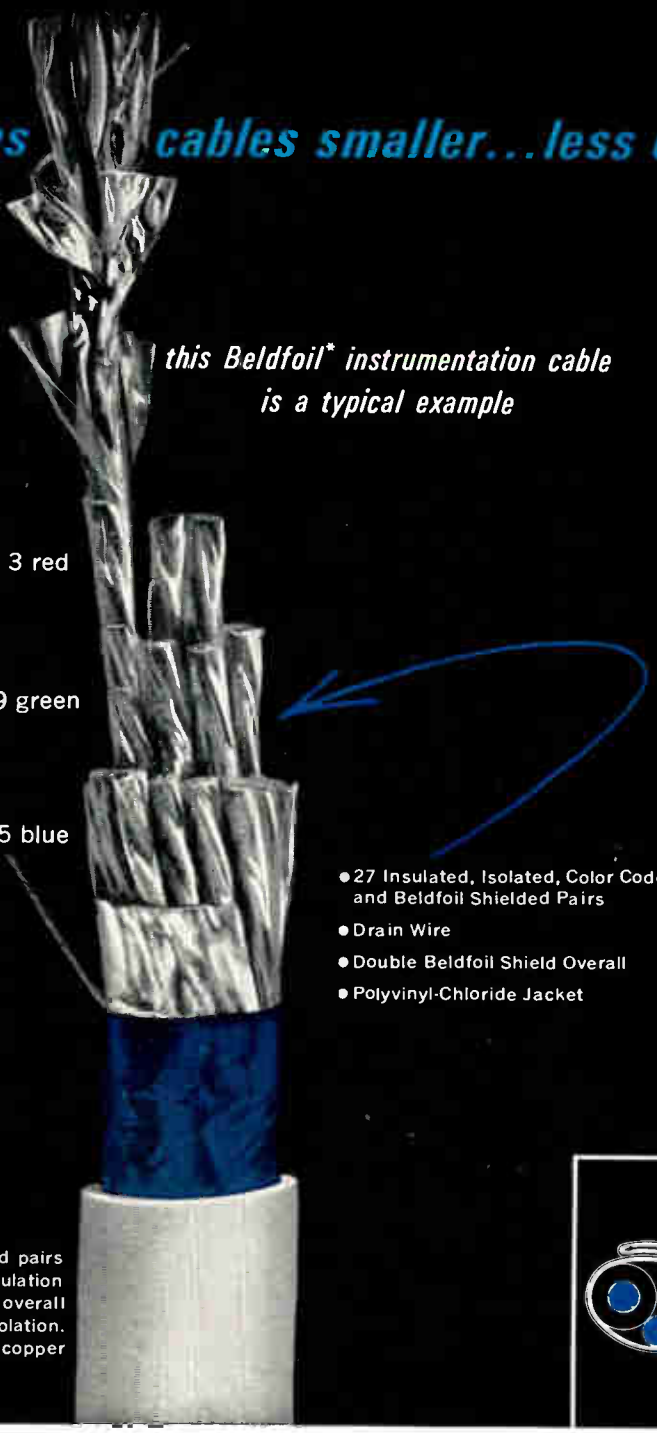
Stabilization Gyro

Data sheet C70 2316 001 describes an electrically torqueable, 2-axis free gyro. It provides a space-stabilization reference for uses in environmental extremes. Features: momentum, 700,000 dyne cm sec.; run-up time, 18 sec.; linearity, ±1%; scale factor, 0.1°/sec./ma (±1%). Gimbal freedom: 2 axis sensing with ±3° freedom on each axis. Kearfott Div., General Precision Aerospace, Little Falls, N. J.

Circle 267 on Inquiry Card

Complex? No!

BELDEN designs cables smaller...less complicated



Belden engineers have designed thousands of Beldfoil shielded cables similar to this one..special instrumentation, strain gauge, and control cables. They can and will design a smaller cable to reduce the size of your product..a less complicated cable that will do the same job better..or perhaps a single cable to do the job of two or more different cables. Many well-known manufacturers of specialized electronic products depend on Belden for special cable design. If a smaller, less complicated cable will improve your product..call on Belden.

*Belden Trademark Reg. U.S. Pat. Off. **du Pont Trademark

*BELDFOIL shielding is a lamination of aluminum foil with Mylar which provides a high dielectric strength insulation that is lighter in weight, requires less space, and is usually lower in cost. For multiple-paired cables with each pair separately shielded, the Mylar is applied **outside** with an **inward** folded edge. This gives 100% isolation between shields and adjacent pairs.

Write Belden Manufacturing Company, 415 South Kilpatrick Avenue, Chicago 80, for data sheet on Beldfoil shielding.

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 · CHICAGO

8-6-2

The Systems Engineering Section of ELECTRONIC INDUSTRIES

ELECTRONIC INDUSTRIES

ELECTRONIC SYSTEMS

TROPO SCATTER SYSTEM

Ace High, an 8300 mile communications system, consists of 82 stations, extending from Turkey to Norway. Almost 7000 miles of this telecommunications complex consists of tropospheric scatter radio equipment developed by Radio Engineering Laboratories. The tropo equioment has 60 voice channels in 680-970MC range.

The Army is testing a land-navigation system to assist forces in movements over difficult terrain. The LNS consists of power supply, gyrocompass, heading and position indicator, computer, and map-plotting board. The computer receives directions from the compass and distance from the vehicle's odometer. The map plotter shows the vehicle's position and direction with a lighted dot and an arrow.

A voice communication system, VCS-100B, used at missile launch sites or satellite tracking stations has been developed for Philco by Remanco, Inc. The central communication complex consists of three systems: an operational voice communication system; a voice paging system; and a terminating system. The VCS-100B has provisions for six networks, each of which operates as a separate party line with up to 50 participants.

An ATC system, which gives identification and location in three dimensions, has been ordered by the FAA. The Advanced Radar Traffic Control System (ARTS) is being developed by Univac. ARTS is a track-while-scan system. The exact position of each aircraft, as well as the predicted position prior to the next radar sweep, is displayed on a video screen. A total of 100 targets can be tracked at once.

A system which analyzes trapped electrons from nuclear blasts is helping scientists at Lockheed to understand the natural radiation in the Van Allen belts. A mystery of the belts is how electrons are lost. This is difficult to measure since natural radiation adds particles as they are lost. Man-made radiation adds no new particles. This radiation is measured and may supply the answer.

An airborne K_u-band beacon tracking-radar system, with a range of 50 nautical miles, is being developed for the Air Force by Cutler-Hammer Inc. System tracks and provides distance and angular measurements between an aircraft carrying the radar and one carrying a transponder. Range measuring accuracy is better than 0.1% of true range.

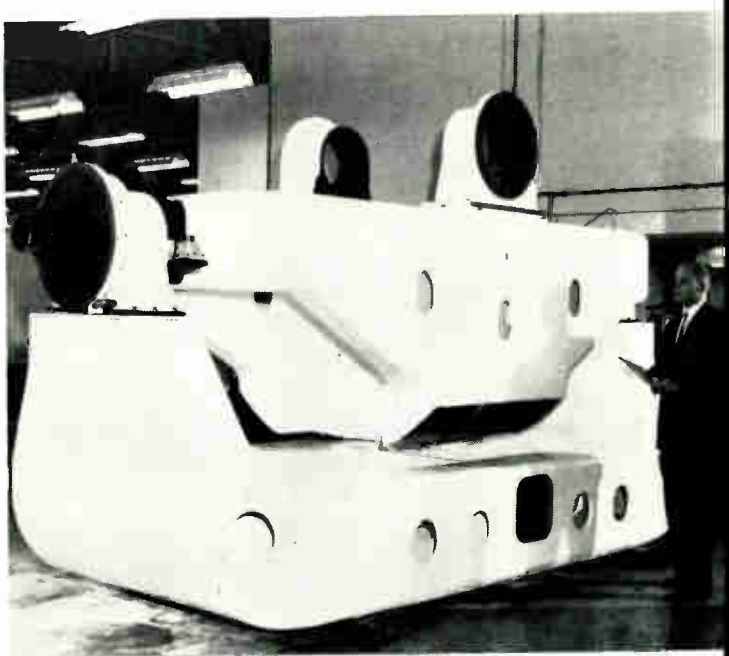
European investors keep up with American stock transactions by an intercontinental computer system. Quotron II, designed by Scantlin Electronic, Inc., gives split-second information on some 4000 listed and over-the-counter securities. It uses a pushbutton, desk-top interrogator which is connected to the Quotron computer center in New York via RCA TransAtlantic cable.

Audlok, a system designed to synchronize the broadcasting of TV pictures from widely separated remote locations, has been developed by NBC. Audlok takes a submultiple (below 5kc) of the 31.5kc synchronizing generator signal and transmits it, phase-controlled over an audio circuit, to a distant city. This controls the remote pictures so they arrive back at the originating city in precisely the same time phase.

Pittsburgh Steel is installing General Electric measurement and control system (GE/MAC) that will be used in connection with two new basic oxygen furnaces. The system includes indication, recording and control of basic oxygen-furnace parameters such as oxygen pressure and flow, lance height and cooling water, exhaust-gas temperature through spray-water cooling, and hot metal and steel temperature.

LIGHT TOUCH

A 25-ton gimbaled tracking mount, which points a 3500 lb. laser telescope system to an accuracy of 2 sec. of arc, has been built for NASA by Northrop. The massive mount members rest on hydrostatic bearings that permit the system to be moved with finger-tip pressure. Mount operates in both equatorial and X-Y modes.



Operational amplifiers are important in measurements and R&D work. Capable of simulating a variety of circuits, they can be used to add, subtract, differentiate, integrate or amplify either linearly or with controlled nonlinear coefficients, under signal conditions. Here is a chance to learn how they work.

UNDERSTANDING HIGH-SPEED OPERATIONAL AMPLIFIERS

Operational amplifiers are devices which make use of negative feedback to process signals with a high degree of accuracy. This accuracy is limited in the ideal case only by tolerances in the values of the passive elements in the input and feedback networks.

An operational amplifier is a high-gain amplifier designed to remain stable with large amounts of negative feedback from output to input.

General-purpose types are useful for linear amplification with precise values of gain, and for accurate integration and differentiation operations. These have low output impedance and are dc-coupled, with the output dc level at ground potential.

* * *

To obtain negative feedback from the output to the input, the output must be inverted with respect to the input. Negative feedback (Z_f, Fig. 1b)—through a resistor, capacitor, inductor, network or nonlinear impedance—is applied from the output to the input. The input to which negative feedback is applied is generally termed −input or −grid.

An operational amplifier, using negative feedback, operates like a self-balancing bridge. It provides whatever current is needed through the feedback element to hold the −input at null (ground potential). The output signal is a function of this current and the impedance of the feedback element.

The −input, held to ground potential by the feedback current, appears as a low impedance to any signal source. Using resistive feedback, for instance, the input appears to be the resistance of the feedback element, divided by the open-circuit gain of the amplifier.

If current is applied to the −input, it would tend to develop voltage across the impedance of the feedback element, and move the −input away from ground. The output, however, swings in the opposite direction, providing current to balance the input current and hold the −input at ground. If the feedback element impedance is high, the output voltage must become quite high to provide enough current to balance even a small input current.

Since, usually, we are concerned with voltage rather than current signals, an additional element is used in most applications; input impedance Z_i. This impedance, in series with the −input, converts into *current* that parameter of the input signal appearing as voltage at the output; Fig. 1c.

Voltage Amplifier

If Z_i and Z_f are both resistors (Fig. 2), the operational amplifier becomes a simple voltage amplifier, the gain of which is $-Z_f/Z_i$.

When a voltage is applied to A in Fig. 2, current flows through Z_i. Were it not for the amplifier, this current would also flow through Z_f and to ground through the low impedance at C; Z_i and Z_f would then operate as a voltage divider, raising the voltage at B. But, the amplifier serves to hold the voltage at B (−input) at ground potential. To insure such operation, the amplifier must supply a voltage at C so that current through Z_f exactly equals the current flowing through Z_i. When B is thus held at ground potential, the voltage across Z_i is obviously equal to the applied voltage at A.

The current through Z_i is equal to the applied voltage at A divided by the impedance (in this case, resistance) of Z_i, or E_{in}/Z_i. This identical value of current must flow through Z_f to keep B at ground. The voltage at C, then, must be E_{in}/Z_i (the value of current in Z_f) multiplied by Z_f. The output is inverted from the input; thus $E_{out} = (-E_{in})\left(\frac{Z_f}{Z_i}\right)$, and the voltage gain of this amplifier setup is $-Z_f/Z_i$.

Differentiation

Earlier, it was noted that an operational amplifier with a resistor as a feedback element responds with an output voltage equal to the product of the input current and the feedback resistance. Now let us see

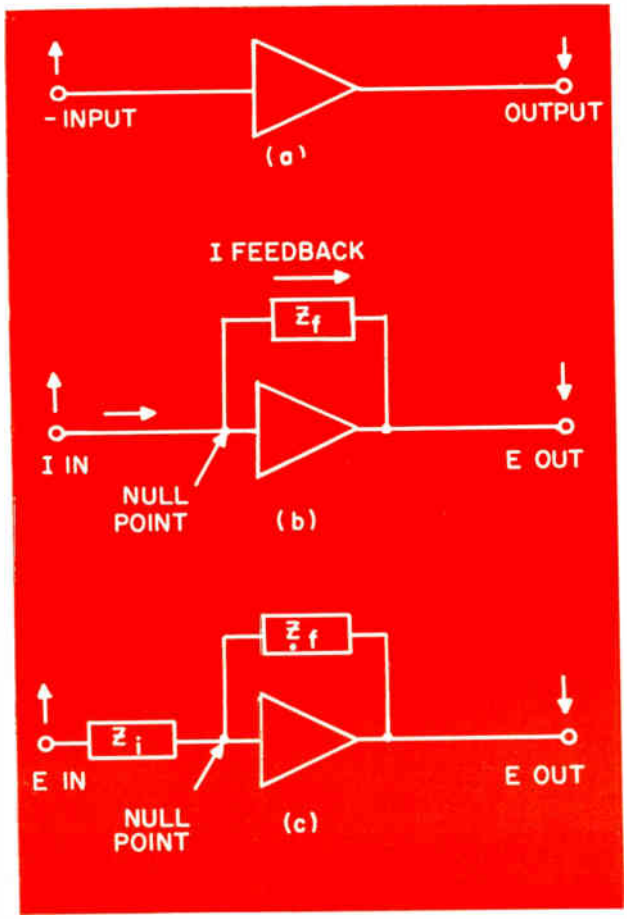


Fig. 1: Normal operational amplifier symbols are shown in (a.) The —input and output are out-of-phase (arrows). Feedback element Z_f is shown in (b). In (c) the input element Z_i converts a voltage signal (E_{in}) to current, balanced by current through Z_f.

Fig. 2: Operational amplifier, using resistors for both Z_i and Z_f, performing as a voltage amplifier.

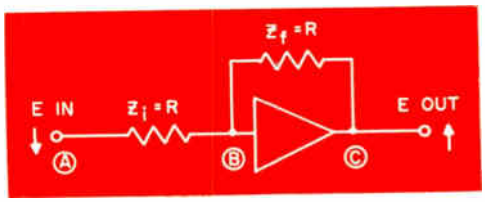
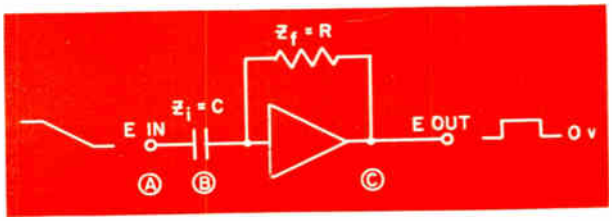


Fig. 3: Operational amplifier as a differentiator. Output here is proportional to the rate of change of the input voltage.



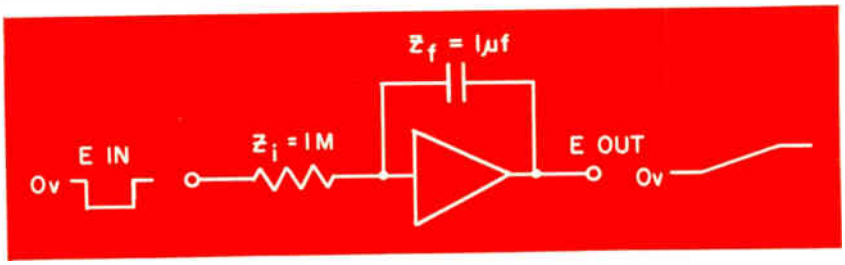
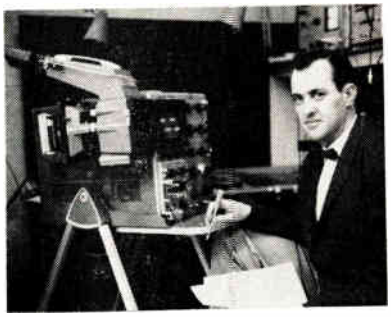
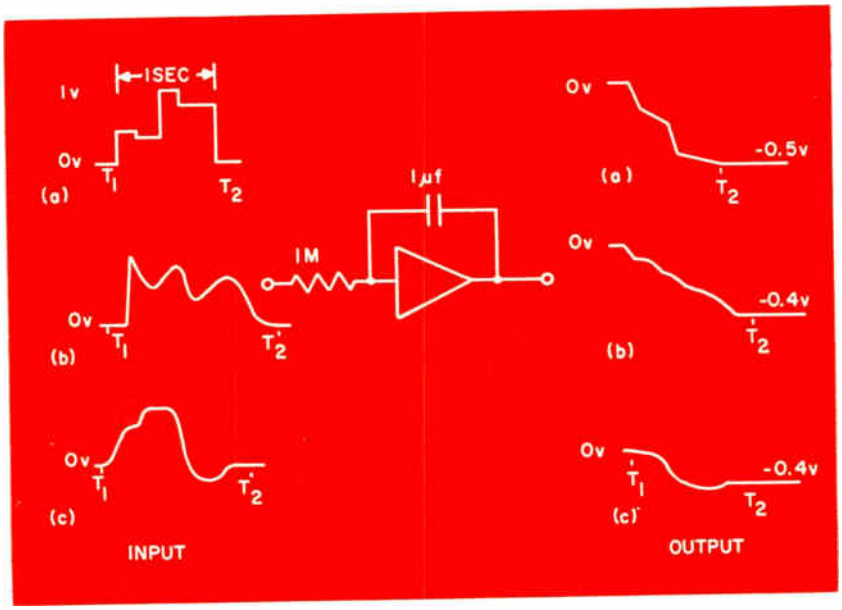


Fig. 4: Operational amplifier as an integrator (left). Output rate of change in this instance is proportional to the input voltage.

Fig. 5: Series of waveforms (right) integrated to determine "area under the curve" between T_1 and T_2. Note that in (c) the negative portion of the input waveform reduces the net integral.





By GEOFFREY GASS
Staff Field Engineer
Tektronix, Inc.
Beaverton, Oregon

what happens if a capacitor is used instead of resistor Z_i; Fig. 3.

The current through a capacitor is proportional to the *rate-of-change* of the voltage across the capacitor. A steady state dc voltage across a capacitor (assuming an *ideal* capacitor) passes no current through the capacitor, and thus no balancing current need be furnished by the output to hold the −input of the amplifier at ground. Output voltage then is zero.

If the voltage at the input is changed, however, the *change* causes a current to flow through the capacitor. Amount of current that flows is directly proportional to the capacitance times the *rate-of-change* of the input voltage.

To show this, let us assume that the potential at the input is +100 vdc, and it is changed smoothly to +95 vdc in 5 sec. This represents a rate-of-change of 1 v/sec, the change taking place over a period of 5 sec. If the value of Z_i is 1 μf, then, a current of −1 μa will flow through Z_i for that 5-sec period.

The amplifier will cause an equal and opposite current to flow in Z_f. If a value of 1 megohm were selected for Z_f, the 1 μa necessary to balance the circuit will require +1 v to appear at the output during the time 1 μa flows through the capacitor.

This operation is differentiation: sensing the rate-of-change of an input voltage, and providing an output voltage proportional to that rate-of-change.

The actual relationship of output to input is: $E_{out} = -\left(\frac{dE_{in}}{dt}\right)(RC)$, where the expression dE_{in}/dt indicates the rate-of-change (in volts-per-second) of the input signal at any given instant, and R and C are Z_f and Z_i, respectively.

In our example, a constant rate of change was used and a constant voltage level out was obtained. Had the rate been less even, the output signal would have shown this dramatically with wide variations in amplitude. The differentiator senses both the rate and direction of change. It is very useful in detecting small variations of slope or discontinuities in waveforms.

Integration

If the resistor and capacitor used for differentiation were interchanged, a resistor used for Z_i and a capacitor for Z_f (Fig. 4), the characteristics would be exactly opposite. While in differentiation an output voltage proportional to the rate-of-change of the input was obtained, by interchanging the resistor and capacitor, the output signal becomes a rate-of-change proportional to the input voltage.

This characteristic permits the use of the operational amplifier for integration. This is because the instantaneous value of the output voltage at any time is a measure of both amplitude and duration (up to that instant) of the input signal.

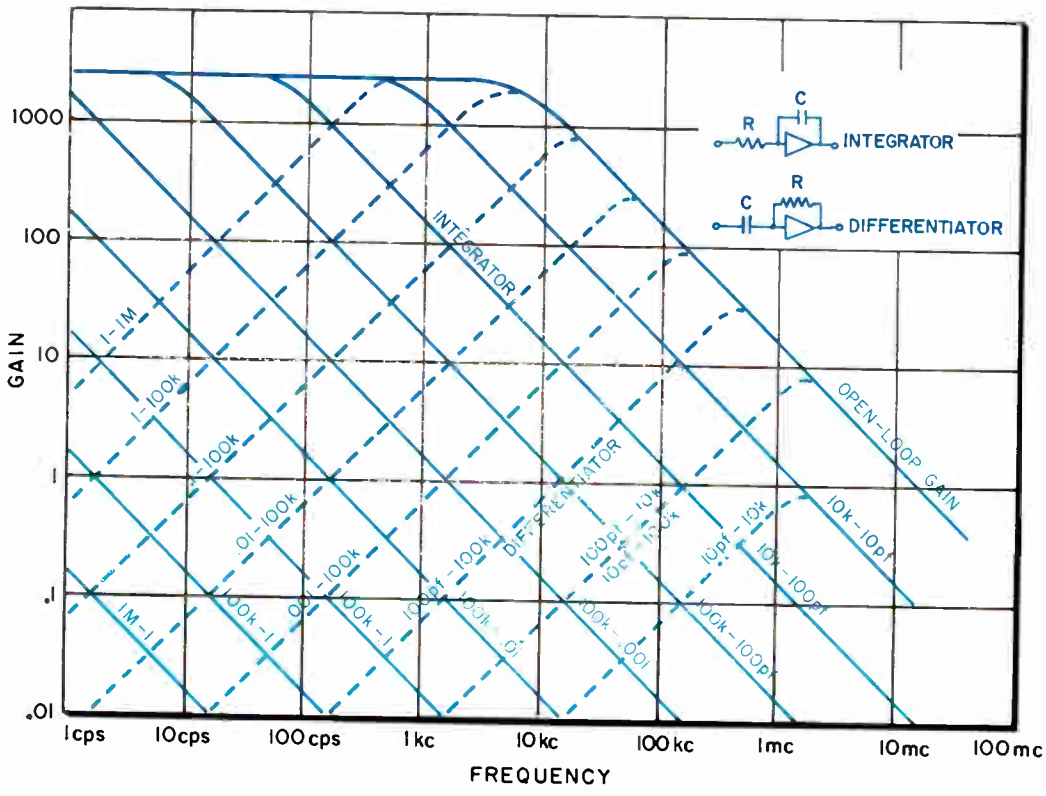


Fig. 6: Average gain characteristics for integration and differentiation.

Fig. 7: Operational amplifier driving tunnel diode with very low impedance (r). Diode, stabilized at high frequencies by rf-terminated jig, can be driven by a very slow ramp voltage. Linear drive of the tunnel diode allows differentiation of the current to obtain the di/de curve (see Fig. 8).

In the operational amplifier, integration operates in the following manner: Let us assume the conditions where $Z_i = 1$ meg, and $Z_f = 1$ µf, and the input signal level is 0 v. No current flows through Z_i; thus, no balancing current is needed through Z_f. Suppose now a dc voltage of −1 v is applied to Z_i. This will cause a current of −1 µa to flow in Z_i, and the amplifier will have to provide a balancing current through Z_f. To obtain a steady current of 1 µa through 1 µf, a continually rising voltage will be needed at the output, the rate of rise being 1 v/sec. This rate of rise will continue until the input voltage is changed, or the amplifier reaches its swing limit or approaches its open-loop gain.

This rate-of-rise, though helpful in understanding the mechanism by which the amplifier performs integration, does not provide the answer sought from an integrator. The significant characteristic is the exact voltage level at a certain time, or after a certain interval.

Before the amplifier reaches its output limit, suppose the input voltage to Z_i is removed. The output does not return to ground, but remains at the level it reached just before the signal was removed. Rate of rise has stopped, because the necessity for providing 1 µa through Z_f to maintain the null at the −input has been removed. With an ideal capacitor and amplifier, the output voltage would remain indefinitely at the last level reached, until an input signal of opposite polarity were applied to Z_i, and a negative-going rate-of-change at the output were needed to maintain the null at the −input.

Absolute integrator output level at the end of some interval is the sum of the products of each voltage applied to Z_{io} since the output was at 0, times the duration of each voltage, that sum divided by −RC.

The mathematical expression for the output level

reached in a given interval of time $(T_2\text{-}T_1)$ is:

$$E_{out} = \left(\frac{-1}{RC}\right) \int_{T_1}^{T_2} E_{in}\, dt$$

The integral sign indicates that the value to be used is the sum of all of the products $(E_{in} \times dt)$ shown, between the limits (T_1, T_2) noted. The expression dt shows infinitely small increments of time.

It is not necessary to understand and be able to manipulate expressions in integral calculus to make use of an operational amplifier integrator.

The integrator provides a voltage output proportional to the net number of volt-seconds applied to the input. If the total volt-seconds of one polarity is equalled by those of the opposite polarity, the output level at the end of the selected interval will be zero.

Typical integrator waveforms are shown in Fig. 5. An interesting example is shown in (c). Its 4 voltage levels, of different duration, cause the integrator output to fall at 4 different rates, reaching a final level representing the total number of volt-seconds contained in the waveform. It should be apparent that the integrator can measure the total volt-seconds contained in even the complex waveform of (b). Such a measurement would be difficult to make by direct waveform observation. This type of operation is often referred to as "taking the area under the curve," since the area underneath a waveform plotted against time (i.e., the area bounded by T_1, T_2, the waveform and the 0 v line) is the number of volt-seconds involved. Also, the instantaneous value of E_{out} at any time is proportional to the input volt-seconds up to that time.

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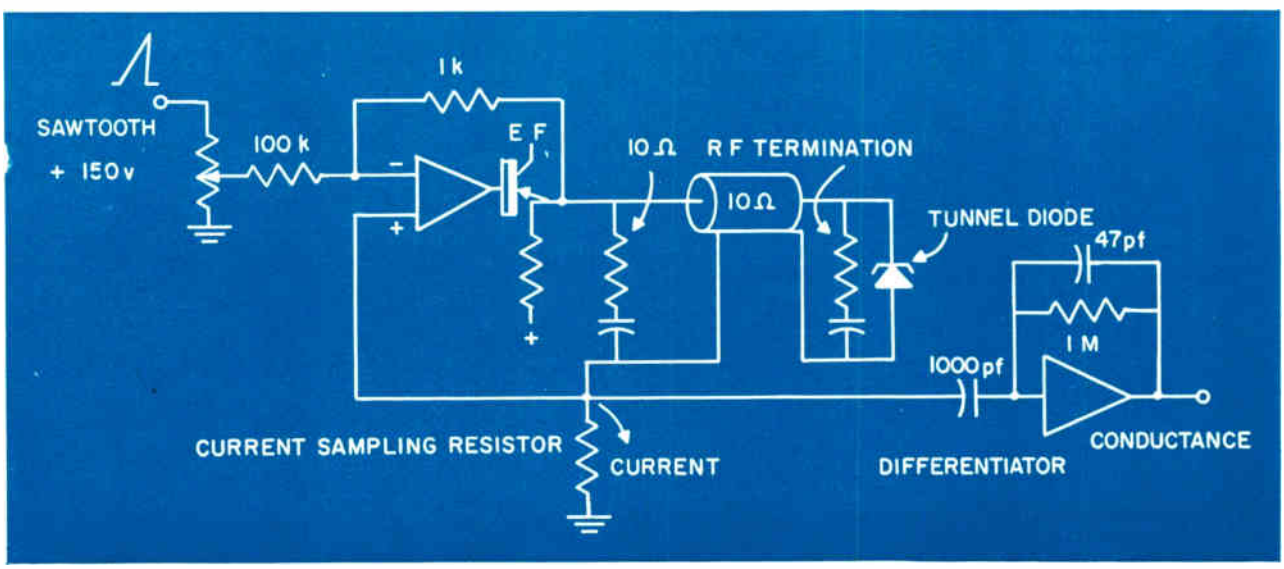


OPERATIONAL AMPLIFERS (Concluded)

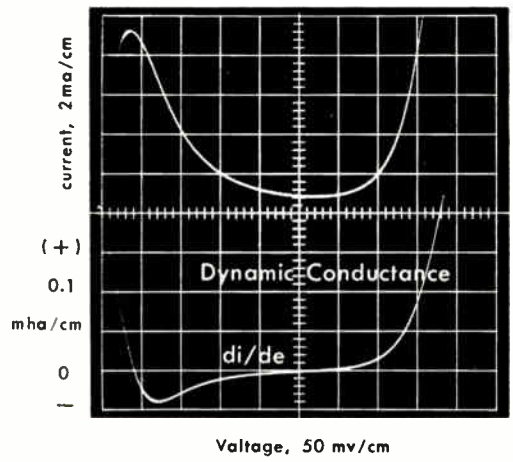
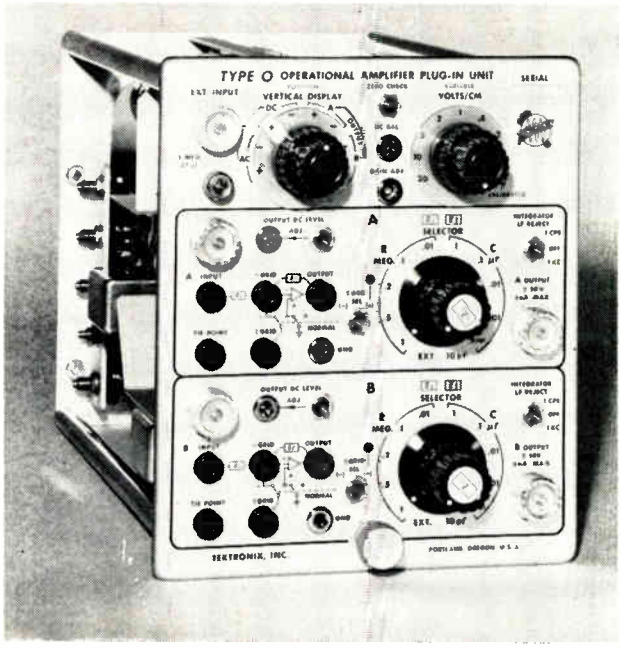


Fig. 8: Dynamic Conductance waveform.

In the cases used as examples, RC was 1 ($10^6 \times 10^{-6}$), and the numerical value of the output voltage at the end of the integrating interval was the number of volt-seconds in the input waveform. Using other values of R and C does require some added calculation. To find actual input volt-seconds, the output voltage must be multiplied by $(-RC)$. To illustrate, let us suppose R is 200,000, C is 0.01 μf and the output voltage, after the selected interval, is −2.5 v. Multiplying −2.5 by $(-2 \times 10^5 \times 1 \times 10^{-8})$ provides 5×10^{-3}, or 5 mv/sec positive polarity. Because of the polarity-reversal in the amplifier, it is necessary to multiply by $(-RC)$ to obtain the proper sign in the answer.

If a waveform to be integrated contains both + and − polarity portions during the integrating interval (d) in Fig. 5, the output will be proportional to the *difference* between the volt-sec-

Fig. 9: Tektronix Type O Operational Amplifier Plug-In Unit.



onds of each polarity, the integrator being an averaging device. To add the 2 polarities, instead of allowing them to be subtracted, precede the integrator with an absolute-value amplifier (full-wave rectifier) which inverts one of the polarities.

The operational amplifier is now being used not only as an electrical and electronic tool, but in control engineering and for mathematical studies.

As an electronic device, the amplifier can be used to make capacitance, resistance and impedance measurements. In solid-state fields, the amplifier has been used to study tunnel-diode performance through plots of E-I and di/de curves. Also, diode reverse leakage current can be measured and B-H curves plotted. Many sampled data studies can also be made: sampling and sampled-pulse integrations and differentiation.

Using semiconductors and tubes as external active elements, the amplifiers are also being used for a number of nonlinear functions: compression, expansion, root and power function, limiting, clipping and fast-response log-arithmetic amplification.

The amplifier can also be used to provide rate-intensification of oscilloscope traces for photography of transients. Other uses include dc-coupled current measurement and high-input impedance amplification.

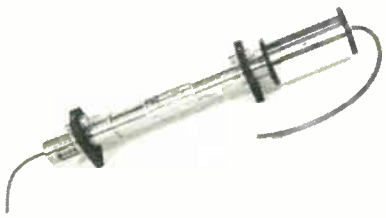
ELECTRONIC INDUSTRIES

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

LOW NOISE TWT

Operates in 2.0 to 4.0GC band. Min. small signal gain is 35db.

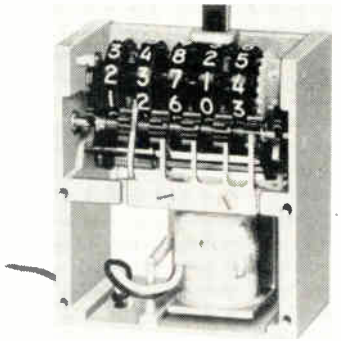


The HA-100B has a min. saturation power output of 1w. Low noise and high power output results in a wide range of linear operation. This reduces the effects of inter- and cross-modulation when multi-signal reception is experienced. In some systems, the tube eliminates one amplification stage normally required when a low-power, low-noise TWT is used. Tube Div., Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif.

Circle 130 on Inquiry Card

ELECTRIC COUNTER

For limited panel space; features foolproof resetting.

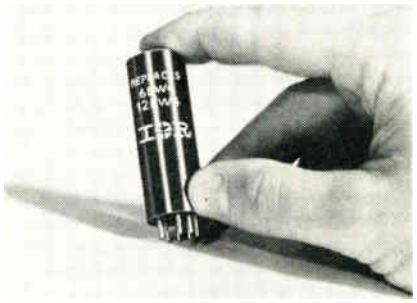


Model 5-Y-11479 is an open-frame electric counter. The major design highlight is the manner in which it resets. The pushbutton reset assures positive zero resetting. As the reset pushbutton is pressed initially, resistance is met. When force is applied to overcome this, it bottoms out, guaranteeing complete resetting. Available in 24vdc as a standard stock item. Max. speed is 1000 counts/min. Durant Mfg. Co., 685 N. Cass St., Milwaukee, Wis.

Circle 132 on Inquiry Card

TUBE REPLACEMENT

High-voltage silicon rectifier is equipped with tube base.

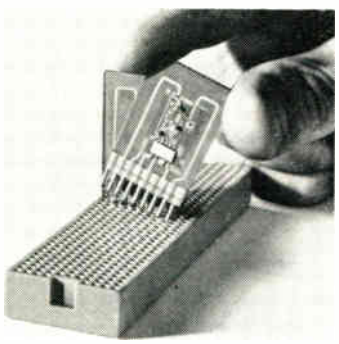


The ST-13 allows direct replacement, with suitable dropping resistor, of vacuum-tube types 6BW4 and 12BW4. It provides instant operation and requires no filament supply. It has a low operating temp., and shows no aging characteristics. The component is rated at 1600v. PRV, 1130v. max. RMS. Max. output current is 0.5 amp @ 100°C. Operating temp. range is −40°C to 140°C. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 134 on Inquiry Card

INTERCONNECTION SYSTEM

Saves from 3 to 10 times the space required for existing modular packages.

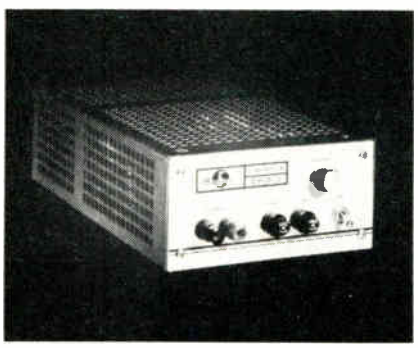


This new system uses thin-film deposition on a precision, moldable ceramic. The vitrified ceramic is molded with grooves that can house conventional connector contacts attached to the thin-film circuit. This makes the system pluggable into a motherboard. The system has high reliability. Active elements also are added to the circuitry as a secondary operation producing a hybrid device. The entire circuit is protected by a seal of transparent epoxy. Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 131 on Inquiry Card

DC POWER SUPPLIES

Max. output currents are 0.5, 1, 2, and 4a.

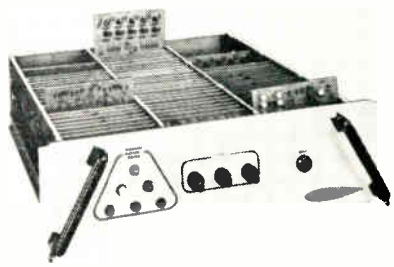


The QB-50 series consists of 4 units. All are rated at 50vdc. These models are available in 25, 50, 100 and 200w. Output can be adjusted over a 2:1 adjustment range. Regulation is within ±0.01% (line and load combined), and ripple is less than 300μv RMS. Transient response time of 25μsec. or less permits rapid recovery from abrupt changes in input voltage or output load. This provides a smooth, spike-free output. Sorensen, unit of Raytheon Co., Richards Ave., So. Norwalk, Conn.

Circle 133 on Inquiry Card

DATA TRANSMITTER

Has a parallel-to-serial converter and a vertical parity detector.



The model KD-5040 data transmitter scans input storage units for completed messages. On locating a loaded unit, it locks on and selects a transmission channel. The transmitter inserts various data into the message header and sequentially inserts control data in appropriate locations. The unit has a horizontal parity generator. Visual operating and fault indicators and internal fault-isolation circuits make it an ideal transmitting device for data-transmission subsystems. ITT Corp., 320 Park Ave., New York 22, N.Y.

Circle 135 on Inquiry Card

Need Potentiometers That Meet MIL-R-27208A?

Only Bourns Gives You All Four

MIL-SPEC STYLE RT10
Bourns TRIMPOT® Model 220

MIL-SPEC STYLE RT11
Bourns TRIMPOT Model 3010

MIL-SPEC STYLE RT12
Bourns TRIMPOT Model 224

MIL-SPEC STYLE RT22
Bourns TRIMPOT Model 3250

(units shown actual size)

	Model 220	Model 224	Model 3010	Model 3250
Resistances	100Ω to 30K	10Ω to 100K	10Ω to 100K	10Ω to 50K
Power Rating	1.0W	1.0W	1.0W	1.0W
Humidity-Proof	YES	YES	YES	YES

The TRIMPOT Division Environmental Laboratory is capable of performing tests to MIL-R-27208, MIL-R-22097 and MIL-R-12934.

These four potentiometers not only meet the specs, they beat the specs. All four have higher operating temperature, lower end resistance, better shock and vibration performance, lower temperature coefficient, higher dielectric strength and higher insulation resistance than the specs call for.

Where MIL-R-27208A sets a maximum operating temperature of 150°C, Bourns gives you 175°C. Where Mil Specs ask for 50G shock and 20G vibration, Bourns provides 100G shock and 30G vibration. Where Mil Specs call for a temperature coefficient of 70PPM max., Bourns offers 30PPM nominal and 50PPM max.

All four models exceed MIL-STD-202B, Method 106, for cycling humidity. In addition, all units have solid electrical grade-A nickel, gold-plated pins suitable for soldering or welding, and feature Bourns' exclusive, indestructible SILVER-WELD® termination.

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Circle 60 on Inquiry Card

NEW PRODUCTS

POWER SUPPLY

Has a ripple of less than 0.5% RMS with continuous 5a., 125v. load.

Model GFL has an output of 0-125vdc. It delivers up to 625w. of well-filtered dc power. Load regulation has an output voltage variation of 1.5v. for each ampere of load current or 6% of no-load voltage. The dc impedance is 1.5Ω for no-load to full-load service. Electro Products Laboratories, Inc., 6120 W. Howard, Chicago 48, Ill.

Circle 136 on Inquiry Card

FREQUENCY DISCRIMINATOR

Delivers output proportional to deviations in predetermined reference.

Model 790 is a Hall-effect, 60-cycle direct and continuous freq. monitor. The discriminator's output can be visually displayed or used in various methods of remote indication. Freq. fluctuations can be instantaneously recorded with an X-Y recorder. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 138 on Inquiry Card

IONIZATION CONTROL

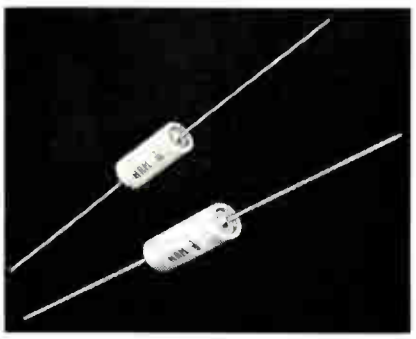
Continuous linear readout from 10×10^{-4} Torr to 2×10^{-10} Torr.

The RGS-6 control is a compact, solid state instrument. It provides continuous automatic linear readout, and has an emission regulator for good stability. Emission is variable from 10μa to 10ma. Pressure decade is indicated in an illuminated window. Vacuum-Electronics Corp., Terminal Dr., Plainview, L. I., N. Y.

Circle 140 on Inquiry Card

METAL FILM RESISTORS

Available in ⅛, ¼ and ½w. sizes; rated at 125°C; derated to 0w. at 175°C.



In the HRM units, the metal-film coated substrate is permanently protected by a hermetic sealing system free from mechanical and thermal stress. The metalized ends of the impermeable ceramic sleeve combine with a flexible diaphragm to provide a metal-to-metal bond. The bond responds to pressure differentials without compromising the seal or affecting resistive-element terminations. They are available in tolerances of 1%, 0.5%, 0.25% and 0.1%. Voltage coefficient is less than 5ppm/v. on all values. Resistance range of the ⅛w. unit is 30.1Ω to 301K. For the ¼ and ½w. units it is 49.9Ω to 1 megohm. Electra Mfg. Co., Independence, Kans.

Circle 137 on Inquiry Card

SERVOMOTORS

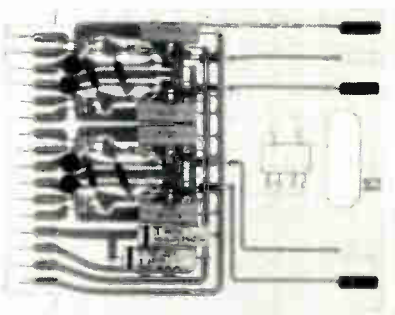
Two and 4-pole versions. Output ratings 0.5 and 1.25w.

These size 15 commercial servomotors are 60-cycle units. One is a 4-pole version with an output rating of 0.5w. and a stall torque of 1.5 oz.-in. The other is a 2-pole version with an output rating of 1.25w. and a stall torque of 1.4 oz.-in. Both have center-tapped control windings for use with push-pull servo amplifiers. Aluminum or stainless-steel housings and pinion or plain round output shafts are available. Both models have lifetime lubricated ball bearings, extremely uniform air gaps for high reliability, and class-B insulation to permit continuous operation in amb. from 0 to 55°C. Units may be servo-mounted or face-mounted. Singer Co., Diehl Div., Somerville, N. J.

Circle 139 on Inquiry Card

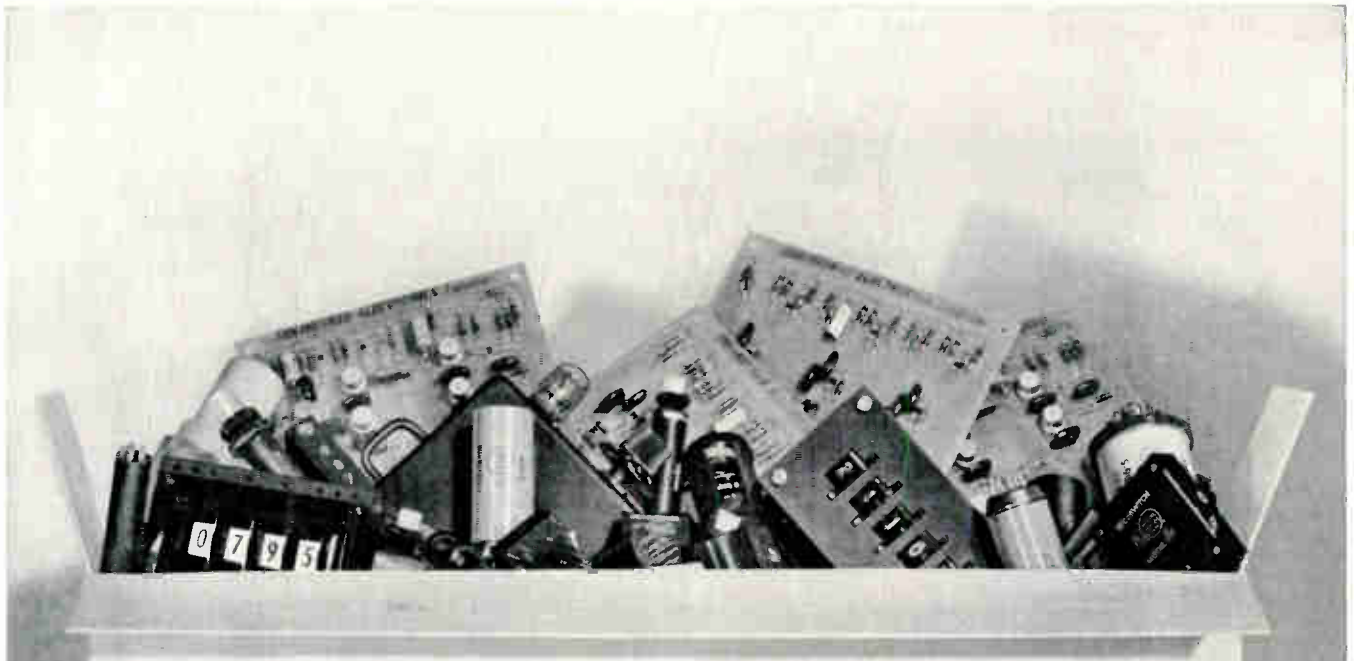
FLIP-FLOPS

May be set and cleared at a 25MC rate. Each output can drive 5 loads.



The type 2016 FF digital-logic circuit is a plug-in package. There are 2 independent FF circuits/card. Each FF contains 2 set and 2 clear diode inputs. The circuit consists of two 3-input cross-coupled NAND gates, each gate supplying 1 cross-coupling diode and 2 diode inputs. The FF is triggered by a positive-going pulse or level which is at least 10nsec. wide. Input and output characteristics are −6v. (±0.6v.) to ground (−0.5v.). Output-pulse rise time with 2 unit loads and 25pf shunt capacity is 8nsec. The fall time is 8nsec., and the delay time is 15nsec. max. Temp. range is −20°C to +50°C. Rese Engineering, Inc., A & Courtland Sts., Phila., Pa.

Circle 141 on Inquiry Card



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THOUSANDS OF PACKAGED ANSWERS TO YOUR SYSTEM DESIGN NEEDS

Make your block diagrams, and we'll fill your needs exactly from the industry's widest line of digital circuit modules. The design problems have been solved, the headaches eliminated, the performance proved. You save untold engineering hours and dollars. (And the circuits you use are guaranteed.)

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GERMANIUM-TRANSISTOR DIGITAL CIRCUITS (T- AND CT-SERIES)

T-Series units are in cylindrical packages, identical CT circuits on cards. Available in commercial and military versions. Write for Catalog T-113.

EXTENDED-SERVICE CIRCUITS—TO 10 MC (G-SERIES)

A family of economical, compatible transistor circuits on etched cards. Four frequency sub-groups: 0-100 kpps, 0-1 mpps, 0-5 mpps, 0-10 mpps. Get exactly the speed you want, pay only for the speed you need. Write for Catalog G-53.

UNIVERSAL NOR-NAND DIGITAL CIRCUITS (U- AND UC-SERIES)

Silicon-transistor modules in welded, transfer-molded, modular form or on circuit cards. Two frequency sub-groups: 0-1 mpps and 0-10 mpps. Units perform logic and active functions to 125°C.; cards exceed temperature requirements of MIL-E-5400F, Class II. Write for Catalog U-93.

TRANSISTORIZED DECADES (N-SERIES)

Miniaturized counters, converters, storage units in cans or on cards for medium-speed (250 kc) and high-speed (5 mc) application. Write for Catalog NR-13A.

MINISIG® TRANSISTORIZED INDICATORS (R-SERIES)

High-gain filament and neon indicators with built-in transistor driver-amplifiers. Principal use is to indicate signal levels or the state of storage elements. Cylindrical and rectangular packages. Write for Catalog NR-13A.

ROTARY THUMBWHEEL EECoSWITCHES AND ASSEMBLIES

Manually operated rotary switches with direct readout to coded electrical outputs—decimal, BCD, BCD with parity, many others. One-third the volume of conventional rotary switches. Exclusive detent makes accidental hang-up impossible. MIL-quality construction. More than 560 possible configurations. Write for EECo-SWITCH Catalog 014.

DIGITAL SYSTEM BREADBOARD EQUIPMENT

Fastest, surest way to breadboard digital systems. Available in standard and high-speed (to 10 mc) versions, portable and rack-mounted styles. Uses standard EECO modules, permits pushbutton tests at operating frequencies. Designer can hook up, take down or change circuitry at will, using patchcords and plugs. No soldering, no waste of time or materials. Write for T- or G-Series breadboard brochures.

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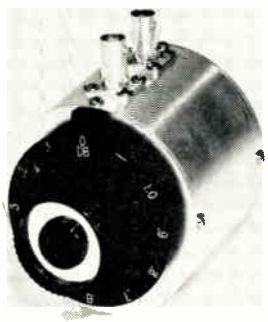
For Catalog T-113, circle 15 on inquiry card; for Catalog G-53, circle 16; for Catalog U-93, circle 17; for Catalog NR-13A, circle 18; for Catalog 014, circle 19; for breadboard brochures, circle 20.

NEW PRODUCTS

TURRET ATTENUATOR

Features tenth db stepping; operates in a freq. range of dc to 900MC.

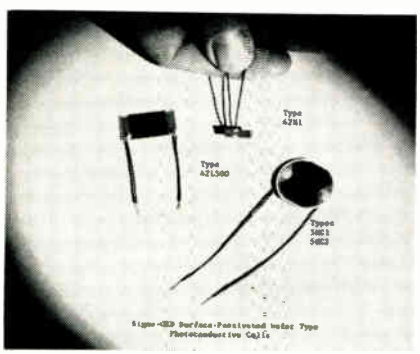


Model TC-50 provides precise attenuation by using resistive pi-pads mounted in a machined rotor assembly. The pads themselves use low-tolerance resistors to maximize accuracy of circuit values. The attenuator has a 50Ω input impedance and an insertion loss of approx. 1db. At 30MC the accuracy of the TC-50 is ±0.02db and its VSWR is 1.1:1. At 900MC these ratings are ±0.05db and 1.3:1 respectively. The r-f attenuator has a full range of 1db in steps of 0.1db. Telonic Industries, Inc., 60 N. First Ave., Beech Grove, Ind.

Circle 142 on Inquiry Card

PHOTOCONDUCTIVE CELLS

New surface-passivation process eliminates can packaging.

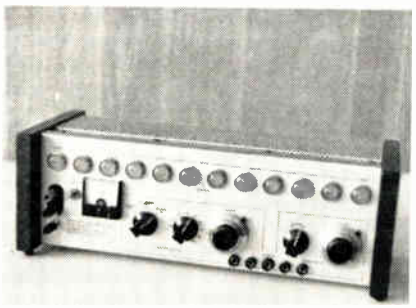


Two new series of high-reliability photocells feature unique wafer construction. This construction is possible because of a new surface passivation process, which is equivalent in effect to hermetic sealing. The space-saving chips are 0.150 x 0.500 x 0.15 in., ready for soldering to PC boards. The series 42 has a rise time from dark resistance (2.5 or 50 megohms) to 4 times saturated light resistance at 100 ft. candles of 1 msec. Power ratings are 75mw to 350mw. Sigma Instruments, Inc., 170 Pearl St., Braintree 85, Mass.

Circle 143 on Inquiry Card

SORTING VOLTMETER

Sorts components by voltage characteristics into 2 to 10 categories.

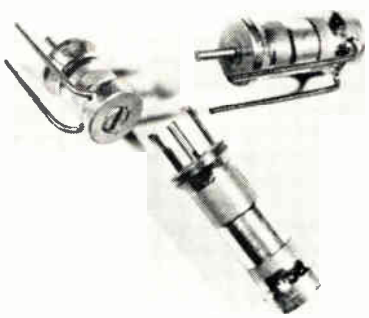


Each sorting decision made by the 35A10 is indicated by one of the 12 panel lamps. Classification categories as narrow as 100mv can be selected. Center and span voltages from 100mv to 1Kv. It may be used in automated inspection systems since electrical output of each decision and automatic programming inputs are provided. Accuracy is ±0.1%. Response time less than 200msec. Input impedance 16 megohms. A panel meter aids in initial programming. J. Omega Co., 2278 Mora Dr., Mountain View, Calif.

Circle 144 on Inquiry Card

TRIMMER CAPACITOR

Allows mounting printed-circuit board; permits vertical trimming.



All models of the Pin Terminal Mini Trimmer are 5/16 in. in dia. The 1 to 5pf model stands 0.480 in. above the board; the 1 to 10pf model stands 0.680 in.; and the 1 to 14pf model stands 0.870 in. It features a direct traverse tuning mechanism. This gives completely linear, precision tuning with capacitance change of 0.4-0.6pf/turn, and a guarantee of no capacitance reversals. It has a dcwv of 750v. and dielectric strength of 1500v. Q factor at 50MC is 500 min. Operating temp. is −55° to +125°C. Corning Glass Works, Corning, N. Y.

Circle 145 on Inquiry Card

CRYOGENIC TRANSDUCER

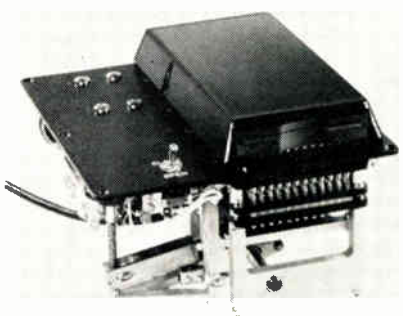
Operates at −320°F. Static error band ±1.0%; temp.-error band, ±3.0%.

The Model 426 absolute pressure transducer is now available in an optional design capable of cryogenic operation. A flexure-pivot supported wiper is driven directly by the pressure capsule. This eliminates friction-producing bearings and complex multiplying linkages. The optional cryogenic design uses special materials almost insensitive to temp. Specs: ranges, 0-15 to 0-200psia or psig; operating temp., −320 to +165°F; vibration, 10g. Bourns, Inc., Instrument Div., 6135 Magnolia Ave., Riverside, Calif.

Circle 146 on Inquiry Card

MULTIPLE CONTACT SWITCH

Programming device performs thousands of control functions.



The card-actuated multiple-contact switch, model No. 540, is punched-card controlled. It performs thousands of complicated switching and control functions which were previously done by hand operation or tape-control methods. It is 9¼ x 8⅜ x 7 1/16 in. deep and can be mounted anywhere because of its remote control features. The switch has 540 contacts. This allows new applications in machine programming, missile and aircraft check-out equipment, etc. Switch Div., Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle 147 on Inquiry Card

DC-TO-50 MC, 10 MV/CM

Solid-State Oscilloscope

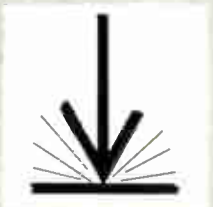
for accurate, reliable measurements . . . even in difficult environments.

The type 647 Oscilloscope and plug-in units add new convenience to display and measurement of high sensitivity, wide-band, dual trace applications.

Adaptable and versatile, the oscilloscope retains accuracy, within stated specifications, *under extensive temperature variations . . fluctuating line voltages . . difficult conditions.*

TEMPERATURE

Non-Operating —55 °C to +75 °C. Operating —30 °C to +65 °C.



SHOCK

Non-Operating 20 G's max, 2 shocks, each direction, along each of 3 major axes.

HUMIDITY

Non-Operating meets Mil-Std-202B, Method 106A, except freezing, vibration, through 5 cycles (120 hours).

VIBRATION

Non-Operating or Operating 0.025" pk-pk, 10-55-10 cycles, (4 G's max), 1 min cycles, 15 min each major axis.

ALTITUDE

Non-Operating 50,000 ft. Operating 15,000 ft. 50-to-400 cps line freq.

Type 647 Features

with 10A2 and 11B2 Plug-In Units

- 100 v—130 v line voltage. No calibration changes with line fluctuations. 50-to-400 cps line frequency. Low power—185 watts, approximately. Convection cooled—no fan needed.
- Dual-trace operation. 10 mv/cm sensitivity. Dc-to->50 Mc passband. Less than 7-nsec risetime.
- 6-cm by 10-cm display area. Internal, no-parallax graticule. Controllable graticule illumination. 14-kv accelerating potential.
- Bright line automatic triggering. ÷10 external trigger attenuator, (on main time-base triggering). 'Ground' input positions on each vertical channel.
- 2 time bases, independent triggering. Sweep rates to 0.1 μsec/cm. 10X sweep magnifier.
- Sweep delay 50 sec to 1 μsec. Single-sweep operation. Wideband (>50 Mc) triggering. External horizontal input.
- 1-kc voltage calibrator, (crystal controlled). Push-button trace finder. Dc-coupled Z-axis amplifier. Current-probe calibrator.

Type 647 Oscilloscope (without plug-ins)	$1225
Type 10A2 Dual-Trace Unit	$675
Type 11B2 Time-Base Unit	$825
2 P6008 Probes	$ 70

U.S. Sales Prices f.o.b. Beaverton, Oregon

Dual-trace display shows input and output pulses of an amplifier at 10 nsec/cm—with trigger source from channel 2 only, for convenient and accurate time relationship between traces. Upper trace is amplifier output. Lower trace is applied step function.

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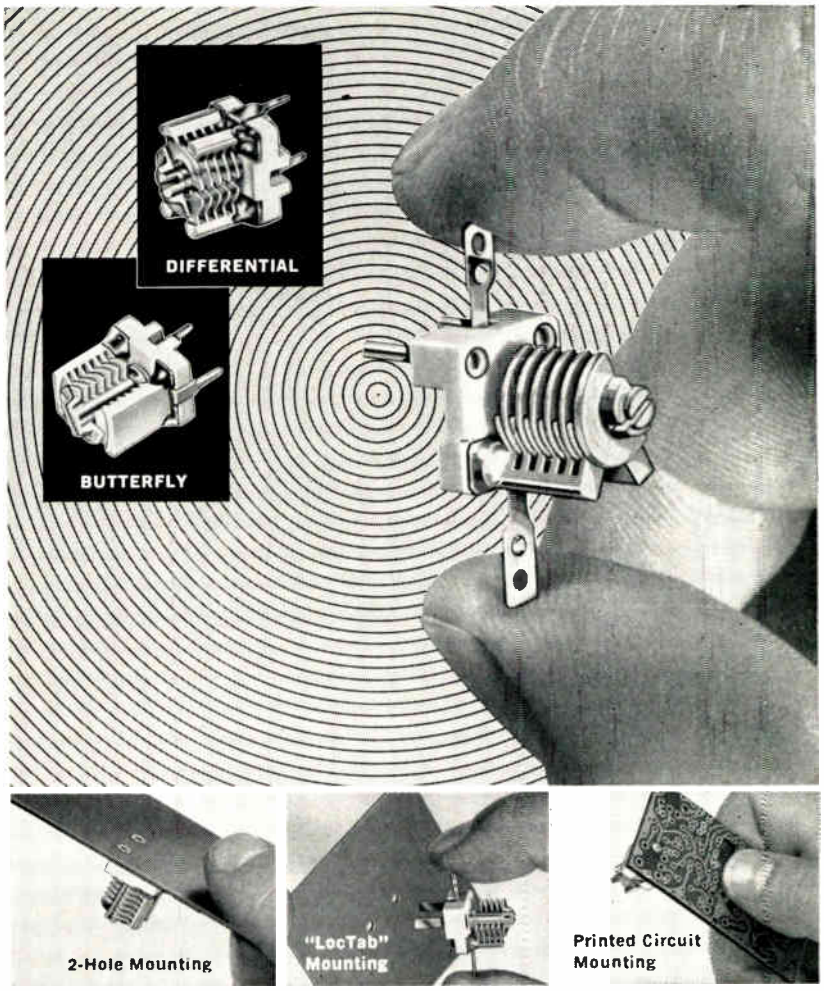
Cut costs — save valuable space with these

SUB-MINIATURE "U, UA, and UB" AIR VARIABLES



Precision machined for high reliability—exceptional mechanical stability!

• HIGH "Q" – GREATER THAN 1500 AT 1 MC! • HIGH TORQUE-TO-MASS RATIO – 2½ TO 10 INCH OUNCES!
• LOW TEMPERATURE COEFFICIENT – PLUS 26 ± 20 PPM/° C!

Cut costs—improve performance—save valuable space with these sub-miniature air variable capacitors! Type "U" requires less than 0.2 square inch for chassis or panel mounting — Types "UA" and "UB" require less than 0.23! No special tools required for installation — slotted rotor shaft accommodates large screwdriver. Rotors and stators precision machined from one piece of solid brass — provide outstanding mechanical stability. Units offer high "Q" (greater than 1500 at 1 mc.), high torque-to-mass ratio, and low temperature coefficient — provide absolute freedom from moisture entrapment found in trimmer capacitors of the enclosed or solid dielectric type.

All metal parts are silver-plated — ceramic is steatite Grade L-4 or better. Exceptionally uniform delta C and voltage characteristics . . . voltage breakdown ratings available to 1300 volts DC. Single Section types available in three fast, easy mounting styles: "Loc-Tab", Printed Circuit and Two-Hole — Differential and Butterfly types available only in Printed Circuit mounting styles. Tuner (coil-capacitor) assemblies available in production quantities to your specifications.

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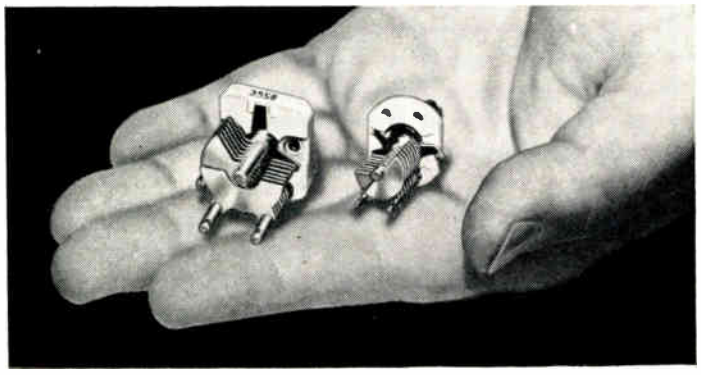

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TYPE "M" AND "S" MINIATURE CAPACITORS – Slightly larger than the "U" and "UA" Types, still excellent for use in compact equipment. Soldered plate construction, heavily anchored stator supports. DC-200 treated steatite insulators. Plates are nickel-plated brass. Available in Single Section, Butterfly, and Differential types with straight, locking and screwdriver shafts. "S" also available in Dual type.

NEW PRODUCTS

MC AMPLIFIERS

Band-pass, 100KC—150 MC. Output, 6v. p-p into 50Ω @ 10MC.

These solid-state units feature wide response and high output. Impedance is 50Ω in and out with noise and hum of 12μv RMS equivalent input. Three different gains available are 20, 40, and 60db nominal. Amplifiers are packaged as signal chassis only (3000 series) and complete amplifier and power supply in an instrument case (4000 series). C-COR Electronics, Inc., P.O. Box 824, State College, Pa.

Circle 234 on Inquiry Card

CERAMIC HEADERS

High alumina ceramic for packaging transistors and other components.

These ceramic headers are available with copper or kovar flanges, with terminations of kovar, and a wide range of nickel alloys. The metallized pads are finished for soldering. Thermal resistance is 6°C/w. using 0.060 in. thick ceramic. Min. spacing without electrical leakage between conductive areas is 0.010 in. Precision helium leak detector testing assures hermetic seals on all units. Centralab, The Electronics Div. of Globe-Union Inc., P. O. Box 591, Milwaukee, Wisc.

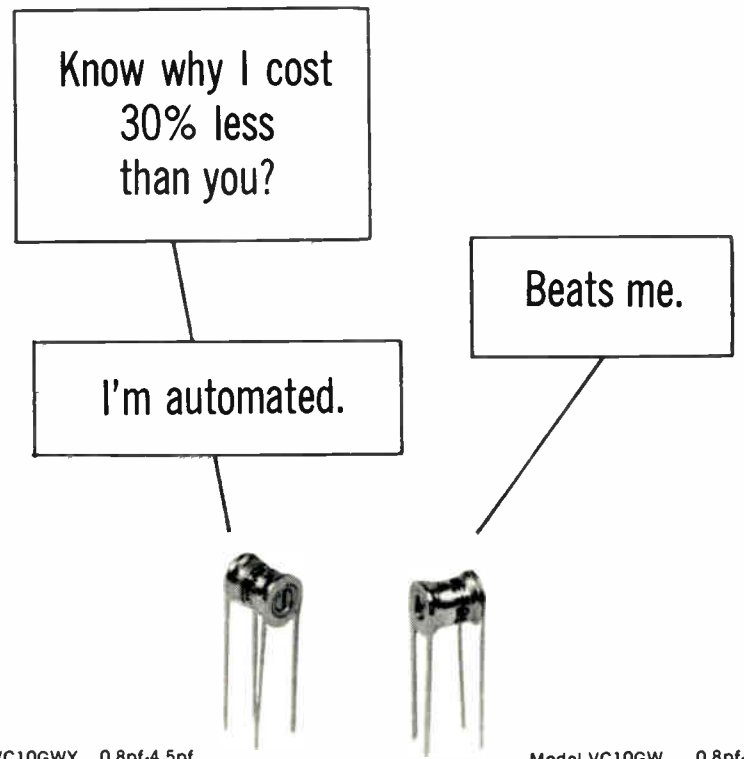
Circle 235 on Inquiry Card

DC POWER MODULES

Short-circuit protection guards against short or overload conditions.

These silicon modules operate at 71°C amb. Remote sensing provides rated regulation at the load, while remote programming allows voltage adjustments without touching the supply. Modules are available in outputs ranging from 3vdc @ 1.5a. to 50vdc @ 150ma. Trygon Electronics, 111 Pleasant Ave., Roosevelt, N. Y.

Circle 236 on Inquiry Card



Model VC10GWY 0.8pf-4.5pf
ACTUAL SIZE

Model VC10GW 0.8pf-4.5pf
ACTUAL SIZE

Specify JFD "Y" Hi-life® trimmer capacitors and save 30 per cent—with increased reliability!

Automated production along with new design advances reduce JFD "Y" piston trimmer costs **30** per cent below those of competitive capacitors. "Y" trimmers capacitors also offer the unique HI-LIFE adjust mechanism which guarantees an adjustment life of 500 cycles*—**600** per cent greater than Mil-C-14409B requirements plus . . .

Features: ■ Special process glass dielectric for high stability over a wide range of operating temperatures (—55°C to 125°C) ■ High Q factor—500 measured at 1 MC ■ Ultra linear tuning with no reversals ■ Fine multi-turn adjustment for increased sensitivity and excellent resolution ■ Space-saving telescopic tuning assembly with little, if any protrusion of adjustment screw for compactness ■ Anti-backlash design maintains its setting despite shock and vibration and gives smooth uniform tuning adjustment.

JFD "Y" trimmers are available in panel mount and printed circuit types—as well as Sealcap, Max-C, split stator, or differential, glass or quartz construction. Special "Y" trimmers can be custom-made to your specs, too. Ask your distributor or write us for Bulletin "Y".

*MIL-C-14409B specifications define a cycle as four complete revolutions in the direction of increasing capacitance and four complete revolutions in the opposite direction.

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Postcard valid 8 weeks only. After that use own letterhead describing item wanted. 1-A EI-09 FEBRUARY 1964

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- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machines.
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- ☐ Mfr. of electronic components, parts, tubes and like products.
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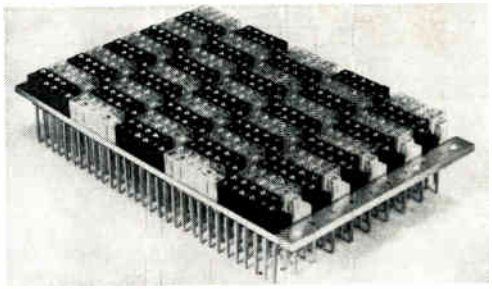

SERIES 5406 Receptacle for a Southern Manufacturer.

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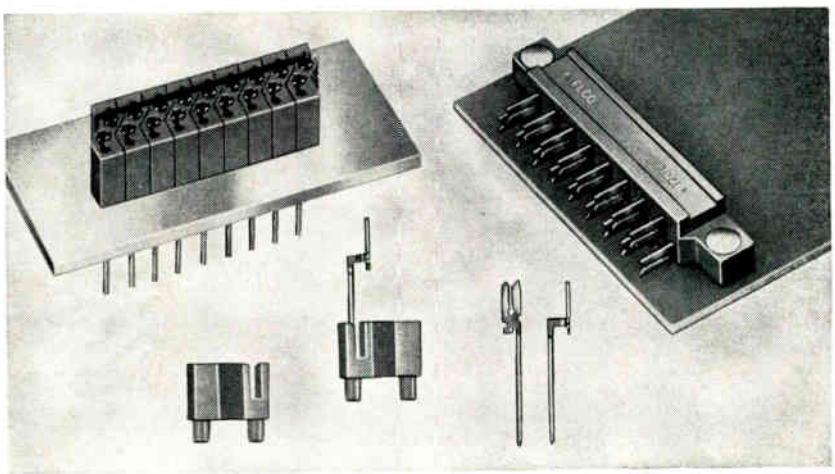
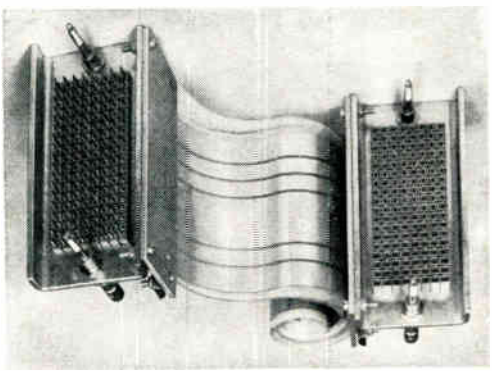
miniature connectors for programmed or hand wire wrapping at .200" sq. grid

SERIES 5501 designed to mate with our 7021 and 7022 module card plugs.



SERIES 5408 Rack-and-Panel Receptacle for an Eastern Manufacturer.

SERIES 5405 Ribbon Cable for a Mid-Western Manufacturer.



Through the use of the new ELCO VARIPLATE* connector, any number of connectors, each with its own complement of contacts, can be constructed on the same distinguishably patterned base plate. The added speed and efficiency of programmed wiring elevate this modularly designed family to new levels of performance and versatility. Series 5501 employs the reliability-proven ELCO VARICON* contacts; other Series shown utilize the equally reliable ELCO VARIMATE* contacts. Send for Bulletin 5501 and other literature to learn how these remarkable new building blocks are applicable to your own sophisticated design parameters and techniques.

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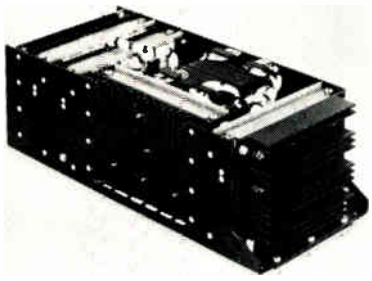
MAIN PLANT AND OFFICES, Willow Grove, Pa., 215-659-7000, TWX 510-665-5573; ELCO PACIFIC, W. Los Angeles, Cal. 90064; ELCO MIDWEST, Chicago, Ill. 60645; and Licensees, Distributors, Importers, Representatives Throughout the World.

NEW PRODUCTS

MEMORY SYSTEM

Operates in severe environments. Read/write cycle, 4.5μsec.



The SEMS-IR is a miniaturized, random-access, airborne core-memory system. Operating temp. is −25°C to +75°C. The 4096-word by 32-bit memory is available in 2 modular welded-circuit packages. One has plug-in module interconnections for field maintenance, and the other has welded module interconnections for max. reliability and package density. Electronic Memories, Inc., Hawthorne, Calif.

Circle 205 on Inquiry Card

TRIODE-PENTODE

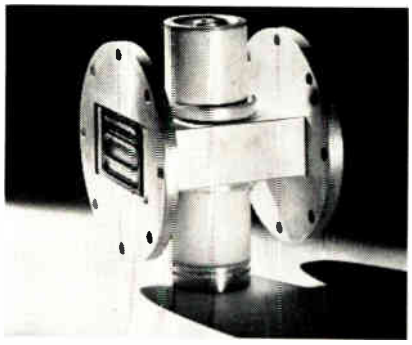
Combines a 5w. audio output pentode and voltage amplifier triode.

The type 6T9 Compactron has a seated height of 2 in. and a dia. of 1.188 in. Significant ratings of the pentode section include 12w. plate dissipation and 6,500 micromhos transconductance. The triode has an amplification factor of 90 and transconductance of 3,000 micromhos. Max. ratings for the pentode: E_p, 275v.; E_{sg}, 275v.; screen dissipation, 2w. For the triode: E_p, 300v.; plate dissipation, 1.2w General Electric, Schenectady 5, N. Y.

Circle 206 on Inquiry Card

WAVEGUIDE SWITCH

Gives 30db isolation when open and 0.2db loss when closed.

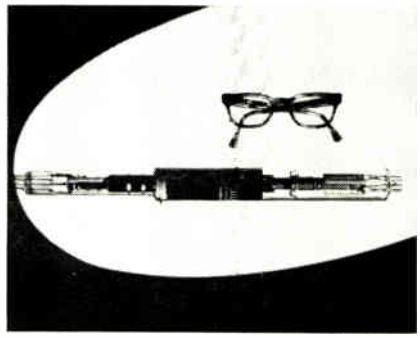


The KU901 is a high-powered broadband waveguide switch. It operates by interaction of electromagnetic wave with a confined hydrogen plasma. The C-band switch has applications in duplexers, eliminating spike voltage; in high-power pulse-width modulators and shapers; and in ring resonators. It has been tested and operated in a SPST circuit at 1megawatt peak and a 0.001 duty factor. Metal-to-ceramic construction permits operation at high amp. temps.; max. seal temp. is 250°C. Switching time is 80nsec. ITT Corp., 320 Park Ave., New York 22, N. Y.

Circle 212 on Inquiry Card

STORAGE TUBE

Uses fiber optics to couple the writing and reading sections.



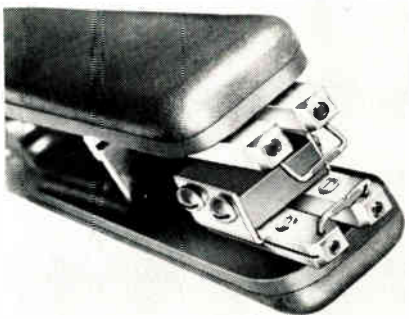
Type WX-4640 is a compact dual-gun scan converter. The converter stores a min. of 7 gray scales. It permits simultaneous writing and reading with enough persistance to preserve a full display of slow-scan or radar-sweep data. The input may be cut off and the last frame read for ½ hr. at standard TV frame rates. Live or tone displays may be completely or partially erased selectively or in total. It uses magnetic deflection, electrostatic focus writing gun; and a magnetic focus and magnetic-deflection reading gun. Westinghouse Electronic Tube Div., Elmira, N. Y.

Circle 213 on Inquiry Card

NEW PRODUCTS

WIRE STRIPPER

Strips thermoplastic insulation neatly and rapidly from finest wires.

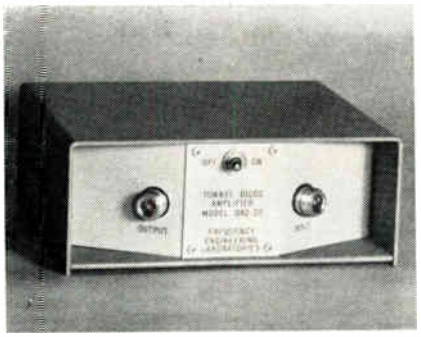


This 5 in. long, 4 oz. stripper features nickel-chrome stripping elements that are flattened and notched. It strips wires even in recessed or crowded areas. It has adjustable wire-stop for accuracy and a spring-guide assembly guarantees tool geometry. Anti-fatigue grips are soft neoprene sponge that stay near room temp. Wassco Glo-Melt Div., American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich.

Circle 214 on Inquiry Card

TUNNEL-DIODE AMPLIFIER

Operates at 1485 megacycles and 2250 megacycles.

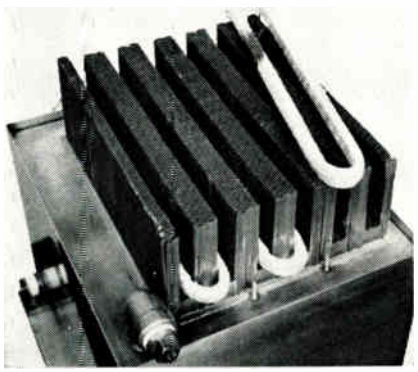


Gain on this tunnel-diode amplifier is 15db min. and noise figure is 5db nominal. Saturation level is +20dbm for 1db compression, and VSWR is 1.3. Both units use their own power source and are fitted with type-N connectors. These broadband devices are suitable for use in countermeasures receivers, broadband communication systems, and telemetry. Frequency Engineering Laboratories, Farmingdale, N. J.

Circle 216 on Inquiry Card

CLEANING TRANSDUCER

Spaced-lamination design doubles efficiency.

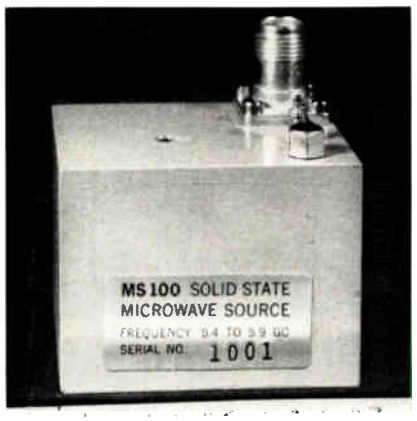


An ultrasonic cleaning transducer, Magnapak Mark II, gives high cleaning capability and production rates. The unit covers the bottom of the tank. Thus cleaning power is distributed evenly throughout the solution. The design gives higher watts/sq. in. density capability. It uses a double-channel core with open ends to provide more efficient and higher amplitude ultrasonic vibration. Westinghouse Electric Corp.'s Industrial Electronics Div., Baltimore, Md.

Circle 215 on Inquiry Card

SOLID-STATE KLYSTRON

C-band unit is mechanically tunable through 5.4—5.9GC.



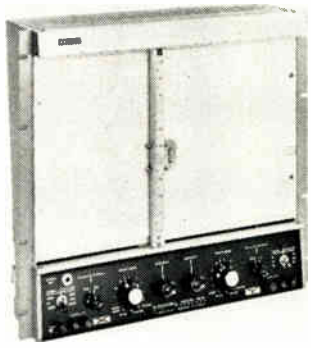
The MS 100 is voltage tunable over a 1% bandwidth. It uses high reliability transistors and varactor diodes. It measures 6 cu. in., and weighs less than 10 oz. Minimum output power is 10mw with spurious noise 60db down over the rated freq. It is more than 50db down outside the range, operating with a 2 to 1 mismatch. Fairchild Semiconductor, div. of Fairchild Camera and Instrument Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 217 on Inquiry Card

NEW PRODUCTS

X-Y RECORDERS

Input resistance 1 megohm at null on calibrated input ranges.

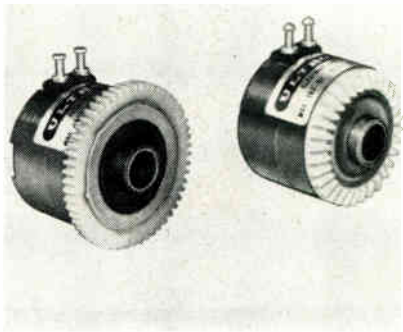


Models 135A and 2D-2A X-Y recorders are available with a 1 megohm input resistance. Each recorder operates from 0.5mv/in. (0.2mv/cm where applicable) to 50v/in. (20mv/cm) in eleven ranges. Stepless range controls permit arbitrary full-scale range setting with 100,000Ω input resistance at null on four most sensitive ranges, and 1 megohm at null on all other ranges. F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Cal.

Circle 227 on Inquiry Card

MINIATURE CLUTCHES

Minimum torque ratings of 10 oz.-in. at speeds to 1000 RPM.



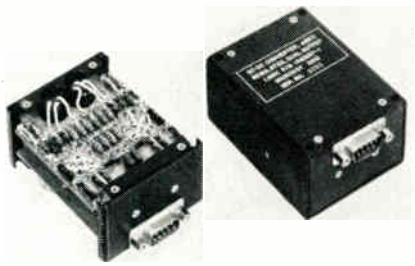
Models 162-B1 and 162-S1 operate in 6, 12, 28, and 90v. ranges at 2.5w. Torque loss with stainless ball bearings is less than 1 oz.-in. Field shaping and the steel-to-brass face enable the magnetic clutches to deliver 15 oz.-in. A 120% overvoltage is permissible for 50% duty cycle. Applications include the driving of potentiometers, servo balance units, remote controls and speed changes. Ultronix, Inc., 111 E. 20th Ave., San Mateo, Calif.

Circle 228 on Inquiry Card

NEW PRODUCTS

DC-DC CONVERTER

Provides highly regulated, isolated dual outputs of 28vdc at 50ma.

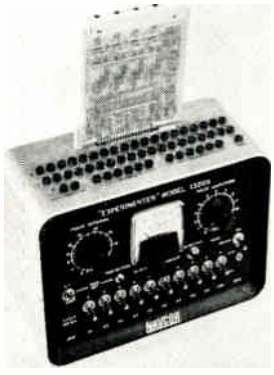


Model 1U110 is a 28v. dc-dc converter. Provides a highly regulated output from a battery input of 22 to 29.5vdc with up to 3v. p-p noise. The unit is protected against both short circuits and reverse polarity. Regulation is ±0.5%; ripple is limited to 10mv p to p. Microdot Inc., Magnetics Div., 5960 Bowcroft St., Los Angeles, Calif.

Circle 193 on Inquiry Card

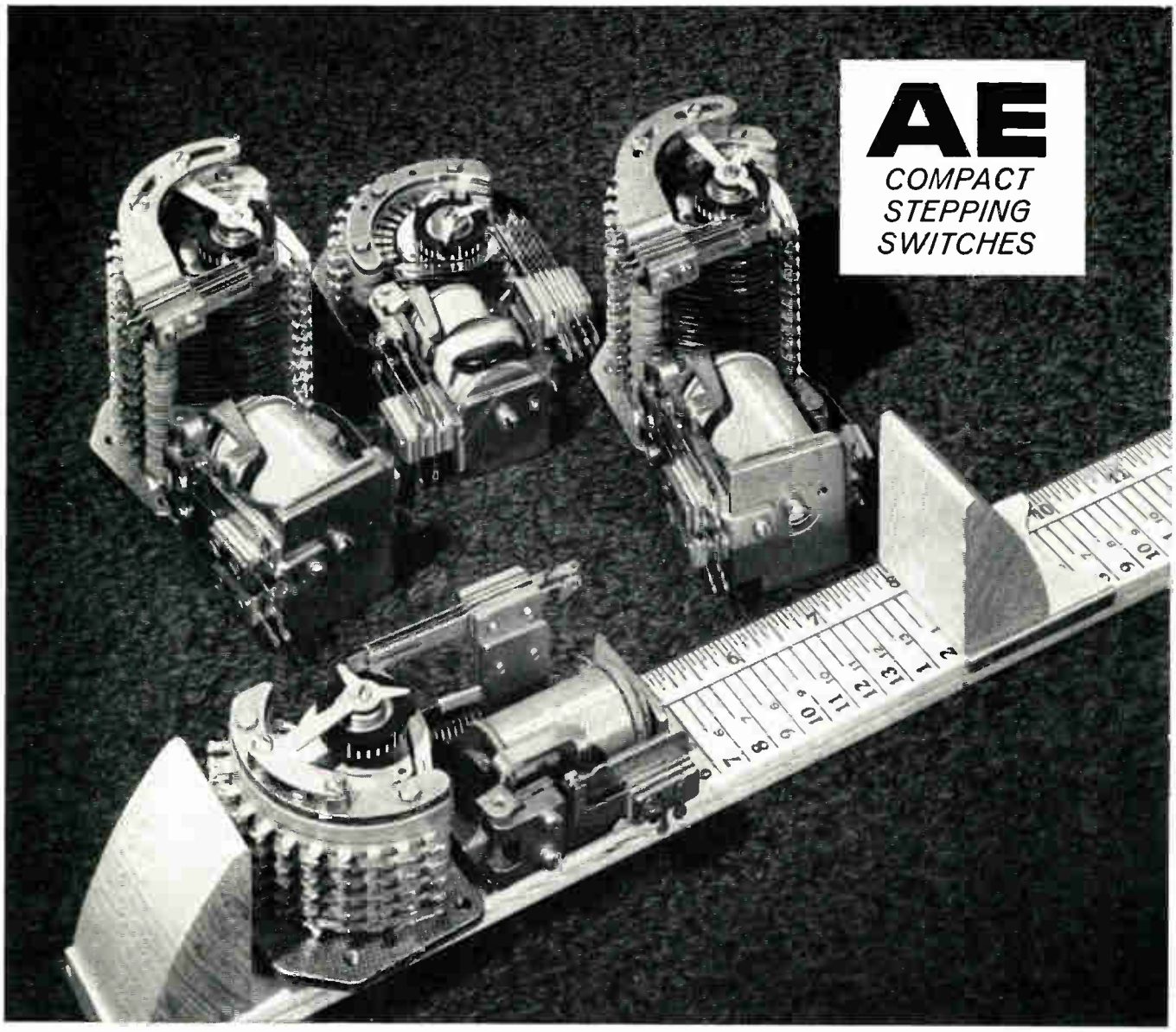
MODULE EXPERIMENTER

For the study, design, test, and demonstration of digital logic modules.



The Navcor Experimenter, Model 1320B, is a general-purpose laboratory instrument. The all-semiconductor unit provides all the voltages and waveforms necessary for designing and testing transistor switching circuits. Coupled with the 400 Series of systems function modules, the portable unit enables logic designers to save time by simulating and testing the design of complex logic configurations before committing them to operational systems. A squarewave generator with a variable freq. of 5 to 500KC produces 2 squarewaves of opposite polarities. Navigation Computer Corp., Valley Forge Industrial Park, Norristown, Pa.

Circle 194 on Inquiry Card



Four compacts to fill big shoes

If you're in search of a switch to handle a large transfer, cycling or counting job in a small space, you can count on one of AE's four compacts to do the job. For instance, the stepping switches, from left to right in the photo, have these features:

Type 40 (in foreground) is no larger than a pack of king-size cigarettes. It is a decimal switch with up to five bank levels, but only 10 points per level, so no extra steps must be taken when counting decimally.

Type 80 is a larger-capacity version of the Type 40, with from six to twelve 10-point levels.

Type 44 is available with up to eight 10-point levels (with 11 points on all levels where specified).

Type 88 is a larger-capacity version of the Type 44, with from six to twelve 10-point levels (with 11 points on all levels where specified).

All four AE compact steppers offer *positive positioning*—an exclusive design feature that makes overthrow impossible, and *locks* the rotor in the correct position.

AE compact stepping switches are available in numerous variations, many directly from stock.

For full information, ask for Circular 1698-K. Write to the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

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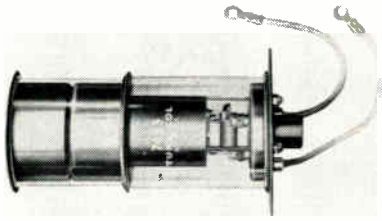
NEW PRODUCTS

HYDROGEN THYRATRON

Functions as inverse clipper in line-type radar modulators.

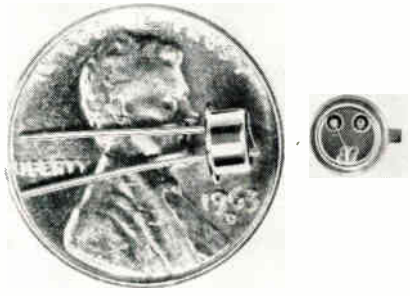


The zero-bias, short-ionization time thyratron clips at a switch-tube level of 35 megawatts in line-type modulators. Heater current is 20a. with 5.0v. heater voltage. Absolute max. ratings include inverse dc anode voltage of 33kv; peak continuous cathode current, 800a.; peak fault cathode current, 2,900a; peak grid trigger current, 15a. Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N. J.

Circle 191 on Inquiry Card

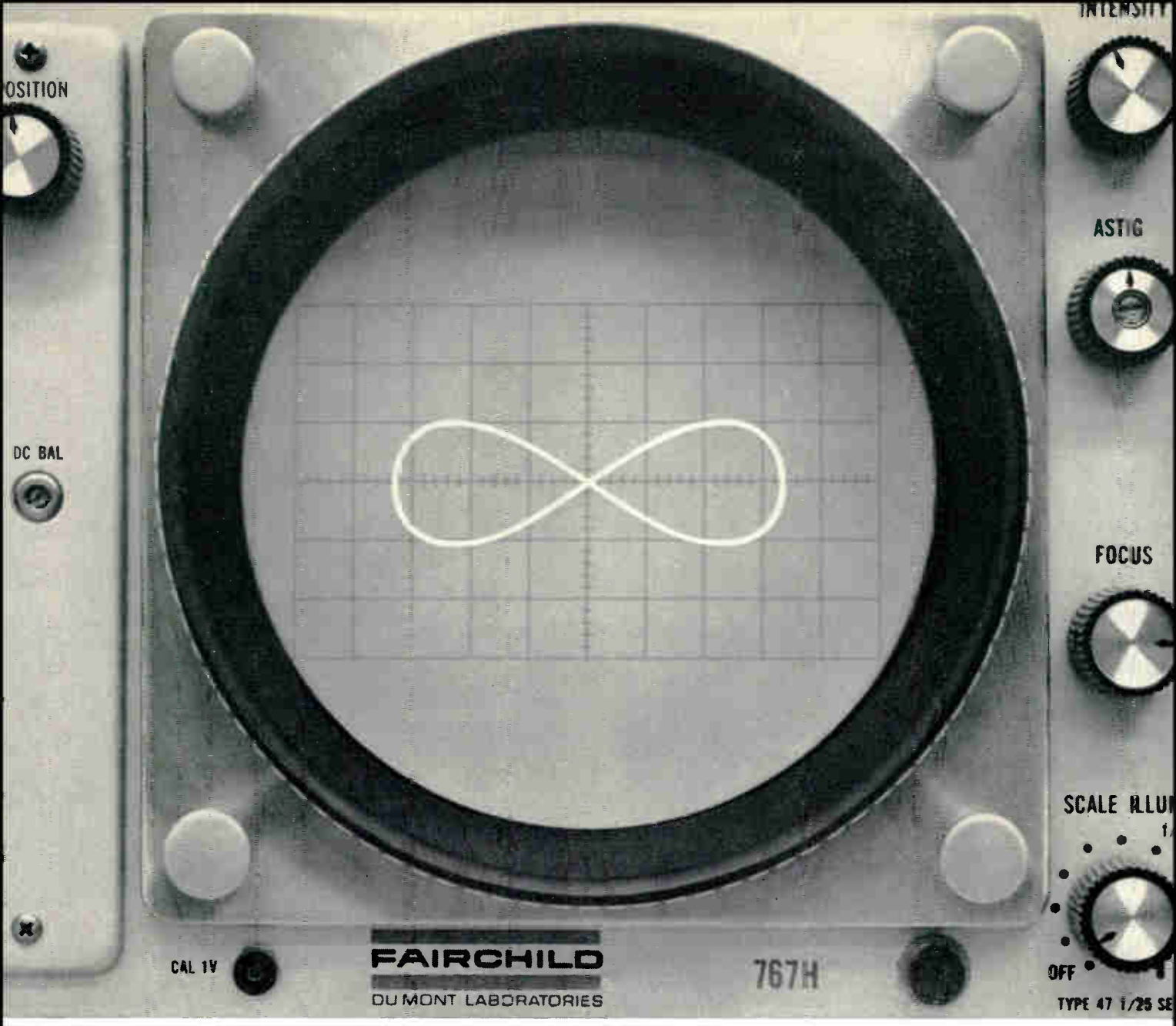
SEMICONDUCTOR LASER

Nsec. response time affords modulation bandwidth in 10MC range.

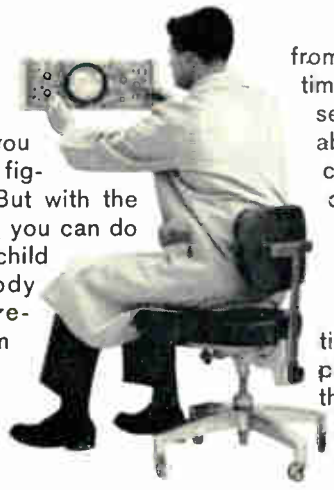


This semiconductor laser, combined with a pulse-freq. modulator, provides a low-noise, line-of-sight voice communications device. The GaAs unit uses multilayer dielectric coatings to give guaranteed threshold current densities of less than 2000a/cm² at 77°K. Pulse freq. modulation technique eliminates shielding the receiver from amb. light. Threshold current is 6a. or less at 77°K and at 100 pps. Spectral output at 77°K is 8400 Å to 8450 Å, depending on power dissipated at the junction. The linewidth ranges from 8 Å at threshold to about 25 Å at 5 times threshold. Korad Corp., 2520 Colorado Ave., Santa Monica, Calif.

Circle 192 on Inquiry Card



Versatility Almost Unlimited



The capabilities of Fairchild's solid-state Series 765H scopes aren't quite infinite (although you can set up this Lissajous figure for fun or profit). But with the many plug-ins available, you can do more with a single Fairchild scope than with anybody else's. For example, frequency may range from DC to 100 mc (3 db down), sweep rates from 5 nsec/cm to 1 minute, rise-times to 3.5 nsec. All Fairchild 765 series plug-ins are interchangeable; among other things, you can get single or multiple X-Y displays by using identical plug-ins in both compartments simultaneously. The main frame of the new 765H series is available in three configurations: bench, rack, and the compact Portascope®. There is also the militarized Portascope. Versatility? Almost unlimited. For more information, write for the Fairchild Instrument Catalog, or ask a field engineering office for a demonstration; there's one in your area. Fairchild Scientific Instrument Dept., Section 42, 750 Bloomfield Ave., Clifton, N.J.

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Circle 76 on Inquiry Card

NEW PRODUCTS

OPTICALLY FLAT CRT

Minimizes parallax error and maintains good deflection sensitivity.

Type M1156 has a shortened tube length and a 3-in. optically flat face. It has high resolution and is electrostatically focused and deflected. It uses past acceleration to optimize light output and maintain good deflection sensitivity. Under normal operating modes, it is capable of better than a 4 mil-spot size at 10 ft.-lamberts. It has high light output and high resolution, making it suitable for digital read-out systems. Electronic Tube and Instrument Div. of General Atronics Corp., 1200 E. Mermaid Lane, Phila. 18, Pa.

Circle 187 on Inquiry Card

LOW-RESISTANCE BRIDGE

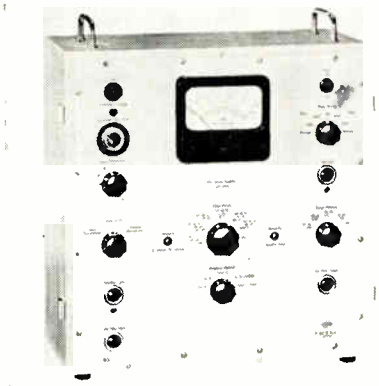
Measures switch contact and connector resistances in 1 milli-ohm area.

Model 209 Portable Kelvin Low Resistance Bridge detects resistance variations on the order of one microhm. Range is 0 to 11Ω in five ranges. Accuracy at bridge current of 1a is ± 0.2% + 1 dial division + 10 micro-ohms. A one decade switch and a 105 division interpolating rheostat provide 1050 dial divisions of resolution. Readings are presented in a straight line with a permanent decimal point located between the dials. A multiplier switch selects 5 ranges of 1000, 100, 10, 1 and 0.1. ESI-Electro Scientific Industries, 13900 N.W. Science Park Dr., Portland, Ore.

Circle 188 on Inquiry Card

VOLTMETER/AMPLIFIER

Accuracy, 0.5db from 10 to 200,000 CPS. *Sensitivity 100μv full scale.*



Model 2604 is a multi-purpose instrument for measuring sound and vibration. Readout is in RMS, absolute average, or instantaneous peak values. Two different meter-averaging times are available: 0.3 sec. and 1.0 sec. The amplifier signal-to-noise ratio is better than 55db at full scale (wideband) for 60db amplification. Max. gain is 100db (100,000x) and the input range is variable in 10db and 20db steps. Output voltage is 10v. at full-scale meter deflection; output impedance is 50Ω. B&K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

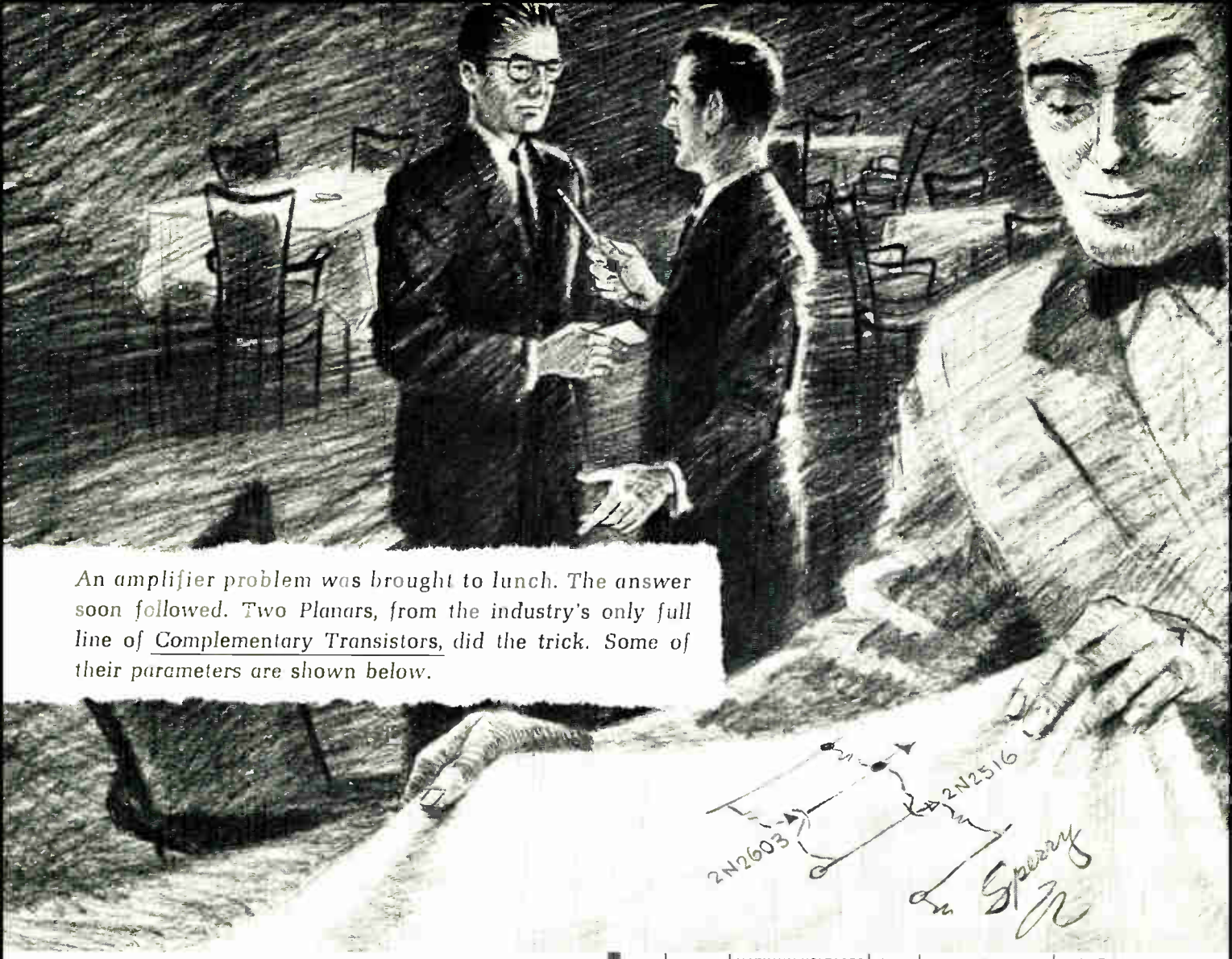
Circle 189 on Inquiry Card

COUNTER-TIMER

Measurement ranges are dc to 50MC; accuracy, ±1 count.

Model 727D solid-state counter has in-line Nixie readout, display storage (memory), floating input with respect to ground, and dc amplifiers. Trigger level error is less than 1μsec. It combines the functions of a counter, time interval meter, and freq./period meter. It has 3 input channels; modular construction is used throughout. Heterodyning techniques are not used. Power consumption is 75w. Computer Measurements Co., San Fernando, Calif.

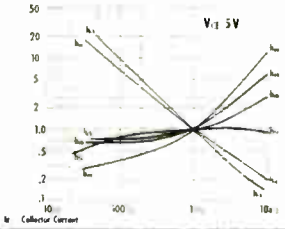
Circle 190 on Inquiry Card



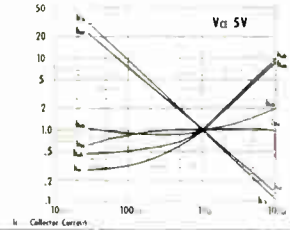
An amplifier problem was brought to lunch. The answer soon followed. Two Planars, from the industry's only full line of Complementary Transistors, did the trick. Some of their parameters are shown below.

"h" Parameters vs. I_c Normalized to I_c = 1 MA

NPN 2N2459-2N2466



PNP 2N2590-2N2593



21234

	TO-46 Case	MAXIMUM VOLTAGES BV_{CBO} (Volts)	BV_{CEO} (Volts)	BV_{EBO} (Volts)	I_{CSO} Max. @ 25°C (μA)	h_{FE} Min.	Max.	@ I_C (mA)	V_{CE}(SAT) Max. (Volts)	f_T Typ. (MC)
NPN	2N2460	100	60	8	.002	70	130	5	0.3	200
PNP	2N2591	—100	—60	—7	—.025	70	135	—5	—0.4	100
NPN	2N2461	100	60	8	.002	120	180	5	0.3	225
PNP	2N2592	—100	—60	—7	—.025	115	200	—5	—0.4	125
NPN	2N2462	100	60	8	.002	170	230	5	0.3	250
PNP	2N2593	—100	—60	—7	—.025	160	275	—5	—0.4	150

Ideas happen anywhere. When a good engineer sinks his teeth into a problem, he doesn't let go until he comes up with an answer. ☐ Our complementary transistors have provided many answers to circuit problems – they help you increase performance with same power (or cut power requirements); reduce number of stages; improve high density packaging. ☐ By manufacturing the industry's first full line of complementary transistors, (not just selecting a PNP that is close to an NPN), Sperry Semiconductor again demonstrates its leadership in PNP low-level silicon devices. Our record of reliability validates our *credentials for the future*. Question them, inspect them, use them – they can help on your military projects and in your industrial control work. Whether you need volume production or personal attention in custom engineering – contact us. It costs you no more to buy from the leader of PNP small signal silicon transistors. ☐ Eastern Regional Office: 69 Hickory Drive, Waltham, Mass.; Midwest Regional Office: 3555 West Peterson Avenue, Chicago 45, Ill.; Western Regional Office: 1680 North Vine Street, Hollywood 28, Calif. Sales Representatives: Orbit Electronics, 250 Carroll Street, Fort Worth, Texas; Perrott Associates, Incorporated, 2321 East South Street. Orlando, Fla. ☐ *Keep in touch – with SPERRY SEMICONDUCTOR, Norwalk, Connecticut.*

SPERRY

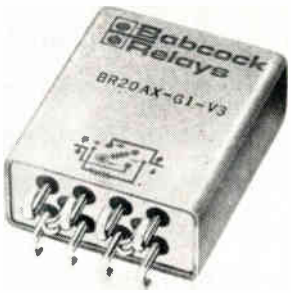
DIVISION OF SPERRY RAND CORPORATION

Circle 78 on Inquiry Card

NEW PRODUCTS

LATCHING RELAY

Subminiature units operate in the dry circuit to 10a. range.



The BR-20 provides over 100,000 trouble-free operations. They feature welded-header-to-can sealing. They are suitable to virtually all aerospace and undersea requirements and meet Mil-R-5757D specs. Header types include plug-in pins, solder hooks, and 3 in. PC leads in a variety of mounting configurations. Babcock Relays, div. of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif.

Circle 221 on Inquiry Card

FILM POTENTIOMETER

Rotating shaft can be misaligned without accuracy loss.

Model 117 has a resistive range of 250Ω/in. to 125KΩ/in. (±10%). Wattage rating is 1w./in.; 500v RMS dielectric strength. Temp. range is from −55° to +150°C. One tap can be provided to suit need. Special electrical specs. allow independent linearity to 0.1%/electrical stroke; wattage to 2w./in.; and dielectric strength to 750v RMS. Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

Circle 224 on Inquiry Card

QUICK-HEAT POWER TUBE

Warm-up time of less than 1 sec. eliminates standby power.

The RCA-8462 is a conduction-cooled beam power tube designed for low-voltage mobile or stationary equipment. It may be used as an r-f power amplifier, oscillator, regulator, distributed amplifier or linear r-f power amplifier. In CW operation the plate voltage is 700v. It provides useful power outputs of 110w. at 50MC, 105w. at 175 MC, and 85w. at 470MC. RCA Electronic Components and Devices, Harrison, N. J.

Circle 222 on Inquiry Card

CRYSTAL DETECTOR

Freq. response is better than ±0.5db from 10MC to 12.4GC.

Model 423A has an SWR of less than 1.5 through X-band. In the coaxial range (10MC to 4.5GC) SWR is less than 1.2. The 423A achieves such performance by using a newly developed semiconductor diode. This diode is in a small sealed capsule that may be easily replaced without tools or soldering. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 225 on Inquiry Card

FLIP-FLOP MODULE

Two operating freqs.: 300KC and 1MC; max. drive 12 loads.

All-silicon basic FF Module has 4 FFs that operate independently. In addition to general-purpose storage, the module can be used as a binary counter, decade counter, shift register, or repeater FF. Operating range is from 0°C to 100°C. Reliability is increased by using metal-film resistors and silicon-mica capacitors. Scientific Data Systems, 1649 17th St., Santa Monica, Calif.

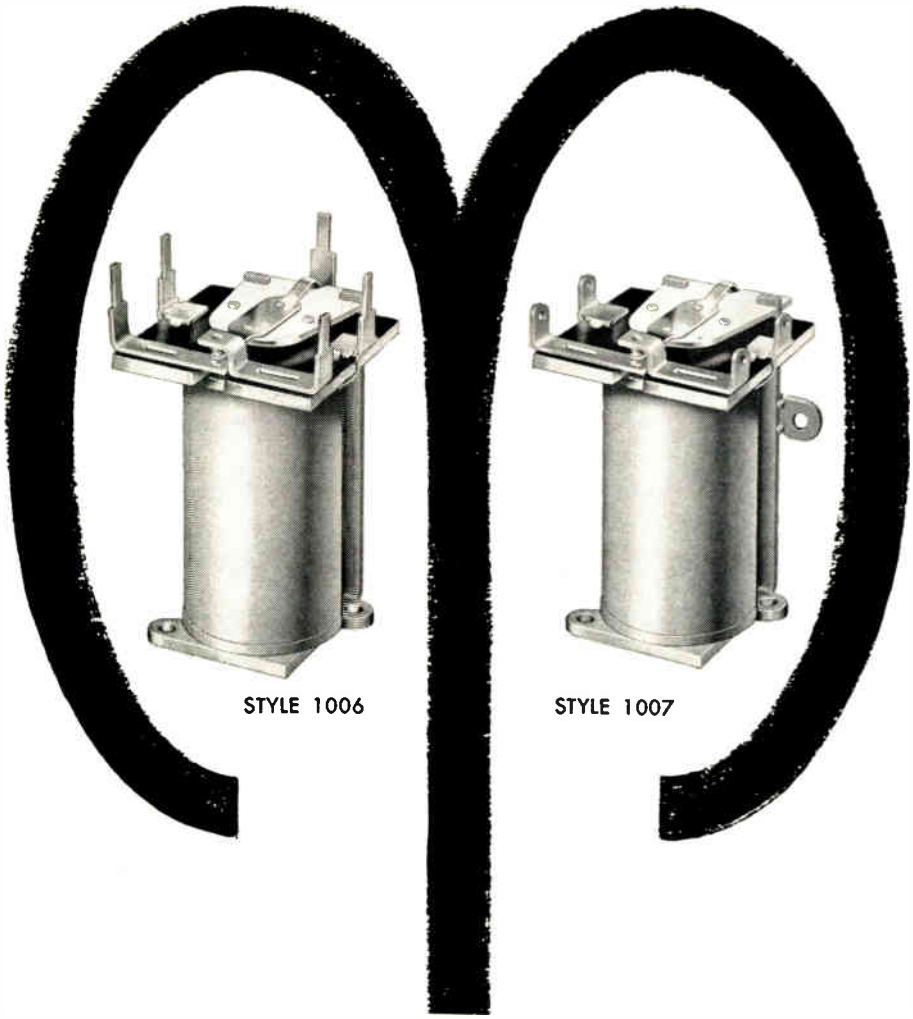
Circle 223 on Inquiry Card

ISOLATOR/HOLDER

Provides good heat conduction and positive retention for transistors.

The 9037 Series isolator/holder provides rapid assembly of the transistor to the chassis. Thermal resistance of 3.8° C/w., transistor-case-to-chassis, is obtained while providing an insulating value of 500vdc. The unit snaps into a ½ in. dia. chassis hole, and requires no wrenches or special assembly tools. The overall height is less than 0.325 in. Available for chassis thicknesses: 1/16, 3/32 and ⅛ in. Augat, Inc., 33 Perry Ave., Attleboro, Mass.

Circle 226 on Inquiry Card



SENSITIVE RELAYS AT SENSIBLE PRICES

Price Electric Series 1000 Relays Now Feature . . .
Sensitive Operation • Solder or Printed Circuit Terminals
Open or Hermetically Sealed Styles • Low Cost

These versatile sensitive relays are designed for applications where available coil power is limited. They retain all the basic features, such as small size, light weight and low cost, that makes the Series 1000 General-Purpose Relays pace setters in their field.

TYPICAL APPLICATIONS

Remote TV tuning, control circuits for commercial appliances (including plate-circuit applications), auto headlight dimming, etc.

GENERAL CHARACTERISTICS

Standard Operating Current:
1 to 7 milliamps DC at 20 milliwatt sensitivity
Maximum Coil Resistance: 16,000 ohms
Sensitivity:
20 milliwatts at standard contact rating; 75 milliwatts at maximum contact rating. Maximum coil power dissipation 1.5 watts.
Contact Combination: SPDT
Contact Ratings:
Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC.
Mechanical Life Expectancy:
30,000,000 operations minimum.
Dielectric Strength: 500 VRMS minimum.

For additional information, contact:

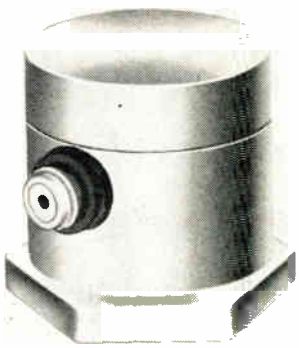
PRICE ELECTRIC CORPORATION

323 Church St. • Frederick, Md. • Phone: 301/663-5141 • TWX 301/553-0462

NEW PRODUCTS

CERAMIC ACCELEROMETER

Senses a signal as low as 0.001g. and spans a dynamic range up to 1000g.



The AC-107 miniature piezoelectric ceramic accelerometer measures shock and vibration over wide freq. and acceleration ranges. It is essentially free of resonances within operating freq. of 1 cps to 20kc. Sensitivity, 30mv/g; capacitance, 500mmf; temp. range, —85°F to 300°F; freq., 50kc. Massa Div., Cohu Electronics, Inc., 280 Lincoln St., Hingham, Mass.

Circle 241 on Inquiry Card

CRYSTAL CAN RELAY

Rated at 2a. at 28vdc and passes 30g vibration and 100g shock tests.

This half-size crystal can relay is suited for logic and sensing-circuit switching. The units have bifurcated contact tips which contribute to the good fidelity for logic and sensing-circuit switching. Mechanical life is 10 million operations. Max. operating time is 4msec. General Electric Co., Schenectady 5, N. Y.

Circle 242 on Inquiry Card

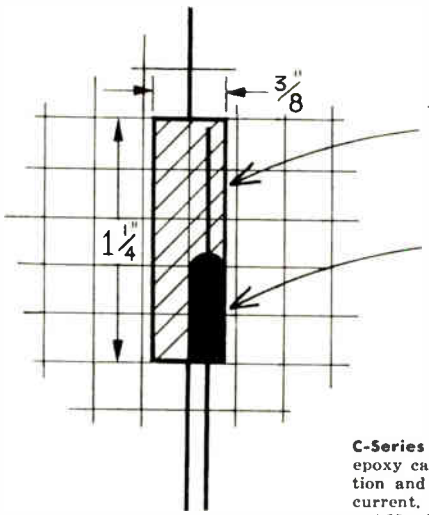
SPEED CONTROL

Holds motor speed accurately in fluctuating environments.

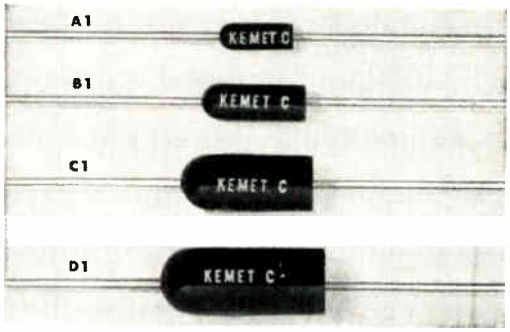
The 1% solid-state speed control maintains synchronous motor speed to ±1% from 22 to 32vdc, and within 0.5% in a constant environment. Speeds from 3600 to 24,000 RPM are available. The device allows hysteresis synchronous ac motors to operate on dc. All advantages of brushless dc motors are inherent, plus speed control beyond that available with dc or poorly regulated ac. Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.

Circle 243 on Inquiry Card

Now...build solid tantalum reliability into consumer circuits at low cost!



C-Series Features: Moisture-resistant, self-extinguishing epoxy cases • Ideally suited for welded module construction and point-to-point wiring • Extremely low leakage current, low dissipation factor, high capacitance stability • +85° C operation at full rated voltage • Capacitance range: .10 to 330 microfarads; 6 to 50 volts • Polar type



KEMET Special C-Series capacitors outperform aluminum electrolytics and save up to 88% in capacitor space!

Now you can *upgrade* many consumer circuits to *higher* reliability – and do it at a sound, economical per-unit price!

The KEMET Special C-Series uses *far less space* to give you *more* than aluminum electrolytics. Sizes and shapes are ideal for welded module construction or conventional point-to-point wiring, also automatic insertion equipment.

The distinctive bullet-shaped end provides fast polarity identification and easy capacitor orientation. Insulated case permits assembly in close proximity to other components in today's small circuit boards. The KEMET Special C-Series, in four precision molded cases, is designed for peak performance under severe shock/vibration conditions. Use coupon for technical data!

"Kemet," "Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation

UNION CARBIDE ELECTRONICS

Send coupon for complete data. (Check—attach to business letterhead)

KEMET DEPARTMENT
Union Carbide Corporation
Linde Division
11901 Madison Ave.
Cleveland 1, Ohio

☐ Please send new technical bulletin No. 5 covering KEMET Special C-Series Solid Tantalum Capacitors

☐ Have a representative call me

EI-2

NAME_____

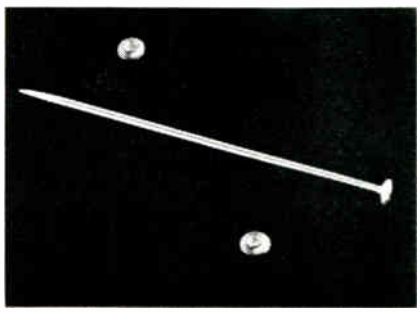
TITLE_____

PHONE (AREA)____ (NO.)_____ (EXT.)____

NEW PRODUCTS

TUNNEL DIODES

Available with peak currents of 1, 2, 5, 10, 20, 50, and 100ma.



These tiny germanium tunnel diodes in Dot packages can be used for amplifiers, down converters, detectors and oscillators. It features a low package inductance, low package capacity and high resistive cutoff freqs. The typical negative resistance of the 2ma unit is 65Ω. Resistive cutoff freqs. are up to 32oc. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y.

Circle 247 on Inquiry Card

TERMINALS

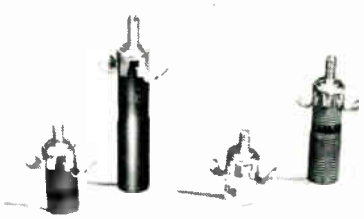
Vibration proof and uniform contact over full length.

Series 250 Tabon terminals are for ¼ in. male tabs. They are made with large radii for easy insertion, and have vertical and horizontal spring-arm action. They are of self-wiping and self-cleaning. Malco Mfg. Co., Dept. ES-2, 4025 W. Lake St., Chicago 24, Ill.

Circle 248 on Inquiry Card

GLASS CAPACITOR

Glass-piston trimmer available in panel-mount and PC series.



Electrical characteristics of this unit include a Q of better than 1000 at 1 MC. Insulation resistance is 10^5 at 500wvdc, and dielectric strength exceeds 2000v. Operating temp. range, −55 to +125°C. Capacitance to 12pf. JFD Electronics Corp., 15th Ave. at 62nd St., Brooklyn 19, N. Y.

Circle 249 on Inquiry Card

WHAT'S NEW

PRINT READER

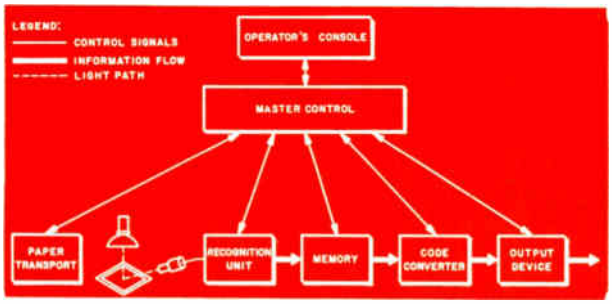
A "General Purpose Print Reader System" that will read typed or printed pages without the use of stylized or magnetic ink letters or numbers has been announced by Philco Corp.

The system will be able to read type produced by most of the typewriters in general business use today. It will read letters in upper or lower case, numbers and common symbols such as periods, commas and dashes.

The system will reduce the period of manual handling of information going into a computer. It will transport and read documents, convert the printed words to machine language, and then write the information onto magnetic tapes, paper tapes or punched cards. When reading the documents, it will correct mistakes and insert the correction in the proper place in the text. It can also rescan immediately characters not initially identifiable. It does not need to scan a complete line thus speeding up the rate of reading.

The print reader system uses a CRT to scan typed or printed documents at a rate up to 2000 characters per second. It then processes its signal information through the electronic system which converts the scanned information into machine language.

General Purpose Print Reader reads typed or printed pages.



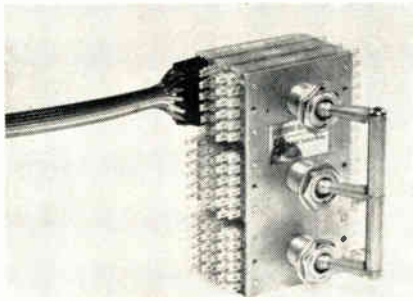
Instructions for programming of the reader are done by "Auto-Load," a system developed by Philco. "Auto-Load" consists of a preprinted sheet containing coded instructions which are recognized by the print reader, and automatically inserted into the internal memory. While sheets for frequently used documents are preprinted, an operator can easily make up a sheet for non-routine batches by pencilling in the information.

The print reader will also clean up smudged or partially printed letters if enough remains for identification. The print reader should greatly reduce the period of manual handling of information going into a computer.

NEW PRODUCTS

TOGGLE SWITCH

Ideal for calibration circuits and peripheral equipment selection.



This 108 DT miniature toggle switch has a body dimension of approx. 3¼ x 1½ x 2⅜ in. Switches are for automatic testing and computer programming and readout uses. It eliminates massive switching schemes. The T-BAR® gold-bonded contacts have an initial contact resistance of 10 milliohms or less. They transfer up to 3a. resistive. T-BAR Div., Electronic Controls, Inc., Danbury Rd., Wilton, Conn.

Circle 237 on Inquiry Card

PEAK POWER CALIBRATOR

Operates from a 105-125 / 210-250v., 50-60CPS power source; weighs 10 lbs.

Type 8900B measures peak r-f power of pulses in the 50 to 200MC range. Accuracy is ±0.6db. It has a precision terminated input circuit, diode detector, dc reference supply, meter, and a chopped video output system. Power level is read out directly on a panel meter and is completely independent on repetition rate and pulse width. Boonton Radio Co., div., Hewlett-Packard Co., Green Pond Rd., Rockaway, N. J.

Circle 239 on Inquiry Card

BLOWER

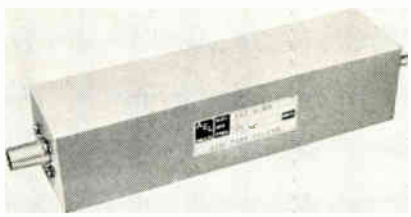
Available with a variety of driving motors and power supplies.

Model D-201 squirrel-cage centrifugal blower can be supplied for 1 or 3 θ, 50-60 CPS, 400 CPS, 350-1000 CPS and 115, 200, 208v. operation. A special induction motor, Altivar, changes shaft speed inversely with air density. This provides constant mass flow at all altitudes. Rotron Mfg. Co., Inc., Woodstock, N. Y.

Circle 238 on Inquiry Card

LOW-PASS FILTERS

Accomplishes lowering of harmonic output of generator signals.



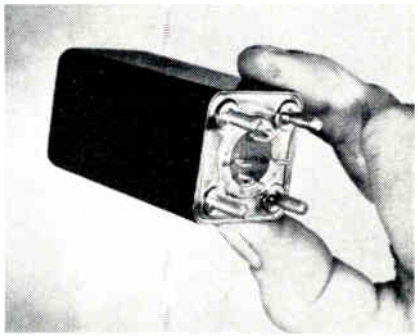
These filters have a minimum of 40db attenuation in the stopband for all harmonics through the fifth. Average insertion loss is about 0.25db; cut-off frequencies is 16, 24, 35, 51, 77, 115, 176, 270, and 400MC. Dimensions are 1½ x 1½ x 6 in. American Electronic Laboratories, Inc., Box 552, Lansdale, Pa.

Circle 240 on Inquiry Card

NEW PRODUCTS

DC-AC SOLID-STATE RELAY

Operating voltage is 18-32vdc. Switching rate, 250 CPS full load.



The Series 2100 provides switching time under max. load conditions of 1msec. max. It has no moving parts. Load voltage is 115vac at 25ma to 1a., depending upon amb. temp. Forward drop is 2v. at 25°C. Forward leakage current in off condition is 50μa at 25°C, 115vac. Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Circle 250 on Inquiry Card

CABLE CLAMP

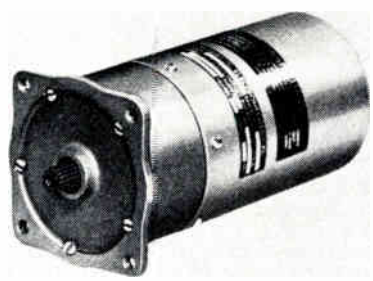
Permits flat-cable clamping to any surface or flat-cable to flat-cable.

Redi-Clamp is a polyurethane foam strip with back-to-back pressure sensitive adhesive that holds indefinitely. Only 10% of the cable area needs be "clamped." Spectra Strip Wire & Cable Corp., Box 415, Garden Grove, Calif.

Circle 251 on Inquiry Card

ROTARY ACTUATOR

Speed is 3.1 sec. in 90° at rated load of 500 lbs. in.



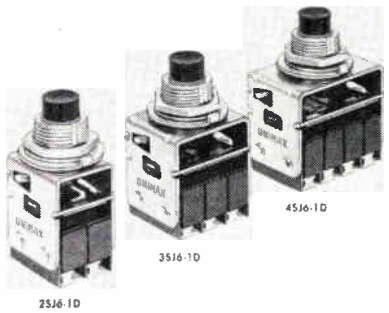
A new line of electromechanical rotary actuators is available. Units give ove 25,000 cycles of operation under norma conditions. These actuators are useful fo automated remote control of valves an similar equipment. Barber-Colman Co Rockford, Ill.

Circle 252 on Inquiry Card

NEW PRODUCTS

PUSHBUTTON SWITCHES

Electrical ratings 5a 125/250v ac; 5a 30v dc resistive.



These pushbutton switches are available with 2, 3, or 4 poles all DT. Max. depth behind the panel is 1-1/16 in. Max. widths are: Type 2SJ6-1D, 2-pole—21/32 in.; Type 3SJ6-1D, 3-pole—29/32 in.; Type 4SJ6-1D, 4-pole—1-11/64 in. Unimax Switch, Div. Maxson Electronics Corp., Ives Rd., Wallingford, Conn.

Circle 244 on Inquiry Card

COAXIAL COUPLER

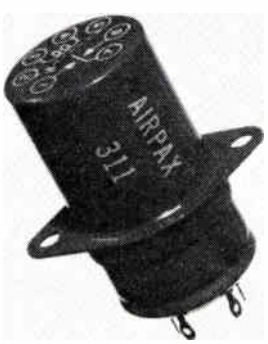
Operates in the 4 to 8GC range; power rating 100w. (CW) and 10kw peak.

Model 3024 offers a minimum directivity of 25db. Forward and reverse coupling 20db is coaxial coupler. Narda Microwave Corp., Plainview, N. Y.

Circle 245 on Inquiry Card

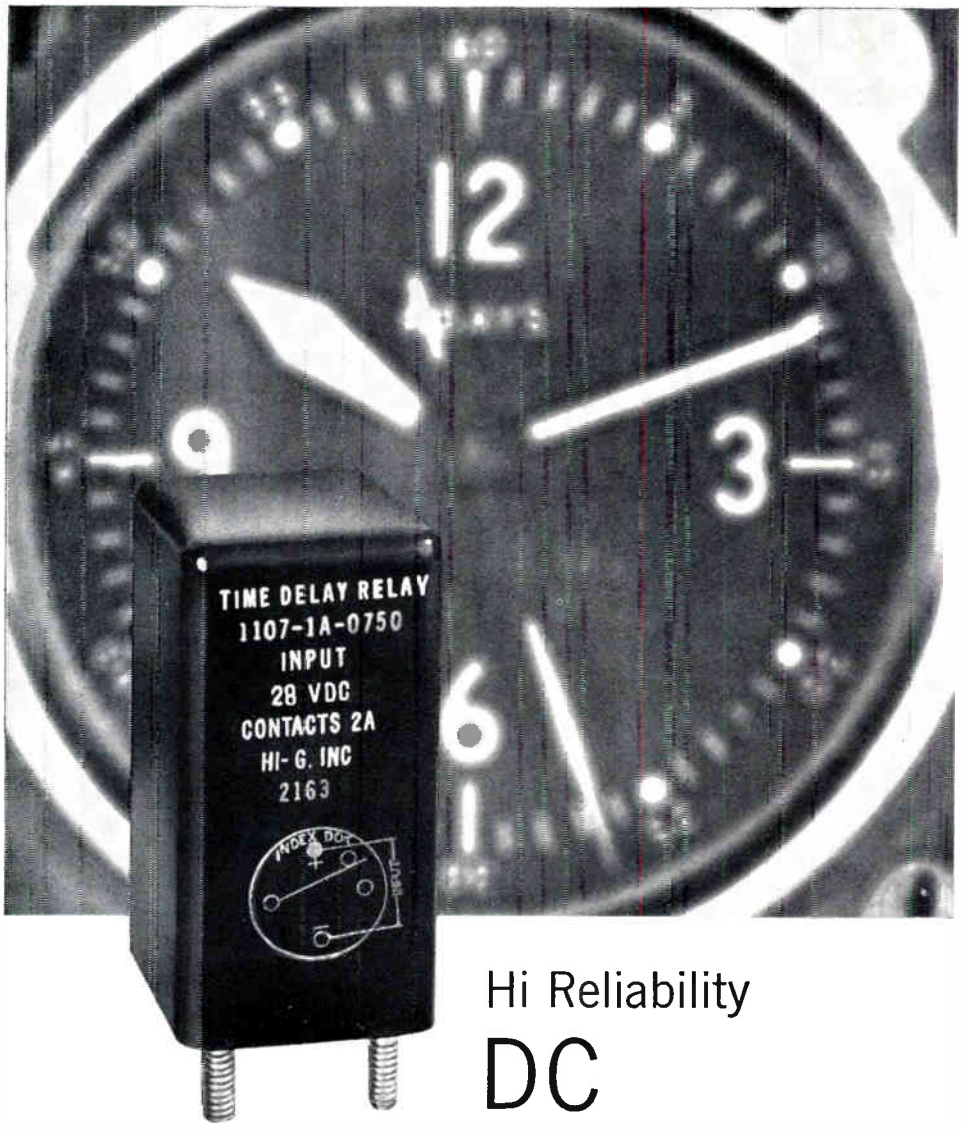
CHOPPER

Electromechanical unit operates at temps. of +125°C at 400 cps.



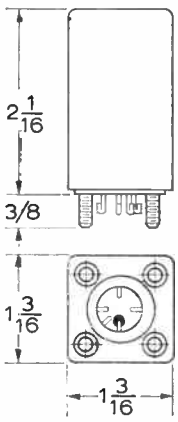
Type 311 uses high-temperature materials and wire to insure 2000 hrs. of life over its −65°C to +125°C operating range. Chatter or bounce is held to 4° maximum. Chopper weight is less than 1.5 oz. Airpax Electronics Inc., Cambridge Div., Cambridge, Md.

Circle 246 on Inquiry Card



Hi Reliability

DC Fixed Time Delay Relay



When **one failure** is one too many, specify **RELIABLE** Hi-G, Inc. Fixed Time Delay Relays. Designed to meet or exceed the exacting requirements imposed by critical aerospace applications, these **commercially available** relays feature the following specifications.

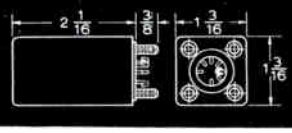
- High and low temperature operation from −65°C to +125°C standard
- Contacts rated to 4 amps resistive
- Vibration: 20 G to 2000 cps
- Delay time range from 50 MS to 180 seconds
- Rated input—18 to 31 VDC (regulated supply **NOT** required)
- 100,000 operations minimum at rated load
- Shock: 50 G for 11 MS

Other precision time delay relays (AC and Adjustable), timing modules, and component packages are illustrated at the right. Consult our Applications Department for special units with other voltages, longer delay times, tolerances, and environmental characteristics.

Send Today for complete technical data.

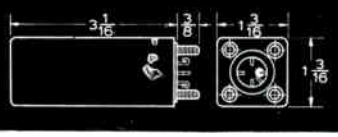
TIME DELAY

18-31 VDC Adjustable Delay
1, 2 or 4 Pole, DC
Standard Units adjustable over 10 to 1 ratio in timing
Standard Delay: 50 MS to 180 sec.



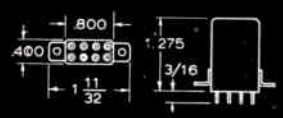
TIME DELAY

115V, 400 CPS Fixed Delay
1, 2 or 4 Pole, AC
Standard Delay: 50 MS to 180 sec.



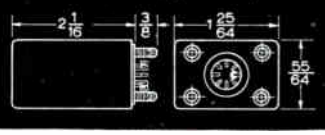
TIME DELAY

Solid State Timing Module
18-31 VDC Fixed Delay
Single Pole, DC
Standard Delays: 1 MS to 30 sec.



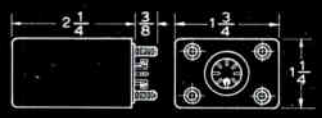
DC VOLTAGE SENSOR

2 PDT Output
Accuracy: 2½%
Range: Any voltage from 17 to 33 in increments of 1/10 volt with ½ volt differential
Power: No external power required



PHASE SENSOR

1 PDT
3 Phase, 60 and 400 cycle
Input Voltage: 115 or 208 VAC
Contact Rating: 1 A, 115 VAC resistive



AND IN RELAYS

A complete line of crystal can units to meet these general specifications: SENSITIVITY: To 12 MW ☐ POLES: Up to 4 ☐ CONTACTS: To 10 Amps ☐ MIL. SPEC: MIL-R-5757D ☐ TEMPERATURE RANGE: −65°C to +125°C ☐ VIBRATION: 20G to 2000 CPS ☐ SHOCK: 50G for 11 MS ☐ LIFE: 100,000 cycles

Hi-G Inc., Spring St. and Route 75, Windsor Locks, Conn.
Overseas Operating Facility: Hi-G d'Italia S.p.A., 276 Corso della Repubblica, Cisterna di Latina, Italy

Hi-G INC.

WHAT'S NEW

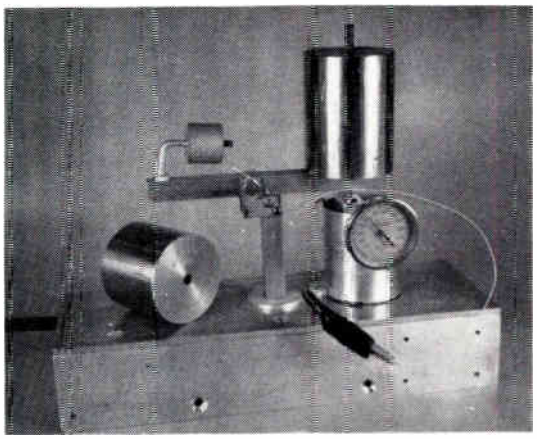
WIRING INSULATION

A SIGNIFICANT PROPERTY OF AN INSULATION POLYMER which can be measured easily is its modulus. The high modulus of a molecularly oriented polyester is an indication of its resistance to plastic flow and cut-through under high pressure stresses.

Its usual properties are peculiar to a film and not to massive or extruded forms of the polymer. The film cannot be treated as a thermoplastic (heat sealed). Thus, the use of this film as a wire insulation requires a cement to hold the "Mylar"* in place and seal the insulation into a moisture-resistant coating around the wire. Several thermoplastics give good results as bonding agents, and a wide range of conductor sizes are available. They are sold under the trademark "Mil-ene" and are made by W. L. Gore & Associates, Inc., Newark, Del. They are insulated with "Mylar" polyester film cemented with polyethylene, PVC, or other materials.

"Mil-ene" insulation (biaxially oriented polyester laminate) is mechanically tough. Tests and use show

*"Mylar" is a DuPont trademark for their biaxially oriented polyester films.



Outstanding toughness of "Mil-ene insulation is demonstrated by cut-through tests where a sharp edge is pressed against the insulation, and by scrape-abrasion tests where a sharp edge is rubbed back and forth across the insulated wire.

that 0.004 in. of this insulation is adequate where 0.012-0.030 in. of commonly used insulations are needed. This provides a thin wall hookup wire that gives large reductions in bulk of wire bundles and cables and yet provides improved reliability over other compounds now widely used. This reduction is particularly great in wire sizes of Awg 20 and smaller.

Dielectric strength of "Mylar" film is very high and because of the good mechanical properties, advantage can be taken of this property in "Mil-ene" wire constructions. However, for long-term ac voltage stresses, the "Mil-ene" is conservatively rated at 100v./mil of insulation. The company believes this rating can be doubled in most uses without much trouble. The insulation resistance is high and it is not much affected by moisture. The dissipation factor and dielectric constant are both low enough so that the insulation can be used with most r-f circuits.

These new insulations are now available in a wide variety of conductor sizes, thickness of insulation, and in cable constructions. Use-cost of this wire is low. Its use is indicated in situations where mechanical superiority is required, or wherever a low-cost, high-reliability wire is desired.

U. S. AGENCY ELECTRONICS

In the 10 - billion - dollar - plus electronics market for the U. S. Government, including all armed services, civil and research agencies are:

	$$$ billions
DOD (biggest spender)	8.3
NASA	1.6
FAA and other agencies (EIA, AIA, and Aerospace Management)	.160

NEW PRODUCTS

SIGNAL GENERATOR

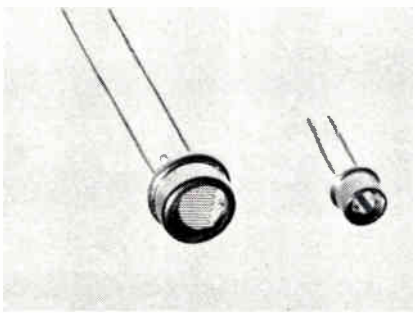
Covers freq. from 15 cps, 50K. Distortion less than 1% at 1kc.

Model H-1 provides a sinusoidal or squarewave signal. It has a continuously variable sq.-wave output of 80mv to 80v., p-p, and a continuously variable sinewave output voltage of 200mv to 20v. RMS. The sq.-wave rise time is less than 3μsec. The freq. response is flat $\pm$1db over the instrument range. Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Tex.

Circle 218 on Inquiry Card

PHOTOCONDUCTIVE CELLS

The rise and fall response times is less than 0.4msec. and 3.0msec.

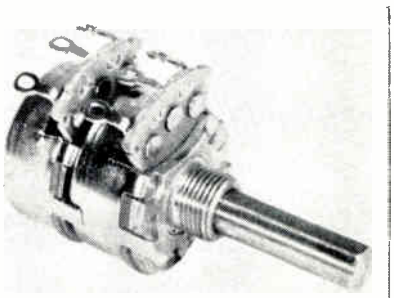


The CL703C, CL703CL and CL903C are cadmium selenide high-speed photoconductive cells. Each allows the design of photoelectric choppers operating at rates to 1000 cps. Light and dark resistances range is from 2.3K to 500 meg. Voltage ratings are available from 60 to 250v. Power dissipation is 50mw or 125mw. Clairex Corp., 8 W. 30th St., New York, N. Y.

Circle 219 on Inquiry Card

POTENTIOMETERS

Matching procedure provides decibel tracking, not ohmic tracking.



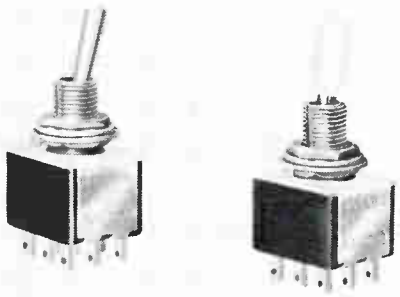
The D47 series are matched dual potentiometers that provide rigid tracking characteristics for improved stereo control. They are a single-shaft, 2 channel unit. Standard tracking is $\pm$3db, with tighter $\pm$1db tracking available. They provide equal residual resistance and rotational alignment of hop-off point. Attenuation range is offered to 90db. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 220 on Inquiry Card

NEW PRODUCTS

UNITIZED-BODY SWITCH

Has 5a. rating at 115vac, and rating 100w. (CW) and 10kw peak.



The toggle in the switch mechanism of this 3PDT unit is linked directly to the movable contact member. This provides positive make and break. Solid silver contacts and terminals are used. The 1-piece body reduces size, weight, and parts to a minimum. Available with miniature bat handles or with color-coded, insulated plastic caps. Alco Electronics, 3 Wolcott Ave., Lawrence, Mass.

Circle 202 on Inquiry Card

MINIATURE INVERTERS

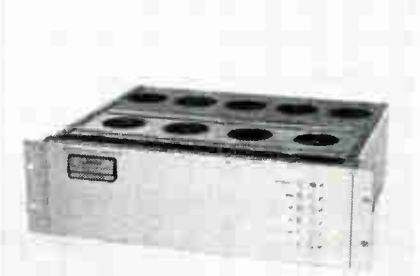
Units supply grid and anode power up to 3w., CW or pulsed.

The SM series are available in a wide range of voltage outputs. Standard outputs are 6.3v., 28vct, and 60, 100, 350, 600, 1000 and 1500v. Units feature self-protection from reverse input polarity, 50v. input transients, and short-circuits. Output voltage is regulated to ±0.25%. Input: 24-30vdc. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 203 on Inquiry Card

A-D CONVERTER

Provides 70,000 11-bit conversions/sec. with 0.05% accuracy.



The Model AD-200 analog-to-digital converter is a bipolar, solid-state instrument. It features optional sample-and-hold circuitry. Input impedance is 10 megohms. Input range is ±10v. Drift is less than 1 bit in 30 days for ±5°F temp. change. Its temp. range is 10°C to 40°C. Interstate Electronics Corp., sub. of Interstate Engineering Corp., 707 E. Vermont Ave., Anaheim, Calif.

Circle 204 on Inquiry Card

NEW PRODUCTS

MINIATURE LAMPS

Clear-tipped lamps are free of diffusion and distortion.

The T-1 incandescent lamps are available in a variety of voltage and candlepower ratings. The 0.125 in. dia. lamps are life rated at 200K hrs. Chicago Miniature Lamp Works, 4433 Ravenswood, Dept. ES-2, Chicago, Ill.

Circle 229 on Inquiry Card

FANS

Provides 105 CFM free air capacity. Requires no maintenance.

Model 8040 is a compact fan that requires no lubrication and is guaranteed for 5 yrs. It is a 115v, 60-cycle single-phase unit. The fan operates on a 4⅛ in. sq. mounting base. Howard Industries, Inc., 1760 State St., Racine, Wis.

Circle 230 on Inquiry Card

MILLI-MICROAMMETER

Measures low level dc currents down to less than 1na.

Model 1811A milli-microammeter features chopper stabilization and a built-in circuit protection. The instrument is available in rack-mounted model. Dynatran Electronics Corp., 178 Herrick Rd., Mineola, N. Y.

Circle 231 on Inquiry Card

SAMPLING OSCILLOSCOPES

Displays signal with 5GC rep. rate without external pretriggering.

The type 1120 dual-trace sampling oscilloscope uses a transistorized type 701 sampling and sweep plug-in. Combining the 1120 main-frames and 701 plug-in provides a system which features direct-coupled dual-channel amplifiers with nominal risetime of 350psec. It also has built-in matched signal delay lines; high sensitivity up to 600μv/cm; and sweep ranges from 2μsec/cm to 10psec./cm. The unit has a tunnel-diode trigger circuit. Repetition rates attained without count-down generators or delay lines. Analab Instrument Corp., Cedar Grove, N. J.

Circle 232 on Inquiry Card

CRT SPOT ANALYZER

Determines spot size, spot growth and degree of aberration.

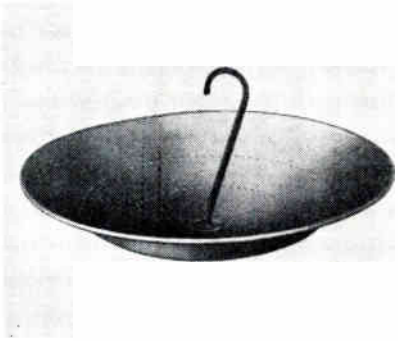
This 2-slit spot analyzer is a complete system. The analyzer lenses focus the spot on the optical slits. When the spot is scanned across the slits, light-intensity variations across the spot are picked up by a photomultiplier. The output is fed to an oscilloscope. Spot parameters may be read directly from the curves on the scope face. Celco, Mahwah, N. J.

Circle 233 on Inquiry Card

NEW PRODUCTS

MICROWAVE ANTENNAS

Plane polarized units operate between 5250 and 10,500 MC.



These antennas are for common carrier, operational fixed, studio-transmitter link, remote pickup and government uses. The antennas, with reflectors in 4, 6, 8 and 10 ft. dia., are all aluminum with solid-spun surface. The feeds are precision-formed waveguide bends, terminating in a close precision sectoral horn. Feed input is a choke flange which permits rotation continuously through 360° in polarization for accurate alignment. TACO, Defense and Industrial Div., Sherburne, N. Y.

Circle 200 on Inquiry Card

TRANSISTOR TESTER

Measures parameters of devices operating at ambient to elevated temps.

The Model 500A features a heat-sink that can be controlled for precise temps. of amb., 40, 50, 60, 70 and 80°C. In addition to transistors it tests diodes, scr's, and zener diodes at voltages to 300v. with peak currents to 50a. It presents digital readout of beta in 0-50 or 0-500 ranges with a 3% accuracy. Saturation resistance, leakage current, and collector breakdown voltage are displayed on the I_c meter and voltmeter. Sierra Electronics-Philco Corp., 3885 Bohannon Dr., Menlo Park, Calif.

Circle 201 on Inquiry Card

NEW PRODUCTS

DIGITAL VOLTMETER

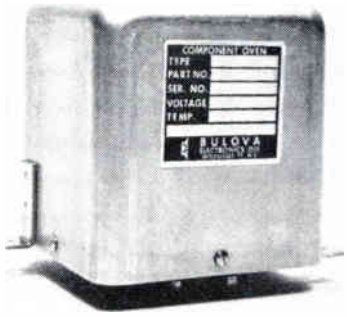
High common mode rejection 60db at 60 cps even with 1000Ω line unbalance.

In the 4700 Series of 3-digit voltmeter and ratiometers, circuits are mounted on epoxy-fiberglass boards. Precision, encapsulated, wire-wound resistors are used in the first two decades. They remain undamaged with overloads up to 500v. on the 1v. range and up to 1000v. on higher ranges. Long-term accuracy rating is ±0.1% of full scale + 1 digit. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 195 on Inquiry Card

COMPONENT OVENS

Maintains temp. within 2° through −55 to 10°C below nom. setting.

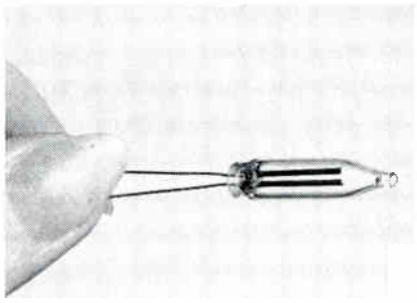


Four component ovens, with temp. stability of 0.1°C at a fixed amb., accommodate crystals, packaged circuits, transistors, diodes and other temp.-sensitive devices. Settings range from 25° to 100°C. Voltages from 6 to 120, ac or dc, and 60 to 400 cps are available. All meet applicable military specs. Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside 77, N. Y.

Circle 196 on Inquiry Card

GLOW LAMPS

Neon glow lamps hold close tolerances needed in circuits.



When used as a voltage regulator the AO 59 maintains voltage between 52 and 59vdc (±1v). Breakdown voltage is 65 to 75vdc and design current is 0.3ma. Rated life is 7500 hrs. of continuous operation at this current. The lamp comes in a standard 27/32 in. tube. It is polarized and dark effect compensated. Lights have shown high reliability. Signalite Inc., Neptune, N. J.

Circle 197 on Inquiry Card

NEW PRODUCTS

KLYSTRON

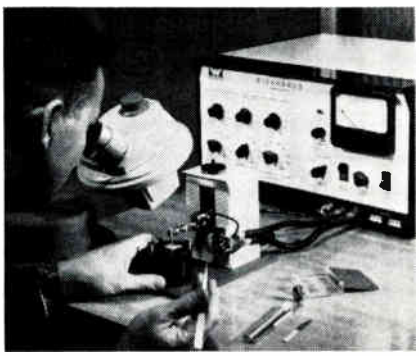
5 megawatt peak, 300kw average; r-f duty cycle, 0.063.

The L-3401 uses non-intercepting modulating anode. This klystron is tunable from 1254 to 1386MC. Typical operating parameters are a beam voltage of 135kv, a beam current of 120a., with an average beam power of approx. 1.3 megawatts. Gain is rated at 35db. Pulse length is 42 msec. The necessary water flow is approx. 200 gpm. Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 198 on Inquiry Card

THIN-FILM BONDER

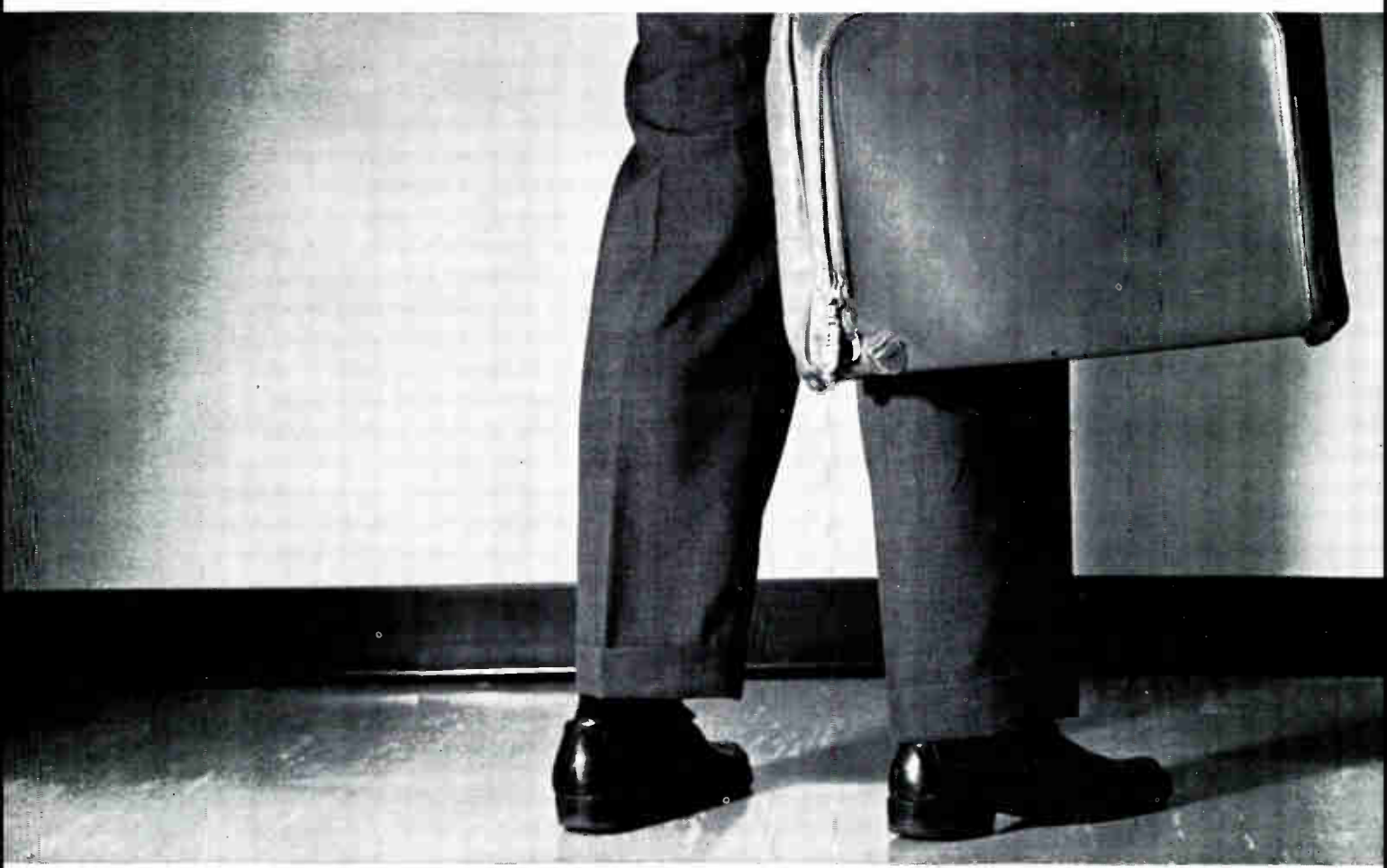
For welding small-dia. wire to deposited thin-film circuits.



Modular microbond welds single-surface wire of 0.001 in. dia., and ribbon of 0.001 in. thick and 0.020 in. wide to deposited thin-film circuits of 300 Å or more. It has an accurate, highly repeatable weld head. Substrate holder simplifies positioning of workpieces. Swing-type foot pedal allows controlable electrode action. It works from an electrical input voltage of 100-130v., 50 or 60 cycle, single-phase. Weld power is provided by 3 sequential cycles. Each is independently controllable for weld-pulse duration and amplitude to allow for pre-weld energy, weld energy, and post-weld energy. Weldmatic Div./Unitek, 950 Royal Oaks Dr., Monrovia, Calif.

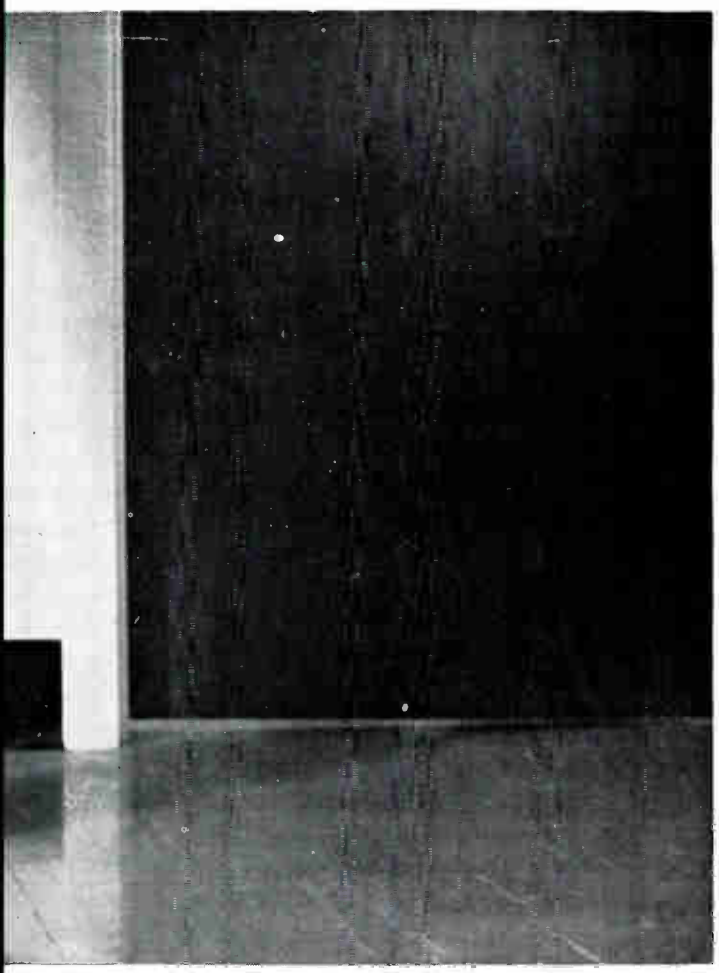
Circle 199 on Inquiry Card

How long does it take an in-the-flesh salesman to get



Your highly trained salesman can travel only so many miles, make so many calls, beat so many bushes, dig out so many customers. Save him for hot prospects. To conserve the asset each salesman represents—to reach through doors and minds otherwise closed —do your specialized business selling in the specialized business press, where your most efficient dollars are invested.

through a closed door?



Longer than it takes an advertisement in the specialized business press—trade, industrial and professional publications that go straight to a pre-selected prospect.

How much does it cost to reach identified prospects with salesmen's calls?

More—by a hundredfold—than it does to reach them with advertisements in the specialized business press.

How can you cover unidentified prospects, as well as identified prospects?

With a vigorous, important, and continuing advertising program in the specialized business press.

The specialized business press is industry's reporter, management's instructor, the sales manager's divining rod, the marketer's market data source. Read by the man who wants to get ahead and the man determined to stay ahead, the business press teaches the newcomer, trains the analyst, retreads the old-timer. It serves, pin-points, identifies. It is not all things to all men. It is specific, seeking out specialized markets. It isolates, clarifies, inspires. It reaches—efficiently.

EDITOR'S NOTEBOOK

MORE RECORD SCRATCH THAN MUSIC?—Naval Ordnance Lab has found the answer to the service-wide problem of playing bugle calls over P.A. without broadcasting 30 db of scratch. Solution — endless-loop magnetic tape, playing through a special "Spotmaster" cartridge tape playback. Ever since live bugling went the way of the rumble seat, most military posts had been using fast-wearing disks to sound colors. In theory, it was an ideal system. It hasn't worked out too well, though.

A NEW 'MUST' FOR WEST POINTERS. All plebes are now expected to learn and understand the use of digital computers. Tradition is strong at the Point, but that doesn't stop the Academy from making progress a part of tradition. For almost a year now, every plebe has received eight hours of "hands on" tutoring on a GE 225 computer. This is only a jumping off point. Plans include minimum instruction but maximum exposure to practical uses. Once mastered, cadets may use the computer throughout the four years to solve class problems, from psychology to higher math.

BEWARE OF RETINA BURNS FROM LASERS! Advice for researchers from the American Optical Co., laser pioneer, suggests that greatest danger is when eyes are in direct laser beam. There is also great danger when the beam is reflected by shiny surfaces. Avoid both direct and indirect exposure. Conservative estimates reveal 500 research groups now in laser work in the U. S. alone. Laser advances have been so fast that proper safeguards haven't caught up. The firm is working on safety lenses and protective filters.

A PRIZE OF $20,000 FOR THE FIRST EARTHMAN who communicates with a spaceman anywhere in outer space. That is, except for Mars. This is the stipulation made in the will of a Frenchwoman, a Mrs. Marc Guzman. She left the money (in francs, of course) in care of the French Academy of Science. This generous though somewhat segregated bequest was made in 1908! It was reported only recently by the International Telecommunications Union. (Some of our best friends are Martians.)

WE'RE A STAR JUST LIKE THE REST OF 'EM—Photos of the earth taken from satellites are distorted by the same phenomenon that makes stars twinkle, dispite camera size, reports a Sylvania scientist. Some atmospheric scintilation is always present. Satellites will give us better pictures of the moon than of our own earth until we lick space shimmer. Scientist Dr. John Harding suggested possibility of using X-rays, gamma rays, optical frequencies and microwaves for space photos of the earth.

DID SHE OR DIDN'T SHE?—California authorities reported to FCC that a woman was hearing calls of "Help—Can you help me?" on her TV receiver. A search led to a neighboring 13-year-old radio enthusiast. He claimed that in testing a new rig with a dummy load he had transmitted the phrase "**Hello**—Can you help me?" to grand dad in the next room. The woman who made the report admitted she might have misheard the message.

U. S.-JAPAN STUDY BIOLUMINESCENCE—According to American and Japanese scientists, cooperating on research, analysis and understanding of the lightning bug's glow may hold the key to how energy is transferred within living organisms. Much has already been learned from a tiny crustacean, Cypridina. Japanese scientist at Princeton isolated crystallized Cypridina "luciferin," substance that reacts with the enzyme liciferase to give light. Japanese soldiers used dried, crushed Cypridina with water instead of flashlights to read messages and maps in World War II.

RIGHT IN YOUR OWN BACK YARD—A Maryland Air Force base asked FCC to help find the source of unwanted code sending on one of its air-ground channels. An FCC monitoring unit determined the call signal by reading the dots and dashes and identified it as a second harmonic of an amateur station. FCC easily found the address of the station and passed it on to base command for follow-up action. Coded interference ceased. The licensee was a member of the force of the complaining base.

HAS THE JAPANESE SANDMAN FINALLY GONE ELECTRONIC? A Japanese firm markets a little black box called an "electronic sleep-inducer." The pocket-size unit runs on three 9-volt cells, or an AC adapter. Producer Toa Musen Co., Ltd., claims rhythmic, weak pulses affect the brain when applied through eye pads and to the back of the neck, inducing drugless sleep. Toa also claims that two hours with the thing may duplicate a full night's rest. Pulses are 1.0 mm/sec. long, repeated at about 100 cps., plus or minus 10 cycles.

NO MORE BLACK BOXES AT HONEYWELL! Beige is the rage, nowadays. The automatic controls maker has taken on the color as a standard for its process instruments. For operators and engineers who like to be around instrument cases and open cabinet doors, there is a textured dark beige. For technical personnel enamored with dials, panels, and components, there is a smooth light beige. For the conservative, who can't feel in the pink without a black box nearby, Honeywell still offers the traditional color at no extra cost.

D. I. S. C. ANNOUNCES REVISION TO MIL-K-3926 TO MEET CONTROL KNOB STANDARD MS-91528-C

NATIONAL RADIO ANNOUNCES IMMEDIATE AVAILABILITY OF CONTROL KNOBS TO MEET MS-91528-C.

Just announced by the U. S. Government Defense Industrial Supply Center! New tougher tests included in Mil-K-3926 to guarantee the continued utility of control knobs under adverse conditions and after continued rugged use.

1. New flammability tests in K-3926 will require that all control knobs made to MS-91528 be subjected to a direct flame for a period of not less than 15 seconds after which time the knob material must not support combustion for any period greater than 30 seconds.

2. All control knobs which are manufactured by assembling and cementing together various parts must now be subjected to a torque test on the cemented parts such as dials and caps. These parts must withstand a minimum torque of 5 inch pounds, after being subjected to a grueling test, without showing signs of loosening or coming away from the main body of the knob.

3. Set screw torque test. After completion of environmental testing which also includes salt spray and radiation tests, set screws are subjected to a tightening torque test. The 4-40 UNC-3A set screw is subjected to 3 inch pounds of torque and the 8-32 UNC-3A set screw is subjected to 15 inch pounds of torque. Upon examination after the test, there must be no evidence that physical damage has occurred.

4. Knob identification. Each control knob must be clearly marked with the mil standard number and also the military type number designation. These markings must remain clearly legible after completion of all environmental testing. During environmental testing control knobs must undergo exposure to intense salt spray, extremes of temperatures and humidity, ultra-violet radiation and vibration, after which they must be usable.

5. After environmental tests are completed knob inserts with a ⅛" shaft hole are torqued to 15 inch pounds, and for ¼" shaft hole inserts, the torque is 30 inch pounds. After the test there shall be no movement of the insert within the knob, cracking, or other failures.

How is it possible for National to make knobs available to the revised specifications so fast? Because National Radio Company has complete facilities for "in-house" testing and can perform all of the tests in the presence of a resident naval inspector as soon as new production is accomplished.

NATIONAL RADIO COMPANY, INC.

Dept. EI 1-64

37 WASHINGTON STREET, MELROSE 76, MASSACHUSETTS
Area Code 617, Phone NOrmandy 5-4800, TWX 617-665-5032

A wholly owned subsidiary of National Company, Inc. • Canada: Len Finkler, Ltd., 2 Tycos Drive, Toronto.

ELECTRONIC INDUSTRIES

PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

INCENTIVE DEALS MAY TRIM DEMANDS FOR ENGINEERS

The change in Federal buying methods from "cost plus fixed fee" (CPFF) to incentive contracts may eventually mean cuts in technical manpower.

The dollar-saving switch to incentive-type contracts for defense and aerospace was started during the Kennedy administration. It fits in closely with President Johnson's drive to save money.

According to DOD, only 12% of its buying is still on CPFF; by 1966 perhaps as much as 90% of all procurement will be by incentive contracts. The method is also being studied by NASA.

Deutsch & Shea, Inc., N. Y. advertising agency, has explored the effect of the contract change on technical staffing and recruiting. No change in technical staff size is expected right away, according to 92% of management and 98% of personnel heads taking part in the Deutsch & Shea study. Most see little change in makeup of technical groups in coming months.

Over a longer period of a few years, though, changes in staffing seem likely to occur. So reports more than 30% of executives. Some 33% of top management see one or more long-range changes on technical staffs. Reduction in staff size is most often listed. A shifting toward applied and practical technical men and away from theory and planning is often noted. There are also notes on general upgrading of technical staffs toward greater effect and output. Personnel men expect that incentive contracts will regain more non-technical people to take care of the incentive contracts.

In recruiting, the most obvious long-term effect, hiring will be more selective. Emphasis on finding and hiring top people was the change most often mentioned.

IOWA TECH. SCHOOL GETS ENGINEERS' COUNCIL OK

The educational program of Iowa State University Technical Institute has been approved by the Engineers' Council for Professional Development (ECDP). The two-year Iowa school was started in the fall of 1960.

Four courses are now offered by the institute—electronics, mechanical technology, construction and chemical industries technology. The latter course will be eligible for accreditation in 1965.

Under ECDP rules a program is not eligible for accreditation until it has graduated at least one class.

FRESHMAN COURSE STRESSES ENGINEERING FUNDAMENTALS

Freshmen at Lafayette College in Easton, Pa., are trying out a new concept in engineering education.

Prof. William G. McLean, director of engineering, said the course—"Fundamentals of Engineering"—introduces students to engineering by dealing with all aspects of the broad field. The course covers methods of engineering in general rather than specifics of disciplines.

AMERICAN INDUSTRY HELPING 'C' STUDENTS TO PUSH ON

A special summer program through San Jose State College to help high school students with a "C" average become interested in engineering and science careers is being financed jointly by several firms.

The program, underwritten by Lockheed, IBM and FMC Corp., is aimed at freshmen and sophomores who have "grades of 'C' or lower in most academic areas, little interest in school, a poor self concept, very little or too much pressure from parents to achieve, and under-estimated potentials to do academic work."

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 160.

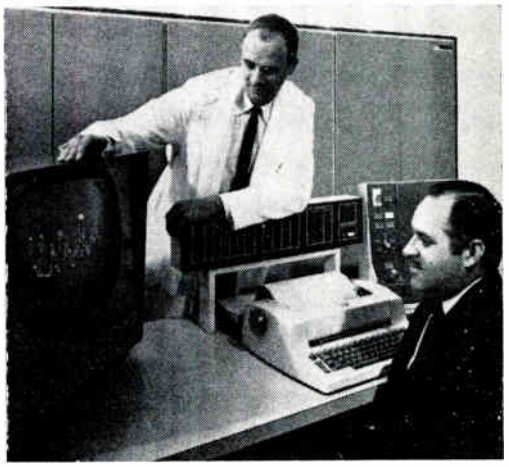
NSPE SEEKS CONGRESS HELP FOR NSF GRADUATE PROGRAM

A spokesman for the National Society of Professional Engineers states that the quality and capability of engineering brainpower will rise almost immediately if Congress approves the $25 million asked by National Science Foundation for a traineeship program. The program would cover graduate study in engineering, mathematics and physical sciences.

Paul H. Robbins, executive director of the NSPE, told a Senate subcommittee that "the single most important insurance policy we can buy to insure that we have the most competent engineering brainpower is through graduate education." There is "evidence of the broad, national need for Federal support for graduate fellowships" in these fields.

Under the NSF proposed program, colleges and schools that grant degrees in engineering, mathematics, or physical sciences, and which have staff and facilities for more students, will be invited to submit proposals for grants.

EDP IN MEDICAL RESEARCH



Dr. Richard Yoder, Tulane University Medical School, discusses brain wave signals on CRT monitor. At console of IBM 1410 EDP system is W. J. Nettleton, Jr., assistant director of Tulane Bio-Medical Computing System Center. The system is used to analyze electroencephalogram wave forms. Tulane and IBM are in joint study on how to use computers in problems of medical research.

Small and medium-sized firms looking to expand into foreign markets are often discouraged by the serious obstacles, both financial and technical. But many of the benefits of having overseas offices can be achieved through a cross-licensing arrangement that permits both parties to manufacture each other's equipment and to share in respective research and development work.

ONE APPROACH TO FOREIGN MARKETS— CROSS-LICENSING!

SALES OF ELECTRONIC PRODUCTS in the world market may double by 1970. Current volume is about $20 billion. The United States produces about three-quarters of total world-wide output in electronic goods. Yet, our own domestic market in many electronic areas is, in effect, shrinking as some overseas markets continue to grow at rates considered *fantastic*, especially in Europe.

In 1962 the total output of manufactured goods by all American companies operating in foreign countries reached $28.1 billion. The output of U. S. firms in Europe alone reached $11.8 billion in 1962, an 87% increase over 1957!

U. S.-owned plants manufacturing electrical products in Europe produced about $680 million worth of goods in 1957, and more than $1.2 billion in 1962.

Total exports of U. S. electronic products in 1962 was only $765 million.

The European market for military systems, computers, microwave components and test equipment is increasing at a rate faster than our own domestic market, though the domestic market still leads in total dollars. U. S. production of electronic products abroad far outweighs exports.

What does all this mean? It means simply that the overseas market for U. S. electronic goods, especially in Europe, is growing rapidly.

Most of the large blue-chip corporations and even many medium-sized American firms have little trouble taking advantage of the tremendous opportunities that the overseas market is offering right now. The small electronics firm in the U. S. finds things a little different when it invades the European market.

ELECTRONIC EXPORTS RISING

U.S. exports of electronic products in 1963 are estimated at $975 million in total. The 1964 forecast is for $1,297 million. Electronic products exported were mostly communications equipment, test instruments, computers and EDP systems, detection and navigation systems, television equipment and semiconductors.

What About Small Firms?

How can a small U. S. electronic firm spread its market to Europe, hurdle foreign tariff walls and save on overseas shipping?

Houston Instruments Corporation, Bellaire, Tex., answered this challenge with an arrangement called *cross-licensing*. In brief, a U. S. firm and a European firm agree to make and sell each other's products, but within their own market areas and under their own labels.

Though not a new idea, this is the first time such an arrangement has come about in the electronic industry, according to Houston spokesmen. Actually, one might say the deal involves an exchange of software technology, unlike the import or export of hardware. Aside from exchange and sharing of technical *secrets*, the agreement may also include an exchange of engineers for a period of time. It is, in effect, a merger except for exchange of stock.

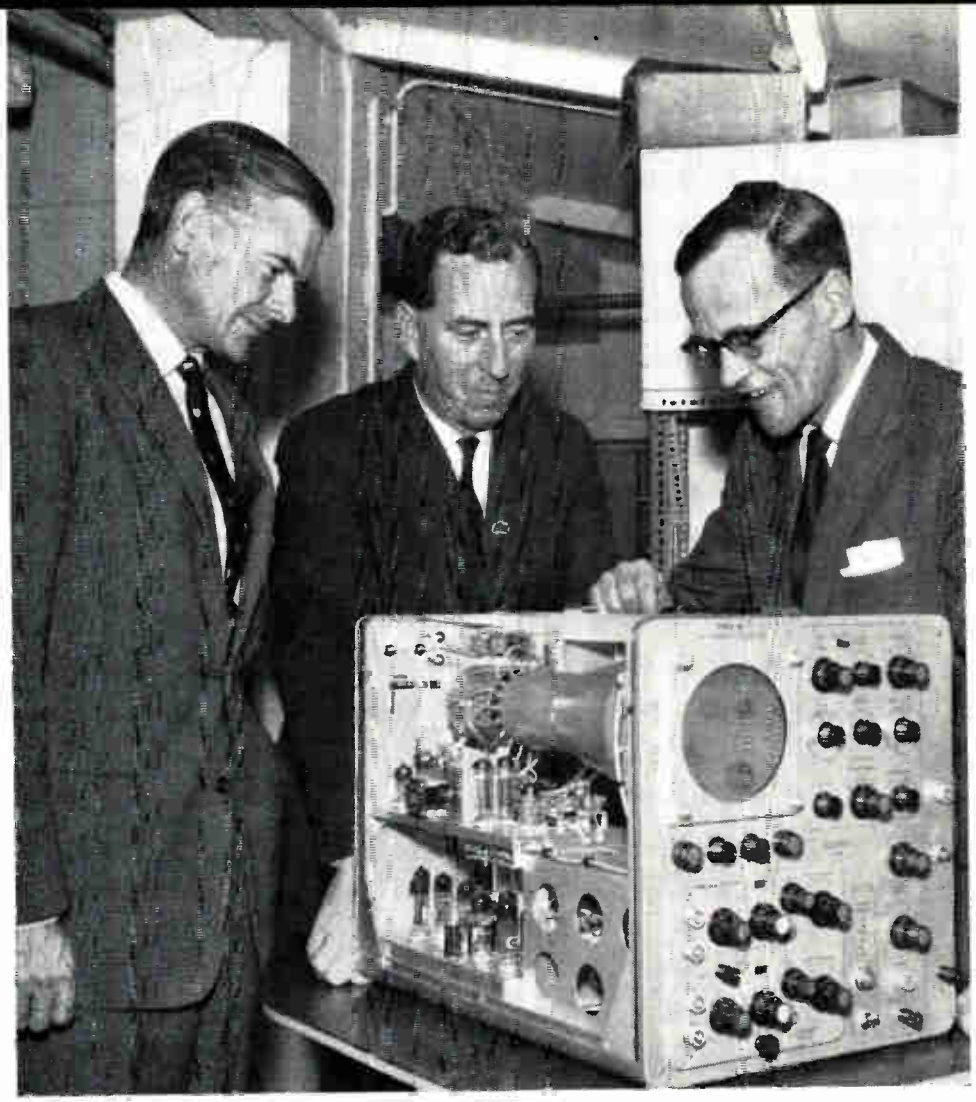
The cross-license agreement, in this case, involves Houston Instruments and Advance Components Ltd., of Ilford, England. Both firms have signed such a pact and are now producing each other's line of electronic test instruments. Advance will market Houston's instruments under the Advance label in England and the European Economic Community (EEC). Houston will sell Advance products, Houston-labelled, in the Western Hemisphere.

The meat of such cross-licensing deals is that both firms take over all rights to each other's research and development; they pay royalties to each other. The current Houston-Advance rate is 6%.

Why Cross-Licensing?

Houston's chairman, E. V. Hardway, Jr., reports that this link with Advance does not have the real or imagined advantages that might accrue from a similar

By ROBERT J. BRAMLETT,
Assistant Editor,
ELECTRONIC INDUSTRIES



E. G. Wakeling (left) Managing Director of Advance Components Ltd. made arrangements with Houston Instruments Corp. for unique cross-license agreement. With Wakeling are P. L. Sidey (center) Advance Sales Director, and M. G. Hinton, Research Director, examining an oscilloscope made by an Advance division.

Houston Instrument Board Chairman E. V. Hardway, Jr. (left) reviews marketing strategy with company president R. D. McMillan, Jr., before presenting new line of Advance instruments at sales seminar at firm's plant in Bellaire, Texas.

Final checkout of pilot run of VM-77B Millivoltmeter is made by Houston Instrument Vice President George More (left) and E. V. Hardway, Jr., corporate chairman. Five additional Advance-designed test instruments are due off the production line during the first three months of 1964.

deal with a firm in the EEC. (England is not in the EEC.) Why, then, should Houston—with distributors in ten nations—turn to cross-licensing to get a bigger foothold abroad?

For one thing, Houston had insufficient means to start a wholly-owned subsidiary in Europe. Setting up such a company, international talks, back-and-forth trips and other matters would have drained away too much time and effort. Also, there were no firms in Europe that Houston felt would be interested in a joint venture.

"An alternative was a jointly owned company in England, where there were some interested firms," Mr. Hardway said. "We thought we might also license one of these firms, or make a cross-license deal with one. Through elimination, we looked at cross-licensing in detail. It seemed to have many good business advantages for a growing company. The disadvantages were more psychological, or sentimental, rather than real."

For several years Houston had been selling through foreign outlets in England, Australia and Sweden. They were, in fact, started in 1959, the company's first year of business, after incorporation in December, 1958. In following years, distributors were taken on in other nations likely to have prospects for Houston's line of X-Y recorders and test instruments. Sales were through open accounts, yet credit losses were minute. Percentage-wise, Houston had fewer account losses in foreign marketing than it had in the U. S. (*Continued on page* 161)

● **A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department**

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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 _____

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Company	Div. or Dept.	Title	Dates

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Approached by Export Houses

In recent years Houston had been approached by New York export houses. These firms claimed world-wide marketing set-ups with agents in nearly every nation. But a closer look revealed that there would have been little gain in convenience, crating and handling costs. Profits would have been lowered, market control lost. Houston still favored distributors.

Houston's export sales had been mostly on its X-Y recorders, which sell for about half the price of its nearest domestic competitor. But — high customs duties, shipping costs and markups raised Houston's overseas price to nearly twice the domestic price. Yet, strangely, higher priced foreign sales averaged 15 to 20% of total sales. In poor domestic months, in fact, foreign orders often reached as high as 30% of total sales.

This was obviously a market worth holding onto! Now, what would the potential be if Houston was producing and selling in the same country with these customers? There would be no tariffs. And there would be lower and perhaps lowering tariffs between its neighbors.

"We speculated at the time that manufacturing within the EEC might result in foreign sales actually being greater than those that we enjoyed in the U. S.," Mr. Hardway recounts.

Sought 50-50 Joint Venture

Houston's original plan called for a product-hungry company in Europe to put up most of the cash, and some technical talent, to match product rights. In the plan, patent rights and know-how on Houston's line would be furnished by Houston in a 50-50 joint venture. Houston would also hold option to buy back any stock held by the other firm at an inflated price within a certain period.

EUROPE BUYS MOST TEST EQUIPMENT

In 1962 U.S. firms exported about $47 million in electronic test equipment. Biggest buyer was the Netherlands at $10.5 million. Canada followed with $9.5 million. Europe, including the Common Market nations,* plus England, Sweden and Switzerland, bought a total of $25 million in U.S. test equipment. Shipments of test equipment for export in 1963 may amount to more than $50 million.

*Belgium, France, Germany, Italy, Luxemburg, Netherlands.

Through consulates and overseas friends, Houston officials put out feelers. At the same time they compiled an impressive file of tax data and business facts from the EEC and England. Houston Vice President George More went to Europe to look in on distributors, and to follow up leads from firms interested in Houston's plan. He took the file with him.

Mr. More reports that the 50-50 plan was not met with much enthusiasm; a ceiling had been placed on the cash participant's gain. Houston decided that it had to be some sort of joint venture, or none at all. Thoughts turned to England.

England is prominent in the test instrument field. It also has similar concepts in making contracts.

A Letter From Advance

A letter from E. G. Wakeling, Joint Managing Director of Advance Components Ltd., referred to the firm's high profit growth. It cited a high royalty paid to one American firm, and offered to discuss licensing of Houston's line.

Described by Houston men as a "doer" rather than a "talker," Mr. Wakeling put it this way: "We found during our talks, first with Mr. More and later with Mr. Hardway, that we were oscillating on the same frequency on almost every point."

"Each side would gain new products; each side had identical marketing attitudes; each side had the same general hopes and fears, the same characteristics and ideas, even down to things like prime costs percentages."

To merely license a British company at a reasonable royalty rate, despite cash flow, would reduce sales and profit growth. U. S. products made in Britain would have to be sold in the EEC with large markups because of tariffs. Cross-licensing then appeared even more attractive.

"Current overseas laws penalize firms making investments abroad," said Mr. Hardway. "Export sales of technical hardware over high tariffs and through distributors with high markups are vulnerable. They are usually limited in either volume or duration."

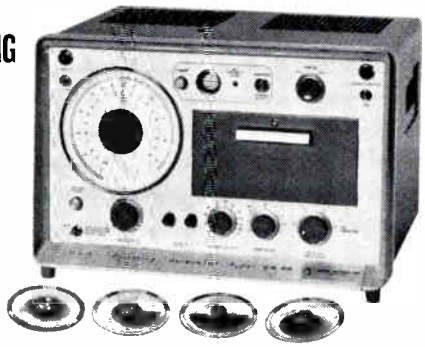
The Ideal Counterpart

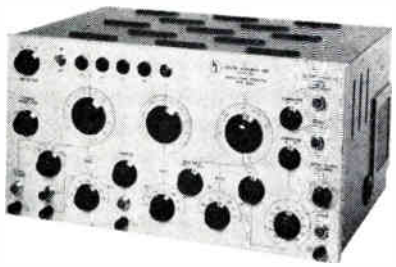
Houston planners reflected—"What would be the ideal arrangement for a small company like Houston that doesn't have much money to invest, or time to waste, on foreign investment aside from distributorships? Suppose the company could find a foreign counterpart—perhaps in England—of say near equal size, with compatible and proven products.

"It should have a similar aggressive product development program. What if it were willing to exchange patent rights, manufacturing rights and know-how across the board in a product area? The basis would be equitable royalties."

Such a find might bring broader product lines and a mutual sales increase at no initial cash outlay in either direction; rights would not be bought, simply exchanged. With firms of equal size, development

CROSS-LICENSING (Continued)





Top to Bottom: Houston Instrument versions of Advance VM 77 Voltmeter; SG 88 Signal Generator, 5002C Double Pulse Generator.

and engineering costs would be halved.

Each would sell the other's products under its corporate name or image, assuring buyers that a home company stood behind the products. Users, as a rule, care only about "who makes it? Can I get parts and service?"

If one firm made a major R&D and sales breakthrough, the other could respond instantly from previous exchange of data. The product could be presented in both countries at nearly the same time. If one firm was caught short as sales took hold too fast, one could appoint the other as distributor until it caught up. Meanwhile, products would be marked (by law) to indicate the maker, but would also bear the licensee's mark to assure customers of ready service and parts.

Equitable Agreement

Suppose an imbalance should occur. One firm's product development program might far exceed the other while the second firm enjoyed high and disproportionate sales on products it did not develop. The agreement would remain equitable as royalties favored the originator of the new and fast-selling product.

"When we first heard of Houston's interest in the possibility of an arrangement with an European company," Mr. Wakeling recalls, "we ourselves were undergoing strong expansionary pressure, both through market demand for our products and as a result of a large injection of cash from a public Rights Issue of shares.

"We were, of course, product-hungry," Mr. Wakeling admitted.

"Our turnover had increased four times and our pre-tax profit had increased roughly six times from 1958 to the end of 1962. For three years running the quoted value of our shares had showed the highest growth in Britain's electronic industry."

Firms Wanted to Grow

Interest remained high. Both companies wanted to grow; they had similar outlooks. From resumed talks came a proposal that if cross-licensing got off to a good start and proved profit-making, a joint venture to produce the Advance-Houston lines within the EEC should then be considered.

The Advance-Houston Cross-Licensing and Cross-Distributorship agreement was signed on March 15, 1963, effective on October 1. The delay was to protect distributors. The agreement also covered unpatented products, and included a minimum discount distribution clause to cover temporary import of finished goods.

From the start, Advance took up its option to make and market Houston's line of X-Y and T-Y recorders. Houston licensed the Advance signal generators including the unique SG 88. This instrument will produce any desired wave form at frequencies down to 0.005 cps. Houston also took on the Advance VM 77 voltmeter and 5002C double pulse generator.

New Product Stages

Wholesale discounts were extended. For buying and sorting parts for assembly in one country and test in the other, fair charges were decided. A new product might go through these stages:

1. Import with color scheme and corporate image of buying company, but marked "Made in U.S.A." or "Made in England."

2. Import of complete array of parts for assembly and test.

3. Import of specially tooled parts not available in the importing country.

4. Complete Americanizing or Anglicizing.

Weighing all factors, the arrangement had much to offer for both parties. But there were also some negative factors. Mr. Hardway lists a few:

1. **Fear of the Unknown**—There is a certain suspicion of foreign markets. It is more or less proportional to distance.

2. **Mental Laziness**—Day to day problems of doing business domestically are sometimes difficult enough. Managements hesitate to venture into unknown areas. Effort in known areas offers more immediate satisfaction and *tangible* results, which are more appreciated by associates.

3. **The Engineering N.I.H. (Not-Invented-Here) Factor**—This can be a serious internal problem. Engineers often have paternal feelings for products they develop, or help to develop. Asking them to be objective as to what is best for the company and its stockholders may be asking too much. For success in cross-licensing, though, it must be asked.

4. **The Corporate Ego**—Management finds it hard to permit another firm to market its products under the other's name. It's hard to give up any portion of sales or areas of direct marketing control to another firm, even if past efforts were only meager.

Such human frailties and obstacles make it more difficult to put a cross-license agreement in force, in Mr. Hardway's opinion.

'Deal Unique in Industry'

Houston management feels the agreement is unique in all industrial fields. A deal of this nature "requires concessions, sacrifices and mutual trust that very few firms are willing to grant." While most U.S. firms clamor to get a plant, a distributorship, or a partner inside the common market, Houston, in effect, has given up its European markets for "sound business reasons."

COMPUTERS LARGEST EXPORT SEGMENT

In 1963 the U.S. exported an estimated $183 million in computers and accessories. West Germany bought the biggest share at $27 million. France the next at $20 million. Japan received some $19 million in EDP equipment, while England took in nearly $17 million. Total U.S. computer exports in 1962 were valued at $136 million. The total for 1961 was $110 million.

In 1962 and through most of 1963, Houston's sales were fairly evenly distributed throughout universities, military and government agencies, industrial research and other fields, including overseas markets. Sales now are about $1.4 million, mostly from recorders, instrument and digital voltmeter lines, and from subsidiary Houston Magnetic Products Corp.

The Texas firm expects sales to rise considerably through making and marketing Advance-designed instruments. Additional income will come, of course, from royalties from Advance sales of Houston-designed recorders.

Everything seems to indicate that a cordial, profitable and long-range relationship has been established between the two companies.

LETTERS

to the Editor

"American Industries Are Our Challenge"

Editor, ELECTRONIC INDUSTRIES:

Your editorial "American Industries Are Our Challenge" (October 1963) was an excellent one in that it urged looking ahead a longer period than we are wont to do, that it urged scanning the whole range of industries, and that we need "to learn how other industries work and how electronic technologies can best be applied to maximize industrial profits."

This suggests sound market-research technique, on a long-range basis: If we were to scan the growth "industries" of the future, I am sure that "education" would find a place (among the leaders). It is currently about 9-10% of the GNP when formal schools, military and industrial training, and adult education are encompassed; when a broader definition is applied such as in Fritz Machlup's "Production and Dissemination of Knowledge in the U. S.," the total could range up to 29% as he has analyzed it to include all forms of knowledge (home and church training, research and development, communication, etc.) for performing useful services in our society.

The education "industry" committed to tremendous growth for the next decades, is woefully under-researched, since only 1/10 of one percent of the expenditures have been so applied. We are relying namely on older, established, even primitive techniques with some very modest advances. The productivity of the process seems unchanged from 1900-1950 whereas manufacturing rose eight-fold in the same period, according to economist Harold Clark. This latter productivity gain is related to a change in capital expenditures of 75% "bricks and mortar" — 25% equipment to 25%-75% respectively over the same interval; in education, 75%-25% has remained unchanged. This suggests great potential for similar "equipping."

However, to confidently apply our energies to finding equipment solutions seems hazardous at this stage since there is a lack of fundamental agreement on learning theory; and it is on such that we would have to build. In view of the probable critical need for increasing education expenditures (for exponentially increasing population, for greater education per individual, for retraining obsolescent members of the work-force, for coping with the knowledge explosion, for aiding underdeveloped areas, etc.), it would seem urgent to secure substantial support for accelerated basic research (probably in psychological areas, curriculum demands) to enable us to put a firm foundation under electronic research and development to find the advanced systems which should be used to maximize the social "profits" needed.

The problem is receiving the continued attention of the Educational Media Council, which reflects the technological development effort in education.

B. Edelman
Assistant Manager
Government-Industry Relations
Western Electric Co.
222 Broadway,
New York 38, N. Y.

Becoming A P.E.—

Editor, ELECTRONIC INDUSTRIES:

Here at New Bedford Tech we have encouraged our engineering seniors to take the Engineers - In - Training exams in the state of Massachusetts. We have been most gratified in that a good majority of the seniors have taken these exams and are on the road to establishing themselves professionally.

The article in the December issue of E.I. by Mr. Richard Stranix is very well thought out, and I believe it would be well to make a copy of it available to our engineering seniors. Accordingly, if company policy permits, I would appreciate receiving forty (40) copies of his article for distribution to our students.

L. M. Gonsalves
Prof. and Chairman
Electrical Engineering Dept.
The Commonwealth of Massachusetts
Department of Education
New Bedford Institute of Technology
Technology Center, New Bedford

DEW or DEW?

Editor, ELECTRONIC INDUSTRIES:

This is in regard to Mr. DeMent's articles (Nov. 1963) on the laser as a weapon, in which his preoccupation with acronyms may confuse the reader who has little experience in this field.

Having been associated with the accoutrements of the heroes and villains of several space operas over the past twenty-two years, I offer the following explanation:

The Directed Energy Weapon (DEW) such as the proton gun, the death ray, and the Delameter should be distinguished from the Distributed Energy Weapon (DEW) such as the nuclear ballistic missile, and the efficient Distant Early Warning (DEW) system.

George O. Smith
International Std. Eng., Inc.
APO 757, New York, N. Y.

The Metric System—

Editor, ELECTRONIC INDUSTRIES:

In regard to "Metric System Conversion" Electronic Industries, Sept. '63, I must accuse you of not giving the matter the attention it deserves.

The metric system is a legal system in the United States and it is entirely up to us engineers and scientists to use it.

Your magazine could contribute substantially to the use of this superior system by having all quantities expressed in the metric system. A very good proposal was made quite recently to use both systems side by side with the metric equivalent in parenthesis and after a little while with the English systems value in parenthesis. Thus, every one would get used to the metric system.

As a matter of record, it is not 82% of the world's people that use the metric system, but rather 90%-92%. It is also a matter of fact that the Roman numerals, complicated as they were, prevented the advance of mathematics inherited from the Greeks. Does the same apply to us?

Karl Steiner
P.E. M.E.I.C.

P. O. Box 2134
Hammond, Ind.

TIMELY CAPABILITIES

Gen. Omar N. Bradley, (left) board chairman of Bulova Watch Co., inspects precision manufacturing and timing devices for industry and defense. Harry R. Gewertz, (right) is manager of the firm's new Systems and Instruments Division. The new department includes Bulova's research, development, timer engineering and precision manufacturing all under one head. The division will concentrate on electro-mechanics and electro-optics R&D.

MICHIGAN JOINS CONTEST FOR NASA RESEARCH CENTER

Among Boston, Philadelphia and a few other U. S. cities and regions vieing for NASA research installations, the latest is Michigan.

University of Michigan President Harlan Hatcher has advised NASA officials at Langley Research Center, Hampton, Va., that the University is submitting a proposal outlining reasons for locating the proposed center in Michigan.

The 50-million-dollar center was originally set for Boston when Congress blew the whistle for further study of the proposal.

FRENCH FIRM PRODUCES LOW-COST STEEL DELAY LINE

A French company has come up with a new low-cost steel delay line for SECAM color TV receivers. The firm, Compagnie Generale De Telegraphie Sans Fil (CSF) of Paris, reports that production price of the lines may be less than 15 francs.

The company's Physico-Chemical Research Department states that the use of mild steel as the medium for the propagation of ultrasonic waves will permit construction of delay lines at the low cost.

Delay time and tolerance is 0.17 μsec. from 20 to 55°C. Bandwidth on SECAM circuits is 2 MC. The structure is conventional, ultrasonic waveguide terminated by transducers of lead titanate piezoelectric ceramics.

ELECTRONIC CONTRACTS RISE FOR NASA APOLLO MOONSHOT

Contracts for electronic work on the Apollo moonshot program are being handed out at a growing rate, according to NASA reports.

Latest contracts are for development and fabrication of electronic guidance and navigation systems for Apollo's lunar excursion module. This is the craft that will actually do the moon landing. Similar contracts have been given for the unit to house the astronauts on the lunar trip. Still others have been awarded for the supply unit for the moon probe.

Contracts for the landing module alone amount to $60 million.

WESTINGHOUSE MAKING CRT'S WITH BONDED SAFETY SHIELDS

Westinghouse is now putting out TV picture tubes with a glass safety shield cut and sagged to match the contour of the tube viewing area. The firm says that the shield—the PPG implosion system—provides improved constrast and better resolution.

The PPG implosion system is the Pittsburgh Plate Glass Company's laminated safety shield. The shield is applied right to the picture tube, being laminated with either a clear polyester or epoxy resin.

Lamination of the shield to the tube does away with two reflecting surfaces.

GE STARTS NEW OFFICE TO HANDLE R&D FALLOUT

Joining what may become a race to commercialize aerospace/defense R&D fallout, or "spin-off" if you prefer. General Electric has set up a new office to speed up GE activity in this field.

Its New Business Development Opation will be in Schnectady, N. Y. NBDO will identify, evaluate and develop opportunities derived from new products and technologies. This will apply specifically where no person or no division has been assigned duties to conduct a business or to do exploratory work.

NBDO will advance new business opportunities until they are ready to be assigned to new or existing product groups within the GE complex.

Headquarters for the new operation will be hard by GE's research laboratories. UBDO will eventually fan out to do its work at the most strategic locations among GE's 125 divisions.

ELECTRONIC PHONE EXCHANGE

Field test installation of electronic telephone exchange for high-speed switching of calls now at Portage, Ind. Pilot is under rigorous test for several months before being connected into 2,400 - line Portage network in mid - 1964. Called E-A-X(TM) (Electronic Automatic Exchange) the system has a number of unique services to be tested out. Robert L. Artman (left) E-A-X engineer for Automatic Electric Labs (GT&E subsidiary) and William J. Phillips, director, switching systems, inspect switching matrix.

RADIO-TV CLUB HONORED FOR FIGHT-FOR-SIGHT AID

The National Council to Prevent Blindness has honored the Radio and Television Square Club for its seven-year support of Fight for Sight.

In those seven years the club has raised more than $70,000 for the Council. Part of the money has been used to start a Children's Eye Clinic at the Columbia Presbyterian Hospital—Eye Institute.

DOCTORS BUILD HEART 'MODEL' USING ANALOG SIMULATION

Two medical doctors just completed a research program in simulation uses for analog computers in medicine.

Dr. John J. Osborn, Presbyterian Medical Center, San Francisco, and Dr. James G. Defares, University of Leyden, The Netherlands, used an analog system to build an electronic model of the human heart and the circulatory system.

With engineers of Beckman Instruments' Analog Computer Facility, Richmond, Calif., they simulated complex functions of heart chambers and blood volume. They matched elasticity of arteries and pumping of chambers.

Studies may lead to advanced techniques in medical research and to future clinical uses. The doctors reported good results in confirming diagnoses and in estimating patient reaction to treatments.

SMALL FIRMS' SHARE FALLING, REPORTS SBA OFFICIAL

Greater efforts are needed to help small business get "its fair share of Government contracts," reports Irving Maness, Deputy Administrator of the Small Business Administration.

Mr. Maness added that the myth that small business is unable to compete with large business has "long since been exploded as being without foundations."

He pointed out that 16,000 small firms in this country are going out of business each year and that according to figures released by Sen. John J. Sparkman (D.-Ala.) there are 19,000 fewer small firms today than there were in 1957.

TUBE OUTPUTS CONSOLIDATED IN ONE RAYTHEON PLANT

Raytheon will consolidate all receiving tube production at Newton, Mass. Production is being discontinued at the Raytheon plants in Quincy, Mass. and North Windham, Me.

Added circuit module activities will be transferred to Quincy to add to the output of these devices.

WEST GERMAN STATION JOINS GLOBAL COMSAT NETWORK

West Germany is the latest to join the growing list of nations in global communications by way of satellite.

Relay I, NASA's orbiting communications vehicle, carried the first message from a new German ground station at Raisting to the United States. The message was the first official German use of the station which joins the world-wide network of ground stations for Relay experimentation.

The station can handle two-way voice conversation, teletype, photo facsimile and data transmission. Seven ground stations are now in the net concerned with Relay and Telstar experiments.

PROCESSOR EQUIPMENT FOR AIR FORCE

The Air Force has awarded a $630,000 contract to Hamilton-Standard, Broad Brook, Conn., to design and build processor equipment.

The equipment will permit fabrication, testing, and in-process analysis of micro-circuits without exposing them to harmful environments between processing steps. The 24-month programs call for two integrated micro-electronic processors.

POCKET-HELMET RADIO ALLOWS IN-SQUAD CONTACT FOR ARMY

The Army has come up with a little pocket/helmet receiver and a hand-held transmitter for communication between members of a squad.

The whole unit weighs 24 oz. (9 oz. receiver and 15 oz. transmitter) and uses two dry cells smaller than pencil flashlight type. The rig is expected to replace the seven-pound "Handie-Talkie" in current use. A 12-inch antenna is made of flexible steel tape.

The set is rugged and weatherproof, says the army, and is designed to operate in any kind of climate.

NEW EIA DIVISION

Electronic Industries Assoc., Distributor Products Div., was officially "born" with the election of officers and approval of scope and committee structure.

Norman A. Triplett was elected Chairman of the Division, which serves electronics parts manufacturers who market products through parts distributors.

ELECTRONIC INDUSTRIES

Advertisers — February 1964

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Militarized real-time computer introduced by Honeywell EDP packs an 8,192-word memory with a six microsecond cycle time into a 500-lb., 30 cu. ft. package. Designed for data processing under tactical conditions, the M-190's peripheral equipment rack contains paper tape punch and reader, input/output typewriter.

NEW IR THERMOMETER IS NON-CONTACTING

Infrared Industries, Inc., has presented a new and "improved" radiation thermometer.

The TD-8, according to IRI, is a non-contact, electro-optical device that eliminates faults of predecessors. Its "unique ability to perform is due to the use of indium antimonide infrared detectors which operate in longer wavelength regions."

The unit's built-in sight can measure a spot 0.25 in. in diameter. It will measure from 150° to 2500°F and register a reading on a meter within 2% of true value, according to IRI.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS

ANOTHER APPROVAL FOR EL-MENCO...

BELL TELEPHONE LABORATORIES
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September 13, 1962

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A NOTE OF APPRECIATION

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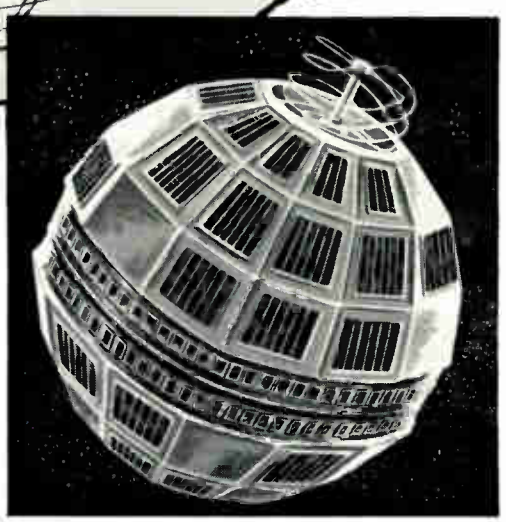
You will note that you are listed as one of the companies which helped us make Telstar a success. In behalf of Bell Laboratories, I would like to take this opportunity to express again our appreciation for your cooperation in this important endeavor.

Sincerely,



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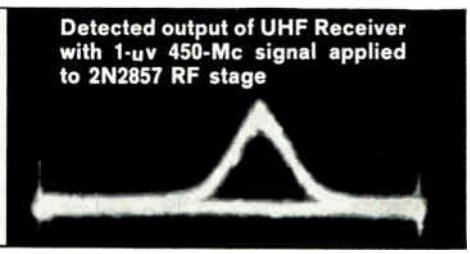
Never Before A Commercially Available Silicon Transistor With The Low-Noise Performance of RCA 2N2857

4 db NOISE FIGURE AT 450 Mc



DESIGNED FOR UHF • SPECIFIED FOR UHF • 100% TESTED FOR UHF

The low-noise npn 2N2857 uses a new miniature structure to achieve these outstanding characteristics:

- Extremely low noise...4 db typical in 450 Mc common-emitter RF amplifier
- High Gain...14 db typical at 450 Mc in neutralized 20 Mc bandwidth amplifier
- Excellent 450-Mc Mixer Performance...NF=7 db, Gain=15 db (typical)
- Excellent UHF Oscillator Performance...Power Output=40 mw typical at 500 Mc, 20 mw typical at 1 Gc (unit will oscillate at frequencies to 2 Gc)
- Maximum Ratings...V_{CBO}=30V, V_{CEO}=15V, P_t=200 mw at 25°C free-air
- Gain–Bandwidth Product=1200 Mc Typical

Each RCA 2N2857 is tested for maximum noise figure and minimum power gain @ 450 Mc as a standard factory procedure. Specified 2N2857 values are based on ½-inch leads. With shorter leads gain can be improved as much as 1.5 db gain and noise figure as much as 0.5 db.

RCA also offers New Silicon NPN Transistor 2N2708 designed specifically for VHF Applications. The new RCA 2N2708 planar epitaxial transistor is specifically designed for VHF applications to 500 Mc. Here are some of the features of this new transistor:

- 200 Mc wideband RF amplifier...15 db min. gain (neutralized common-emitter)
- Maximum ratings...V_{CBO}=35V, V_{CEO}=20V, V_{EBO}=3V
- Gain–Bandwidth Product...700 Mc min.
- NF=8.5 db max. at 200 Mc, I_C=2 ma

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Call your RCA Representative today for complete information on these outstanding RCA transistors. For further technical data, write RCA Commercial Engineering, Section CJ-2, Electronic Components and Devices, Harrison, N. J.

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