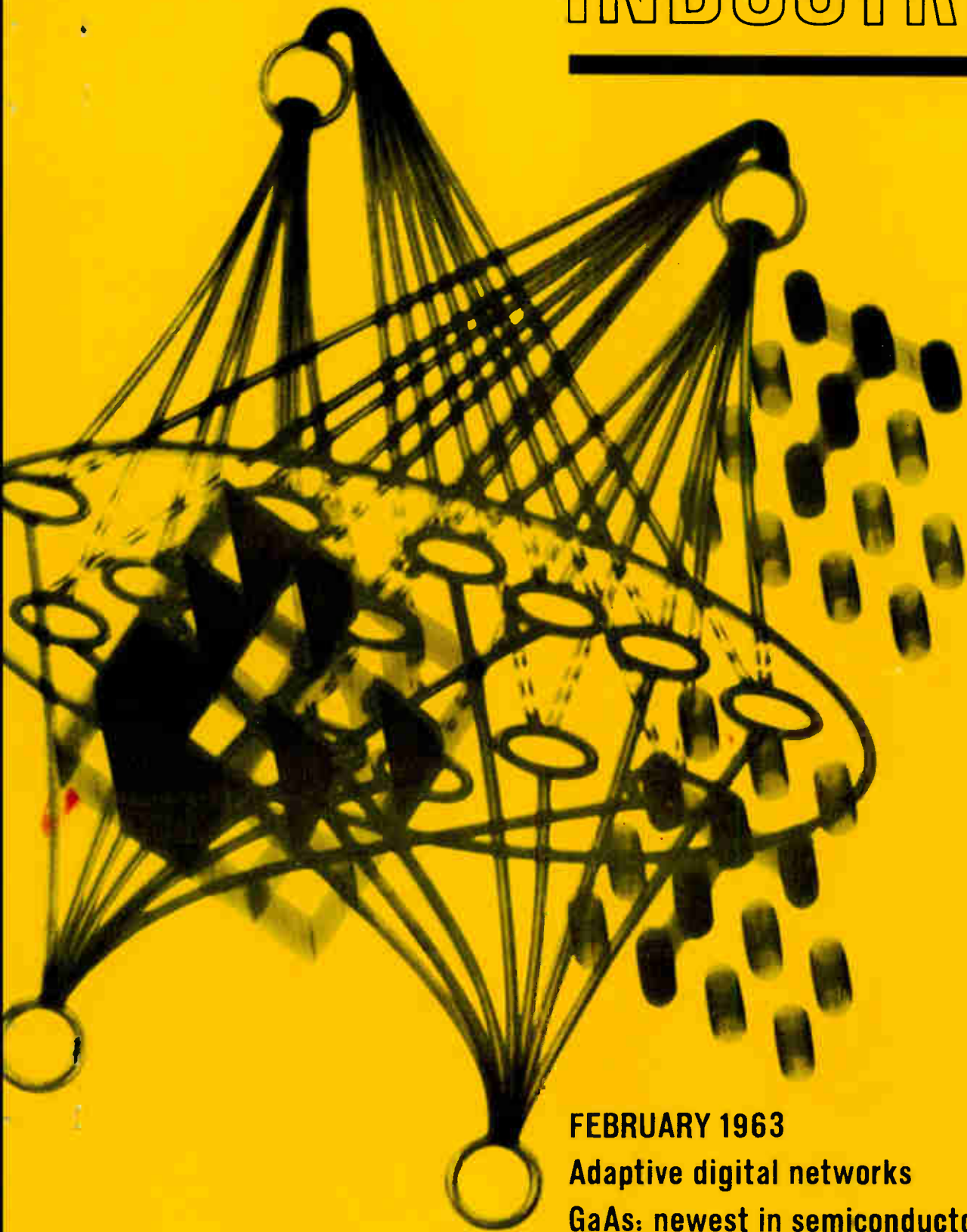


ELECTRONIC INDUSTRIES



FEBRUARY 1963

Adaptive digital networks

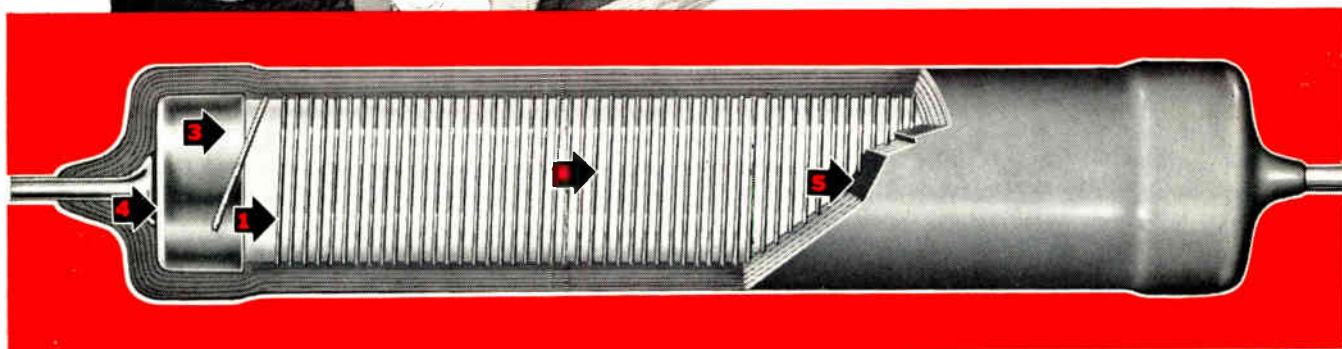
GaAs: newest in semiconductors

Self-verification for reliability

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RELIABILITY...

build it into your circuit with
RS and HS Miniature Power Resistors



DALE pioneered the silicone coating which gives these precision power resistors outstanding environmental protection. An additional benefit is the assurance of **INHERENT STABILITY** which has resulted from Dale's vast experience in the technology of winding fine resistance wire. Operating temperatures range from -55° to 350° C. RS (up to 275°) and HS (up to 350°) resistors feature low temperature coefficient and long life stability in a broad range of sizes from $\frac{1}{4}$ to 13 watts. Dale's participation in the **MINUTEMAN** High Reliability Component Development Program has provided new levels of achievement in design and processing of resistors. Add reliability to your circuit by specifying Dale RS and HS Resistors. Available with weldable leads.

SPECIFICATIONS

• RS available in nine sizes ($\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 2.5, 3, 5, 7, 10 watts)
HS available in eight sizes (1.25, 3, 3.25, 3.75, 4.25, 6.5, 9, 13 watts) • Continuous operating temperatures: -55° to 275° C. for RS; -55° to 350° C. for HS • Meet functional requirements of MIL-R-26C. (RS meets characteristic G) (HS meets characteristic V) • Resistance range from 0.05 ohm to 175K ohms, depending on type and tolerance • Tolerances: 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3% • Temperature coefficient: 0.00002/degree C.

HERE'S HOW DALE "BUILDS IN" RELIABILITY

- **CENTERLESS GROUND** cores of high purity ceramic untouched by hand or foreign material assure that wire lays firmly and uniformly, eliminating local hot spots.
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Write for Dale Resistor Catalog A

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SHELBY A. McMILLION,
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ELECTRONIC INDUSTRIES

TIME FOR EVALUATION?

Unquestionably, the Institute of Electrical and Electronic Engineers (IEEE) Show and Convention at the New York Coliseum next month will be the largest and best attended show that our industry has ever staged. Some 50,000 new members—from the AIEE—will be eligible this year, swelling the membership rolls to 150,000. It should be a matter of some pride to all of us in the electronic industry that this is one of the country's largest shows, and a credit to our enthusiasm and vigor.

From the other side, however, it seems to us—and to many others to whom we've spoken—that there is much more to do and see at these conventions than any individual can take in. The show is already too large, and yet attendance mounts every year. It is time that some serious thought is given to the problems of both the engineer and the exhibitors who come to New York to participate.

The problem is that we really have two separate and distinct events scheduled at exactly the same time. And both are so formidable that no engineer can hope to cover both adequately.

The technical sessions, alone, offer some 250 papers. There will be 54 sessions, with as many as 9 going on at the same time. Some will be at the Waldorf Astoria, and others at the Coliseum, so that the engineer must shuttle back and forth to catch the papers that interest him. (What does he do when two papers of major interest to him are delivered at the same time?)

From the exhibitor's viewpoint, all this shuttling back and forth of engineers represents just so many potential sales contacts that are missed. Interestingly enough, it is the more dedicated, conscientious engineers who get caught up in this treadmill, and these are the men that the exhibitors are most eager to see.

The Show, itself, will have some 850 manufacturers

displaying their products. This is where the buyers and sellers *hope* to get together to their mutual benefit.

But such large crowds make it difficult for the exhibitor to attract the attention of potential buyers. Some manufacturers have estimated that they have just a few seconds in which to attract the attention of the buyer as he moves past the booth.

Also working against the engineer—and the exhibitor—is the sheer number of display booths. There is simply not enough time to cover the exhibits adequately, so those attending must pick their "spots." This practice diminishes the value of the Show for everyone. The engineer loses because he cuts down his chances of picking up useful technical information, and the exhibitor loses because he misses the opportunity of extending the applications of his products.

Ideally, the engineer should have time to cover not only the exhibits in his own narrow field, but those in other fields as well. Exposure to other techniques extends his professional ability and this, after all, is the main reason that he goes to the Show.

A number of attempts have been made to evaluate what a show of this type can do for the manufacturer in terms of its cost in manpower, exhibit material and other expenses. No one, as far as we know, has a definitive answer to this very important question.

In summary, we need to take a good look at shows and conventions, their purposes and their operation. Exhibitors are spending a great deal of money to display their products at these affairs. In many cases, it represents the largest single expense in their sales budget. Every effort should be made to see that they get their money's worth.

We believe that these are serious problems that demand attention from the Show managements and the associations.

ELECTRONIC INDUSTRIES

Vol. 22, No. 2

February 1963



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HIGHLIGHTS

of this issue

Gallium Arsenide: What is its Status? page 47

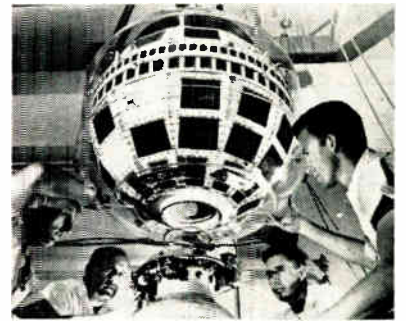
Gallium Arsenide was first used a few years ago, mainly in tunnel diodes. Unfortunately, these had a high failure rate. After this short emergence the material seemed to "drop from sight." However, the material was not forgotten—it had too much to offer. Here we bring the use of this material up-to-date and project its use into the future.



Gallium Arsenide

Telstar Revived page 74

Our first "switchboard-in-the-sky" performed excellently from July to November of last year. Then it went dead. A specially modified command code revived the satellite.



Telstar Revived

Self-Verification—Needs and Methods page 92

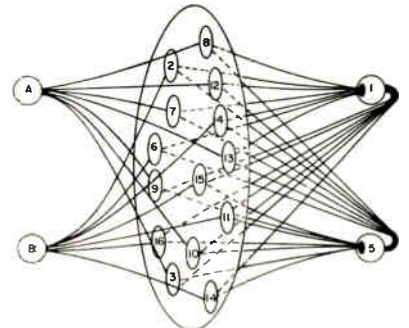
These methods can prove of inestimable value in insuring that when the button is pushed the desired reaction will take place. This article points out how self-verification can be applied, and alerts planners of future systems to its advantages in reducing "no-go's."

A Variable Frequency Multivibrator page 101

The astable multivibrator is commonly used to operate pulse sensitive circuits. It is sometimes desirable to be able to vary the frequency. Design of a stable solid state oscillator whose frequency can be varied electronically is described.

Designing Adaptive Digital Networks page 104

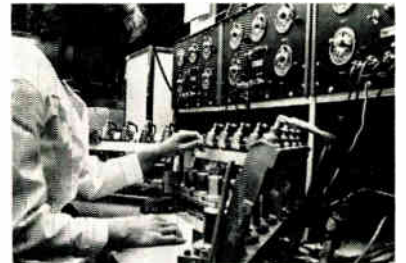
Is a machine's ability limited by the intelligence of its designer? Or can a machine be designed to learn? Self-Organize? Here are some thought-provoking experiments.



Adaptive Digital Networks

Improving Semiconductor Reliability page 110

Space activities have emphasized the importance of component reliability. Here is a basic approach towards improved reliability in semiconductor devices. The simple methods contained here can be used by every manufacturer of these devices.



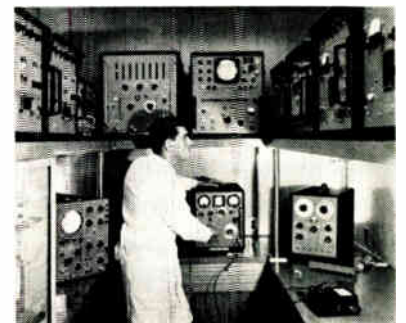
Semiconductor Reliability
Calibration Lab. on Wheels

Automatic Frequency Selection Circuitry page 114

Many systems need built-in circuitry to supply several frequencies for testing and calibration. Simplified design information for such circuitry is given here. The circuits described can supply up to eight frequencies. The frequency selection can be made automatically.

Calibration Laboratory on Wheels page 184

Interest in standards-level measurements continues to grow. Here's a new approach to the problem of furnishing calibrations where they are needed—bring the laboratory to the instrument.

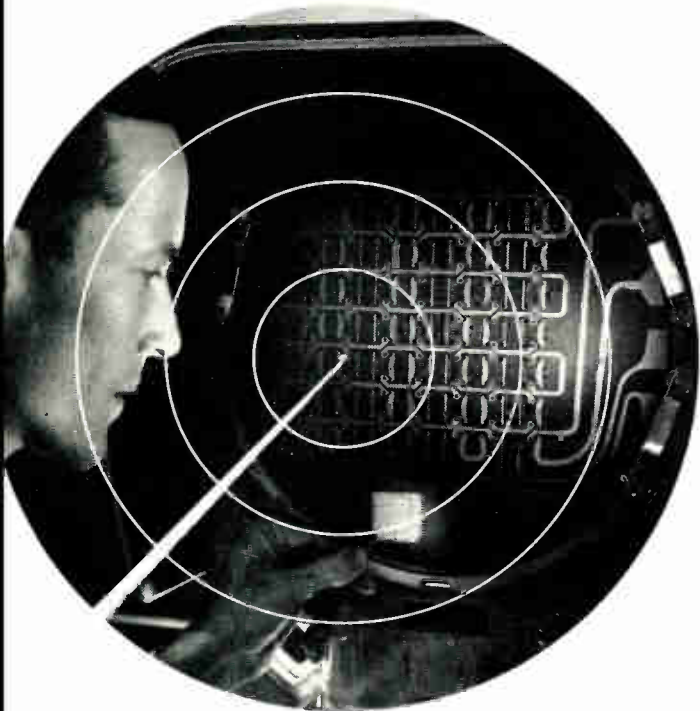


1963 International Solid-State Circuits Conference page 198

Advances in the field of solid-state device applications and circuits are highlighted in this year's conference. Details concerning the meeting are given and the variety of subjects covered are outlined.

RADARSCOPE

Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation



COMPUTER MEMORY

Key to the development of RCA's new "Flux Logic Element Array" or FLEA memory for computers is the tweezer-held "memory plane," above. Produced by a series of photographic processes, this unit is capable of storing 128 bits of information in the form of magnetic fields and processing it at a rate of 100,000 items/second.

NEW COLOR TV TUBE, originally developed in the U. S., is the heart of a new low-cost color receiver system which will appear on the U. S. market next year, imported from Japan. These are the plans of the importing firm, Spica International Corp. The tube is a two-gun shadow mask type using two-color phosphors instead of three. The first sets imported will reportedly sell at \$150 to \$160 manufacturer's cost, or about \$250 list.

CONCERN IS EXPRESSED over the increasing number of satellites and the danger of their cluttering up the space radio frequencies. The series of SYNCOM satellites, being constructed by Hughes Aircraft Co., will use small Bulova transistorized timers accurate to within several minutes per year. It operates as an elapsed time switch, shutting down a transmitter after a specified time lapse.

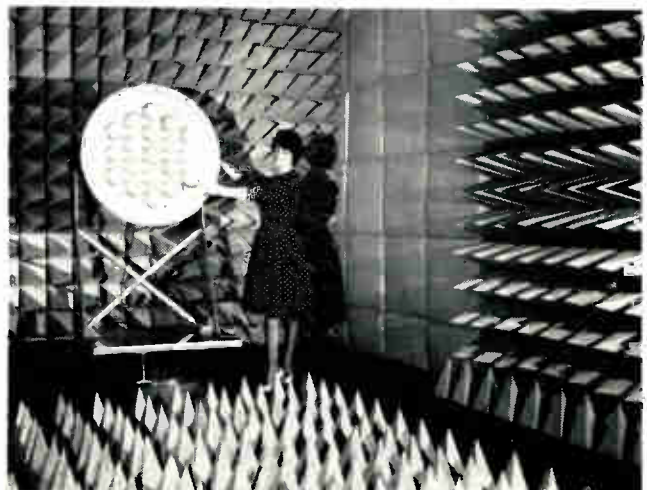
THE U. S. SPACE PROGRAM has been characterized by Dr. L. Reiffel, Director of Physics Research at Armour Research Foundation, as "a vast commitment, which, if not cut back by unforeseen events, will reach unbelievable proportions in 10 years. By 1970, 5% of our gross national product will be funneled into our space program," he stated.

FEDERAL FUNDS FOR R&D are expected to reach \$14.7 billion in fiscal year 1963. This is an increase of three and a half billion or 31% over the 11.2 billion spent for R&D during fiscal 1962. An estimated 4.5 billion will go for research, 8.5 billion for development, 1.6 billion for R&D plant or facilities, and 100 million for scientific and technical information. About 80% of Federal funds for R&D go for support of work outside of the government, 65% is expected to go to industry, 12% to educational institutions, and 4% to other non-profit organizations and foreign performers.

PROJECTIONS FOR THE NEXT DECADE by the Aerospace Industries include the prediction that microminiature parts and molecular electronic and thin-films will increase by at least 20% and perhaps as much as 80%. The use of conventional parts will decline by the same percentages. The present densities, using printing wiring, are about 10,000 equivalent parts per square foot. The use of molecular electronics, among other techniques, is expected to increase this density to one million equivalent parts in the next years.

FOR MICROWAVE TESTS

New anechoic chamber at Sylvania is used to test microwave antennas. Walls are made of special, non-flexitive pylons which dissipate r-f energy. Antenna under test is a 19-element array.



ENGINEERING ENROLLMENTS dropped again alarmingly in the United States this Fall, despite wide-spread efforts by government and private agencies to counter the decline. Even the most pessimistic predictions of manpower experts were upset when only about 66,000 freshmen enrolled in the nation's engineering schools for the first semester of 1962-1963 term. The Engineering Manpower Commission estimated in June that 33,200 engineers would graduate in 1966. That figure now will have to be lowered to about 28,000 engineering graduates. Manpower experts are puzzled by the decline, in light of the publicity the engineering shortage is receiving. Among the reasons given are the higher entrance requirements and the decline in war veteran enrollment.

THIN FILM MANUFACTURING facility has been developed for the Navy by IBM and demonstrated at the Naval Avionics Facility in Indianapolis. The continuous process uses vacuum evaporation equipment and results in manufacturing rates many times faster than present methods. The equipment will turn out as many as 750 circuits per hour containing over 3,000 thin film components. The development is still in the pilot stage. The Navy will experiment with various types of circuits made by attaching miniaturized semiconductor elements to the film that was produced by the IBM developed system. The pilot production equipment will also be used by the Navy to study ways to specify procurement of microelectronics in weapons systems.

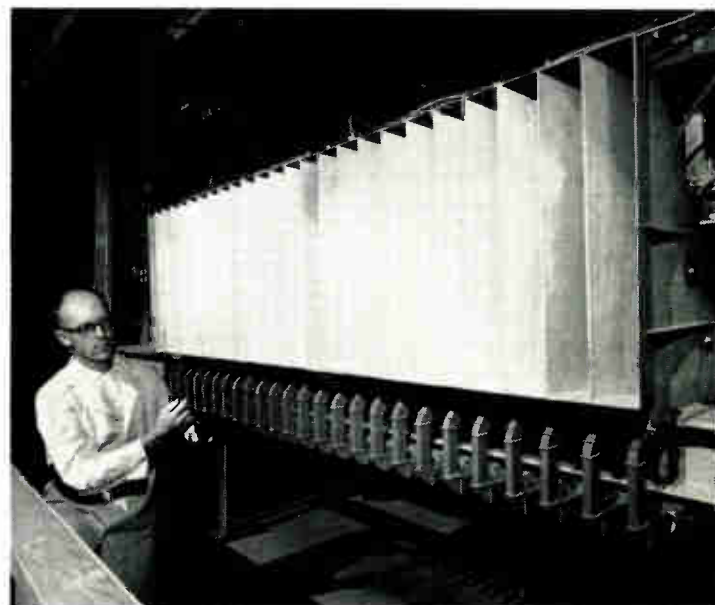
FCC IS TIGHTENING UP on building permits for UHF-TV stations. The Commission suspects that many prospective UHF broadcasters are obtaining construction permits with no intention of constructing a station until there are enough receivers capable of receiving all channels. The FCC came out with a statement saying that it is putting broadcasters "on notice that the Commission fully expects, when it grants a construction permit, that construction will commence and be completed within the time specified in the permit." "Specifically," the Commission said, "there will be no extensions of construction time unless the builder can show that causes beyond his control prevented completion. Scarcity of UHF receivers will not be a valid reason."

NEW CONCEPT of large scale power generation using a gas-cooled nuclear reactor and a magneto hydrodynamic (MHD) generator has been developed by Westinghouse scientists. The nuclear MHD plant would be used to supply heat for an advanced steam plant and would have a total capacity of 500,000 kilowatts of net power. Its efficiency would be slightly over 47%, better than most advanced conventional plants in operation today.

TECHNICAL QUESTIONS on specific subjects telephoned to ASTIA—the Armed Service Technical Information Agency—will be answered within one hour, says Col. James O. Vann, Commander. This fast response is available to the 300,000 scientists and engineers working directly or indirectly for DOD. First subject for the service is semiconductors. Documents and semiconductor devices have been indexed, using a new microthesaurus, a source of specific retrievable terms developed for this rapid service. The ASTIA collection is now growing at the rate of 42,000 reports a year. Other subjects that will be added within the next few months are lasers, masers, ultra violet, plasma physics, and bionics.

ANTENNA ARRAY

This self-focusing steerable antenna array was developed by Electronic Communications Inc. for the U.S.A.F. Rome Air Development Center. They are now completing a two-dimensional array for RADC. The 25-element array shown is capable of automatically radiating the conjugate of a received wave front to produce focus at a distant point. It is electronically steered.



AS WE GO TO PRESS

COMMUNICATIONS



Lt. Cmdr. J. DeBold supervises tests of the operations control center aboard USNS Kingsport. The Kingsport recently joined the Military Sea Transportation Service as a floating terminal for a space communications network. Ship's terminal equipment was developed and integrated under supervision of the Bendix Corp. as prime contractor for the U. S. Navy's Bureau of Ships.

TAKES TOP NASA POST

Admiral Walter F. Boone, USN (Ret.) has assumed his duties as NASA Deputy Associate Administrator for Defense Affairs, a newly created position to which he was recently appointed.

His primary duty will be to strengthen the flow of technical and management information between NASA and DOD.

EXPERIMENTAL DATA LINK DEMONSTRATED

Computer data was recently sent over a high-quality TV channel at a rate of 20 million bits of information per second. This transmission went over an experimental link from the IBM Advanced Systems Development Div. laboratory in Yorktown Heights, N. Y., to the AT&T microwave repeater station at Harriman, N. Y. and back. Total distance was about 40 miles.

TV channels and other broadband facilities have been used up to now only in a few data transmission systems, generally at speeds of 100,000-500,000 bits/sec. Most "long distance" communication of data in business systems today is by common carrier telegraph

LASER HAS SHORT BEAM FOR SPACE RANGEFINDING

A laser that fires short beams of light has been developed by Raytheon Co. for range-finding applications, particularly in the environs of space.

The laser rangefinder may help solve ranging problems entailed in safe rendezvous of satellites and other space vehicles. On the battlefield the device gives target distance data for pinpoint shelling of the enemy.

The rangefinder's accuracy is dependent only on the length of the spear of light fired from the transmitter barrel. Key to this precision is a method which cuts the beam segment down to, at present, only 20 ft. in length. Beams from commercially available lasers are thousands of feet long.



Lightweight and portable, the laser rangefinder makes use of pin-thin beams produced by lasers, and the principles of radar.

SYLVANIA METHOD MEASURES MICROWAVE FIELDS

Sylvania Electric Products, Inc., Waltham, Mass., has developed a new technique for precision measuring of hypermicrowave frequency radio fields.

The technique uses a tiny "mirror" or disc in the antenna field to reflect the strength of a signal back to the transmitting antenna. Spinning the disc varies the reflected signal and distinguishes it from that transmitted.

The reflected or received signal is then amplified and recorded. The spinning disc is moved through the field to accurately measure its characteristics.

NEMA UNIT COMPILES POWER SUPPLY TERMS

A concerted move to improve communications between makers and users of electronic power supplies has been started by the newly formed Electronic Power Supply Group of the National Electrical Manufacturers Association.

The program will result in the production of NEMA "Standards for Terminology." The group plans to concentrate on terms that have created the greatest problems.

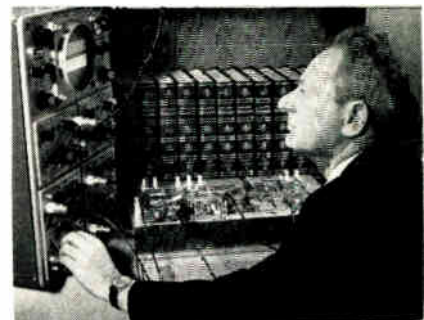
More News on Page 8

(up to 75 bits/sec.) and telephone lines (up to 2400 bits/sec.).

Also demonstrated was a system operating over telephone lines. In this test, data was sent over an experimental high quality telephone channel at 8,000 bits/sec. This system can be made to compensate for telephone line distortion by automatically adapting itself to each telephone line used.

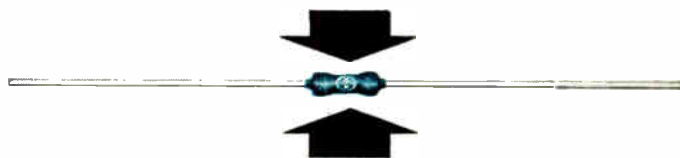
Another factor responsible for higher transmission rate is the use of a vestigial sideband phase modulation system that almost doubles the capacity of the voice channel. A further increase is made possible by carrying the information in both the polarity (positive or negative to ground) and amplitude (two possible values) of the data signal.

20,000,000 BITS/SEC.



Dr. Emil Hopner, Computer Communications Manager, IBM Advanced Systems Development Div., sends computer data at 20 million bits/sec. from Yorktown Hts. to Harriman, N. Y., and back over 40-mile experimental TV link. System does not require modulation of computer signals for transmissions.

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ELECTRONIC SHORTS

SPACE POWER

COBOL-61, a report on a Common Business Oriented Language for programming electronic digital computers, has been extended and its revised manuscript sent to the Govt. Printing Office for publication early this year, the Dept. of Defense has announced. COBOL-61 Extended was submitted by a committee of the Conference on Data Systems Languages, a voluntary group composed of representatives of computer manufacturers, DOD, and other major users of computers. It updates but does not supersede COBOL-61. The two principal extensions of the revised report consist of specifications for a Report Writer function, and also for Sorting.

A new "six-in-one" radar has been installed aboard the first of two missile tracking ships which are to double the length of the Atlantic Missile Range. The Sperry Rand Corp. radar uses two synchronized antennas, three and four stories high. Called the Integrated Instrumentation Radar or the "I-squared R," it is basically a combination L and X-band transmitting and receiving antenna slaved to a C-band antenna. Both antennas will transmit alternately vertical and horizontal polarization so the IIR is not one radar but six.

AEC has awarded a contract to the Martin Co., Baltimore, Md. to investigate the feasibility of a radioisotope-fueled power plant nearly 200 times as powerful as the first atomic generator placed in orbit last year by this country. Contract calls for development of a conceptual design for a 500-w power system which would use the decay heat from radioactive material and a thermionic conversion system. The system would require no moving parts.

An all-digital simulator which will match the characteristics of the new Lockheed C-141 "Starlifter" jet transport, is to be designed and built by Curtiss-Wright Corp., East Paterson, N. J. Work on the new training device, which will use a general purpose, all-digital computer, is being carried out under a contract awarded by the Strategic Systems Office, USAF, Dayton, Ohio. Delivery is scheduled for early next year. Because of the all-digital computation, any future changes on the aircraft can easily and quickly be programmed into the simulator.

A patent, titled "Image Display Device," has been awarded to Glen A. Burdick, a senior engineer of the Electronic Tube Division of Sylvania Electric Products Inc., Seneca Falls, N. Y. The patent pertains to the fabrication of a color TV screen. It details a method of matching the light optics used in the screen-forming process with the electron optics existent in the finished tube.

NASA and the Japanese Ministry of Posts and Telecommunications have agreed to cooperate in the testing of experimental satellites launched by NASA. The Japanese will make available a ground station with capability for communication by means of artificial satellites. NASA will arrange for use of experimental communications satellites locally by Japan as well as on a joint basis. Transmission over the satellite links are to be used for test purposes only. Each of the agencies will defray all the cost of their respective activities.

A missile guidance checkout system that automatically runs through a test procedure, pinpoints where trouble exists—and even tells the operator how to fix it—is being readied by Hughes Aircraft Co. at Culver City, Calif., for delivery to the Air Force. The system is called VATE for Versatile Automatic Test Equipment. It will be used initially to test the inertial guidance systems of Titan and Minuteman ballistic missiles. Later it will be used for other systems.

The Radio Standards Laboratory of the Nat'l Bureau of Standards, Boulder, Colo., has started a service for the calibration of waveguide noise sources in the microwave frequency region. This service is offered in WR90 waveguide at three selected frequencies—9.0, 9.8, and 11.2 GC. It is performed for standards laboratories, industrial firms, and various research groups.



Thermionic converter for demonstration purposes is checked over by J. Lawrence (top) and Dr. V. Wilson, scientist at the G-E Research Laboratory in Schenectady, N. Y. Dr. Wilson is furnishing technical guidance and assistance to the G-E operation at Palo Alto, Calif., for development of nuclear thermionic space power systems.

WESTINGHOUSE DEVELOPS SUPERCONDUCTING MAGNET

Westinghouse research scientists have developed a new kind of superconducting magnet. This magnet brings its high-strength magnetic field outside the bath of liquid helium in which all such magnets must be immersed.

The intense field is made available in air and room temperatures. Previously, the useful field of superconducting magnets was available only at -452°F . and in a restricted liquid environment.

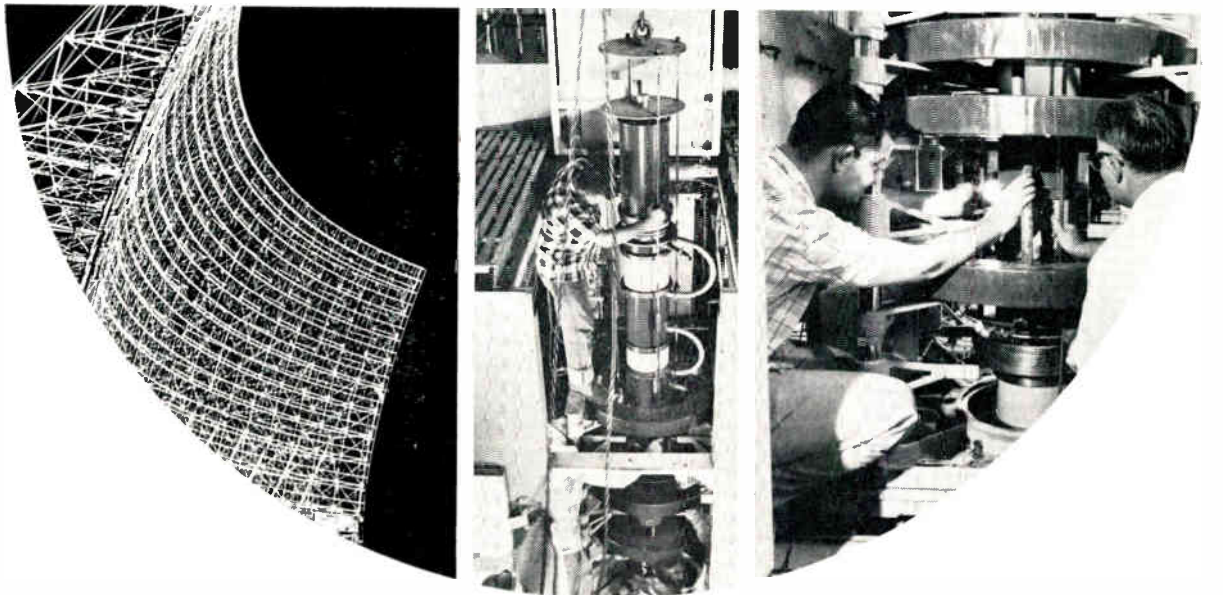
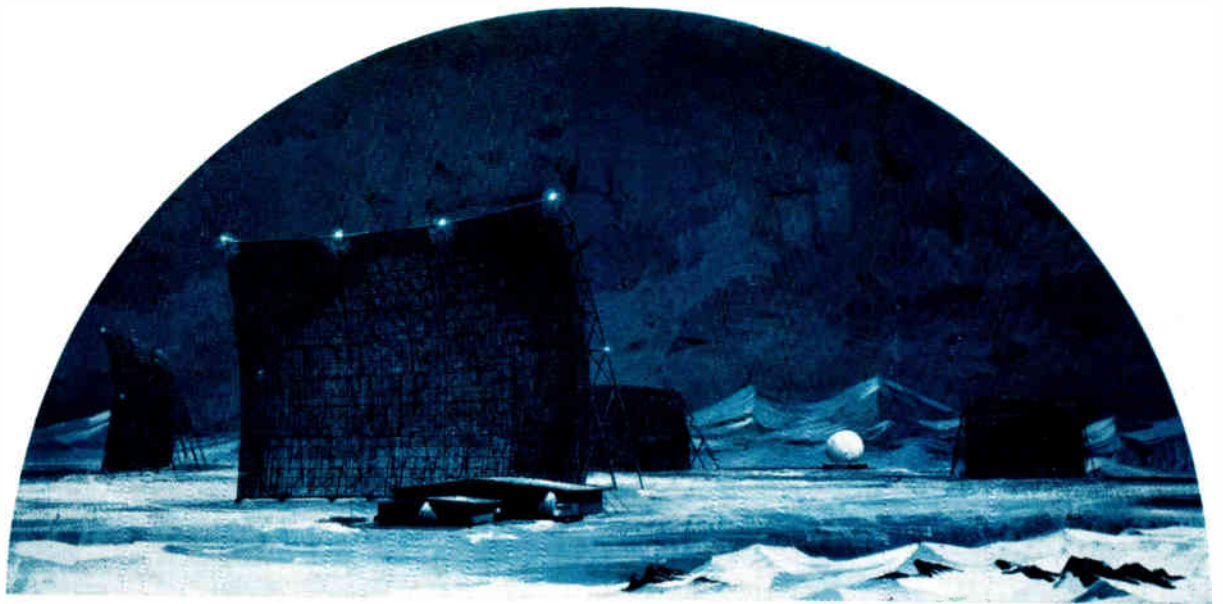
Two developments make the external-field magnet possible. They are: (1) A high-field solenoid with a sizeable inside diam. (2) A helium container, or Dewar, which keeps the coil immersed in liquid helium and still makes the magnetic field available outside.

DU PONT TO WITHDRAW FROM SILICON BUSINESS

Du Pont Co. has announced that it will withdraw from the silicon business in March. The company has manufactured hyper-pure semiconductor silicon for the electronic industry since 1952.

The company believes that the capacity for producing semiconductor grade silicon in the U. S. exceeds the demand, both now and in the foreseeable future.

(More news on page 10)



SUPER POWER RADAR TRANSMITTERS FOR BMEWS

Continuously scanning the northern approaches to England and North America from installations at Fylingdales Moor, England, Thule, Greenland, and Clear, Alaska, the U. S. Air Force's Ballistic Missile Early Warning System is the free world's first warning of enemy ICBM attack. Continental Electronics has delivered all of the transmitters for surveillance and tracking radars at the three BMEWS installations. ■ Provided under subcontract to General Electric and R.C.A., Continental's AN/FPT-7 super power transmitters use specially-developed klystron tubes to produce multi-megawatt radar signals. Serving what is described by the Air Force as, "the world's most powerful operational radar", the BMEWS transmitters were designed by the specialists in super power transmitting equipment.

Continental Electronics

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AS WE GO TO PRESS

PATHFINDER



Engineer examines a new gyroscope developed by Sperry Gyroscope Co. for use in highly accurate inertial guidance systems for aircraft and space vehicles. The ball-bearing supported gyroscope can be made at a fraction of the cost of more exotic gyros that use such supports as air, magnetics or fluids.

TERMAN TO RECEIVE IRE FOUNDERS AWARD

Dr. Frederick E. Terman, Vice President and Provost of Stanford Univ., will receive the IRE Founders Award at a banquet March 27 at the Waldorf-Astoria Hotel, New York. The presentation will be a feature of the first national meeting of the Institute of Electrical and Electronic Engineers.

UNIQUE FUEL CELL BURNS HYDROCARBONS

A practical fuel cell that operates on hydrocarbon fuels has been developed at General Electric Research Laboratory, Schenectady, N. Y.

This experimental cell, self-starting, maintains itself at about 2,000° F. without externally applied heat.

The GE cell has a solid electrolyte of zirconia, a refractory oxide. Several are stacked together to form a "fuel battery." Scientists estimate the top efficiency of natural gas-fueled batteries to be about 30%. (Greater efficiency may be possible with other hydrocarbons.)

In the natural gas cell, the gas breaks down into hydrogen and carbon. Carbon builds up inside the cell to form one electrode. Oxygen is obtained from air which is introduced into the other electrode (molten silver). Then oxide ions migrate through the zirconia electrolyte to the carbon electrode.

The oxygen yields its electrons to

CRT DISPLAYS BOTH CURVES AND DATA

A new CRT developed by General Dynamics/Electronics — San Diego combines the advantages of using shaped electron beams for alpha-numeric data with those of a writing mode for drawing curves and vectors. This data can be combined with radar displays and other high-resolution video systems.

Alpha-numeric data is presented by passing the beam through an etched matrix between gun and tube face. The beam takes the shape of one of 64 characters and symbols.

The same gun is used to draw curves and vectors. Here the electrons pass through an aperture larger than the beam. Extra tube brightness is achieved by greatly increased currents and voltages.

WESTINGHOUSE TELETYPE NET COMPUTER-CONTROLLED

Westinghouse Electric Corp. now has a computer-controlled teletype system. A tele-computer center just outside Pittsburgh is serving a 700-station nationwide company network.

A UNIVAC 490 Real-Time Computing System automatically routes teletype messages from one place to another. If lines are busy, the computer stores messages and sends them to proper destinations when they are free.

The company formerly used a semi-automatic switching center. It handled about 20,000 messages a day. The computer system is expected to handle twice that amount.

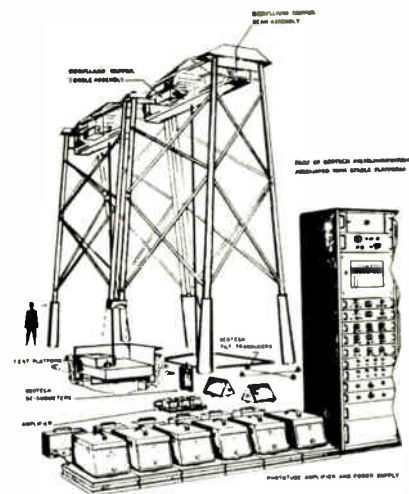
NEW AIR RATE TO AID ELECTRONIC INDUSTRY

A special commodity rate, designed to encourage large-scale use of air freight by the electronic industry, will be offered by Pan American Airways.

The new commodity rate for transatlantic shipment of electronic data storage, processing machines, digital and analog computers and individual units thereof is \$0.36/lb. for shipments of 2,200 lbs. or more.

the carbon, then combines with part of the carbon to form carbon monoxide gas. The electrons are then conducted out of the cell as electric current.

The left-over carbon monoxide and hydrogen gases are then burned within the cell to supply heat for the self-sustaining feature.



Sketch shows "Stable Table" recently installed at Newark, Ohio, Air Force Station to test missile inertial guidance systems.

CALIBRATION FACILITY HAS "STABLE TABLE"

The stable table designed to test inertial guidance components at Newark Air Force Station, Newark, Ohio, is located four stories underground.

The table is isolated from the influences of temperature, magnetic fields, humidity, and "noise" such as vibrations set up by passing trucks or even the pressure of a light breeze against the building.

Seven feet square, the stable work platform is suspended like a pendulum from a 25 ft. high structure especially constructed and instrumented by The Geotechnical Corp. of Garland, Tex.

The suspension system that combats all external motion uses two spring-like devices of beryllium copper especially made by The Beryllium Corp. of Reading, Pa.

SCIENTISTS DEVISE "RADIATION YARDSTICK"

Scientists at Lockheed Missiles & Space have come up with a "radiation yardstick" for engineers designing structures and shielding for atomic reactors.

The new method measures the fast neutron absorption factor (cross section) in gold—which is used as a standard reference in evaluating the absorption characteristics of other materials. The work, performed under contract from the AEC, provides an accurate determination of the neutron absorption factor of gold in the energy range from 10,000 to 600,000 electron volts. Scientists heretofore have been unable to agree on a common denominator for this range.

(More news on page 23)



**SPRAGUE HYREL® ST
SOLID TANTALUM CAPACITORS**
Meet Minuteman Goal April, 1962



**...AND NOW HYREL® FT
FOIL TANTALUM CAPACITORS**
NOVEMBER, 1962

SPRAGUE HYREL® FT FOIL TANTALUM CAPACITORS SURPASS MINUTEMAN PROJECT GOAL!



**SPRAGUE successfully meets 2nd of two Minuteman targets,
having previously achieved solid tantalum capacitor goal**

**Failure Rate Goal of .001%/1000 hrs.*
has been bettered by wide margin!**

Sprague HYREL FT Foil Tantalum Capacitors have exceeded Minuteman's component development objective, attaining a use condition failure rate of .00045% per 1000 hours in recently completed tests. Sprague's qualification to the Minuteman Foil Tantalum Capacitor Specification, like its earlier qualification to the Minuteman Solid Tantalum Capacitor Specification, is unrestricted and "across-the-board."

Backing this performance is Sprague's record of pioneering in highly reliable capacitors, which earned the opportunity to

participate in the Air Force's Minuteman Component Development Program at Autonetics, a division of North American Aviation, Inc.

All of the special processes and quality control procedures that make HYREL FT Foil Tantalum Capacitors so reliable can now help improve the dependability of your military and aerospace electronic equipment. A tantalum capacitor engineer will be glad to discuss the application of these capacitors to your projects. For engineering assistance without obligation, write to Mr. C. G. Killen, Vice-President, Industrial and Military Sales, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

*at 60% confidence level by accelerated qualification tests.

SPRAGUE COMPONENTS

CAPACITORS
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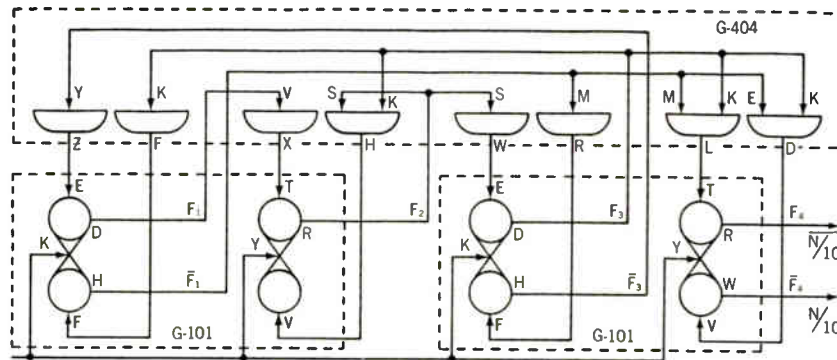
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ECo G-Series Circuit Applications - Number 4



Set-Reset Logic:

$$\begin{aligned}
 F_{1S} &= \bar{F}_3 & F_{3S} &= F_2 \\
 F_{1R} &= F_3 & F_{3R} &= \bar{F}_1 \\
 F_{2S} &= F_1 & F_{4S} &= \bar{F}_1 F_3 \\
 F_{2R} &= F_2 F_3 & F_{4R} &= \bar{F}_1 F_3
 \end{aligned}$$

Note:

No clock term is necessary because G-101 flip-flops are internally steered.

Input (Trigger):

Amplitude: 6-volt p-p negative pulses
at rise times to 20 nanoseconds.
Frequency: 0 to 10 Mpps

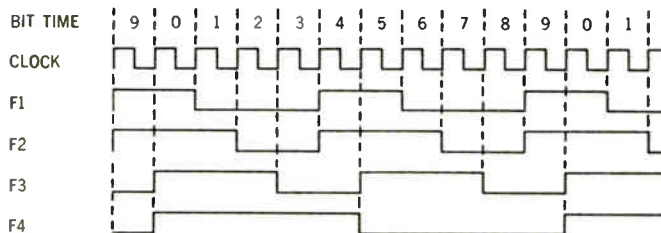
Output:

Signal Levels: -6VDC = "1",
0VDC = "0"
False Level (worst-case) Load:
40 ma, each output
Rise Time: 20 nanoseconds maximum
Fall Time: 50 nanoseconds maximum

Power Required:

-12VDC @ 190 ma maximum
-6VDC @ 66 ma maximum
+6VDC @ 12.4 ma maximum

ECo Modules Required: Two G-101
dual JK flip-flops, one universal logic C
G-404 circuit



A 10 MPPS DECADE SCALER—AND MORE

USE IT AS AN N/10 COUNTER WITH SYMMETRICAL OUTPUTS:

Synchronous decade scaler shown operates at input frequencies to 10 Mpps. Outputs F_4 and \bar{F}_4 are symmetrical square waves. Also, since F_4 and \bar{F}_4 have no logic load, they have full drive capability (40 ma each).

USE IT AS AN N/5 COUNTER:

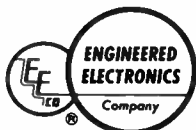
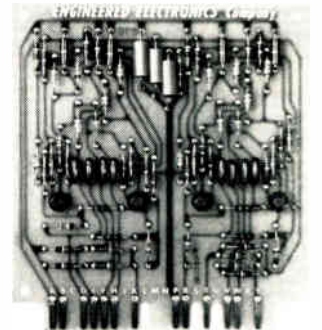
Because the first three stages complete a counting cycle for every group of five input clock pulses, they may be used as an N/5 counter if the fourth stage is deleted.

USE IT AS A SOURCE OF DELAYED CLOCK PULSES:

Output waveforms of second and third stages are identical, but third-stage output is delayed one clock time. Pairs of signals such as these are useful for timing systems requiring two or more clocks for logic propagation.

AND MORE:

These are just a few applications for this 10 Mpps scaler—and for ECo's new G-Series extended-service digital-circuit modules. Perhaps others will be of interest to you. Write, wire, or phone today for details. Ask for the new G-Series catalog or a call from one of our experienced staff of applications engineers.



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Telephone: 547-5651 Cable Address: ENGELEX

COMING EVENTS

...in the electronic industry

FEBRUARY

- Feb. 18-19: 4th Electrical / Electronic Trade Show, Electrical Reps. Club, Electronic Reps. Ass'n.; Denver-Hilton Hotel, Denver, Colo.
- Feb. 18-20: 13th Nat'l. Conf. on Standards, ASA; Biltmore Hotel, New York, N. Y.
- Feb. 20: 4th Annual Reliability Symp., Los Angeles Sec., ASQC; Statler-Hilton Hotel, Los Angeles, Calif.
- Feb. 20-22: 10th Int'l. Solid-state Circuits Conf., IRE (PGCT), AIEE, Univ. of Pa.; Univ. of Pa., Sheraton Hotel, Philadelphia, Pa.
- Feb. 21-22: Quality Control Conf., Western Reg., ASQC; Flamingo Hotel, Las Vegas, Nev.
- Feb. 22: Gen'l. Mtg., Ass'n. of Electronic Parts & Eqpt. Mfrs.; Chicago, Ill.
- Feb. 22-24: Annual Trade Fair and Eng. Display, San Diego Committee for Nat'l. Eng. Wk.; Electric Bldg., Balboa Prk., San Diego, Calif.
- Feb. 23: AMS Mtg., New York, N. Y.
- Feb. 24-28: AIME Annual Mtg.; Dallas, Tex.
- Feb. 26-Mar. 1: 19th Annual SPE Tech. Conf.; Statler-Hilton and Biltmore Hotels, Los Angeles, Calif.

MARCH

- Mar. 1-2: APS Mtg.; Rice Univ., Houston, Tex.
- Mar. 2: 7th All-Day Seminar, Dayton Sec., ASQC; Engineer's Club, Dayton, Ohio
- Mar. 3-7: Gas Turbine Conf. & Products Show, including Aviation & Space Conf., ASME; Statler-Hilton Hotel, Los Angeles, Calif.
- Mar. 4-8: Pittsburgh Conf. on Analytical Chem. & Applied Spectroscopy, Pittsburgh Analytical Chem. Soc., Pittsburgh Spectroscopy Soc.; Penn-Sheraton Hotel, Pittsburgh, Pa.
- Mar. 5-7: 1963 Microminiaturization Cong., AWI; Sheraton Hotel, Philadelphia, Pa.
- Mar. 5-7: Southeastern Plant Eng. & Maint. Show & Seminar, Southeastern Shows, Inc., AIPE; Merchandise Mart, Charlotte, N. C.
- Mar. 7-8: IAS Propulsion Mtg.; Cleveland, Ohio.
- Mar. 10-13: AIChE Nat'l. Mtg.; Roosevelt Hotel, New Orleans, La.
- Mar. 11-15: 1963 Nat'l. NACE Conf.; Americana Hotel, New York, N. Y.
- Mar. 12: Annual Mtg., Ass'n. of Electronic Parts & Eqpt. Mfrs.; Chicago, Ill.
- Mar. 13-14: 13th Nat'l. Conf. on Instrumentation for the Iron & Steel Ind., ISA; Pick-Roosevelt Hotel, Pittsburgh, Pa.
- Mar. 15: 10th Annual Quality Control

- Clinic, Milwaukee Sec., ASQC; Milwaukee Inn, Milwaukee, Wisc.
- Mar. 15-16: Information Processing Conf., Computing Devices Committee, AIEE; Calif. Inst. Tech., Pasadena, Calif.
- Mar. 15-17: Michigan State Conv., ARRL; Saginaw, Mich.
- Mar. 16: Annual Quality Control Seminar, S. Conn. Sec., ASQC; Univ. of Bridgeport, Bridgeport, Conn.
- Mar. 18: Workshop-Seminar — Quality Control Mgmt., Boston Sec., ASQC; MIT Faculty Club, Boston, Mass.
- Mar. 18-22: ASM Western Metal Exp. & Cong.; Ambassador Hotel and Pan-Pacific Audit., Los Angeles, Calif.
- Mar. 20-29: Sym.—“Quantitative Spectroscopy at Elevated Temperatures and Selected Applications in Space Science,” AFOSR, AF Cambridge Res. Labs., ARPA, NASA, Inst. Def. Analysis, ONR, Calif. Inst. Tech.; Calif. Inst. Tech., Pasadena, Calif.

'63 Highlights

- IEEE Int'l. Conv., Mar. 25-28; Coliseum and Waldorf-Astoria Hotel, New York N. Y.
- ICEAS, Int'l. Conf. & Exh. on Aerospace Support, Aug. 4-9, AIEE, IRE, ASME; Sheraton-Park Hotel, Washington, D. C.
- WESCON, Western Electronic Show and Conf., Aug. 20-23, IRE, WEMA; Cow Palace, San Francisco, Calif.
- National Electronics Conf., Oct. 28-30, IRE, AIEE; McCormick Place, Chicago, Ill.
- NEREM, Northeast Research and Eng. Mtg., Nov. 4-6. IRE; Boston, Mass.

- Mar. 23: Annual Nat'l. Conv., Intercollegiate Broadcasting Syst.; New York Univ., Univ. Hts., New York, N. Y.
- Mar. 25-27: Space Testing & Support Mtg., IAS, ARS; Cocoa Beach, Fla.
- Mar. 26: 12th Annual Dinner & Hamfest, SSB Amateur Radio Ass'n.; Statler-Hilton Hotel, New York, N. Y.
- Mar. 26: 19th Annual Quality Control Conf., Rochester Sec., ASQC; Univ. of Rochester, Rochester, N. Y.
- Mar. 26-28: American Power Conf.; Sherman Hotel, Chicago, Ill.
- Mar. 27-28: Spring Textile Eng. Conf., ASME; Clemson House, Clemson, S. C.
- Mar. 30: Quality Control Conf., Battle Creek-Kalamazoo Soc., ASQC; Univ. Ctr., W. Mich. Univ., Kalamazoo, Mich.
- Mar. 31-Apr. 3: 41st Annual NAB Conv. & 17th Annual Broadcast Eng. Conf.; Chicago, Ill.
- Mar. 31-Apr. 5: Nat'l. Spring Mtg., AChS; Los Angeles, Calif.

APRIL

- Apr. 1-3: “Pressure Vessels for Aerospace Applications,” 4th Annual Structures & Materials Conf., IAS, ARS; Palm Springs, Calif.
- Apr. 1-5: 1st Annual Dallas Ind. Trade Fair, State of Texas; State Fair Park, Dallas, Tex.
- Apr. 4-6: Mtg., Southwest Sec., ASEE; Rice Univ., Houston, Tex.
- Apr. 14-19: Spring Mtg., Electrochemical Soc., including Symp. on Thin Films for Electronic Application; Penn-Sheraton Hotel, Pittsburgh, Pa.

“CALL FOR PAPERS”

1963 PGAP Int'l. Symp., July 9-11, 1963, Boulder, Colo., Laboratories, Nat'l. Bureau of Standards. Papers should be original works in one or more of the following fields: antennas, propagation, radio astronomy, electromagnetic theory, propagation in plasmas, space telecommunications and related subjects. A 100-word abstract and 1,000 word summary should be submitted in duplicate, with title, name and address of author by Mar. 1, 1963. Send material to: Mr. Herman V. Cottony, Chairman, Technical Program Committee, 1963 PGAP Int'l. Symp., Boulder Laboratories, Nat'l. Bureau of Standards, Boulder, Colo.

ENGINEERING EDUCATION

Short courses of interest to engineers

Electromagnetic/Eddy Current

A workshop-seminar covering procedures and techniques of electromagnetic/eddy current testing of metals is being held bi-monthly by *Magneflux Corp.*, Chicago, Ill. The 40-hour program has been scheduled for the weeks of Feb. 11 and May 13. The course includes a survey of electromagnetic testing fundamentals, probe and through-coil applications, terminology, circuitry, frequency selection, hysteresis effects, and magnetic property determinations. It also covers the interpretation and evaluation of signals and various methods of setting standards. It is designed for quality and training supervisors, reliability engineers and like personnel. Only eight students al-

(Continued on page 15)

now clean transistor circuits ultrasonically

...but only if you are using the Hughes MICROSEAL* transistor — in any industry standard package — with no fragile, thermo-compression bonded leads!

Ultrasonic cleaning tests were performed recently with planar MICROSEAL transistors—all picked at random from the production line and immersed in a bath of trichloroethylene. Some were subjected to 40 KC and others to 90 KC, maximum cavitation in both instances. Each group was checked after one minute, six minutes and eleven minutes. The results: not a single failure in either group. The reason: in the Hughes MICROSEAL transistor the usual 0.0007" thermo-compression bonded wires have been replaced by solid internal emitter and base connections that measure 0.015" in diameter. The conclusion: the Hughes MICROSEAL transistor is an ideal no-compromise device

for use in missiles and space vehicles, in high-speed, flip-flop computer applications, and in communications systems—in fact, in any transistorized component or system demanding a high degree of resistance to shock, acceleration, vibration and moisture. ■ Other important facts about the Hughes MICROSEAL transistor: complete MICROSEAL-transistorized circuit boards may be immersed in an ultrasonic bath to remove solder flux and other foreign matter; the MICROSEAL transistor may be better shielded from radiation because of its small size: 0.030" thick and 0.080" in diameter; and each MICROSEAL transistor will meet environmental and life-test standards delineated in MIL-S-19500C.



For details on local delivery or export, contact your Hughes representative; or your Hughes distributor for off-the-shelf stock. Or write Hughes Semiconductor Division, Marketing Dept.

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COMING EVENTS

PROCLAIM "WEEK"



Cap Kierulff (l), Pres. of Pacific Electronic Trade Show, accepts resolution proclaiming week of Feb. 4-10 Western Electronic Week from Ernest E. Debs, Chm., Los Angeles County Bd. of Supervisors. Los Angeles city Mayor Samuel W. Yorty also signed it. Trade Show (Feb. 8-10) is main event of WEW

(Continued from page 13)

lowed per class. Tuition is \$100 per student. For more information, contact: Robert C. Eichin, Dir. of Training, Magneflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

Reliability vs. Cost Control

A series of seminars on how to reduce costs and still improve reliability and quality control is being held by the *Reliability Dynamics Inst.* at locations throughout the country. One is at the Conference Center, Boston Univ. Extension Service, Andover, Mass. Courses include: Quality Cost Analysis, Mathematics of Reliability, Reliability Systems Integration, Experiment Design, Quality Control System Manual Preparation, PERT/Reliability and other timely subjects.

Quality control and design engineers or operations executives should find these seminars helpful. Leading working authorities in their fields conduct practical 1 or 3-day seminars. For brochure giving course outline, speakers and locations, contact Reliability Dynamics Inst., W. Acton, Mass.

WESCON OFFICE MOVED

The business office of the Western Electronic Show and Convention in Los Angeles has been moved to the Travelers Building, 3600 Wilshire Blvd.



The 164



A 160



"made-to-measure precision"

How to
twist the power
in a 50Ω line
around your finger
(and live!)

Wrap your fingers around the selector knob on a Sierra 164 Bi-Directional Power Monitor, and you're ready to measure power flowing either way in the line. Twist the knob, and you see reflected; twist again, and you're reading incident. The knob, in your gentle fingertip grasp, takes the sweat and swearing out of switching. To us, that's really living.

A 164 has other qualities that help add sparkle to life afield, or in the lab. With just 9 easy-to-calibrate plug-in elements, it covers one of the widest dynamic ranges around: 1 to 1,000 watts and 2 to 1,000 MC. At 7½ lbs., the case with handy carrying strap practically floats off the end of your arm. And when you mate it to a Sierra Series 160 Coaxial Load, you've got a termination wattmeter that's the living end.

The 164 Power Monitor costs \$110, complete with Type N connector and a sunny smile from your Sierra sales representative. The smile is optional. So are matching Type UHF, C, LC, HN, BNC, or TNC connectors. Even before you buy, you're entitled to a bulletin that gives full information in a spirit of sobriety. Write us for it, or contact your nearest Sierra representative.

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P. O. Box 669
60 Herricks Rd.
Phone: Pioneer 6-6520

NEW YORK
Harvey Radio Company, Inc.
103 W. 43rd Street
Phone: JUDson 2-1500
Milo Electronics Corporation
530 Canal St.

Phone: BEekman 3-2980
Terminal-Hudson Electronics, Inc.
236 W. 17th St.
Phone: CHelsea 3-5200

SYRACUSE
Harvey Electronics-Syracuse, Inc.
Pickard Drive
Box 185
Phone: GLenview 4-9282

NORTH CAROLINA
WINSTON-SALEM
Electronic Wholesalers, Inc.
938 Burke St.
Phone: PARk 5-8711

OHIO
AKRON
Akron Electronic Supply, Inc.
107-117 S. Arlington St.
Phone: 762-8818

CINCINNATI
Herringer Distributing Co.
112 E. Liberty St.
Phone: GA 1-5282
OAYTON
Esco Electronics, Inc.
3130 Valleywood Drive
Phone: 298-7461

OKLAHOMA
TULSA
Engineering Supply Co.
1124 E. 4th St.
P. O. Box 3007
Phone: LUther 3-8121

PENNSYLVANIA
PHILADELPHIA
Aimo Industrial Electronics, Inc.
412 N. 6th St.
Phone: WALnut 2-5918

PITTSBURGH
Cameradio Co.
1121 Penn St.
Phone: EXpress 1-4000
WARRINGTON
Atlas Electronics
125 Titus Ave.
Warrington Industrial Park
Phone: DIamond 3-1860

RHODE ISLAND
PROVIDENCE
Wm. Dandreta & Co.
28 Wolcott St.
Phone: UNion 1-2800

TENNESSEE
NASHVILLE
Electro Distributing Corp.
1914 W. End Ave.
Phone: 255-8444

TEXAS
DALLAS
Engineering Supply Co.
6000 Denton Dr.
Phone: FLEetwood 7-6121

EL PASO
McNicol, Inc.
811 N. Estrella
Phone: LOGan 6-2936

HOUSTON
Harrison Equipment Co., Inc.
1422 San Jacinto St.
P. O. Box 1505
Phone: CAPITol 4-9131

SAN ANTONIO
The Perry Shankie Co.
1801 S. Flores St.
Phone: CAPITol 3-1801

UTAH
SALT LAKE CITY
Standard Supply Co.
225 E. Sixth South St.
P. O. Box 1047
Phone: ELgin 5-2971

WASHINGTON
SEATTLE
C & G Electronics Co.
2221 3rd Ave.
Phone: MAIN 4-4355
Seattle Radio Supply, Inc.
2117 Second Ave.
Phone: MA 4-2341

WISCONSIN
MILWAUKEE
Taylor Electric Co.
4080 N. Port Washington Rd.
Phone: WOodruff 4-4321

TEAR OUT THIS BROCHURE FOR YOUR FILES

It's the new Bourns Precision Potentiometer Summary Brochure, containing specifications, dimensions and prices for the entire Bourns precision potentiometer line. (If someone has already torn it out, circle the reader service card or write us, and we'll send you a copy promptly.)

BOURNS, Inc.

1200 Columbia Ave., Riverside, Calif.



BOURNS PRECISION POTENTIOMETERS

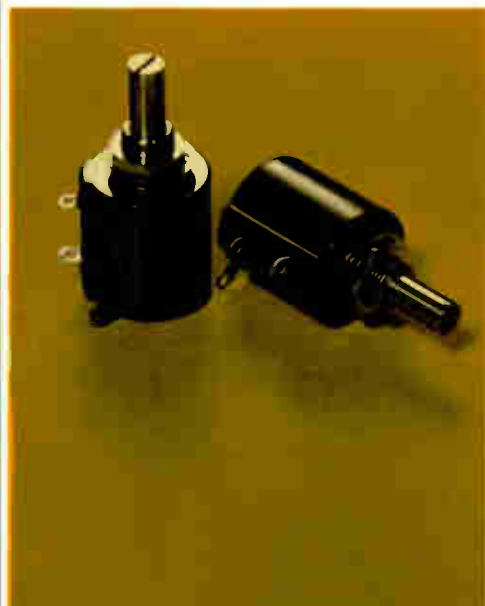
... represent a completely new approach in precision potentiometer design. The same reliability concepts that have made Bourns TRIMPOT® Adjustment Potentiometers the undisputed leaders in their field, have been incorporated into Bourns precision units. Single wire termination — the precision potentiometer industry's No. 1 cause of failure — has been eliminated by Bourns exclusive SILVERWELD® termination. Sealed construction—previously unavailable — is a standard feature of all Bourns precision types. And resistance elements have been lengthened, while overall size has been reduced! These and many other quality design features, combined with the most stringent reliability assurance program in the industry, make Bourns precision potentiometers the answer to the industry's long awaited need for completely dependable precision components.



BOURNS

BOURNS, INC., TRIMPOT® DIVISION
1200 COLUMBIA AVE., RIVERSIDE, CALIF.
684-1700, TWX 714-682-9582 CABLE BOURNSINC

7/8 INCH DIAMETER PRECISION POTENTIOMETERS. THREE, FIVE, AND TEN TURN TYPES. Bourns Models 3510, 3520 and 3500, comprise the most complete 7/8-inch line in the industry. These three, five, and ten turn units combine military reliability with reduced size, yet contain a resistance element 20 percent longer than comparable types. This longer element provides better resolution, cooler operating temperatures through improved power-heat dissipation, and higher total resistance. Molded, all plastic moisture resistant cases ensure excellent humidity resistance . . . standard units exceed steady state requirements . . . optional units meet cycling requirements of MIL-STD-202B, Method 106.



Model 3500 — ten turn

Resistance Values _____ 500 to 125K ohms
 Resistance Tolerance _____ ±3% standard, closer tolerances available
 Linearity (Independent) _____ ±0.2% standard
 Electrical & Mechanical Rotation _____ 3600° (+10°; -0°)
 Power Rating (70°C) _____ 2.0 watt
 Operating Temperature Range _____ -65 to 125°C
 Humidity _____ Standard - MIL-STD-202, Method 103 (Steady State). Optional Feature - MIL-STD-202, Method 106 (Cycling)
 Vibration _____ MIL-STD-202, Method 204, 20G
 Shock _____ MIL-STD-202B, Method 202, 100G
 Mechanical Life _____ 100,000 cycles (2,000,000 shaft revolutions)
 Size _____ 7/8" diameter; 1" case length
 Weight _____ Approximately 1.0 ounce

PRICES:	Model	1-9	10-24	25-99	100-249
	3500	11.99	11.39	10.79	9.59



**Model 3510 — three turn
 Model 3520 — five turn**

Resistance Values _____ 200 to 50K ohms (3510)
 _____ 200 to 75K ohms (3520)
 Resistance Tolerance _____ ±3% standard, closer tolerances available
 Electrical and Mechanical Rotation _____ 1080° (3510)
 _____ 1800° (3520)
 Linearity (Independent) _____ ±0.30% standard
 Power Rating (70°C) _____ 1.0 watt (3510) 1.5 watt (3520)
 Operating Temperature Range _____ -65 to 125°C
 Humidity _____ Standard - MIL-STD-202, Method 103 (Steady State) Optional Feature - MIL-STD-202, Method 106 (Cycling)
 Vibration _____ MIL-STD-202B, Method 204, 20G
 Shock _____ MIL-STD-202B, Method 202, 100G
 Mechanical Life _____ 100,000 cycles (2,000,000 shaft revolutions)
 Size _____ Diameter 7/8"; 0.549" case length (3510)
 _____ Diameter 7/8"; 0.678" case length (3520)

PRICES:	Model	1-9	10-24	25-99	100-249
	3510	14.99	14.24	13.49	12.74
	Model	1-9	10-24	25-99	100-249
	3520	13.50	13.10	12.30	11.10

Standard Resistance Range _____ 500 to 100K ohms
 Resistance Tolerance _____ ±5% standard, closer tolerances available
 Linearity (Independent) _____ ±0.25% standard
 Electrical & Mechanical Rotation _____ 3600° (+10°; -0°)
 Power Rating (70°C) _____ 1.0 watt
 Operating Temperature Range _____ -65 to 125°C
 Humidity _____ Standard - MIL-STD-202B, Method 103 (Steady State) Optional Feature - MIL-STD-202B, Method 106 (Cycling)
 Vibration _____ MIL-STD-202B, Method 204, 20G
 Shock _____ Exceeds MIL-STD-202B, Method 202, 100G
 Mechanical Life _____ 50,000 cycles (1,000,000 shaft revolutions)
 Size _____ 1/2" diameter; 1" case length

PRICES:	Model	1-9	10-24	25-99	100-249
	3700	24.50	23.28	22.05	19.60



1/2 INCH DIAMETER PRECISION POTENTIOMETER. TEN-TURN TYPE. The Model 3700 combines unusually high performance with miniature size. Measure only 1/2 inch in diameter by 1 inch long, the Model 3700 features independent linearity of 0.25%, power rating of 1 watt at 70°C, and 125°C maximum operating temperature range. Standard model exceeds steady state humidity requirements, and as an optional feature, meets the stringent demands of MIL-STD-202B, Method 106.



PRECISION POTENTIOMETER READ-OUT DIALS. These attractive, easy-to-read dials are available in anodized black or clear finishes for all Bourns 3, 5, and 10-turn precision potentiometers. Dials require only 1 inch of panel space and can be easily read to four places. Settings can be estimated to a fraction of a thousandth. Dials are easily mounted; no extra holes in the panel are required. Knobs screwed directly to pot shaft eliminate backlash. An optional locking device permits positive locking without shifting dial reading. These sturdy dials have been tested for 250,000 cycles with no sign of appreciable wear.

Part No.	Description	1-9	10-24	25-99	100-199
H412	H462 1/4" Brake	8.95	8.50	8.06	7.61
H411	H461 1/4" No Brake	7.75	7.36	6.98	6.59
H432	H482 3/32" Brake	9.30	8.84	8.37	7.91
H431	H481 3/32" No Brake	8.10	7.70	7.29	6.89
H422	H472 1/8" Brake	8.95	8.50	8.06	7.61
H421	H471 1/8" No Brake	7.75	7.36	6.98	6.59



Resistance Values _____ 1K to 100K ohms
 Resistance Tolerance _____ ±5% standard, closer tolerances available
 Electrical & Mechanical Rotation _____ 3600° (+10°; -0°)
 Dial Accuracy (Including Linearity) _____ ±0.5% standard
 Repeatability of Dial Reading _____ 0.1% voltage ratio
 Power Rating (25°C) _____ 1.50 watts
 Operating Temperature Range _____ -65 to 125°C
 Humidity _____ MIL-STD-202B, Method 103
 Vibration _____ MIL-STD-202B, Method 204, 10G
 Shock _____ MIL-STD-202B, Method 202, 50G
 Mechanical Life _____ 10,000 cycles
 Size _____ 3/4" diameter; 1" case length
 Weight _____ 0.62 ounce

Model	1-4	5-9	10-24	25-49	50-99	100-249
	3600	20.52	20.52	19.00	17.10	16.22 15.20

3/4" DIAMETER KNOBPOT® POTENTIOMETER, READOUT DIAL, KNOB - ALL IN FRONT OF PANEL. The Model 3600 KNOBPOT potentiometer - an exclusive Bourns design - introduces a new component concept in precision potentiometer-dial applications. A 10-turn precision potentiometer, readout dial, and knob in a single compact package measuring only 3/4" in diameter by 1 inch long. The potentiometer mechanism, built inside the knob, occupies no space behind the panel. The easy to read, integrated 3/4" clock dial eliminates assembly and phasing during mounting.



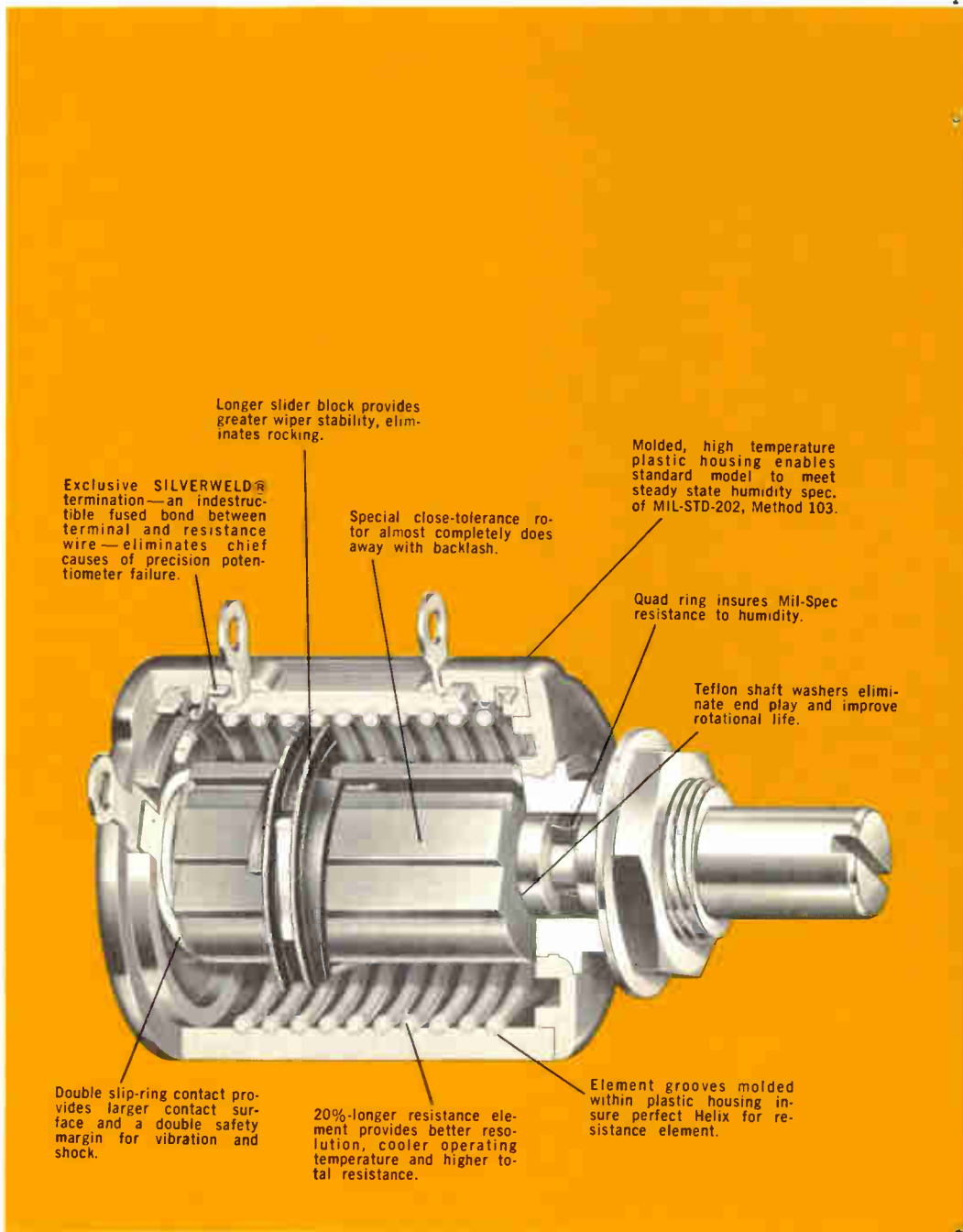
KNOBPOT POTENTIOMETER ACCESSORIES. Many attractive accessories are now available for the Model 3600 KNOBPOT potentiometer. Color snap rings of high temperature plastic are available in red, yellow, blue, green, and white per MS 71528B and MIL-STD-242 (Bu-Ships). Standard Mil-Spec. 1 inch diameter slip-over knobs, made of high temperature plastic, are available in MIL-SPEC red, yellow, blue, green, black, and grey. A stainless steel locking brake with high temperature plastic handles easily snaps into place between the potentiometer and the panel. Stainless steel skirts provide a finishing touch of high-polish glamour.

Part No.	Description	1-24	25-99	100-499
H93	Colored Snap-Ring	.35	.30	.25
H94	Slip-Over Knob	1.25	1.07	.97
H95	Stainless Steel Skirt	1.50	1.25	1.00
H96	Locking Device (Brake)	1.25	1.07	.97

QUALITY DESIGN. The construction details shown in the cut-a-way drawings of the Model 3500 are not necessarily descriptive of all models, but are typical of the design features found in Bourns precision potentiometers. These high-reliability features have evolved through Bourns long experience in the potentiometer field — specifically through the Company's capability in producing quality miniature parts, precision plastic moldings, and dependable seals.

QUALITY CONTROL. All units are individually inspected to guarantee full conformance to all key physical and electrical specifications. One hundred percent inspection for contact pressure (wiper and both collector ring pickoffs) also assures low noise levels and reliable performance for a minimum of 100,000 cycles or 2 million shaft rotations.

RELIABILITY ASSURANCE. A final measure of quality is Bourns Reliability Assurance Testing Program — the most stringent in the potentiometer industry. Random samples are selected from stock and checked for stability and performance under extreme conditions of cold, humidity, shock, and vibration — each condition at the limit of published specifications. Load life and rotational tests are also performed. This unique reliability program is your final guarantee that Bourns components will always meet or exceed published standards of performance and reliability. In addition to precision potentiometers, Bourns manufactures a complete line of leadscrew actuated adjustment potentiometers and relays. Write for the TRIMPOT Summary Brochure or contact your nearest Bourns sales representative or distributor for price and delivery information.



Longer slider block provides greater wiper stability, eliminates rocking.

Exclusive SILVERWELD[®] termination — an indestructible fused bond between terminal and resistance wire — eliminates chief causes of precision potentiometer failure.

Special close-tolerance rotor almost completely does away with backlash.

Molded, high temperature plastic housing enables standard model to meet steady state humidity spec. of MIL-STD-202, Method 103.

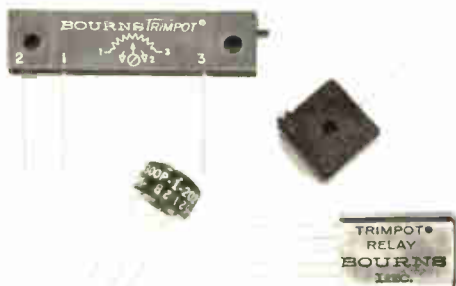
Quad ring insures Mil-Spec resistance to humidity.

Teflon shaft washers eliminate end play and improve rotational life.

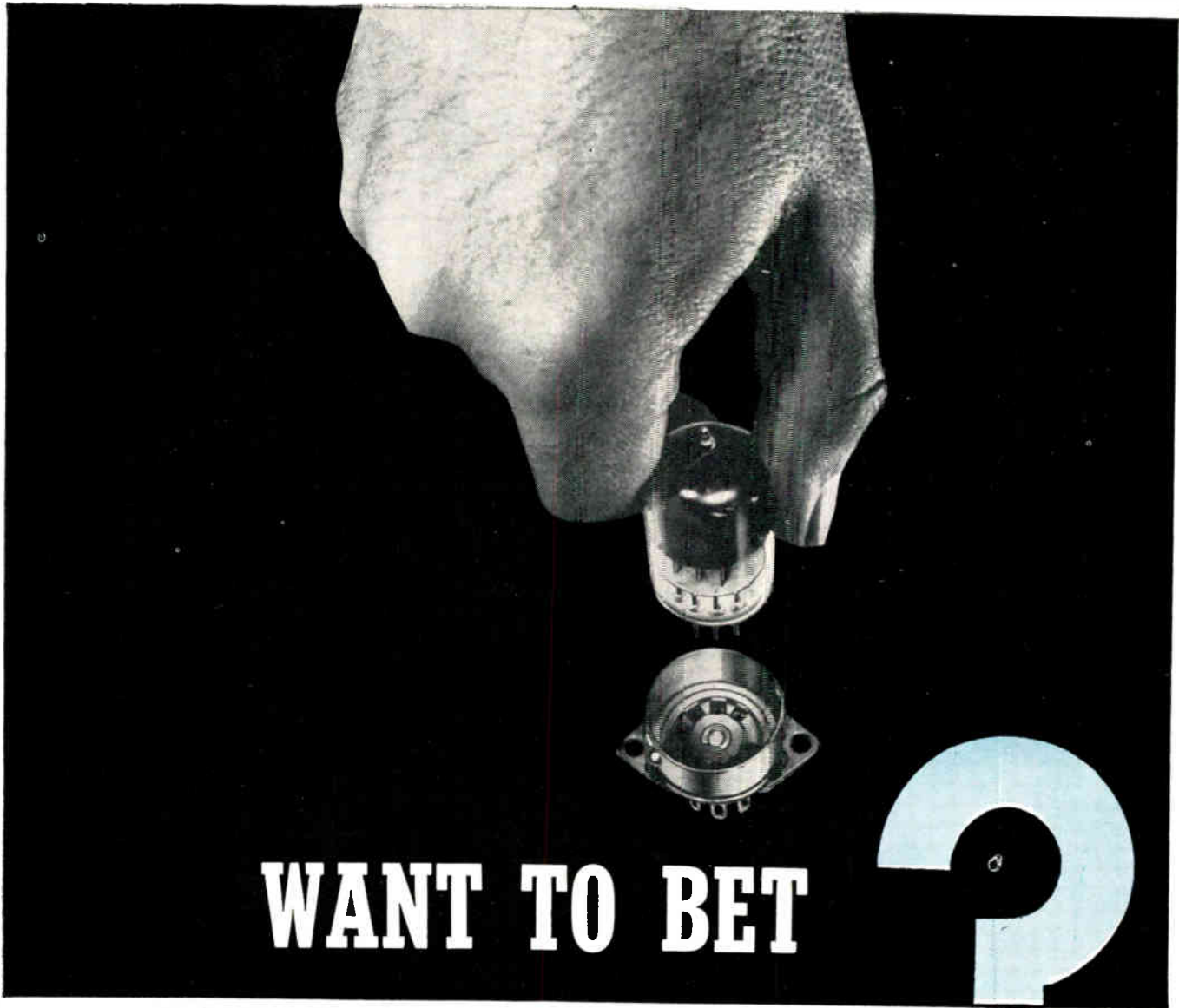
Double slip-ring contact provides larger contact surface and a double safety margin for vibration and shock.

20% longer resistance element provides better resolution, cooler operating temperature and higher total resistance.

Element grooves molded within plastic housing insure perfect Helix for resistance element.



Bourns, Inc. owns the following United States Letters Patent relating to certain of its precision potentiometers: 3,069,646. Other patents pending.



WANT TO BET

YOU CAN'T DAMAGE TUBE-PINS WITH ELCO PATENTED E-Z MATE* SOCKETS

Virtually no pin damage occurs with E-Z MATE* Sockets and we'll bet you a free 6-pack to prove it! These sockets with go-and-no-go "brain power" (available in all our 7- and 9-pin saddle and snap-on models except ceramic) permit tubes to find correct insertion position almost automatically; allow you to design them into formerly inaccessible locations, as well. Proven production capabilities, ready replacement, lowered prices are more reasons why more quality manufacturers specify them for their equipment with the same reliability as our VARICON† Connectors. You will, too!

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New Main Plant and Offices: Willow Grove, Pa., OLdfield 9-7000, Area Code 215, TWX 215-659-0494
Also Subsidiaries, Licensees, Importers, Representatives, Distributors Throughout the World

Send for your Free Test
6-Pack and our just-off-the-press
Tube Socket and Shield Catalog

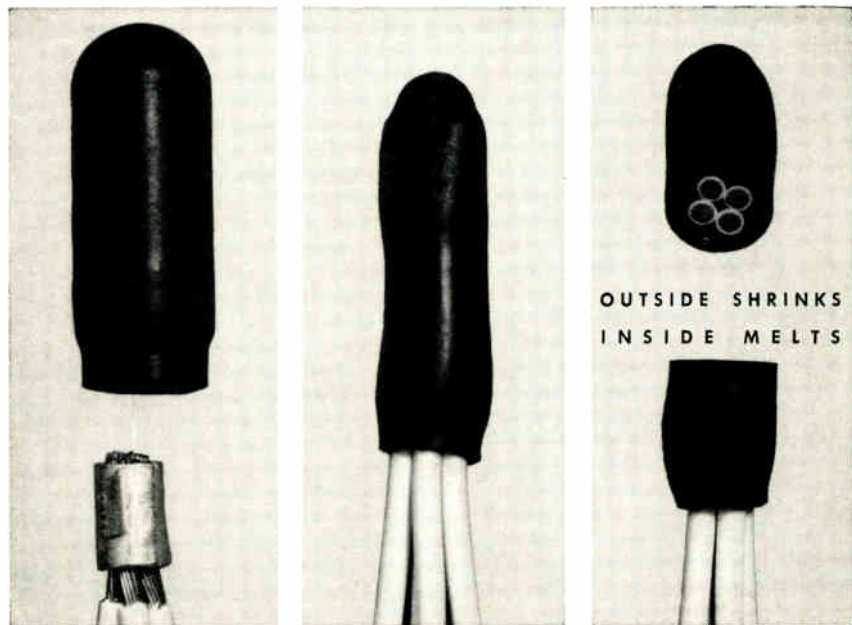
ELECTRONIC INDUSTRIES • February 1963

*PATENTED †TRADE MARK

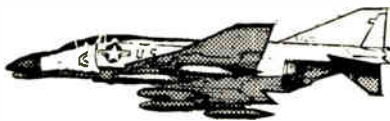
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CAPS

HEAT SHRINKABLE
SELF-POTTING



THERMOFIT SCL



When Thermofit SCL Splice Caps are heated briefly, the cross-linked polyolefin cap shrinks. The thermoplastic inner wall melts, flows and is forced into the voids between the wires by the pressure of the shrinking cap. The new device provides a tough homogeneous *moisture-proof* molding of high dielectric strength.

Thermofit SCL Splice Caps are used extensively throughout McDonnell's Phantom II, the world's fastest operational jet fighter.

A SUBSIDIARY OF
RAYCHEM
CORPORATION



RAYCLAD TUBES
INCORPORATED
REDWOOD CITY, CALIFORNIA

NEWS BRIEFS

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

FILTRON INC., formerly of Port Washington, L. I., has opened a new 65,000 sq. ft. manufacturing and administrative building in East Northport, L. I. Six separate facilities have been consolidated in the East Northport plant.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., New York, N. Y., has formed **ITT INTEL-COM, INC.** Intelcom will provide engineering and technical assistance in planning military satellite communications systems for the DOD.

ELECTRONIC COMMUNICATIONS, INC., St. Petersburg, Fla., has dedicated their new 75,000 sq. ft. addition to their present engineering facilities. ECI engineering and manufacturing facilities now total 275,000 sq. ft.

ONONDAGA ELECTRONICS DIV., SPEER CARBON CO., Syracuse, N. Y., has just completed a \$400,000 expansion and modernization program of the company's manufacturing and development facilities.

BAIRD-ATOMIC, INC., Cambridge, Mass., has acquired **UNILECTRON, INC.** of Cambridge. Unilectron will be operated as a wholly owned subsidiary of Baird-Atomic.

SUPERIOR TUBE CO., Norristown, Pa. has purchased, for an undisclosed amount of cash, the **MOLECU-WIRE CORP.**, Scobeyville, N. J. Superior will operate Molecu-Wire as a wholly owned subsidiary.

TIMELY TECHNICAL PRODUCTS, INC., Verona, N. J., and the **FLUOROCARBON CO.**, Anaheim, Calif., combined operations by an exchange of stock. The corporation will be known as The Fluorocarbon Co. with Timely Tech operating as a wholly-owned subsidiary.

ANTENNA SYSTEMS, INC., formerly at Hingham, Mass., has opened a new plant in Manchester, N. H., totaling 65,000 sq. ft. of floor space.

GENERAL PRECISION, INC., Tarrytown, N. Y., has formed two new groups—an **INFORMATION SYSTEMS GROUP** in Glendale, Calif., and a **SIMULATION and CONTROL GROUP** in Binghamton, N. Y. General Precision's **GPL DIV.**, Pleasantville, N. Y., has become a division of General Precision's **AEROSPACE GROUP**.

FILTRON CO., INC., Flushing, N. Y., has acquired an additional 20,000 sq. ft. of manufacturing and production space. This additional space houses the **FIL-SHIELD DIV.**

TECHNICAL MEASUREMENT CORP., North Haven, Conn., has begun manufacturing operations in its new two-story, 35,000 sq. ft. facility, next to the company's existing 65,000 sq. ft. plant in North Haven. The new facility was erected at a cost of \$700,000.

SYSTEMS DIV. OF FREQUENCY ENGINEERING LABORATORIES has transferred operations to its new building at the Monmouth County Airport, Wall Township, N. J.

GLASS-TITE INDUSTRIES, INC., Providence, R. I., has agreed to sell its 50% interest in **BURNDY-ESCON, INC.**, to the **BURNDY CORP.**, Norwalk, Conn. Glass-Tite will receive 10,000 shares of Burndy common stock which it will hold as an investment.

SPERRY ELECTRONICS CO., Clearwater, Fla., has been awarded a production contract valued at more than \$500,000 for some 600 temperature-compensated microwave power meter sets, by the Navy Dept., Bureau of Ships.

MARTIN CO., ORLANDO DIV., Orlando, Fla., has awarded the **POTTER INSTRUMENT CO., INC., PRINTER DIV.**, Plainview, L. I., approximately \$200,000 additional for follow-on production quantities of the Model 3314-2 which is being used for ground checkout of the Pershing Missile.

LITTON INDUSTRIES, Beverly Hills, Calif., has purchased **EMERTRON, INC.**, headquarters Silver Spring, Md., a subsidiary of **EMERSON RADIO**, for an undisclosed amount of securities. It will become part of Litton's **SYSTEMS GROUP**, and its operations will be coordinated with Litton's newly-formed **RADCOM DIV.**, College Park, Md.

GENERAL DYNAMICS/ELECTRONICS, Rochester, N. Y., has been awarded a \$795,275 contract for mine-detecting equipment by the U. S. Navy's Bureau of Ships.

PERLITE CORP., has formed a new division, **BLUE METALS**, which will produce and sell germanium and germanium compounds. It is located at 2001 Front St., Chester, Pa.

THE CARBORUNDUM CO., Niagara Falls, N. Y., has been awarded a \$249,360 research contract to develop new or improved ceramic cutting tools. The sponsoring agency is the Manufacturing Technology Laboratory, Aeronautical Systems, Div., AFSC, U. S. Air Force, Wright-Patterson Air Force Base, Ohio.

NORTH ATLANTIC INDUSTRIES, INC., Plainview, N. Y., has received a contract valued at \$300,000 for 14 Servo Repeater Units from the **SPERRY GYROSCOPE CO.** The units will be used in the Lafayette Class, Polaris submarines.

A contract to develop and build optical systems for the Orbiting Astronomical Observatory (OAO), has been awarded to the **PERKIN-ELMER CORP.**, Norwalk, Conn., by **SYLVANIA ELECTRIC PRODUCTS, INC.**, a subsidiary of General Telephone and Electronics Corp. The contract is valued in excess of \$1.5 million.

MID-WEST

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio, has begun production on a \$340,000 order for electronic dollar bill changing machines. The initial order is part of an exclusive licensing arrangement with **MODEL VENDING CONTROLS, INC.**, Akron, Ohio.

GENERAL TELEPHONE & ELECTRONICS CORP., has announced that **LEICH ELECTRIC CO.**, Genoa, Ill., and **ELECTRONIC SECRETARY INDUSTRIES, INC.**, Waukesha, Wisc., have been merged into **AUTOMATIC ELECTRIC CO.**, North Lake, Ill. All three companies are wholly-owned domestic subsidiaries of GT&E.

ITT KELLOGG COMMUNICATIONS SYSTEMS DIV., IT&T CORP., has been awarded a contract for more than \$6 million to supply and install an intersite communications system for the Minuteman missile site at Whiteman Air Force Base, Mo. The award was made by the Ballistic Systems Div. of the U.S.A.F. Systems Command.

BODINE ELECTRIC CO., Chicago, Ill., has purchased **MICRODYNE, INC.**, Wheeling, Ill. Microdyne will operate as a completely separate subsidiary of Bodine.

BASIC PRODUCTS CORP., Milwaukee, Wisc., has reached an agreement to acquire **LINDBERG ENGINEERING CO.** of Chicago, Ill. and Downey, Calif. Basic will pay more than \$3 million cash for Lindberg's assets.

WEST

SERVICE BUREAU CORP., subsidiary of IBM, Palo Alto, Calif., has started construction of a \$500,000 data processing center in Palo Alto.

GENISCO, INC., has moved its operations to a 101,000 sq. ft. plant at 18435 Susana Rd., Dominguez Industrial Park, Compton, Calif.

HURLETRON INC., has completed a new 25,000 sq. ft., air-conditioned, manufacturing and production facility at Whittier, Calif.

ELECTRO RACK has moved into a 20,000 sq. ft. plant at 1341 So. Claudina St., Anaheim, Calif.

THE DEUTSCH CO., ELECTRONIC COMPONENTS DIV., Bonning, Calif., has been selected by **LOCKHEED MISSILES AND SPACE DIV.**, Sunnyvale, Calif., as a subcontractor on a miniature connector high-reliability test and qualification program for space systems applications on USAF vehicles.

CORNING GLASS WORKS, Corning, N. Y., has acquired a substantial minority interest in **SIGNETICS CORP.**, Sunnyvale, Calif. Price is undisclosed but according to reports it is understood to have exceeded \$1 million.

UNITED AEROSPACE DIV., UNITED ELECTRO-DYNAMICS, INC., Pasadena, Calif., has received a fixed-price contract amounting to \$598,000 from the USAF Ballistic Systems Div. for the production of 56 transistorized airborne telemetry systems.

GERTSCH PRODUCTS, INC., Los Angeles, Calif., has expanded its manufacturing and engineering space by 33% with the lease of an 18,000 sq. ft. office and plant building adjoining Gertsch's present plant facilities.

COMPUTER CONTROL CO., Los Angeles, Calif., has been awarded a \$173,000 contract for a DDP-19 (Digital Data Processor) by the Ordnance Research Laboratory of Pennsylvania State University, Pa.

ELECTRADA CORP.'S DATA PRODUCTS DIV., Los Angeles, Calif., has received a contract from **IT&T'S FEDERAL LABORATORIES** in excess of \$500,000 for several advanced models of Electrada's **DATACOM** system.

BECKMAN INSTRUMENTS, INC., Fullerton, Calif., and **VECTOR MFG. CO., INC.**, Southampton, Pa., have announced tentative agreement for merger of Beckman and Vector in a pooling of interests based on an exchange of 70,000 shares of Beckman common stock for Vector's assets and business. Plans call for Vector operations to be transferred to a newly formed corporation of a similar name to operate as a Beckman subsidiary.

GIANNINI CONTROLS CORP., Duarte, Calif., has announced plans to acquire a modern 54,000 sq. ft. plant adjacent to its corporate headquarters in Duarte, to house its **TRANSDUCER DIV.**

HUGHES AIRCRAFT CO., El Segundo, Calif., has been awarded a \$27,610,000 contract to manufacture electronic data analysis systems for the USAF Minuteman.

AUTONETICS, A DIV. OF NORTH AMERICAN AVIATION, INC., Downey, Calif., has received a \$10.8 million contract from **REPUBLIC AVIATION, INC.**, Long Island, N. Y., to produce an additional 191 **NASARR** radar systems for the USAF's **F-105 Thunderchief**.

UNLATCHABLE
to 12 V with
UNMATCHABLE
speeds < 36 nsec t_{on}

New 2N2699,
PHILCO MADE*
Brings Higher Voltage to
Ultra-High Speed Switching!



SWITCHING SPEED TEST CIRCUIT

COMPARE

PARAMETER	PHILCO 2N2699	Fastest Switching GeMesa Transistor
$V_{CB-V_{CES}}$	15 v	15 v
V_{CEO}	8 v	NOT SPECIFIED
V_{CEX} (min latch-point)	12 v	11.5 v
V_{EBO}	4 v	2.5 v
h_{FE}	40 to 200	40 min
V_{BE}	0.3 to 0.45 v	0.3 to 0.5 v
f_T	300 mc min	300 mc min
C_{ob}	3.5 pf max	4.0 pf max
Turn-on Time	36 nsec typ (in above circuit)	Latch (in above circuit)

Philco continues to improve on the world's fastest switching transistors. The new Philco 2N2699, a Germanium PNP Micro Alloy Diffused Electrode Transistor in a TO-18 package, complements ultra-high speed switching with higher V_{CEO} , higher V_{EBO} , lower C_{ob} , and freedom from avalanche (and resultant latching) to 12 volts.

Compare Philco 2N2699 performance with the best of Germanium Mesa Transistors (see table of parameters) for ultra-high speed switching needs at high voltages. For lower voltage applications, the Philco 2N2699 offers extra design margin. Write for complete data. Dept. EI263.

*In stock, for immediate delivery, at your
Philco Industrial Semiconductor Distributor*

**Micro Alloy Diffused Electrode—a new
Philco process that combines the high
voltage of Micro Alloy Diffused-base
Transistors and the power dissipation
of Diffused Mesa Transistors.*

PHILCO

A SUBSIDIARY OF *Ford Motor Company*
LANSDALE DIVISION, LANSDALE, PA.

Circle 9 on Inquiry Card

World Radio History



MARKETING

Facts and Figures Round-Up

INFRARED MARKET DISCUSSED IN TALK

Reading between the lines of a recent talk on a predicted \$500 million market for infrared products by 1965, is the matter of the mix of engineering and marketing. Speaker was Robert Manley, who heads his own New York marketing-consulting firm. His talk was given at EIA's Industrial Electronics Division winter conference in San Francisco.

Manley's words re-echoed EIA President Horne's admonition that the industrial electronics market offers the greatest potential for expansion during the 1960's.

Mr. Manley noted that "the millions the government is pouring into infrared research and development appears to be nearly ready to produce sophisticated television picture tubes and related devices that were needed to give infrared equipment real utility." He further noted that the present infrared market is largely military, partially because manufacturers have been reluctant to finance new ventures here since in the 1950's many of them risked large cash outlays with little rewards.

Here again, Mr. Manley pointed up what can be regarded as the awkward beauty of military businesses that try to go commercial. His survey found danger "for companies to make future plans for commercial business without carefully analyzing the impact of new breakthroughs in infrared flowing from military-financed research and development." Earlier, he observed that "the

small companies which now dominate the commercial infrared market will have to keep on their toes to sustain their position because military producers have an inside track on research from which future commercial applications will evolve."

It remains, again, to be seen whether government-financed technical ingenuity can be matched with commercial marketing ingenuity—to sell electronic products as well as these products have been designed. Producing highly-subsidized military/aerospace products to be commercially competitive and reliable is an infrared of another color. And, if lasers and masers can make inroads into the infrared market, that is yet another technical complication with further marketing implications.

AUTOMATION-AGE CONTRACT WATCHED

Marketing men are eying an automation contract developing between Kaiser Steel Co. and United Steelworkers of America. In a word, this "automation-age" contract has terms to split cost savings between management and labor.

For a while, it remained to be seen whether the manufacturer of automation equipment would participate in the problem of phasing-in automation. Or, perhaps that role would fall only to the customer (in this case, Kaiser Steel); or, maybe a combination of equipment manufacturer and customer. The Kaiser case offers one precedent. Earlier, the International Association of Machinists (IAM) and U. S.

SALES AND EARNINGS—51 AEROSPACE COMPANIES

There are 51 companies identified as aerospace manufacturers by the Securities Exchange Commission. Sales for these manufacturers, which parallel those for the industry as a whole, are estimated to show a billion-dollar increase to \$15 billion. Earnings of these companies are estimated at \$350 million for the year, compared to \$257 million in 1961.

Despite this improvement in the dollars of net profits after taxes, the average net profit as a percentage of sales continued to be on the order of 2½%. This is substantially lower than the average for all manufacturing industries, which is estimated at 4.5%. For the first two quarters, the industry has been retaining more than 60% of its earnings after taxes for reinvestment in essential facilities and research and development programs. There is every indication that this level will be maintained at the same or at a higher rate throughout the year.

Source: Aerospace Industries Association of America, Inc.

Industries formed an Automation Research Foundation, dually exploring developments. This research continues. It remains to be seen whether automation-created savings will be shared with present employees only. After present-employees quit or retire, whether or not their jobs are phased-out with them also remains to be seen. At any rate, a new dimension of "statesmanship" is becoming part of the total electronic marketing capability.

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in December, 1962.

Accelerometers	107,701	Generators	71,862	Resistors, variable	130,126
Amplifiers & Access.	1,146,832	Generators, signal	255,473	RFI Equipment	39,197
Analizers	185,191	Generators, test	72,966	Semiconductors	1,032,556
Antennas & Access.	584,025	Generators, Time Code	63,801	Solar Cells	132,768
Batteries	1,461,969	Gyroscopes	36,704	SSB Equipment	5,078,778
Cable	582,281	Handsets	341,290	Switches	263,388
Cable, coax	30,750	Headsets	809,599	Switches, radio	40,316
Capacitors	154,729	Indicators	28,975	Switches, rotary	215,158
Coils	37,027	Loran 'C'	1,278,331	Synchro Resolvers	63,225
Communications Equipment	9,426,836	Loudspeakers	26,707	Synthesizers	77,885
Computers	1,045,690	Mapping & Survey Sets	4,116,942	Tape Readers	150,000
Computer Displays	1,315,448	Meters	246,825	Tape, recording	46,472
Converters	108,750	Meters, Field Strength	90,800	Telegraph Equipment	155,738
Counter-Timers	69,391	Microphones	511,819	Telephone Equipment	170,068
Delay Lines	43,606	Modulators	44,110	Telemetry Equipment	394,859
Detectors	79,818	Navigation Equipment	2,308,260	Thermocouples & Access.	735,554
Digital Speech System	49,225	Oscillators	477,062	Timing Sets	76,039
Dynamometers	38,200	Oscillators, sub-carrier	108,510	Tracking Equipment	106,709
ECM Equipment	3,075,000	Oscilloscopes	310,415	Transducers	113,225
Filters	85,393	Power Supplies	92,449	Transformers, pulse	28,955
Fire Control Systems	2,750,139	Printer, high-speed	125,347	Transmitters, synchro	167,090
Flight Trainer	800,000	Radio Equipment	450,760	Transponders, radar	25,012
Fuel Cells	89,225	Radiotelephone Sets	64,775	Tube, cathode ray	94,269
		Radar Monitors	56,000	Tube, electron	2,861,326
		Receivers	108,071	Tube, klystron & magnetron	377,266
		Recorders/Reproducers & Access.	2,181,831	Tuners	30,557
		Relays	106,605	TV Equipment	97,845
		Resistors	37,483	Vacuum Equipment	63,051
				Voltmeters and Converters	36,210



more
to come

more
to come

more
to come

more
to come

more
to come

For recent data on Raytheon's growing lines of entertainment receiving tubes, write: Raytheon Company, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

Circle 10 on Inquiry Card

World Radio History



KISSIN' COUSINS—CARBON-TO-CARBON

ONE PIECE MOLDED CONSTRUCTION SERIES 53M



One-piece molded carbon construction whereby contact of wiper to element is 100% carbon — eliminating metal-carried carbon wiper — and resulting in quieter performance — longer life — zero backlash. Units are totally enclosed against moisture and other environmental hazards for greatest stability.

BRIEF SPECIFICATIONS:

Power Rating — 2 watts • Working Voltage — 500 v.d.c. • Resistance Range — 50 ohms to 10 megohms, linear, 250 ohms to 5 megohms, tapered.

Available with shaft seals, mounting seals, high torque, ganging, non-metallic shafts, L & T Pads, Concentric shafts, high-voltage standoff, backlash assemblies, locking bushings.

Meets specifications per MIL-R-94 — Style RV4.

WRITE FOR COMPLETE SPECIFICATIONS...

CLAROSTAT

CLAROSTAT MFG. CO., INC. DOVER, NEW HAMPSHIRE



REFLECTION

Polished surface of a wafer of gallium arsenide casts back a reflection of observer's eye at RCA, Somerville, N. J. Gallium arsenide, a newer semiconductor material, is being used by RCA in many applications, most recent of which is the injection laser. Additional information concerning this material and its use can be found in this month's issue.



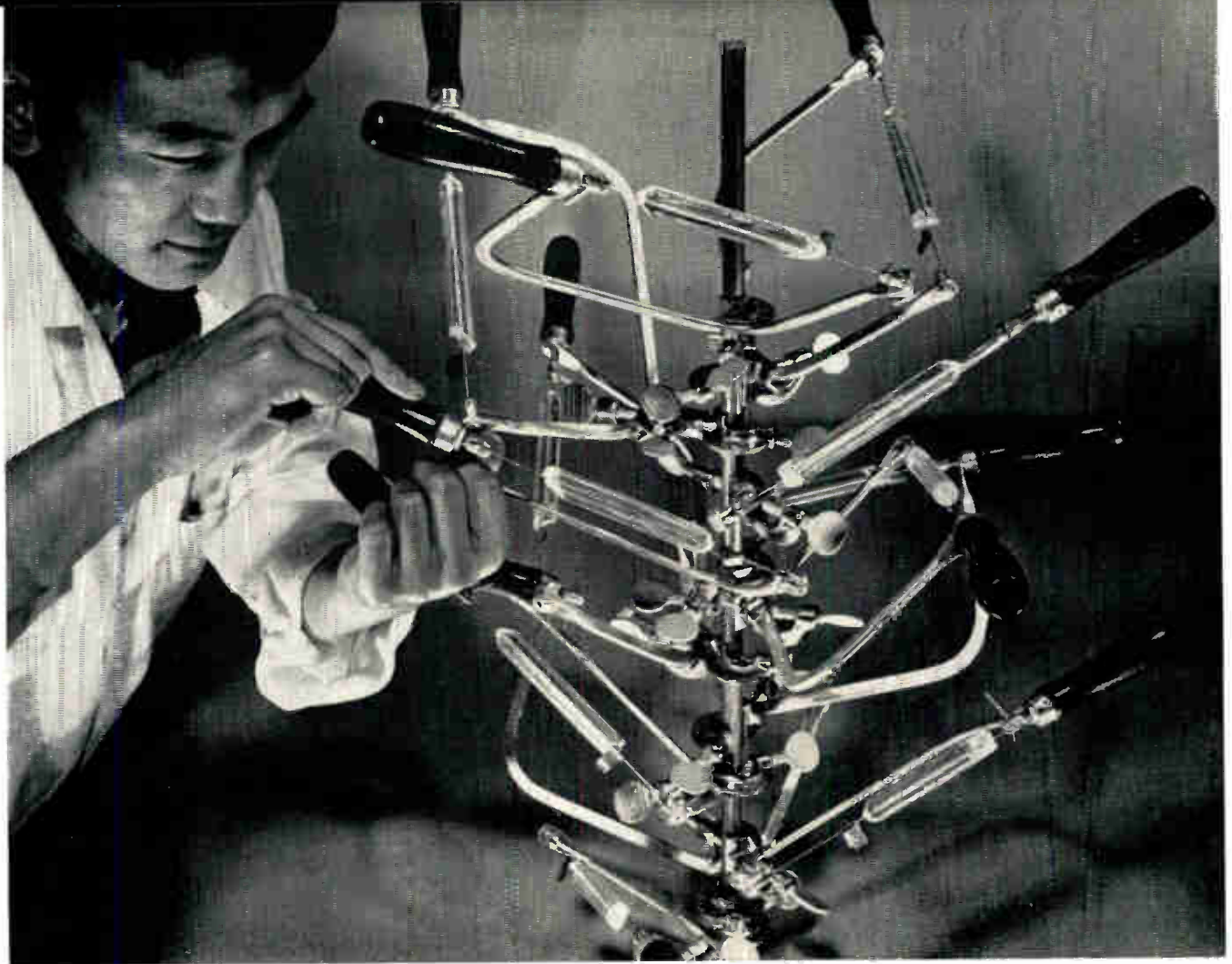
SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES



ROCKET-BORNE

Technician at Perkin-Elmer Corp., Norwalk, Conn., makes final adjustments on ultraviolet spectrometer before its delivery to the Dept. of Astronomy of Princeton University. Instrument is for use in nose cone (r) to measure ultraviolet energy emitted by stars.





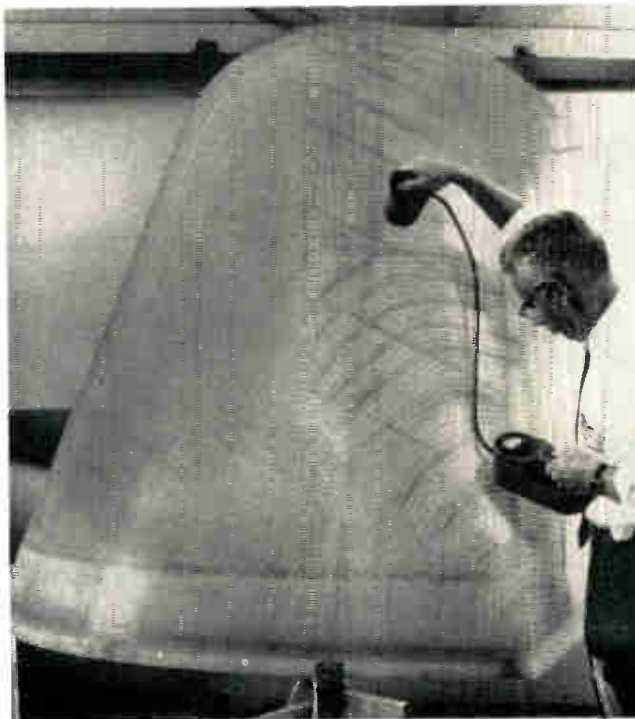
MAN-MADE TREE

Taut wires put through hardening plastic cylinders form straight holes on this apparatus at Electro-Optical Systems, Incorporated, Pasadena, California. These holes are later filled with experimental laser

material. This simple but unusual system results in a thin laser rod with a thick plastic cladding that gives it the proper dimensions for end polishing, pumping and flashing in standard test equipment.

"NO ICE"

Goodyear Aircraft Corp. engineer measures moisture content of a nose radome for a C-130B aircraft before the plastic structure is shipped. Structures contain heated ducts which carry hot air between two of the radome's three reinforced fiber glass layers. Pilot controlled, the de-icing unit uses heat of the plane's engines to warm surface of the radome. Goodyear is supplying radomes for the aircraft under contracts from Warner - Robins Air Material Area, Robins AFB, Ga., and Lockheed-Georgia, prime contractor for the aircraft.



BIRTH OF A BRAIN

Final connections are made to a memory plane for Minneapolis-Honeywell's new subminiature computer, Pico. Basic 3,072-word memory is formed by stacking planes such as the one shown and can be expanded to 8,192 words. The entire computer weighs 20 pounds and requires only 46 watts of power to operate.



MORE THAN 100 KLEIN PLIERS

SPECIALY DESIGNED FOR THE ELECTRONIC FIELD

Special skills are important in the wiring of today's sophisticated assemblies for electronic and telemetry systems. Klein has developed special pliers to assist in solving difficult assembly problems.

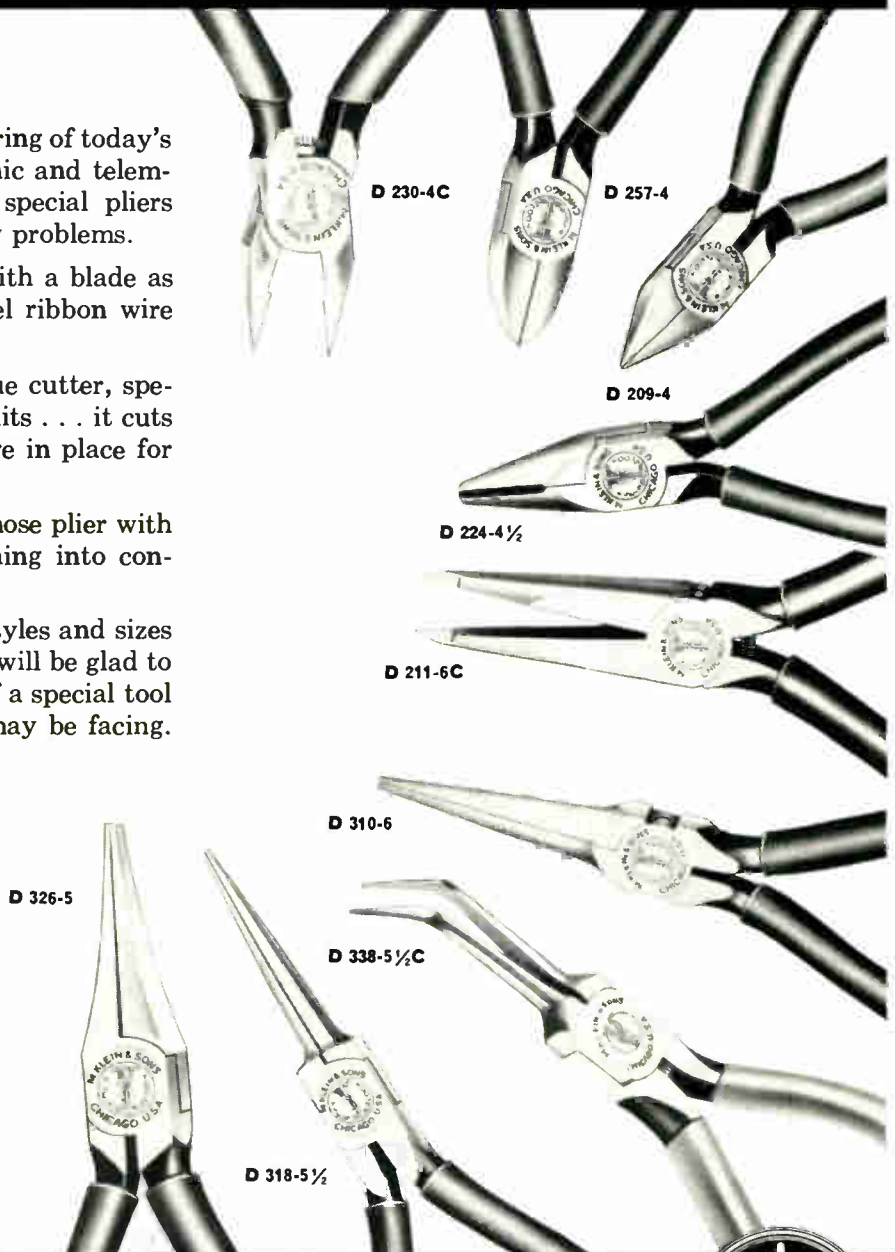
- For instance, there is a plier with a blade as hard as a file for cutting nickel ribbon wire (No. D230-4C).
- For instance, there is an oblique cutter, specially designed for printed circuits . . . it cuts and crimps the end to hold wire in place for soldering. (D 052-C).
- For instance, there is a needle nose plier with the tip bent to facilitate reaching into confined spaces. D 338-5½ C.

In all, there are over 100 different styles and sizes of pliers available from stock. Klein will be glad to discuss with you the development of a special tool to solve a particular problem you may be facing.

ASK YOUR SUPPLIER

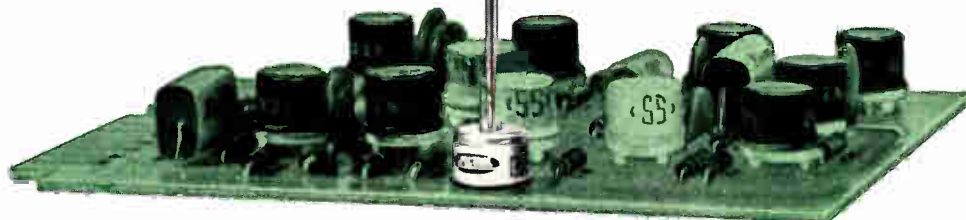


The Klein Plier Catalog illustrating and describing the complete Klein line of pliers is available on request.



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 Established 1857 **KLEIN** Chicago Ill. U.S.A.
 INCORPORATED
 7200 McCORMICK ROAD, CHICAGO 45, ILL.

SPECTROL Transistor Circuit Trimmers



New Spectrol Model 80 single-turn trimming potentiometers in TO-9 size case... *the smallest MIL qualified trimming potentiometers available today...* give your circuits precision adjustment in $\frac{1}{4}$ of the space required for most other trimmers.

Standard MIL grid terminal spacing of the 80-3-1 transistor type simplifies installation in printed circuits. With standard transistor sockets, units of different resistance ranges can be interchanged easily for breadboarding.

Single-turn adjustment minimizes setting time, and the self-locking shaft maintains precise settings under severe shock and vibration conditions without external shaft locking. Units meet or exceed the rigid immersion requirements of MIL-STD-202B, Method 104A, Condition A (immersed in hot water) and may be completely potted, including the shaft head, without danger of leakage. Mechanical end-stops prevent possible overtravel of the wiper and subsequent open circuits which could damage transistors.

For panel or chassis mounting, two new case styles are introduced, the 10-32 threaded bushing type and the $\frac{3}{8}$ "-32 threaded case type. The threaded case has the added advantage of mounting essentially *within* the panel with virtually no projection to front or rear.

All three Model 80 trimmers are available in production quantities. Contact your nearest Spectrol distributor for immediate delivery and quantity prices. Prices for transistor circuit trimmers, in popular resistances: \$6.00 each in 1-9 quantities.



Panel cutaway showing 80-5-3 $\frac{3}{8}$ "-32 Threaded Case Type

(lower) 80-5-2 10-32 Threaded Bushing Type

SPECIFICATIONS

MECHANICAL

NUMBER OF TURNS 1 • ROTATION End stops (continuous rotation available) • SHAFT TORQUE 0.2 to 5.0 oz. in. • LIFE EXPECTANCY (SHAFT REVOLUTIONS) 1,000 • OPERATING TEMPERATURE RANGE -55°C to $+150^{\circ}\text{C}$

ELECTRICAL

STANDARD RESISTANCE RANGE 50Ω to 50K • RESISTANCE TOLERANCE $\pm 5.0\%$ ($\pm 1.0\%$ available) • POWER RATING 1.0 watt at 50°C • VOLTAGE BREAK-DOWN (ANY TERMINAL TO SHAFT AND/OR HOUSING) 500 volts RMS, 60 cps • INSULATION RESISTANCE (ANY TERMINAL TO SHAFT AND/OR HOUSING) 1,000 megohms at 500 volts dc.

SPECTROL

ELECTRONICS CORPORATION

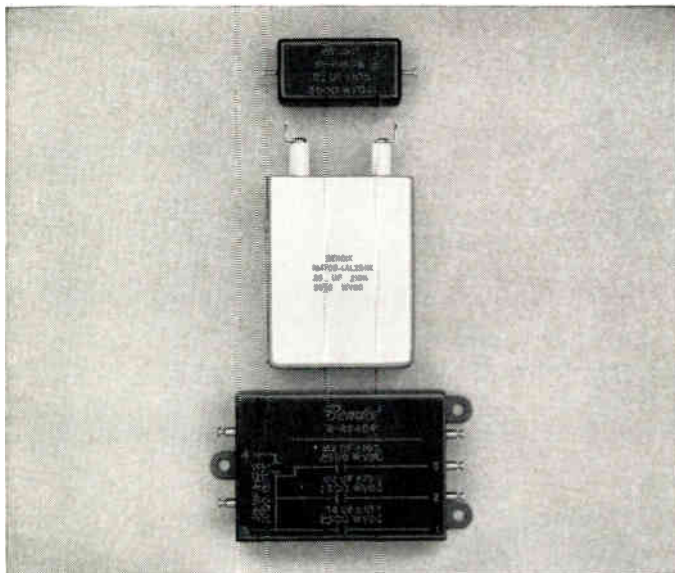
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New York

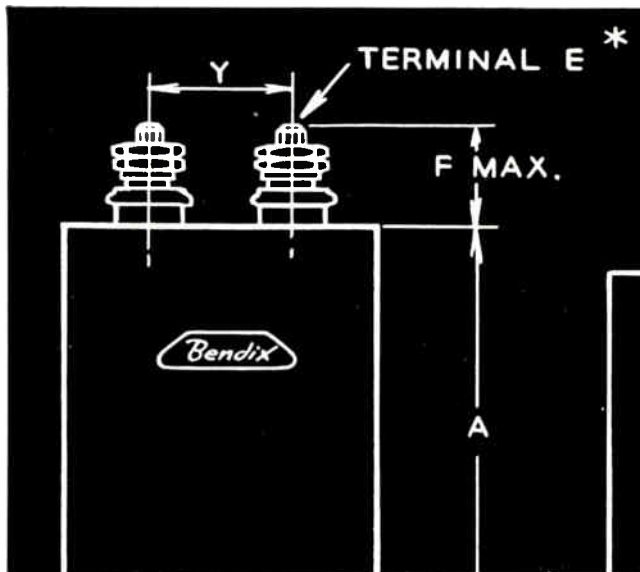
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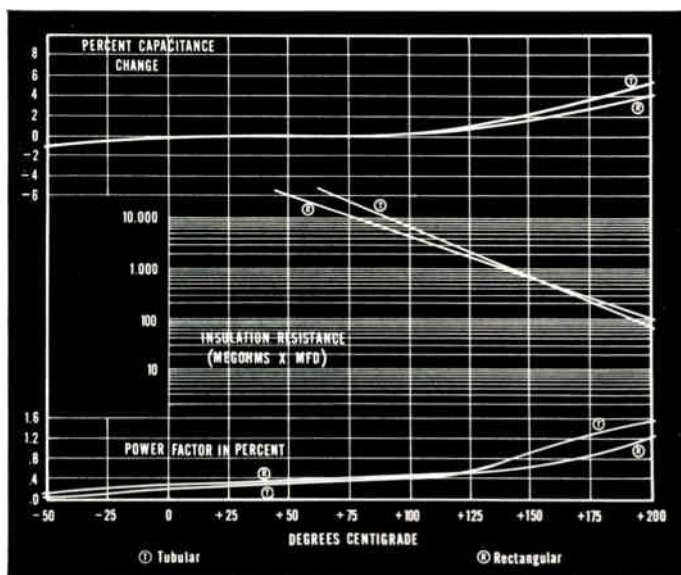
World Radio History



Our high-voltage capacitors



are smaller



offer superior electrical characteristics



and have impressed some pretty important people.

Our series of small, high voltage capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C. We're proud of the fact that our capacitors are now being used on Republic's Plasma Space Engine.

The engine is designed for a variety of space applications. As a propulsion device, due to the low thrust-to-weight ratio, this engine can be used to maintain a satel-

lite in a particular orbit, correct interplanetary vehicle course, or provide propulsion for a solar probe.

Bendix capacitors are ideal for applications such as this. They offer excellent qualities of radiation resistance. High temperature capability and mica-like electrical characteristics enable them to withstand extremely high orders of AC in small envelope size at all ambients under 200°C. For full details, write us in Sidney, New York.

Scintilla Division





Why you should buy the **expensive** power supply

Because Alfred supplies have full floating output with 7.5 kv insulation to ground. They can be operated with either positive or negative grounding or full floating. Actually, you save money because you get a double duty power supply. **Because Alfred** supplies have adjustable overcurrent trip-out and current range switching to protect costly devices under test from damage by excessive current. Trip-out current can be set as low as 0.3 ma on 50 ma supplies, 0.5 ma on 150 ma units. These features allow a high current supply to be safely used in low current applications. **Because Alfred** supplies offer millisecond turn-off for quick protection of a load. A shorting relay rapidly reduces output voltage to zero, for power removal simultaneous with other supplies. **Because Alfred** supplies, all of them, go to 0 volts, while competing units start at 50 to 500 volts. You get two-supply capability at one unit price. The wide voltage and current ranges offered by Alfred supplies (see specs below) permit operation of specialized tubes such as photomultipliers, klystrons, TWT's and BWO's. **Because Alfred's** carefully designed supplies have minimum downtime. Derated components are essential to satisfy low ripple and tight regulation specs during floating operation. Trouble-free operation alone will return the difference in price. **Because Alfred** supplies include provisions for system operation. Connections are provided for remote master control and metering. Supplies may be interconnected so that overcurrent relay trip-out in any one unit automatically turns off high voltage in all other supplies. **Because Alfred** uses rugged and reliable taut band meters for monitoring voltage and current, elimination of meter bearing friction assures accuracy with long term repeatability. **Because Alfred** publishes complete specifications on all instruments and guarantees them as stated. For full information on power supplies and associated equipment such as filament supplies, modulators and system control panels, please contact your Alfred engineering representative or write us directly.

SPECIFICATIONS

Model Number	Voltage dc	Current ma	Pk-to-Pk Ripple	Regulation		Price
				Line	Load	
262	0 to 500	0 to 100	5 mv	.01%	.02%	\$ 850
265	0 to 1500	0 to 150	10 mv	.01%	.02%	990
267	0 to 3500	0 to 50	15 mv	.005%	.006%	1090
270	0 to 5000	0 to 50	20 mv	.002%	.006%	1250
271	0 to 5000	0 to 150	30 mv	.002%	.006%	1450

ALFRED ELECTRONICS

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Palo Alto, California
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WASHINGTON NEWS LETTER

BIG GAIN IN NASA BUDGET—NASA, still enjoying high prestige in both Senate and House, is likely to get most of the \$6 billion it is asking for the fiscal year beginning July 1. NASA's yearly budgets have zoomed—as recently as 1960, it was spending only \$500 million a year. This fiscal year it will spend about \$3.7 billion. NASA has so many useful programs working now—both for manned space flights and for scientific exploration—that it's going to be hard for Congress to cut back any of them.

TOUGHER EXPENSE RULES HERE—Companies have until April 1 to get their houses in order as far as new expense account rules are concerned. The Internal Revenue Service's 90-day grace period is to allow firms to convert their record-keeping. What the grace period means is that tax agents will go easy on taxpayers in that time provided they "make a good faith effort to comply as rapidly as possible."

CONTRACTOR CONTROLS TIGHTENED—Congress this year may be forced to rule on how far the Defense Dept. can go in pressuring government contractors. A new angle to Pentagon pressure on contractors has arisen: Now there is talk of a blacklist for contractors who make advertising mistakes. The new angle is added to the controversy over the Pentagon's threats to contractors in labor disputes. It has been charged that the Defense Dept. is trying to make companies give in on labor negotiations by threatening to cancel contracts.

BETTER BREAK FOR SMALL FIRMS—Smaller firms are still taking a licking from the Government in their bid to share in the multi-billion defense and space market, concludes the House Small Business Committee. It may come up with some new legislative proposals this year. The lawmakers are highly critical of the low share of government procurement and R&D dollars going to small firms. They urge new procedures for breaking out of these programs jobs that small firms can do. For example, the Committee applauds the Communications Satellite Program, which requires that small firms participate in procurement.

FTC CHECKING TRADE SHOWS—The Federal Trade Commission warns that a manufacturer

who helps a customer by sharing the cost of a trade show must also make the same cost-sharing available to all other customers. Extending help to just one customer or to certain selected customers is illegal, says FTC.

LABOR PROBLEMS—As 1963 unfolds, Washington finds itself caught up in more and more labor problems. An inkling of future troubles in the aerospace and electronics industries showed up in the recent rounds of open shop or closed shop votes. At Boeing, the union won out, but at Lockheed it was pointed out as "destroying the freedom of choice of the American employee." The union here was the Int'l. Assoc. of Machinists. The Government is very much involved: (1) As chief buyer of defense armaments. (2) As being responsible to the voters, many of whom are workers. (3) And as chief negotiator when labor problems can't be handled locally.

CYBERNETICS?—Electronics also is getting more involved in the socio-political aspects of "cybernetics," or "automation." The Houses of Congress, The White House, national unions and The U. S. Chamber of Commerce are all involved here. While President Kennedy and the Congress worry about a hard core of some few millions of unemployed, the labor unions are calling for cutting the workweek from 40 to 35 hours. A.F. of L. and C.I.O. plan to ask Congress to cut the workweek during this session. But that "could mean a one-eighth cut in production," says the Chamber. And so the battle is joined.

SUBSIDIZE ELECTRONIC EXPORTS?—Rep. Thomas B. Curtis (R., Mo.) says the Government should aid exporters deprived of their overseas markets by below-cost Soviet equipment. An effective cold-war weapon employed by Moscow in recent years has been the driving of Free-World goods from established world markets by low-cost Soviet goods. Once the Reds have gained a local monopoly, up goes the price. Under Curtis Plan, a "U. S. Trading Corp." would back U. S. firms caught in a Red squeeze, and would make up the difference between the Communist price and the going world price. This would mean there would be no disruption of contracts between U. S. suppliers and their overseas customers.

Check Accuracy • Check Durability • Check Cost
**THEN SPECIFY FLUKE DC
 DIFFERENTIAL VOLTMETERS**

★ **ACCURACY**

±0.01%

0-500V DC

★ **DURABILITY**

★ **LOW COST**

\$895⁰⁰ FOB SEATTLE



FLUKE MODEL 821A Now—for the first time—it is possible to obtain $\pm 0.01\%$ accuracy with a differential voltmeter over a 0-500V DC range *regardless of source impedance!* Built-in rugged construction, plus the use of highest quality components and latest manufacturing techniques guarantee long, trouble-free operation. Through simplified circuitry and conservative design, factory selection of components is virtually eliminated insuring ease-of-maintenance . . . minimum down-time. Fluke instruments cover many applications such as: calibrating, testing, and stability measurements of regulated power supplies, DC voltmeter calibration, AC voltmeter calibration and precise AC voltage or current measurements when used with an AC/DC transfer standard. The John Fluke Mfg. Co. is the most experienced manufacturer of differential voltmeters—with over 18,000 in use today! Buy with confidence from the company that developed the *differential voltmeter!*

PARTIAL SPECIFICATIONS:

ABSOLUTE ACCURACY: $\pm 0.01\%$ of input voltage from 0.5 to 500V. $\pm 0.01\%$ of input voltage plus 10 microvolts below 0.5V.

INPUT RESISTANCE: Infinite at null from 0 to 500V

METER RESOLUTION: 5uv maximum; 1 MV full scale.

CALIBRATION: 500V working reference supply calibrated against built-in standard cell.

STANDARD CELL STABILITY: 0.003% per year.

INPUT POWER: 115/230V AC $\pm 10\%$, 50-400 cps, 60 watts.

FEATURES:

- Infinite resistance at null over entire 0-500V range
- Polarity switch
- Taut-band suspension meter
- Standard cell reference
- Recorder output
- In line readout with automatic lighted decimal
- No zero controls

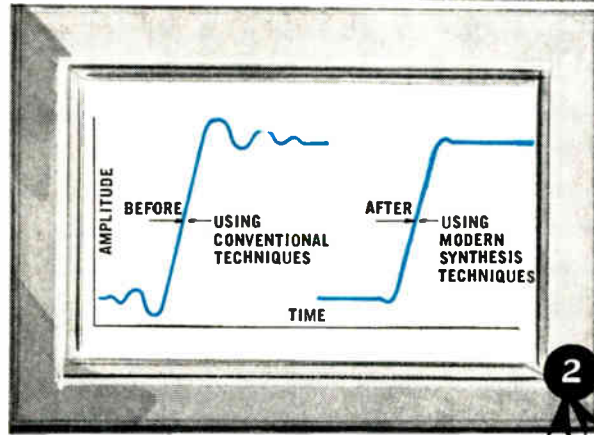
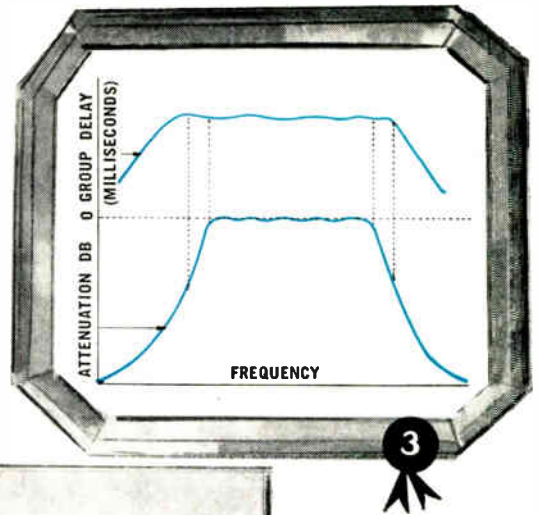
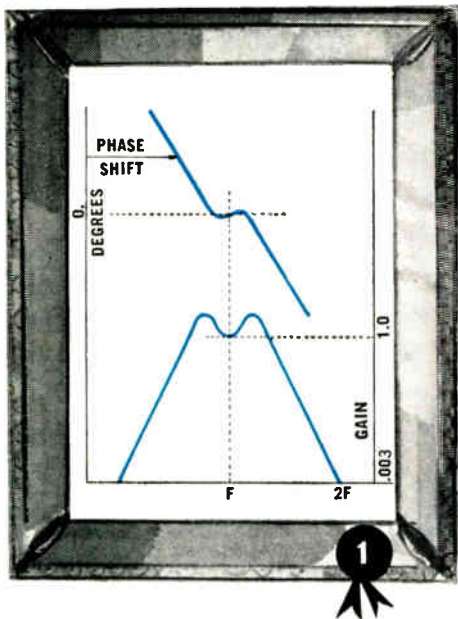
The complete **FLUKE** line of differential voltmeters offers a variety of test/measuring instruments to meet every application at minimum cost. Ask for a demonstration or write for detailed information.

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FLUKE

INSTRUMENTS

All prices FOB Seattle. Prices and data subject to change without notice.



Burnell advances the state of the art with three new filter families

If you are concerned with new systems development, and would like to take advantage of advanced technology and the kind of sophistication that will improve transient response and eliminate obsolete circuitry . . . then here are three new filter families, that have advanced the state of the art, which you can immediately incorporate in your network designs — exclusive from Burnell. Call or write today for literature and technical assistance.

Burnell offers the most complete line of communications network components available to the electronics industry, with a versatility of experience unmatched in the production of filters, delay lines and toroids for interpretation of *complex signals*. Burnell will custom design filter networks to your specifications which may include special delay, attenuation, and transient response, involving precisely specified rise time, overshoot and ringing.

1 ZERO PHASE FILTERS

Impedance	1000 ohms/Grid	400 cps	Center
ATTENUATION & PHASE CHARACTERISTICS			
OP SERIES	OP400 L	OP400 M	OP400 H
Pass Band (3 DB)	±20 cps	±20 cps	±20 cps
Harmonic attenuation 2nd harmonic and all higher frequencies	50 DB		
Harmonic attenuation (2nd)	>15 DB	>25 DB	
Harmonic attenuation (3rd)	>40 DB	>60 DB	
Max. phase ±20 cps	±1°	±1°	±1°
Max. phase ±30 cps			±5°
Phase shift at Center Frequency	0° ± ½°	0° ± ½°	0° ± ½°
Gain =	UNITY	UNITY	UNITY

60 cps equivalent filters are also available having a pass band of ±5% with phase of ±1°.

For the Servo Engineer . . . By specifying Burnell's new line of Zero Phase Shift networks, it is possible to recover, without phase shift, the fundamental frequency from any periodic wave form without using complex squaring circuitry. This advancement in the state of the art is accomplished by combining zero phase shift in the vicinity of the center frequency — with high attenuation in the stop bands.

2 LOW PASS FILTERS WITHOUT DISTORTION

This family of filters is designed with modern synthesis techniques to have specified transient characteristics such as fast rise time, low overshoot and ringing.

60/3 DB Shape Factor	Ringing (over/undershoot)
2:1	<5%
3:1	<2%
4:1	<1%

3

This is part of a family of constant delay band pass filters of unusual characteristics, for example:

- Group delay is constant well into the stop band!
- Matched delay—as an example of delay matched band pass filters, we have produced a set of four filters having the same band widths of 500 cycles at 1½ DB with center frequencies ranging from 680 cycles to 2720 cycles; having a 20 DB band width of 710 cycles with group delay constancy of ±3½% over the pass band and between channels.
- Constant flat delay band pass filter.

Frequency	Attenuation
5210 cps to 8336 cps	< .5 DB
1,000 cycles & below	> 20 DB
10,000 cycles & higher	> 20 DB

Delay: Group delay constant ±1% from 3,500 cps to 9,900 cps.

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Burnell & Co., Inc.

PIONEERS IN microminaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

SUBSIDIARIES: Gray & Kuhn, Inc., Pelham, New York • GLP Electronics, Inc., Bristol, Conn.

EXECUTIVE OFFICE
AND PLANT
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INTERNATIONAL NEWS

Immigrants Help Our Scientific Effort

Many U. S. scientists and engineers born abroad are today contributing much to our scientific efforts, reports the National Science Foundation.

In its report "Scientific Manpower From Abroad," NSF states that 43,523 scientists and engineers immigrated here from 1949 through 1961, many aided by liberalized immigration laws. About 10% of U. S. scientists and engineers today are immigrants.

Scientists and engineers with services urgently needed here gain top preference. Many others have entered through special laws designed to aid refugees from Hungary and other distressed nations.

Some 2,000 scientists and engineers who fled Hungary following the revolution in 1956 have come to the U. S. Their professional contributions have been almost entirely favorable.

Other statistics: Among the 43,523 admitted since '49 were 32,767 engineers and 10,106 scientists. These included 4,917 mechanical, 3,688 electrical, 3,227 civil and 993 aeronautical engineers, 5,994 chemists and 1,089 physicists. Canada, the U. K. and Germany have led in total number of immigrants since mid-1956.

Before 1949, when few records were kept, large numbers of refugee scientists immigrated here from Germany and Austria. Among these, Albert Einstein is perhaps the best known. Of the 40 U. S. Nobel Prize winners in physics and chemistry, six were of German origin and two Austrian.

The report notes the percentage of immigrant scientists in the U. S. has tended to increase with the level of eminence. Fifteen of the 40 Nobel Prize winners noted above were of foreign origin, and 17% of the members of the National Academy of Sciences, a top drawer organization, are foreign-born.

AUSTRALIA

Canberra — MUDPAC — The Melbourne University Dual-Package Analog Computer—is solving engineering, physics, economics and biology projects. Its heart is two AD-1-64PB computers supplied by Applied Dynamics, Inc., Ann Arbor, Mich.

AFRICAN LABOR OFFICIALS



W. African labor officials on 6-week tour of U. S. plants, visit Sorenson Co. power supply mfr. at S. Norwalk, Conn. C. H. Mittel (l), Quality Control and Service Mgr., explains work inspection methods to (l to r) I. Diomande, Ivory Coast Rep.; F. Ayayi, Dahomey Rep.; N. A. Adjetej, Togo Rep.; and Y. I. Kone, Niger Rep.

ASIA

New Delhi—Plessey International, of England, and the Indian Defense Ministry have concluded an agreement under which Bharat Electronics, a government-owned firm, would make Plessey-designed radio transmitters and receivers for the Indian Army.

Tokyo—Twenty-one Japanese electronic firms and Regency Electronics, Inc., Indianapolis, Ind., have agreed to end a 4-year dispute over patent rights. In an agreement negotiated by Paul Davidson, President of Int'l. Importers, Inc., Chicago, Ill., a 3 cent royalty will be paid Regency on each transistor radio using the patent exported to the U. S.

Tokyo—Tokyo Shibaura Electric Co. has developed a watt-hour meter enabling industrial power users to cut power costs by two-thirds by scheduling peak consumption during normal low usage periods.

Bangkok—A stereophonic recording studio here will be equipped by EMI Electronics, Ltd. This studio, one of Thailand's major recording organizations, will buy a fully transistorized mono/stereo mixing console, stereo tape recorder, studio loudspeakers and test equipment.

EUROPE

Berne—Microwave absorbent material for shrouding metallic bodies of landing lamps at Zurich, Switzerland, Airport will be supplied by Plessey Int'l., Ltd., Essex, England. The material prevents reflections from airfield fixtures from confusing the approach radars.

Paris—Compagnie des Compteurs has granted Cubic Corp., San Diego, Calif., the U. S. and Canadian production, marketing and service franchises for one of the French firm's new lines of digital tape recorders and handlers.

London—The Independent TV Authority has installed a new antenna to increase the strength of signals received by 600,000 viewers of London and nearby counties. The 500-ft. tower was supplied by EMI Electronics, Ltd.

Berne—The world headquarters for American Machine & Foundry Co. Int'l. is being moved from New York, N. Y., to Geneva, Switzerland. Since 1952, Geneva has been the firm's headquarters for Europe, Africa and the Middle East.

Bern—H. A. Schlatter, Ltd., Zollikon-Zurich, Switzerland, and Thomson Electric Welder Co., Lynn, Mass., U.S.A., have each agreed to act as agents for the other's resistance welding equipment in Europe and the U. S., respectively.

London—Divorce court proceedings in a courtroom here are being recorded from a battery of six microphones through amplifiers, mixers and correctors in a console into two EMI remote-control tape recorders. The system enables not only all testimony, but even voice inflections, to be recorded.

London—General Electric Co. has formed an Industrial Electronics Div. here as part of its subsidiary, International General Electric Co., of New York, Ltd. The new division will market industrial electronic products in the Common Market and United Kingdom.

London—W. G. Pye & Co., Ltd., Cambridge, England, has developed a small pH meter with a robust, yet tiny, glass electrode to measure harmful effects on teeth of breakdown of food due to bacteria. It is being used to test the effects of a new fluoride toothpaste.

(Continued on page 38)

GIBSON COPPER-TUNGSTEN REFRACTORY CONTACTS IDEAL FOR OIL-IMMERSED CIRCUIT BREAKERS



Refractory Gibsilloys minimize welding and arc erosion in high-capacity current interrupting devices. Copper-tungsten Gibsilloys are more economical, provide a longer operating life in heavy-duty oil-immersed applications.

Refractory Gibsilloys are sintered powdered-metal compositions combining the low electrical and thermal resistivity of silver and copper with the non-welding and arc-resistant properties of tungsten. A wide range of combinations of these metals are available for optimum performance and longest life in such heavy-duty contact applications as circuit breakers, heavy-duty contactors, arc runners, tap changers, relays and switches.

Whether silver-based refractory for in-air operations or copper-based for oil-immersed contacts, Gibson refractory contacts cover a wide range of standard applications, or they can be custom engineered to suit your specific needs.

Gibson "Married Metal" provides optimum bond

The Gibson-developed "cast-on" method of attaching contact to support provides an integral bond approaching 100%, as compared to the usual 85% for brazed or welded contacts of tungsten or molybdenum.

"Married Metal" refractory contacts vastly reduce electrical and thermal resistivity, thus reducing arc-erosion and increasing heat dissipation and contact life, at little or no increase in cost.

Metal Compounding and Shaping

Gibson powder metal techniques provide nearly all required proportioning of refractory metals to meet the most exacting specifications. Gibson working facilities can impart the most unusual shapes not already attained by powder metal molding.

Forms Available

Refractory Gibsilloys are supplied in all normal contact forms, including discs, rectangles and irregular shapes, with flat, spherical or cylindrical face. They are also available in such combinations as bayonet or plunger and split tulip, or as the customer may require.

For complete information write for Technical Bulletin 506, Refractory Gibsilloys.

GIBSON ELECTRIC COMPANY
A subsidiary of TALON, INC.

Box 598, Delmont (Pittsburgh District), Pa.

Representatives in Principal Cities of the United States and Canada

Gibsiloy
ELECTRICAL CONTACTS
Since 1933

INTERNATIONAL NEWS

Paris—A new automatic landing system enables jet aircraft to land under a 100-ft. ceiling and one-fourth mile visibility. It was developed by Sud Aviation, Toulouse, France, and Lear Siegler, Inc., Santa Monica, Calif. The U. S. and French Governments sponsored development of the system, designed to work with existing equipment.

The Hague—Three Dutch companies and a British firm have formed an industrial automation equipment company—Berlaghe, N. V.—with headquarters in Arnhem. It is sponsored by: Maatschappij Van Berkel's Patent, N. V.; Heemaf, N. V.; Landre & Glinderman, N. V., and EMI Electronics, Ltd.

AFRICA

Monrovia—Dielectric Products Engineering Co., Raymond, Me., is building an extensive switching system for use at the U. S. Information Agency Liberian transmitting station near here. A proprietary crossbar r-f switching system will allow remote switching from any of 12 very high-power transmitters to any of 29 antenna systems.

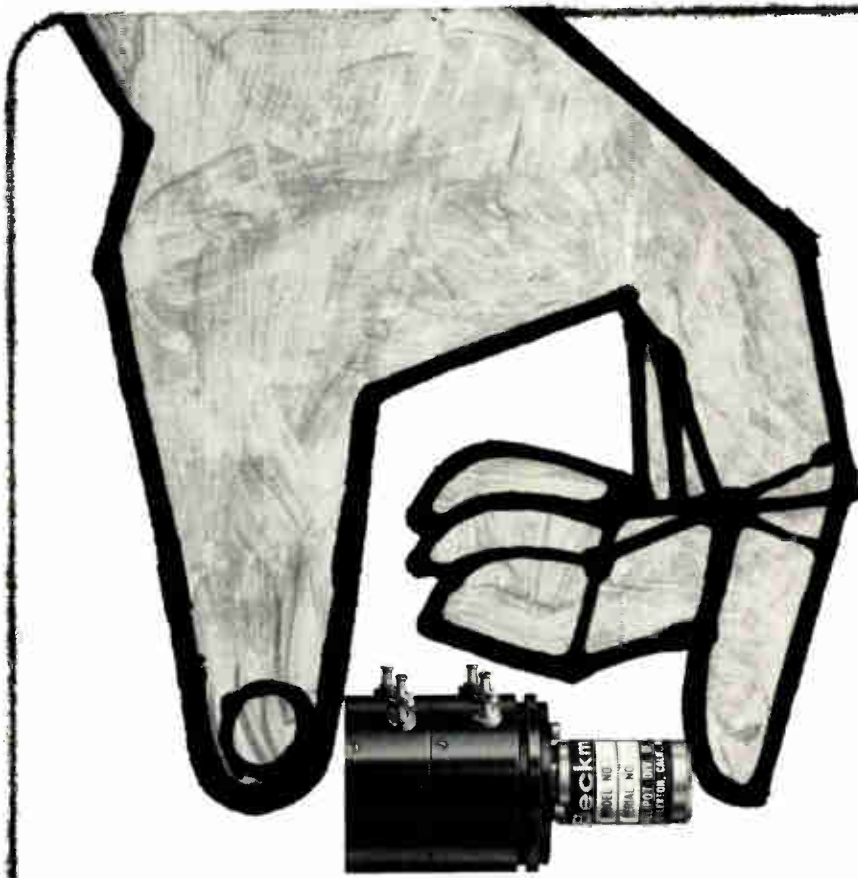
Lagos—The Times Wire & Cable Div., Wallingford, Conn., supplied coax cable for a closed-circuit TV system in the U. S. Exhibition at the recent Nigerian Int'l. Trade Fair. The system was part of a vocational training classroom which helped develop the U. S. Exhibition's theme: "New Skills—New Tools—New Markets."

NORTH AMERICA

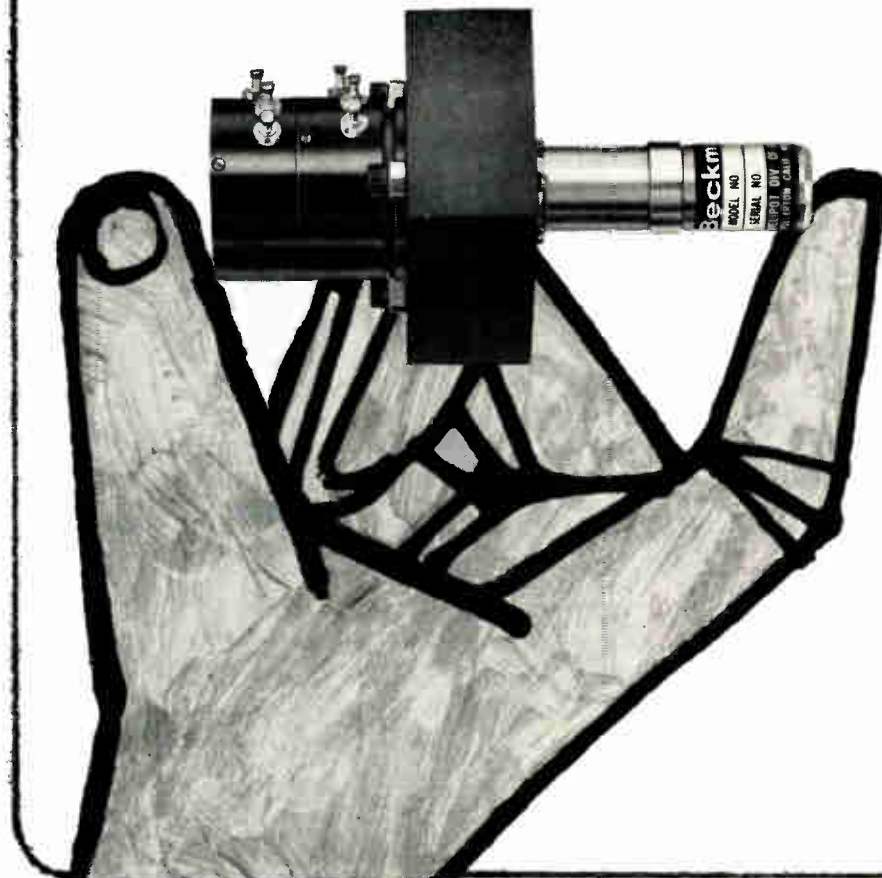
Chicago—Admiral Corp. and its subsidiary, Canadian Admiral Corp., have filed separate complaints against ten American and Canadian firms, charging infringement of record changer patents. Admiral is seeking a "permanent injunction and substantial monetary indemnity" from these firms.

Ottawa—Welwyn Canada, Ltd., London, Ont., maker of precision film resistors and related components, is building a plant in the U. S. at Westlake, Ohio, near Cleveland. Initial production is set for April.

Ottawa—American Brake Shoe Co., New York, N. Y., has purchased Stanwyck Coil Products, Ltd., Hawkesbury, Ont., Canada. Stanwyck makes coils and components for communications equipment, also miniature torque motors.



both the same size...performance-wise



NEW...
FIRST READY-BUILT
SERVOPACKAGE
SAVES YOU 30% ON
SIZE AND WEIGHT

Introducing the Motor-Pot—the year's best example of pint-sizing. In a single package, you get high-performance servomotor, precision potentiometer and gearhead at a 30% saving in size and weight over typical in-line subassemblies. We've done it by cleverly placing the gearhead and part of the motor right inside the pot.

There are two standard models. The Model 45 Motor-Pot with its 1-1/16" diameter single-turn pot and size 5 servomotor. And the Model 46 with a 2" diameter ten-turn pot and size 8 motor. Also any number of custom variations.

The ready-made 45 and 46 give a clue to our in-line capability. And our experience furnishes the proof. We'll meet your most demanding spec with component matching you can count on. One-stop shopping also saves you time and money. There's no testing, positioning and aligning of components purchased from different suppliers. No more do-it-yourself assembly at all!

Your nearest Helipot rep has our full servopackage story. For more information, contact him or write us direct.

ALSO...NEW-GENERATION HALL EFFECT DEVICES,
CLEAN-DESIGN METERS.

Beckman

INSTRUMENTS, INC.

HELIPOT DIVISION
Fullerton, California

INTERNATIONAL SUBSIDIARIES: GENEVA, SWITZERLAND;
MUNICH, GERMANY; GLENROTHES, SCOTLAND.

There's an **AE** Rotary Stepping Switch for every application

Whenever complex switching, recycling, circuit selecting, connecting, totalizing or predetermined counting is called for, there's an AE rotary stepping switch that will do the job better.

Only AE "steppers" offer *positive positioning*—a unique design feature that makes overthrow impossible. The armature not only steps the wiper or cam assembly from one position to the next, but also *locks* the rotor in the correct position. This design eliminates armature and pawl stops, makes readjustment unnecessary.

Six basic types are offered: Type 45, a favorite, large-capacity industrial control component; Types 40, 44, 80 and 88, the family of "compact" rotary stepping switches combining minimal size with large contact capacity; and the Series OCS, a versatile cam-switcher where *you* specify the programming.

Each of these, of course, is available in numerous variations, many of them directly from stock for prototype-schedule requirements. For full information, just ask for Circular 1698-J. Write to the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

AUTOMATIC ELECTRIC

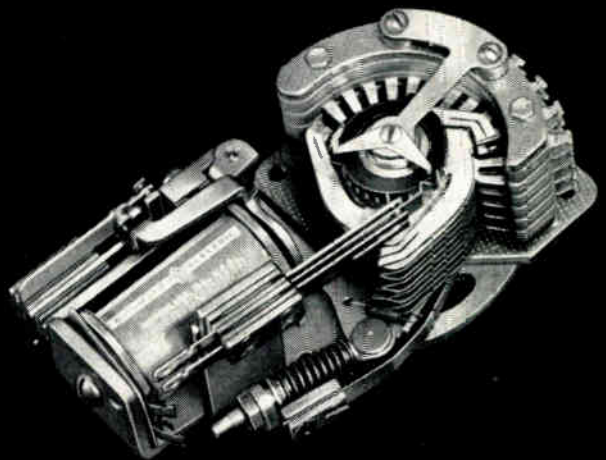
Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



TYPE 80

This is a larger capacity version of the Type 40, with the same "compact" and "decimal" features. It has a capacity of from six to twelve 10-point levels.



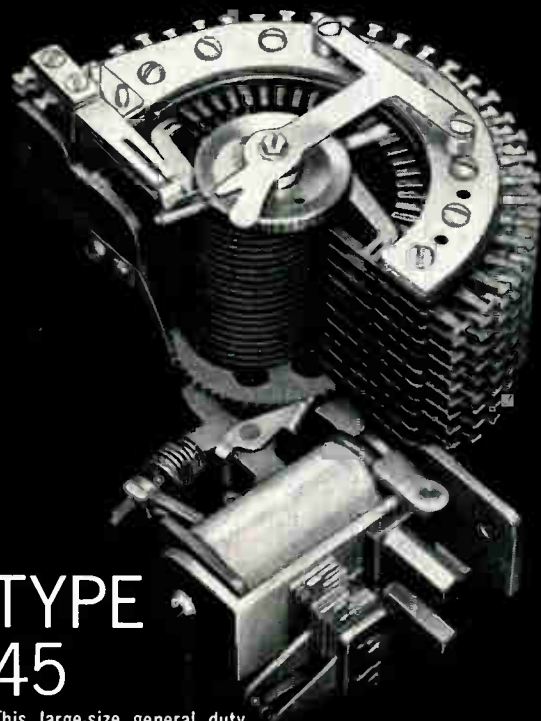
TYPE 40

This is a new compact decimal switch with a capacity of 6 bank levels, but with only 10 points per level, so that no extra steps must be taken, nor off-normal points skipped, when counting decimally.



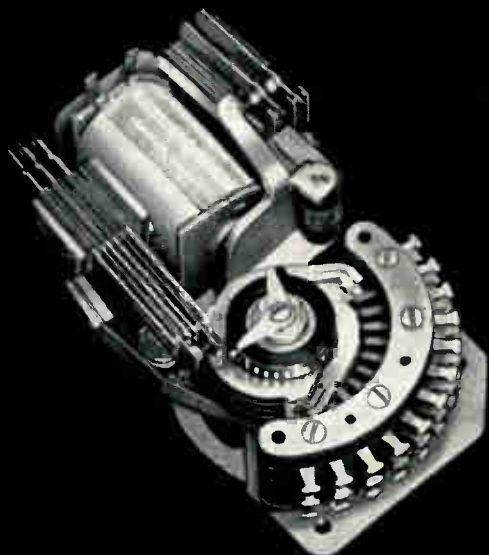
TYPE 88

This is a larger-capacity version of the Type 44. It has from six to twelve 10-point levels, with 11 points on all levels where specified.



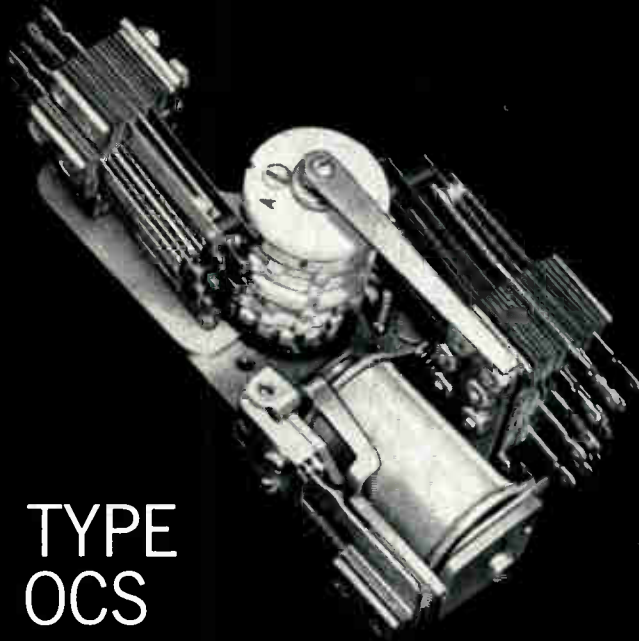
TYPE 45

This large-size general duty switch provides from two to twelve 25-point bank levels, or from one to eight 50-point bank levels.



TYPE 44

One of the first "compacts," this switch is available with up to eight 10-point levels (with 11 points on all levels where specified).



TYPE OCS

This ultracompact switcher with cam-actuated contacts is no larger than a pack of king-size cigarettes. Any programming sequence can be set up on 1 to 8 cams with as many as 36 on-and-off steps per cam.

TELE-TIPS



Record ANYWHERE . . . with the AO Tracemaster Single-Channel Recorder

You can take this compact, lightweight (only 20 lbs.) portable recorder anywhere you need it . . . to the Sahara or the Antarctic . . . next to a pounding oil drilling rig or on a vibrating factory bench . . . and get a perfect trace. The pressure stylus, driven by a unique high-torque-to-inertia pen motor, plus the Direct-Carbon-Transfer writing technique combine to make this recorder far less susceptible to shock and vibration.

The AO Tracemaster 291 recorder will perform well where other similar types fail. In addition, it will operate at a far higher frequency response at wider amplitudes than any other comparable portable recorder, i.e. response is flat from DC to 90 cps. at 30 mm. peak-to-peak. The Direct-Carbon-Transfer writing technique offers the finest definition, resolution and uniformity of trace over this wide frequency range and through all chart speeds. This unique combination of superior frequency response-amplitude characteristic plus Direct-Carbon-Transfer writing method makes it possible for the AO Tracemaster 291 to provide a more precise graphic reproduc-

tion of the actual input signals, thus displaying more useful information.

Send for complete information on the world's finest direct-writing, single-channel portable recorder . . . the AO Tracemaster 291. Also available for fast delivery are the 2 and 3 channel portables, and multi-channel Tracemaster recorders.

SPECIFICATIONS:

Frequency Response: DC to 90 cps. flat at 30 mm. peak to peak. Down 3 db at 125 cps.
Sensitivity: 5 mv/div. to 5 volts/div. in 10 steps
Input Impedance: 2.5 Megohms, either side to ground
 5 Megohms, balanced
Trace Width: .008 in. nominal
Chart Speeds: 1, 5, 20 & 100 mm/sec.
Chart Capacity: 200 ft. roll
Dimensions: 12½" H x 14½" W x 7" D
Weight: 20 lbs.

American Optical
 COMPANY
 INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

INDUSTRIAL ELECTRONICS • Phone: 716-895-4000, TWX 716-858-1380

"BAT RADAR" has been developed by Lockheed which enables a blind man to make his way around such objects as filing cabinets, cars, trees and other people. Transmitted pulses are supersonic sound, same as a bat. The reflected sounds come back to the earphones as a series of clicks. The clicks become louder as the blind person approaches the object. Another system uses the Doppler effect and an echo, and this system can tell more about the objects and their relative motion.

VOICE IDENTIFICATION. At Bell Labs, electronic representations of human voices — or voice-prints—have been made to see if voices can be disguised. The method was found to be 99% accurate, even when the individuals camouflaged their voices.

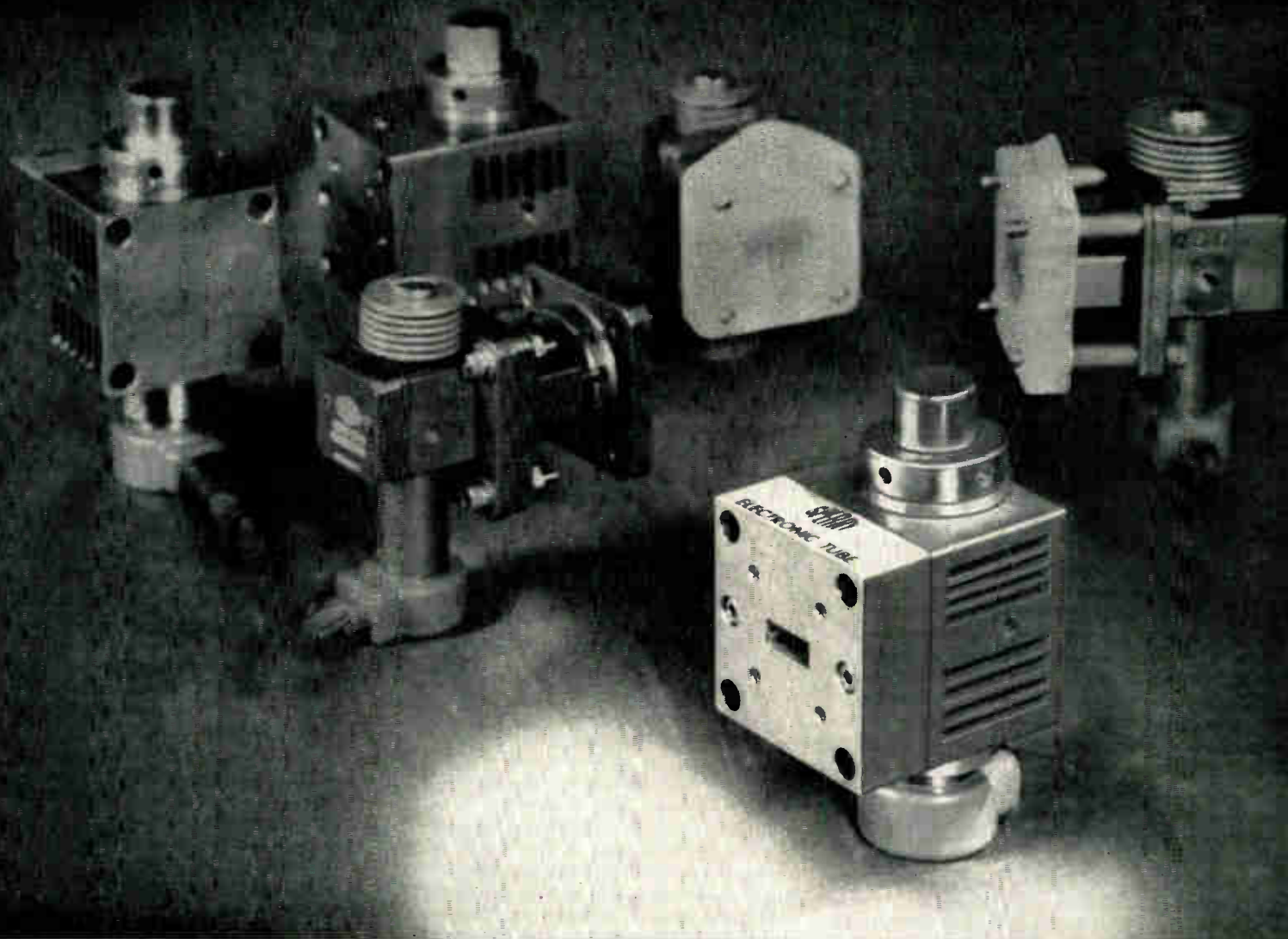
IT'S SURPRISING how quickly the industry has adopted the newest abbreviations. Hardly three years have gone by, and "nanosecond," "gigacycle," and "picofarad" are terms in common usage.

COMPUTER at Minneapolis-Honeywell was turned to job of playing Christmas carols. Special programming technique, in which musical notes are transcribed in special format, onto punched cards, was the first step. The punched cards, which contain data comparable to notes on sheet music, were transferred onto magnetic tape. The tape was then read into the Honeywell 800 computer's memory, where an electrical "loop" was formed to produce the musical tones.

SPACE CAMERA is being designed by Ford's Aeronutronic Division that will show grains of sand or rocks the size of BB pellets on the surface of the moon, and transmit the pictures back to Earth. The camera system will be contained inside a 25-in. balsa wood-covered ball, known officially as a "Lunar Facsimile Capsule," and landed on the moon.

SILENT ENGINE will be developed for the Army by Thompson Ramo Wooldridge Inc. for use in forward areas. The silent engine will operate for an hour on approximately 1-1/3 gallons of fuel, and is expected to be inaudible to the human ear at a distance of 100 ft. under the quietest ambient conditions. It is intended to drive high speed alternators.

(Continued on Page 44)



New SOV-2200 pumps paramps and masers at 35 Gc and delivers 500 mW of power. Operation at any frequency from 31 to 40 Gc is possible with this new oscillator family. Although miniaturized these Sperry oscillators have the frequency, high power, and stability of heavy-weight tubes.

New miniature, high-power oscillators push range to 40 Gc for paramp pumping

A new family of V band two-cavity klystron oscillators provides high power levels for parametric amplifier and maser pumping, doppler systems, and FM communications systems. These tubes cover the frequencies from 31 to 40 Gc. You now get off-shelf to 60-day delivery of two-cavity oscillators from Sperry Electronic Tube Division at any frequency from 12.5 to 40 Gc.

The unique combination of 500 mW power output at frequencies up to 40 Gc, exceptional AM stability, and small size is found only in Sperry's two-cavity design.

These Sperry miniaturized pump tubes weigh just 12 ounces — yet offer the performance formerly found only in much larger, heavier tubes.

The flat-topped "output power vs. beam voltage" mode shape results in outstanding amplitude stability, since variations in beam voltage and temperature produce only negligible variations in output power.

Sperry's two-cavity oscillators deliver power outputs ranging from .5 to 2 watts. Typical output at U band is 2 watts and at V band, 500 mW.

Use of two-cavity klystrons also permits considerable

system simplification, since equipment such as reflector power supply, automatic power leveler, and — in most applications — automatic frequency control can be eliminated.

For applications where outputs up to 300 mW and wide tuning ranges are required, ask about Sperry's tunable, low-voltage reflex klystron pumps.

A free technical booklet describing the entire Sperry line of paramp pump tubes — both two-cavity and reflex — is now available. For your copy, write Sperry, Sec. 190, Gainesville, Florida, or contact Cain & Co., Sperry's national representatives.

SPERRY

**ELECTRONIC
TUBE
DIVISION**

SPERRY RAND CORPORATION
GAINESVILLE, FLA. / GREAT NECK, N. Y.



ELECTRONICS

progress in semiconductors

Got Questions About G-E Functional Components?

For the past few months in these columns we have been discussing the advantages of G-E Functional Components using the Planar Epitaxial Passivated M1 Matrix, including ECLO circuits (emitter coupled logic operators), and custom circuits (or the do-it-yourself type). The concept results in more efficient, flexible and reliable circuits, the circuit possibilities from a single wafer are tremendous; lead time to produce new circuits is inherently short; and areas of the wafer (which provides 1100 transistors and 4000 resistors, if you remember your homework) can be reserved as "test elements" to determine performance characteristics and reliability of all the circuits on the wafer.

The more we discussed it the more the excitement grew; the more the excitement grew the more we discussed it; the more we discussed it the more people became interested; the more people became interested the more questions they asked; the more questions they asked... well, here are the questions most commonly asked, just in case you were thinking of asking any questions!!

Q. Can we get samples on custom circuits?

A. For the past few months we have been delivering ECLO's and some custom circuits. Now, we are ready to supply quantity ECLO samples, with price breaks. And even though we're pretty well flooded, we'll continue to evaluate custom circuits that use your designs.

Q. Approximately what does it cost to get a custom circuit from the M1 Matrix?

A. Well, certainly not \$25,000. As a matter of fact, the tooling (mask) charge is about \$1500.

Q. Would you supply chips unmounted for use in our own micro-miniaturization program?

A. Yes, but you will have to do your own packaging. The interconnections are on the chips; you put on your own leads.

Q. What is the absolute tolerance on resistors?

A. Absolute tolerance is $\pm 20\%$.

Q. Is the ratio between resistors better than the absolute tolerance on resistors?

A. It sure is, by a factor of 2 or 3 to 1. The reason is simple: the resistors on a single chip are diffused simultaneously, resulting in extreme uniformity of characteristics.

Q. How do I go from my discrete component breadboard to a functional component circuit with assurance that the circuit will work?

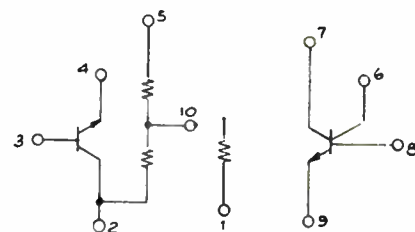
A. By using our TEG's (test element groups). A TEG is a chip containing two transistors and two resistors with all leads brought out through a 10 lead TO-5 can. You can hook up the leads any way you want to duplicate your breadboard circuit. In this way you simulate many of the parasitic capacities and other coupling paths that will exist when the entire circuit is reduced to a single chip. This method brings you closer to the eventual custom circuit than any other technique. And it saves you money too.

Q. Do you have other matrices underway?

A. Yes. For instance, the M2, which is similar to the M1, except specific cross-overs are provided to simplify interconnectors. If you recall the M1, only the collector rings could be used for subsurface crossover. Also, diodes have been added under each resistor.

Q. How about capacitors?

A. These will be part of our M3 Matrix, available early in March, which is identical to the M2, except that wherever five packs of resistors appear, diffused capacitors will appear. These will be about 25 picofarad.



...This schematic is a bottom view of the test element group.

If you have any additional questions on ECLO's, on the application of ECLO's, on custom circuits, on the M1 Matrix system itself, or on test element groups (or any question, for that matter) write us at section 13B143, Semiconductor Products Department, General Electric Company, Electronics Park, Syracuse, New York.



GENERAL ELECTRIC

TELE-TIPS

ULTRASONICS has been found to affect the permeability of human cell tissues. Biochemists see possibilities of controlling the rate of absorption of drugs, permitting more reliable analysis of their effects.

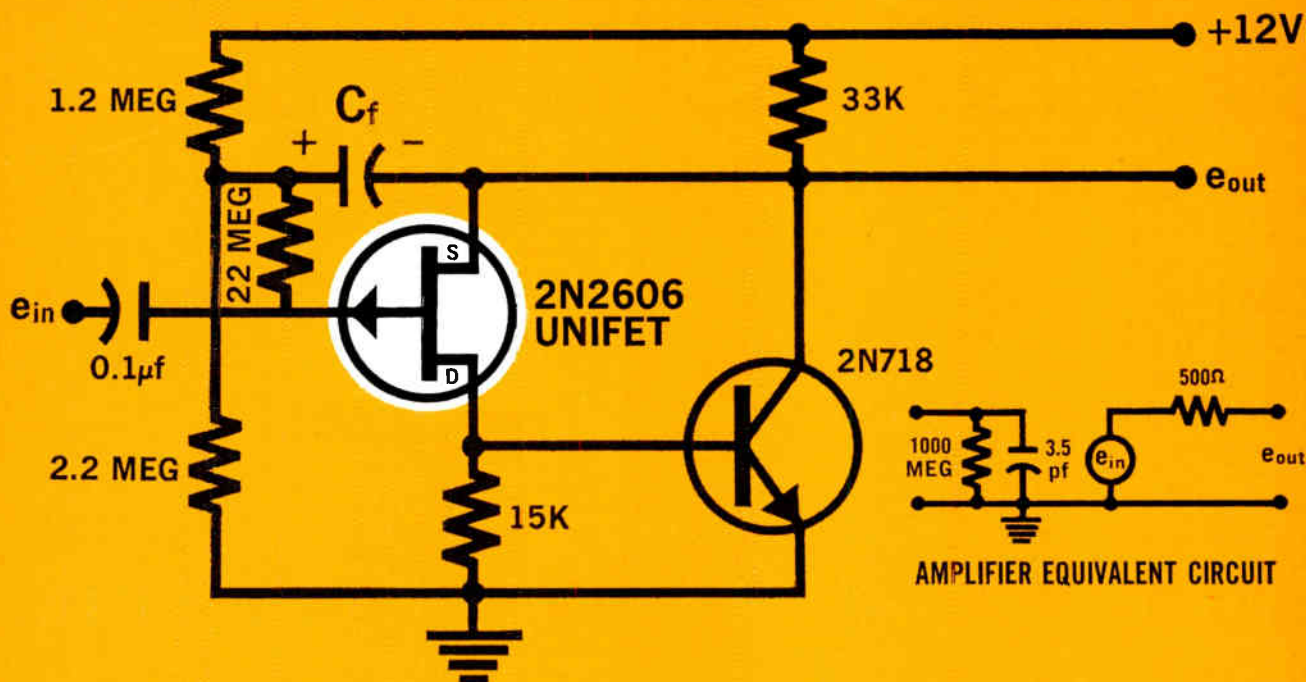
SONIC DEVICE which pinpoints leaks in gas mains has been developed at Illinois Inst. of Technology. Researchers found that any sound in the gas stream inside the pipe issues from the leak with the escaping gas. A signal generator injects an audio signal into the gas stream. At the same time a portable transmitter broadcasts the identical signal on a radio frequency. Transducers are used to sense the signal at the ground level. When the transducer is near the leak the sound level is higher.

VELOCITY OF SOUND in water was measured ten times more accurately than previously possible. By using a pulse superposition method of measurement it was found that the actual velocity is about four parts in ten thousand slower than previously believed. Sound energy is reflected back and forth through a quarter-inch path of water, and velocity is determined from an accuracy measurable frequency rather than by direct timing as previously done.

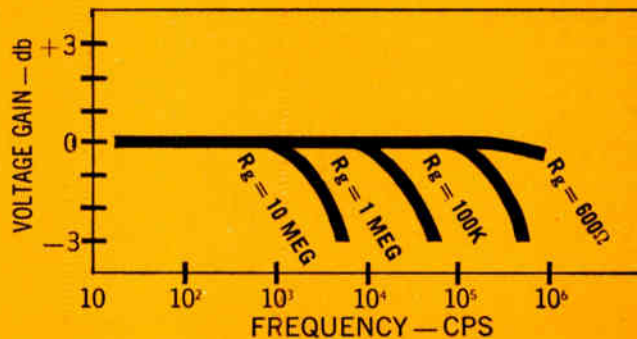
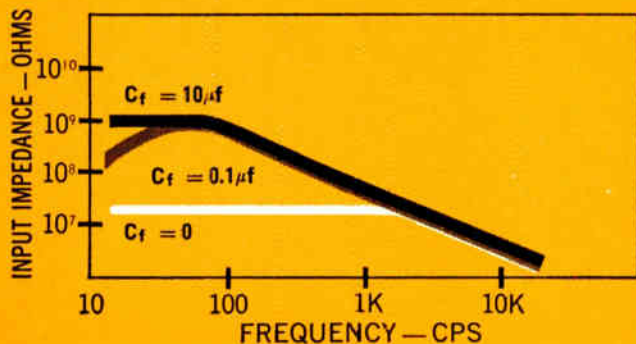
COMPUTER will be used to keep track of the pedigrees and ownership records of some 3.7 million registered Aberdeen Angus beef cattle. The American Angus Assoc. of St. Louis has logged the records of the elite Black Angus population on more than 8 million punched cards and in an 800-page Herd book. They have been placed on 15 reels of magnetic tape, and are being updated with new cattle registrations, ownership transfers and other information on a daily basis by a Honeywell 400 computer.

FIRST HIGH SCHOOL EDP training program utilizing a full scale electronic computer is being organized at Des Moines Technical High School. The school will receive delivery of a Burroughs B260 punched card system in 1963. Des Moines is the second largest center of the heavily computerized insurance industry. A total of 5,000 business students may enroll for courses, including those among Des Moines Tech's 2,000 pupil student body.

How to put Siliconix UNIFETs* to work...



R_{in} - 1000 MEGOHMS — C_{in} 3.5 pf



A SIMPLE ANSWER TO A CUSTOMER'S PROBLEM. A HIGH INPUT IMPEDANCE AMPLIFIER WITH ONLY 9 COMPONENTS. TEMPERATURE RANGE: -65°C TO $+100^{\circ}\text{C}$. POWER GAIN: 66 DB. WRITE FOR APPLICATIONS FILE NO. 606... THE COMPLETE STORY ON THIS AND SIMILAR CIRCUITS USING SILICONIX UNIFETS.

*Four UNIFETs (Unipolar Field-Effect Transistors) now available.

	2N2606	2N2607	2N2608	2N2609	
g_m	150	450	1350	3600	μmho
I_{DSS}	-0.15	-0.45	-1.35	-3.60	ma
C_{is}	4	7	12	25	pf

Pinch-off: 2 volts • Gate-drain Breakdown: 30 volts • TO-18 Package



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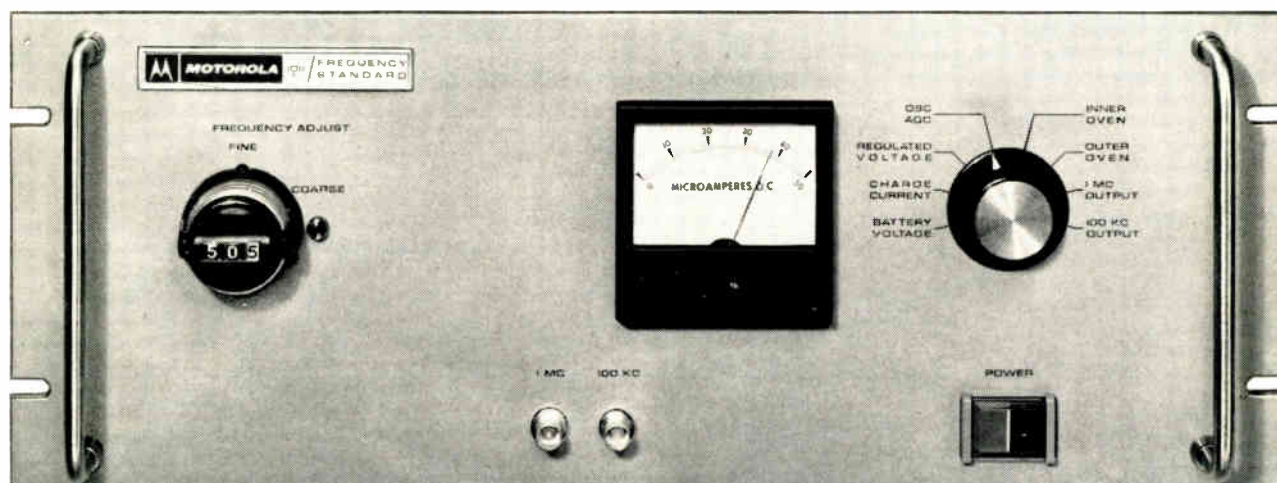
Siliconix assumes no responsibility for circuits shown, nor does it represent or warrant that they do not infringe any patents.

1×10^{-11}
Stability

5×10^{-11}
Aging per Day

5×10^{-11}
Short Term Stability, 1 Second Counts

Less than **2×10^{-10}**
 $20^{\circ}\text{C} \pm 20^{\circ}\text{C}$



Motorola 1011 Frequency Standard—the Ultimate in Stability!

- True proportional control double oven construction.
- Constant gain oscillator circuitry.
- Selected 2.5 mc 5th overtone crystals.
- Solid state silicon design.
- 15-hour sealed nickel-cadmium batteries included.
- Power failure alarms.
- Frequency Adjust setable to 1 part in 10^{11} .
- Fail-Safe dividers.
- Optional 5 mc crystal-filtered output for spectral purity.

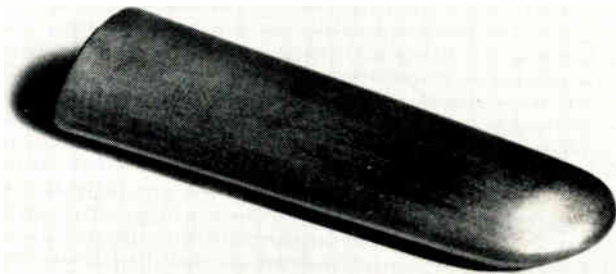
- Regulated power supply.
- Design guaranteed by over 2 decades of Motorola crystal and oscillator experience.
- Model S1065AR includes 15 hour battery pack \$3,950.00.
- Model 1066AR includes 5 mc spectrally pure output \$4,650.00.
- Model SLN6076A extra 15 hour battery pack to provide 30 hour operation \$300.00.

Ask your Motorola Instrument Representative for full details or write Dept. AEI36

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 **MOTOROLA**
PRECISION INSTRUMENTS

Gallium arsenide was first used a few years ago, mainly in tunnel diodes. Unfortunately, these had a high failure rate. After this short emergence the material seemed to "drop from sight." However, the material was not forgotten—it had too much to offer. Here we bring the use of this material up-to-date and project its use into the future.



A gallium arsenide crystal grown by Eagle-Picher Company. This will be shipped to a semiconductor manufacturer where it will be sliced, diced, and processed for use in devices.

By **JOHN E. HICKEY, Jr.**

Managing Editor
ELECTRONIC INDUSTRIES

GALLIUM ARSENIDE: WHAT IS ITS STATUS?

GALLIUM ARSENIDE WAS FIRST USED COMMERCIALY as a semiconductor a few years ago in tunnel diodes. Unfortunately, this use was short lived. The causes were both impurities in the material (probably copper) and the lack of knowledge on the users' part, which led them to use the diode in an unsafe region of operation.

The apparent failure of GaAs left a stigma attached to the material. After its brief emergence into the commercial world, little was heard of GaAs until just recently. Then mention of the material was made a few months ago of its use as an incoherent infrared source, in a diode form. On the heels of this news came the announcement that GaAs could be used as a coherent infrared source. The second device was labeled an "injection laser."

Most engineers do not know that even though the early GaAs tunnel diodes dropped out of sight, the research and development people were hard at work with the material. All signs were that the material held significant benefits over germanium and silicon. The semiconductor people solved the problems associated with tunnel diodes and went on to apply the material to other devices. Later we will describe, in brief form, some of these devices. But first, let's look into the material.

The Material

Gallium, a mercury-like liquid at 30°C, reacts with arsenic vapor at about 1240°C to form molten gallium arsenide. As with germanium and silicon, the molten semiconductor is slowly cooled and can be "frozen" to form a single crystal. The main difficulties in this process are to obtain very high-purity gallium and arsenic, and to keep these materials free of contamination during compound formation and crystal growth.

Once satisfactory single-crystal gallium arsenide

GALLIUM ARSENIDE (Continued)

is obtained, the slicing, dicing, and processing steps are similar to those of germanium and silicon. This is a good feature, because no major changes have to be made in production equipment or methods to make GaAs devices.

Both gallium and arsenic are available in ample quantities for semiconductor devices. Gallium, a by-product of aluminum production, is more abundant than germanium. Arsenic, a by-product of many different chemical operations, is available in virtually unlimited quantities. The relatively high cost of today's gallium arsenide devices basically stems from moderate crystal and device yield, and low production volumes. The same cost problems plagued both germanium and silicon devices during their early stages.

Semiconductor Materials

In Table 1, the elements in Column IV of the periodic table—carbon (C), silicon (Si), germanium

temperature range but is very poor frequency-wise. Hence, gallium arsenide appears, at this time, to be the best all-around semiconductor.

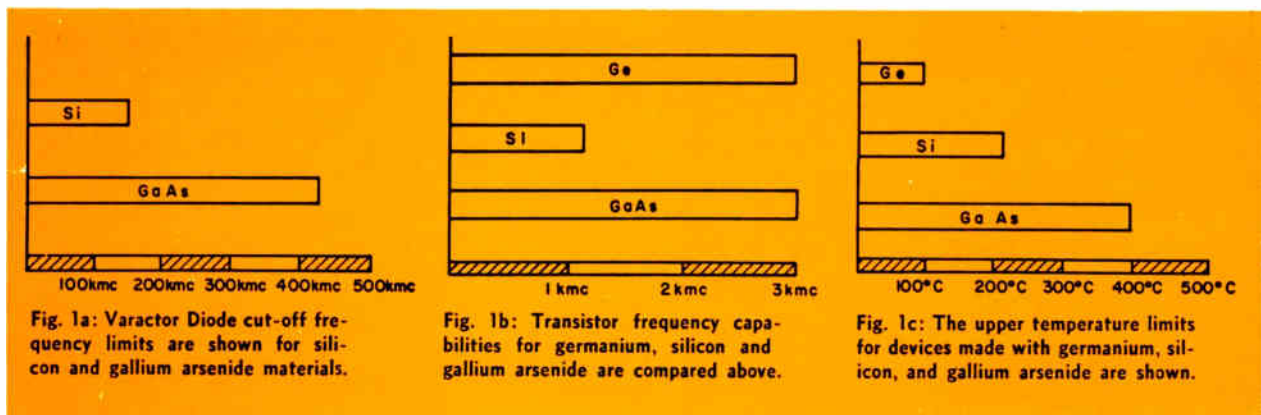
Generally, GaAs has the following points in its favor:

- (a) high frequency operation
- (b) high temperature capabilities
- (c) ability to withstand and operate at higher voltages
- (d) higher radiation resistance.

The first two items were previously mentioned and are obvious. However, one passing remark about the temperature capabilities—the use of this material in normal environments would solve some of the cooling problems presented by other types of semiconductor devices. Often less cooling, or none, would be needed in dense packaging.

Table 3 gives some sign of the material's ability to operate at higher voltages. Also, the material can handle higher power at high frequencies.

The last item listed, higher radiation resistance, is



(Ge), and gray tin (Sn)—are all semiconductors. Compounds of Columns III and V are also semiconductors, as are certain combinations of elements in Columns II and VI. The electron and hole mobilities of these semiconductors, their band gaps, and upper device operation temperature limits are listed in Table 2. The mechanical and electrical characteristics of GaAs are compared to Ge and Si in Table 3.

Gallium arsenide does better than merely combine the best features of germanium and silicon, Fig. 1. Its frequency characteristics are equal, or better than germanium, varying with the device type. Indium antimonide (InSb) has excellent frequency characteristics but must be ruled out for general use because of the very low maximum device temperature. Silicon carbide (SiC) shows excellent operating tem-

perature range but is very poor frequency-wise. The relatively high atomic weights of the elements of the material, combined with the low minority carrier lifetime result in a greater radiation resistance. This makes GaAs devices well suited for space applications (such as in the Van Allen Belt and the radiation areas created by nuclear testing) and in locations near nuclear propulsion systems. This semiconductor may alleviate some of the earlier findings during nuclear tests—that semiconductor devices are low on the reliability list when subjected to radiation fields.

Tunnel Diodes

We've covered some of the basics of GaAs, now we will look briefly at some of the current applications. Heading the list is the original—tunnel diodes! As

we mentioned, the great difficulty was the rapid degradation during operation (temperature had no effect).

The limits in which gallium arsenide tunnel diodes can operate have now been carefully defined. When they are operated within the specified ratings, Fig. 2, there is no danger of degradation.

The following rules clarify the safe operating conditions:

1. Operation on the reverse side of the V-I characteristics is safe as long as the dissipation limits are observed.
2. Operating the tunnel diode from the origin to

Table 1
PORTION OF PERIODIC TABLE

II	III	IV	V	VI
Be	B	C	N	O
Mg	Al	Si	P	S
	Ga	Ge	As	Se
	In	Sn	Sb	Te

Table 2: ELECTRICAL CHARACTERISTICS of VARIOUS SEMICONDUCTORS

Semiconductor	Band Gap (Electron-Volts)	Approximate Maximum Device Temperature (°C) (Theoretical)	Dielectric Constant Air = 1	Electron Mobility, μ_p (cm ² /volt-sec)	Hole Mobility, μ_p (cm ² /volt-sec)
Ge	0.67	100	16.0	3900	1900
Si	1.106	250	11.8	1500	500
GaAs	1.4	450	11.1	~10000	>450
SiC	2.8	>1000	7.0	> 100	> 20
C (Diamond)	6.7	>1000	5.7	~ 1800	1200
InSb	0.18	~-196	15.9	~80000	~1000
InAs	0.33	~- 75	11.7	~33000	460
GaSb	0.68	100	14.0	~ 4000	~1400
InP	1.25	400	10.8	~ 4600	~ 150
AlSb	1.6	500	10.1	> 400	>400
GaP	2.4	1000	8.4	> 100	> 20
AlAs	~2.2	900	-	~ 1200	~200

Table 3: ELECTRICAL & MECHANICAL CHARACTERISTICS of Ge, Si, & GaAs

Property	Ge	Si	GaAs	Units
Melting Point	937	1415	1240	°C
Density (at 25°C)	5.32	2.33	5.31	grams/cm ³
Therm. Coefficient Expansion	6.1x10 ⁻⁶	4.2x10 ⁻⁶	5.9x10 ⁻⁶	/°C
Thermal Conductivity	0.63	0.84	0.52	watt units
Specific Heat	0.074	0.181	0.086	cal/gram-°C
Atomic Weight	72.6	28.09	144.6	number
Lattice Constant	5.657	5.431	5.654	A
Atoms/Cm ³	4.42x10 ²²	4.99x10 ²²	4.43x10 ²²	number
Dielectric Constant	16.0	11.8	11.1	vacuum = 1
Band Gap Energy	0.67	1.106	1.40	electron-volts
Intrinsic Resistivity (300°K)	46	2.3x10 ⁵	3.7x10 ⁸	ohm-cm
Electron Lattice Mobility (300°K)	3900	1500	10000	cm ² /volt-sec
Hole Mobility	1900	500	450	cm ² /volt-sec
Intrinsic Charge Density (300°K)	2.4x10 ¹³	1.5x10 ¹⁰	1.4x10 ⁶	number/cm ³
Electron Diffusion Constant (300°K)	100	38	310	cm ² /sec
Hole Diffusion Constant (300°K)	49	13	11.5	cm ² /sec

GALLIUM ARSENIDE (Continued)

the valley point is safe under all normal conditions.

3. Operation in the region to the right of the valley point in the forward voltage is safe as long as the current through each diode does not exceed 0.5ma for each pf of junction capacitance. For instance, with a junction capacitance of 30pf, the safe operating forward current should not exceed 15ma. Always check the manufacturer's data sheets for specific data.

The significant benefits of using GaAs tunnel diodes are:

1. Twice the voltage range of germanium diodes ;
2. Higher oscillator power outputs ;
3. Higher operating frequencies ;
4. Higher peak-to-valley current ratios.

The tunnel diode is useful for amplification, oscillation, pulse generation, logic and storage uses, voltage sensing, dc to ac inversion, plus many other uses. Because the tunnel diode is a "majority carrier" device, as opposed to a "minority carrier" device such as a transistor, it is capable of very high-speed operation. This makes it useful as a microwave oscillator, low-noise microwave amplifier, logic and storage element with subnanosecond (less than 10^{-9}) switching times, and high-speed threshold sensor for counting nuclear particles.

Tunnel Rectifiers

The tunnel rectifier is an off-shoot of the tunnel diode. The construction is basically the same. But when a tunnel diode is used such that its rectification properties are more important than its negative resistance characteristic, it is a *rectifier*. The peak cur-

rent is generally much less than that of the tunnel diode. Neglecting this small peak current, the tunnel rectifier resembles a normal junction diode with a breakdown voltage of about 1v, but with a much steeper forward slope.

These rectifiers are specially designed as coupling devices in high-speed switching circuits. Their fast switching speed, low power dissipation, and ease of drive make them good for memory device uses. Typical uses include computer memory and logic elements, pulse generators, transistor drivers, and input-output isolators in logic circuits.

Rectifiers

An ideal rectifier would have an infinite reverse resistance, infinite breakdown voltage, zero forward resistance, and operate well at high temperatures. Unfortunately, all rectifiers are limited in these characteristics.

Each semiconductor material has certain advantages. Ge rectifiers have a low forward voltage drop, but must operate below 100°C. Si devices with higher forward voltages are good to about 175°C. GaAs rectifiers have a still higher forward voltage, and a *potential* temperature limit of 400°C. Rectifiers operating at 300°C are available.

The maximum breakdown voltage of the most advanced GaAs rectifiers is limited to about 200 v. But, this limitation is not due to the basic material, and thus, higher breakdown voltages are possible. Present forward current is also limited, but this will be overcome.

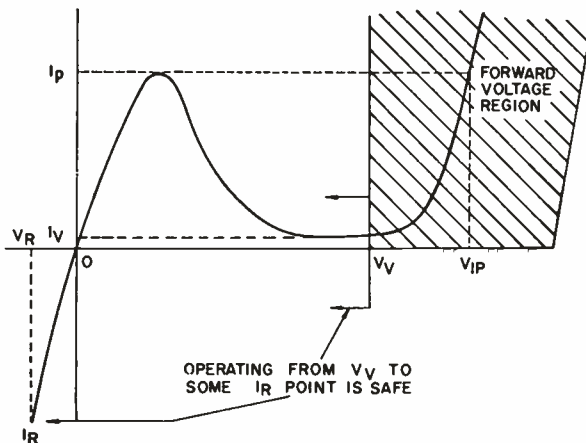
These devices will find use in magnetic amplifiers, control circuits and many other roles where high temperature and/or high frequency properties are important.

Varactor Diodes

A varactor diode is a device having a highly non-linear capacitance-voltage relationship. A varactor should also have very low leakage conductance and spreading resistance. Due to variation of their capacitance with applied voltage, they are good for many circuit functions such as r-f amplification, harmonic generation, frequency conversion, reactive tuning, sub-harmonic generation, and specifically for use in parametric amplifiers.

Three properties of GaAs make the material useful for varactors: high mobility of electrons, large energy bandgap, and low dielectric constant. These properties lead to superior frequency response, very low noise, and good variation of capacitance with voltage. Another feature of GaAs varactors is its wide temperature limits, from liquid nitrogen (-190°C) to

Fig. 2: Unshaded region of characteristic curve is the permissible operating range for tunnel diodes.



+150°C. The high cutoff frequency (possibilities to 300 KMC) is several times that of silicon, the next best material.

Solar Cells

One of the better known uses of solar cells has been a power source on space vehicles. This use places, probably, the most stringent requirements on these devices. The cells must withstand radiation problems such as the Van Allen Belt, and in some cases, high temperature.

The effort on GaAs solar cells has been somewhat restricted because of the complexity and newness of gallium arsenide technology. Even so, a number of these cells were placed on the several satellites recently launched. Results indicate the superior radiation resistance of these cells.

Fabrication of these cells is very similar to silicon cells. And, in many respects, the development of GaAs cells has paralleled that of silicon cells, efficiency of about 13 or 14% in sunlight, while the best gallium arsenide cells are now about 11 or 12%. Theoretical calculations indicate that GaAs will be more efficient than silicon, plus the other benefits of the material.

Development cells up to 2cm² are available in limited quantities. These have a peak spectral response of about 8400 Å at 77°K and 8900 Å at 300°K.

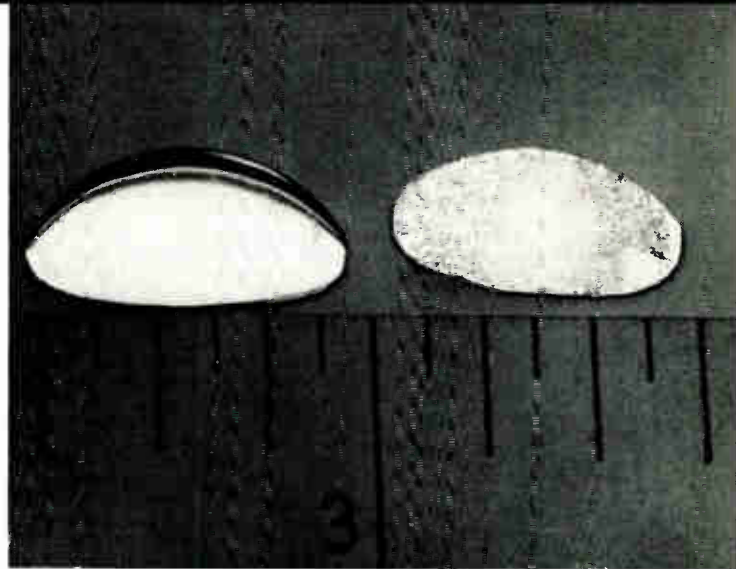
A word of caution to circuit designers—watch how the efficiency of solar cells is stated. There have been cases where the efficiency has been listed at almost 100%, and this was a valid statement because it was a quantum statement. However, the useful efficiency statement for designers should be in terms of power.

Infrared Sources

The latest and most spectacular developments have been the incoherent IR diode and the injection laser using GaAs. There is a similarity in the structure and operation of these two devices.

The IR diode is a pn junction device. When it is biased in a forward direction it emits light of a relatively narrow spectral width in the near infrared. The diode can be modulated by varying the forward current that is applied to the input. These devices are available in small quantities for engineering evaluation. Generally, they are in standard JEDEC packages with a glass window to transmit the radiation.

Some possible uses for these diodes include TV signal transmission, optical communication links, light source for tape and card readers, and logic circuits. Many other applications will be developed.



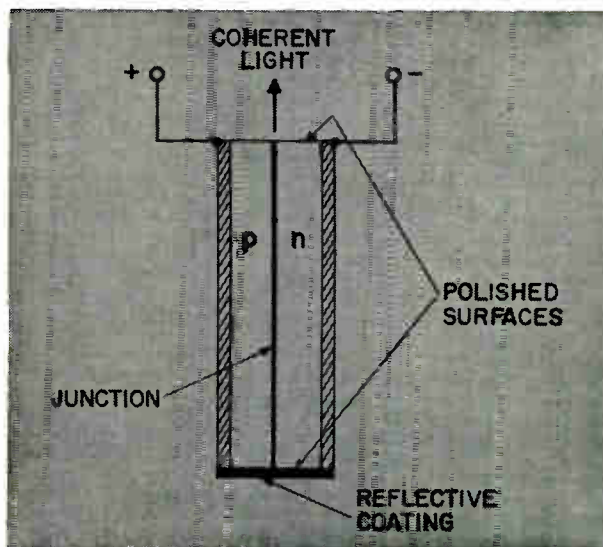
Photograph shows two slices of gallium arsenide. The slice on the left has been polished and is ready for use.

The injection laser is also a pn junction device (see page 125, ELECTRONIC INDUSTRIES, December 1962). There is great interest in lasers because they have the potential of providing communication channels with thousands of times the capacity of present radio channels.

A number of materials, such as ruby, were found to be capable of laser action. However, in all of these devices it was necessary to “pump” electrons to high energy levels from which they could emit light. This “pumping” was supplied by external light sources, usually flash tubes. A somewhat different mechanism has been used to produce laser action in gases. In these devices an electrical discharge through the gas provides the needed energy. With both types of lasers, no simple way has been found to modulate the output light at high frequencies as it is being produced.

The injection laser operates in a radically different manner. Light emission is caused by passing a high

Fig. 3: This is a simplified sketch showing the basic elements of a gallium arsenide injection laser.



GALLIUM ARSENIDE (Concluded)

electric current (10,000 amperes, or more, per square centimeter) through a GaAs semiconductor pn junction. Fig. 3 is a rough sketch of this device. The light is given off by electrons, which convert their energy to light after they pass through the junction. The very high current passing through the junction produces a very high density of photons which excites stimulated emission, producing laser action.

It is very easy to modulate the diode's output radiation by modulating the incoming current. Hence, the modulating problems of the other types of lasers are avoided.

These devices emit infrared at about 8400 Å at an angle that is measured in minutes. By using gallium phosphite (GaP), the researchers hope to develop devices that will radiate light from the near IR through visible light to the blue-green region.

Future Devices

Work on the development of GaAs transistors covers a period of years. Early work was reported by RCA in May 1957, and a working GaAs transistor was demonstrated in May 1960. Developmental work has been continuing at a rapid pace.

At this time the best application for GaAs transistors appears to be either as microwave power transistors or as unipolar devices. In both cases the high mobility of GaAs gives improved results over silicon, and its poor life times is not a great disadvantage. Other benefits are excellent radiation resistance and operation at higher temperatures.

Also under development are zener diodes and switching diodes using GaAs. The switching diodes will have higher switching speeds, in the sub-nanoseconds. There will be many refinements on the devices already covered. Some of these have been mentioned.

No one has mentioned the possibility of using GaAs in the production of integrated circuits. One reason is the lack of expert experience in handling GaAs. However, this is only a temporary deterrent as integrated arrays of unipolar devices appear to be a promising approach.

Acknowledgments

We would like to thank the Semiconductor and Materials Division of the Radio Corporation of America, who have a very rigorous GaAs program, and more specifically, Drs. F. L. Vogel, R. B. Janes, and A. Blicher, and M. F. Lamorte for supplying us with most of the information used in this article.

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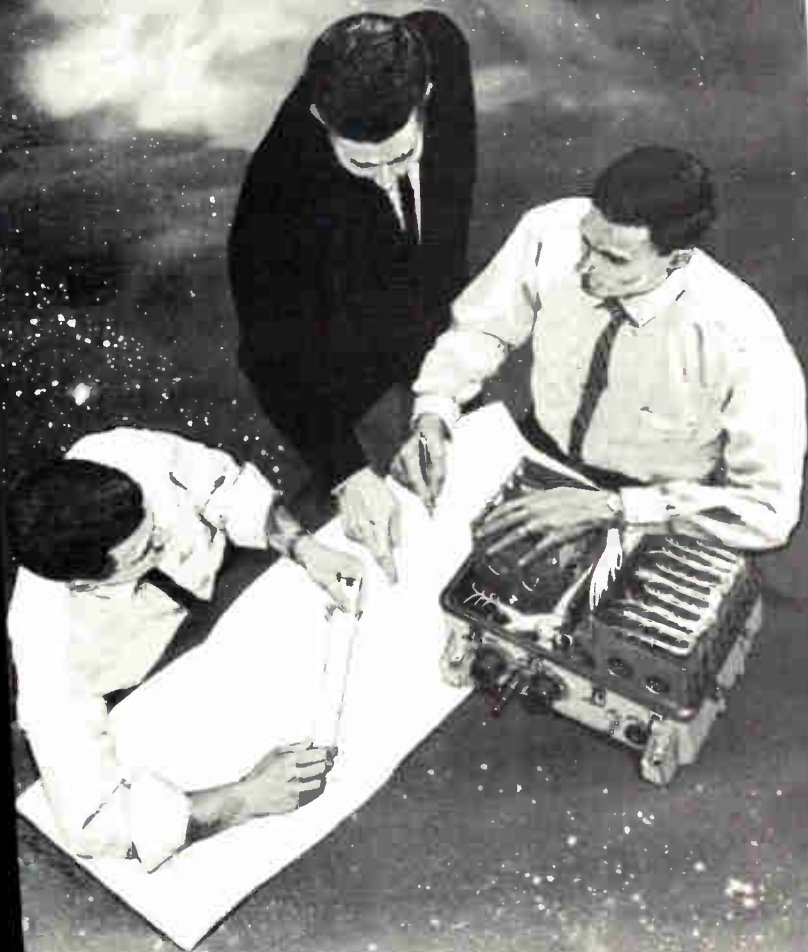
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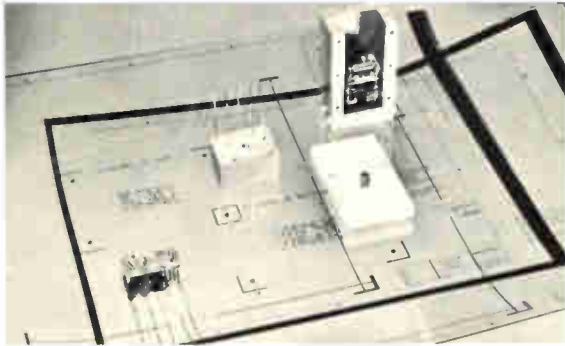
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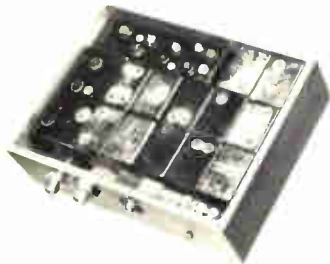
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Welded module development



Azusa Mark II Tracking System at Cape Canaveral

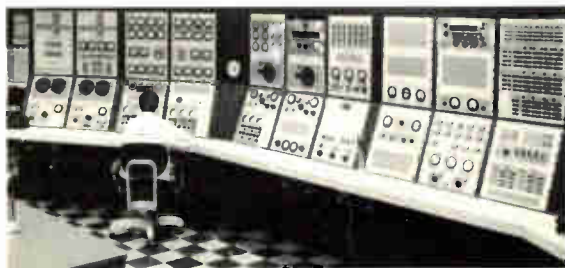


Developmental model of 400 MC transponder, utilizing welded module construction

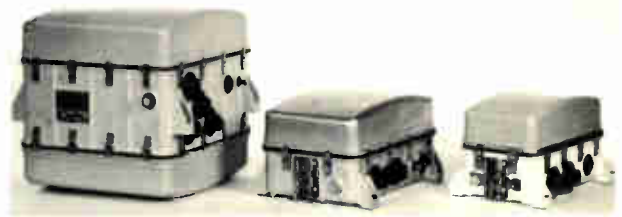
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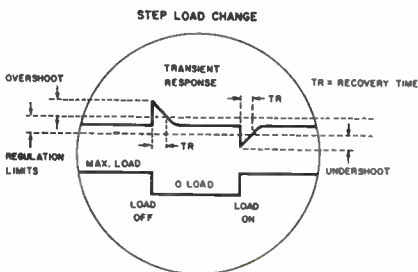
to the Editor

"Power Supplies"

Editor, ELECTRONIC INDUSTRIES:

We welcome the opportunity to reply to Dr. Victor Wouk's comments on your October 1962 Power Supply issue.

Kepeco was pleased to contribute its "Glossary of Power Supply Terminology," and "Nomograph of Voltage Drop" to this excellent issue. Although both of these items had been previously published in the Kepeco power supply catalog, the illustrations for the "Glossary" were especially prepared for *Electronic Industries*. We thank Dr. Wouk for bringing to our attention the discrepancy in the illustration (6a) which accompanied our definition of "Recovery Time." The correct illustration is reproduced below:



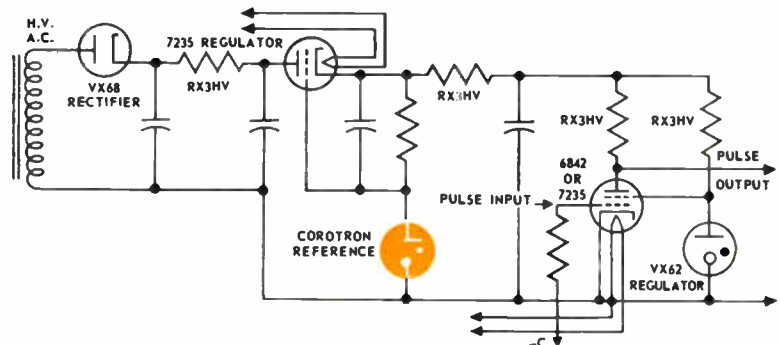
Manufacturers of complex electronic apparatus must of necessity use certain uncommon terms and phrases to properly describe their equipment. We feel that such manufacturers also have an obligation to adequately explain and define the terms that they use. It would be nice indeed if there were some generally recognized technical dictionary whose definitions were completely appropriate to the power supply industry. Lacking this, we at Kepeco have adopted a set of definitions which in our experience serve to adequately illuminate the most commonly used terms. In the main, most other power supply manufacturers have adopted similar definitions and so the publication of the "Glossary" serves a very useful industry-wide purpose.

Regarding the use of the word "efficient" in describing forced-air cooling. The use of forced air cooling is a more efficient method of heat removal (as compared to convection cooling). We
(Continued on page 60)

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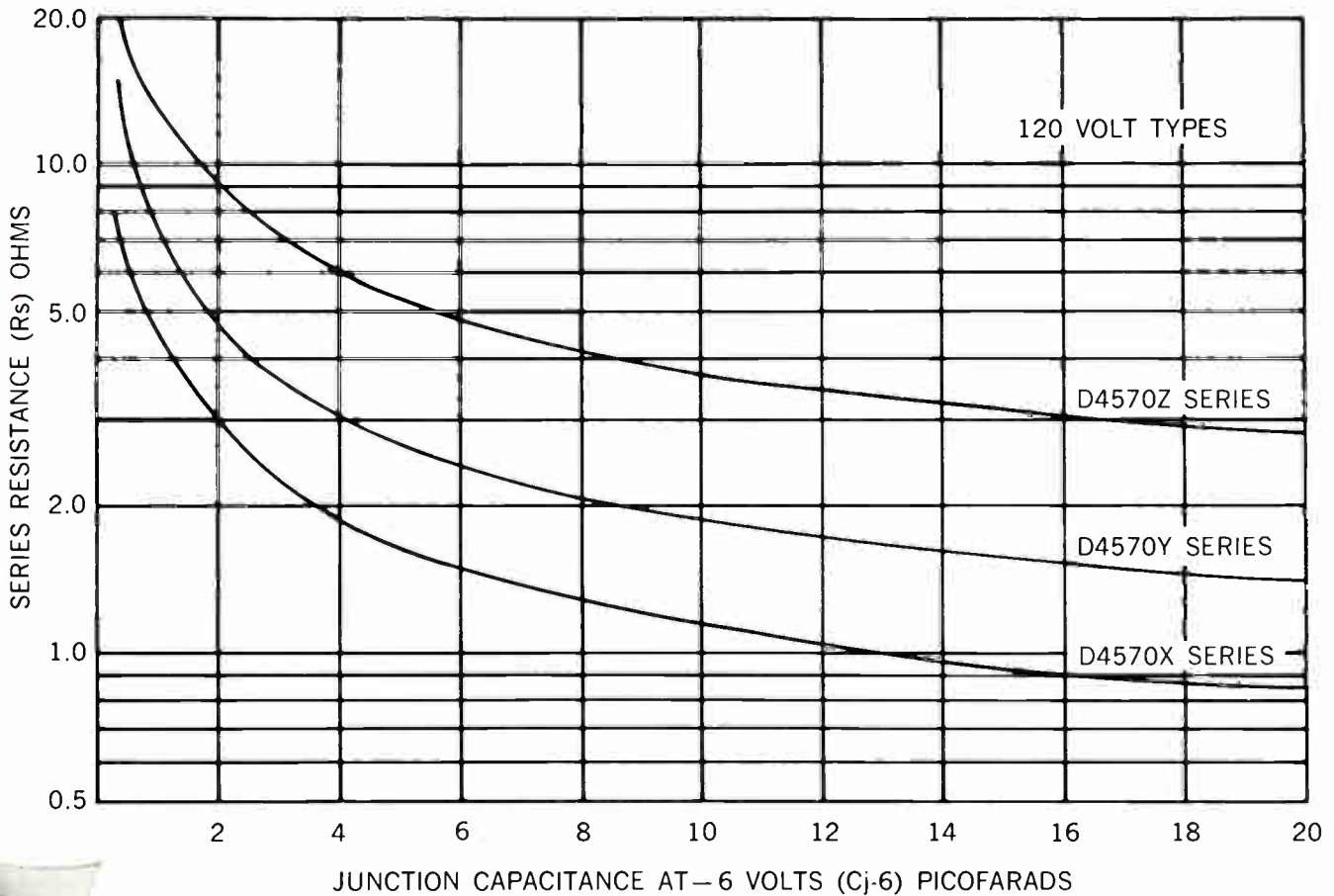
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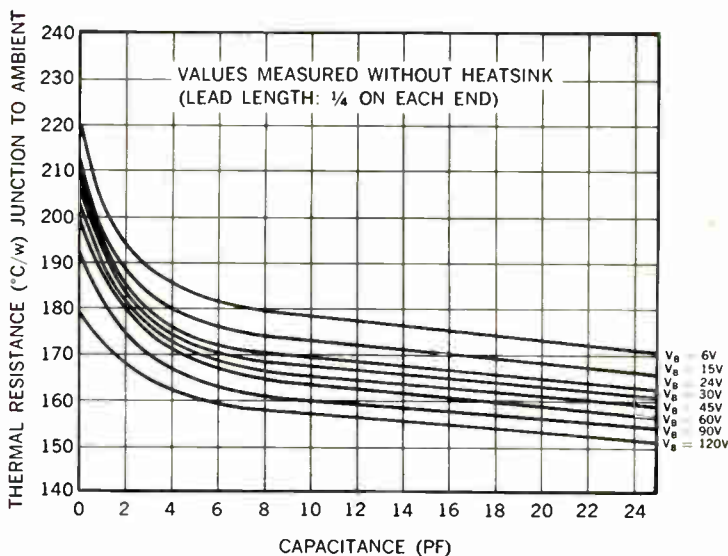
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1 0.4-1.0	D4501 3.5 6.0 11.0	D4511 3.5 6.0 11.0	D4521 4.0 7.0 12.0
2 1-2	D4502 2.0 3.5 8.0	D4512 2.0 3.5 8.0	D4522 2.5 4.3 9.0
3 2-4	D4503 1.5 2.5 6.0	D4513 1.5 2.5 6.0	D4523 1.8 2.8 7.0
4 4-8	D4504 1.1 1.7 4.0	D4514 1.1 1.7 4.0	D4524 1.3 2.0 4.3
5 8-14	D4505 .9 1.3 2.5	D4515 .9 1.3 2.5	D4525 .9 1.5 2.8
6 14-20	D4506 .8 1.1 2.0	D4516 .8 1.1 2.0	D4526 .8 1.3 2.3
Code Number	3	4	5
Voltage Breakdown	30 volts	45 volts	60 volts
Capacitance Code # C _J pf	X Y Z	X Y Z	X Y Z
0 0.1-0.4	D4530 6.7 12.0 19.0	D4540 7.4 13.5 20.0	D4550 7.4 13.5 20.0
1 0.4-1.0	D4531 4.0 7.0 12.0	D4541 4.5 8.0 13.0	D4551 4.5 8.0 13.0
2 1-2	D4532 2.5 4.3 9.0	D4542 3.0 5.2 10.0	D4552 3.0 5.2 10.0
3 2-4	D4533 1.8 2.8 7.0	D4543 2.1 3.2 8.0	D4553 2.1 3.2 8.0
4 4-8	D4534 1.3 2.0 4.3	D4544 1.4 2.3 4.7	D4554 1.4 2.3 4.7
5 8-14	D4535 1.0 1.5 2.8	D4545 1.0 1.7 3.2	D4555 1.0 1.7 3.2
6 14-20	D4536 .8 1.3 2.3	D4546 .9 1.4 2.7	D4556 .9 1.4 2.7
Code Number	6	7	
Voltage Breakdown	90 volts	120 volts	
Capacitance Code # C _J pf	X Y Z	X Y Z	
0 0.1-0.4	D4560 8.0 15.0 21.0	D4570 8.0 15.0 21.0	$Q = \frac{1}{2\pi f C R_s}$ $n = 0.42$
1 0.4-1.0	D4561 5.0 9.0 15.0	D4571 5.0 9.0 15.0	
2 1-2	D4562 3.5 6.0 11.0	D4572 3.5 6.0 11.0	
3 2-4	D4563 2.3 3.5 8.5	D4573 2.3 3.5 8.5	
4 4-8	D4564 1.5 2.5 5.0	D4574 1.5 2.5 5.0	
5 8-14	D4565 1.1 1.8 3.5	D4575 1.1 1.8 3.5	
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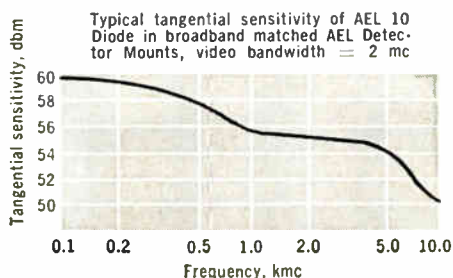
■ NEW HIGH POWER VIDEO DIODES *

A startling break-through in the state-of-the-art. For the first time, the problem of crystal burnout can be eliminated almost completely without the use of power limiters or other crystal protective devices between the crystal detector and its antenna. Permits considerable saving in size, weight, and cost.

These AEL crystal diodes withstand up to 3 Watts of average power or up to 300 Watts peak, yet yield high sensitivities. In a tuned mount, tangential sensitivities vary from -60 dbm, for 2 mc video bandwidth, at 2 kmc to -50 dbm at 10 kmc. Frequency range: 1-10 kmc.

■ HIGH SENSITIVITY VIDEO DIODES *

These are premium diodes for systems requiring the utmost in sensitivity and reliability. As much as 10 db greater sensitivity can be achieved by using these diodes without the need for diode selection.



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LETTERS

to the Editor

(Continued from page 57)

manufacture equipment employing both kinds of cooling as is appropriate to the power level, type of circuit and application.

Dr. Wouk's choice of language is regrettable when he questions the definition of a "Current Sensing Resistor." We do not imply a definition of a current regulated power supply, for indeed this is separately treated as a Constant Current Power Supply . . . "a Power Supply capable of maintaining a pre-set current through a variable load resistance . . ." Rather, we are attempting to explain the meaning of a term widely found in power supply literature namely—the *Current Sensing Resistor—itself*. Dr. Wouk's "modern technology" notwithstanding, the use of a resistor to detect current flow is fairly widespread and is the most common commercial practice. There is therefore, a need to define this commonly used but often misunderstood term.

Dr. Kenneth Kupferberg
Director of Engineering

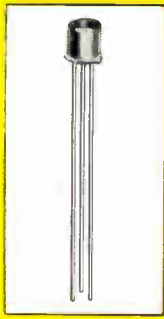
Kepeco Inc.
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"Power Supplies"

Editor, ELECTRONIC INDUSTRIES:

It is very gratifying to know that the review on power supplies published in the October 1962 issue of Electronic Industries received such attention as demonstrated by Dr. Wouk's letter.

I agree that it is very unfortunate that perfection was not achieved in the four articles that composed the review on power supplies. In regard to the article on "Understanding Power Supply Voltage Regulators," Figure 16 has the rectifying elements shorted out. The diode that is presently shown between the positive output of the rectifiers and the negative of the auxiliary supply should be between the positive output of the rectifiers and the negative output of the rectifiers with its cathode also connected to the negative of the auxiliary supply. The diode was drawn in error by the author and is not a typographical error on the part
(Continued on page 64)



- Operation to 150°C Ambient
- 300 Nanosecond Turn-on Time
- High Gate Sensitivity

NEW SILICON PLANAR CONTROLLED SWITCHES

Transitron announces a new series of low current silicon planar controlled switches in the TO-18 package with specifications and ratings exceeding anything now available. The stepped-up performance of these premium devices makes possible many new applications for controlled switches, especially where temperature and switching speeds are critical.

Now in full production, this series, 2N2679-2N2682, features 150°C ambient temperature operation with no voltage derating; 300 nanoseconds total turn-on time; extremely high gate sensitivity; plus the added feature of having all key parameters specified @ -65°C and 150°C wherever applicable.

Furthermore, the planar construction features extremely low leakage — 100 nanoamperes @ 25°C, 100 microamperes @ 150°C — thereby offering increased reliability. These new switches also offer increased current-carrying ability of 350 mA @ 55°C ambient and 75 mA @ 130°C ambient.

For further information, write for Transitron's "planar switch" bulletins.

Circle 33 on Inquiry Card

2N2682 — 200 Volt Type ¹				
Specification	Symbol	Min.	Max.	Units
Forward Breakover Voltage @ 150°C ²	V_{BO}	200	—	volts
Reverse Voltage @ 150°C	V_R	200	—	volts
Forward and Reverse Currents @ 25°C ² @ Rated Voltage @ 150°C ²	I_F, I_R	—	0.1 100	μA μA
Gate Current to Fire @ 25°C @ -65°C	I_{G1}	—	20 100	μA μA
Gate Voltage to Fire @ 25°C @ -65°C @ 150°C	V_{G1}	— — 0.2	0.7 0.9 —	volt volt volt
Holding Current @ 25°C ² @ -65°C ²	I_H	— —	0.5 2.0	mA mA
Forward Voltage @ 200mA @ 25°C	V_F	—	1.25	volts
Turn-On Time @ 25°C	$t_d + t_r$	—	300 ³	nanosecs

1 30, 60, and 100 volt types are also available as the 2N2679, 2N2680 and 2N2681 respectively.

2 With 10K ohm bias resistance between gate and cathode.

3 For maximum limit of 300 nanoseconds, add suffix /A to type designation. For example 2N2682/A.

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TARZIAN ZENERS...

Reliability at Low Cost

**250
milliwatt
Fig. A**

Tarzian Type	.25T5.6	.25T6.2	.25T6.8	.25T7.5	.25T8.2	.25T9.1	.25T10	.25T11	.25T12	.25T13	.25T15	.25T16	.25T18	.25T20	.25T22	.25T24
Breakdown Voltage (V ₀)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	25	25	25	25	25	12	12	12	12	12	12	12	12	4	4	4
Breakdown Impedance (Ohms)	3.6	4.1	4.7	5.3	6.0	7.0	8.0	9.0	10	11	13	15	17	20	24	28
Jedec Type	1N708	1N709	1N710	1N711	1N712	1N713	1N714	1N715	1N716	1N717	1N718	1N719	1N720	1N721	1N722	1N723

Tarzian Type	.25T27	.25T30	.25T33	.25T36	.25T39	.25T43	.25T47	.25T51	.25T56	.25T62	.25T68	.25T75	.25T82	.25T91	.25T100
Breakdown Voltage (V ₀)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	4	4	4	4	4	4	4	4	4	2	2	2	2	1	1
Breakdown Impedance (Ohms)	35	42	50	60	70	84	98	115	140	170	200	240	280	340	400
Jedec Type	1N724	1N725	1N726	1N727	1N728	1N729	1N730	1N731	1N732	1N733	1N734	1N735	1N736	1N737	1N738

**400
milliwatt
Fig. A**

Tarzian Type	.4T6.8	.4T7.5	.4T8.2	.4T9.1	.4T10	.4T11	.4T12	.4T13	.4T15	.4T16	.4T18	.4T20	.4T22	.4T24
Breakdown Voltage (V ₀)	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	25	25	25	12	12	12	12	12	12	12	12	4	4	4
Breakdown Impedance (Ohms)	4.7	5.3	6.0	7.0	8.0	9.0	10	11	13	15	17	20	24	28
Jedec Type	1N957	1N958	1N959	1N960	1N961	1N962	1N963	1N964	1N965	1N966	1N967	1N968	1N969	1N970

Tarzian Type	.4T27	.4T30	.4T33	.4T36	.4T39	.4T43	.4T47	.4T51	.4T56	.4T62	.4T68	.4T75	.4T82	.4T91	.4T100
Breakdown Voltage (V ₀)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	4	4	4	4	4	4	4	4	4	2	2	2	2	1	1
Breakdown Impedance (Ohms)	35	42	50	60	70	84	98	115	140	170	200	240	280	340	400
Jedec Type	1N971	1N972	1N973	1N974	1N975	1N976	1N977	1N978	1N979	1N980	1N981	1N982	1N983	1N984	1N985

**1
WATT
Fig. B**

Tarzian Type	1T5.6	1T6.2	1T6.8	1T7.5	1T8.2	1T9.1	1T10	1T11	1T12	1T13	1T15	1T16	1T18	1T20	1T22	1T24
Breakdown Voltage (V ₀)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	100	100	100	100	100	50	50	50	50	50	50	50	50	15	15	15
Breakdown Impedance (Ohms)	1.2	1.5	1.7	2.1	2.4	3.0	3.5	4.2	5.0	5.8	7.6	8.6	11	13	16	18

Tarzian Type	1T27	1T30	1T33	1T36	1T39	1T43	1T47	1T51	1T56	1T62	1T68	1T75	1T82	1T91	1T100
Breakdown Voltage (V ₀)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	15	15	15	15	15	15	15	15	15	5	5	5	5	5	5
Breakdown Impedance (Ohms)	23	28	33	39	45	54	64	74	88	105	125	150	175	220	260

Fig. C

Tarzian Type	VR-6	VR-7	VR-8.5	VR-10	VR-12	VR-14	VR-18	VR-20	VR-24	VR-28	VR-33	VR-39	VR-47	VR-56	VR-67	VR-80	VR-90	VR-105
Breakdown Voltage (V ₀)	6	7	8.5	10	12	14	18	20	24	28	33	39	47	56	67	80	90	105
Test Current (Ma)	25	25	25	25	12	12	12	12	4	4	4	4	4	4	2	2	1	1
Breakdown Impedance (Ohms)	4.1	5.0	6.0	8.0	10	12	17	20	28	35	50	70	98	140	200	280	340	400

**10
WATT
Fig. D**

Tarzian Type	10T5.6	10T6.2	10T6.8	10T7.5	10T8.2	10T9.1	10T10	10T11	10T12	10T13	10T15	10T16	10T18	10T20	10T22	10T24
Breakdown Voltage (V ₀)	5.6	6.2	6.8	7.5	8.2	9.1	10	11	12	13	15	16	18	20	22	24
Test Current (Ma)	1000	1000	1000	1000	1000	500	500	500	500	500	500	500	150	150	150	150
Breakdown Impedance (Ohms)	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
Jedec Type	1N1603	1N1604	1N1605	1N1606	1N1607	1N1608	1N1651	1N1652	1N1653	1N1654	1N1655	1N1656	1N1657	1N1658	1N1659	1N1660

Tarzian Type	10T27	10T30	10T33	10T36	10T39	10T43	10T47	10T51	10T56	10T62	10T68	10T75	10T82	10T91	10T100
Breakdown Voltage (V ₀)	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
Test Current (Ma)	150	150	150	150	150	150	150	150	150	50	50	50	50	50	50
Breakdown Impedance (Ohms)	3	4	4	5	5	6	7	8	9	12	14	20	22	35	40
Jedec Type	1N1361	1N1362	1N1363	1N1364	1N1365	1N1366	1N1367	1N1368	1N1369	1N1370	1N1371	1N1372	1N1373	1N1374	1N1375

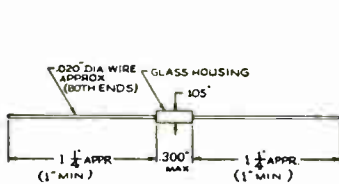


FIGURE A

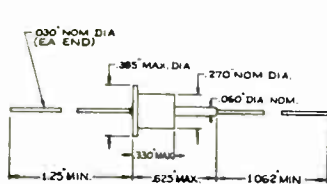


FIGURE B

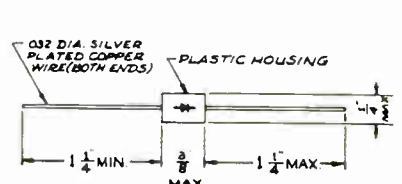


FIGURE C

Need a Zener? Then chances are one of the above will meet your needs. If not, send an outline of your requirements. Engineering assistance and samples are available. A card will bring you Bulletin 61 VR 11.

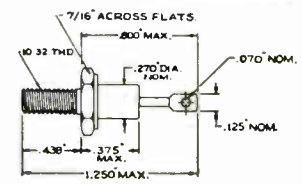


FIGURE D



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Test reports available upon request . . .



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ELECTRONIC INDUSTRIES • February 1963

Circle 35 on Inquiry Card

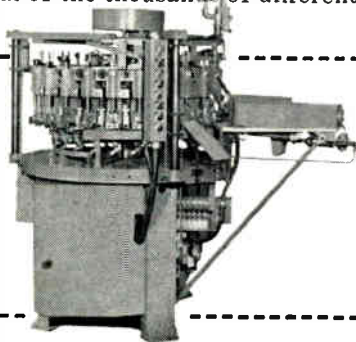
63

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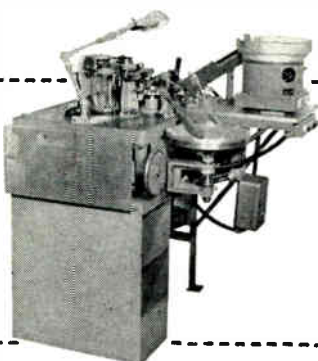
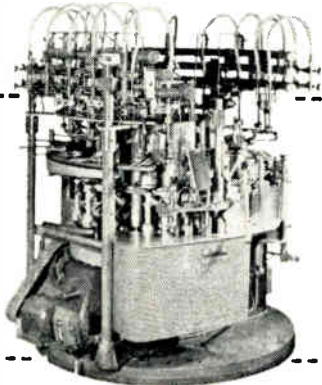
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LETTERS

to the Editor

(Continued from page 60)

of the editors of Electronic Industries.

However, it is also very unfortunate that the true purpose of the article was not conveyed in the article to Dr. Wouk. In the opening paragraphs it is pointed out that the purpose of the article is to reduce the many variety of power supplies to some basic regulating elements. Six basic regulating elements are given. The regulating elements used in the switching regulator are included in this list of six. The fact that the element is in a switching mode vs. a proportional mode does not make it a new regulating element. Utilizing the regulator in a switching mode does permit increased efficiency, smaller size and weight as pointed out by Dr. Wouk, however, other techniques have been used in other power supply designs to gain improvement in performance in critical areas of the design. This, I believe, is quite well summarized in the conclusion of the article where the author pointed out that the six basic regulators can be combined into an infinite number of possible combinations. This is limited only by the ingenuity of the designer and the importance of the second-order effects which provide improved performance in reliability, size, weight, etc.

To include all possible combinations would require a book on the subject rather than a short article. Although switching regulators, as manufactured by Dr. Wouk's company, were not mentioned directly, they were not omitted due to an "incomplete knowledge of a broad field, due to narrow commercial experience."

H. B. Weitzel

Section Head

Electronic Systems Eng.

Sola Electric Co.

Div. of Basic Products Corp.

1717 Busse Rd.

Elk Grove Village, Ill.

"Power Supplies"

Editor, ELECTRONIC INDUSTRIES:

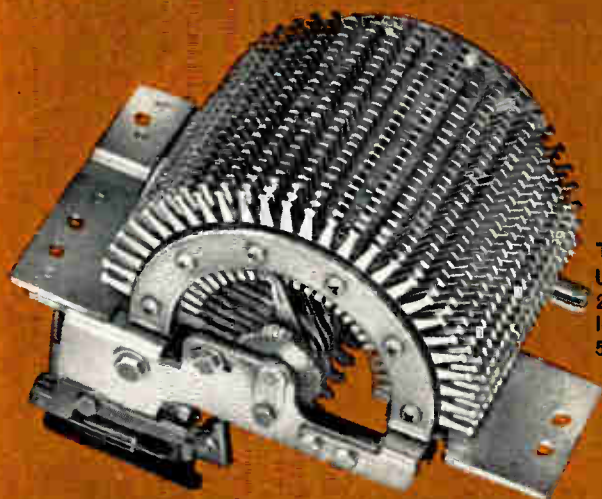
Please send a copy of your "ELECTRONIC INDUSTRIES" October, 1962 articles:

"Specifying D.C. Electronic Power Supplies" on page 128.

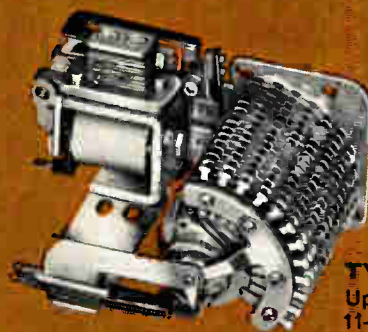
(Continued on page 70)

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- Allow more simplified circuitry
- Avoid synchronization problems



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levels or twelve
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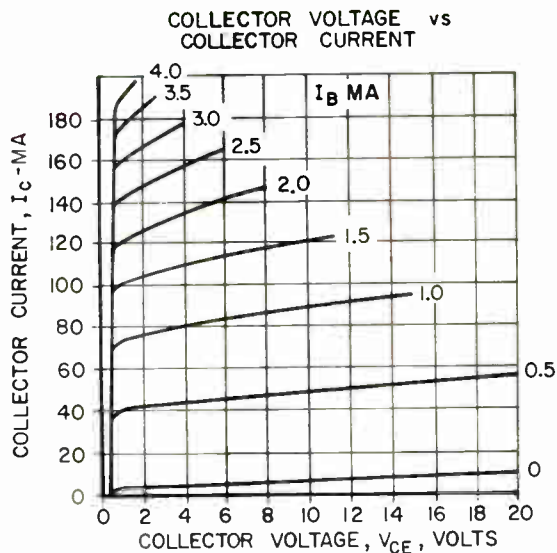
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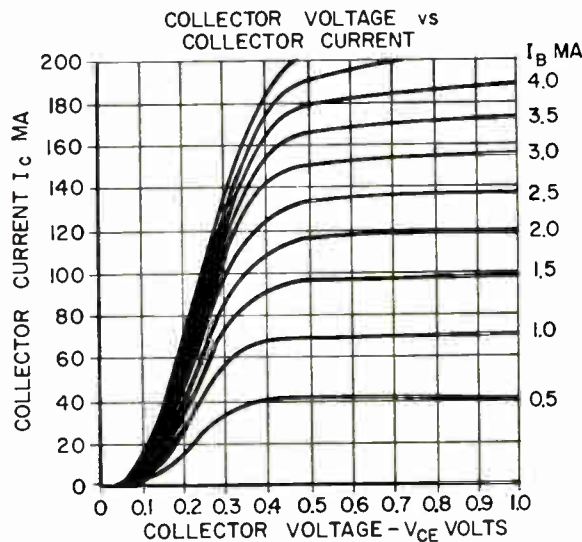
tests, including temperature cycling, moisture resistance, shock, vibration fatigue, life, etc. The TO-46 has .05" lead-to-lead spacing for automatic and direct insertion in printed circuit boards, and is mechanically indexed for positive (and permanent) lead identification.

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large-signal amplifiers



Type No.	Outline	Collector to Base Voltage V_{CB} volts	Collector Current I_C mA	Power Dissipation (free air) P_T mW	Collector Cutoff Current @ V_{CB} μA	Current Gain @ I_C hFE	Saturation Voltage @ I_C V_{CE}^{sat}	Gain Bandwidth Product GBW mc	Switching Times Turn On Time t_{on} , nsec	Storage Time t_{stg} nsec
2N1958	TO-5	60	500	600	30V 0.5	150mA	20-60	150mA 0.45	100	65 25
2N1959	TO-5	60	500	600	30V 0.5	150mA	40-120	150mA 0.45	100	65 25
2N1964	TO-46	60	500	400	30V 0.5	150mA	20-60	150mA 0.45	100	65 25
2N1965	TO-46	60	500	400	30V 0.5	150mA	40-120	150mA 0.45	100	65 25
2N2618	TO-5	60	750	600	25V 0.1	1.0mA 25mA	30-150 75-225	— —	200	— —
2N2618/46	TO-46	60	750	300	25V 0.1	1.0mA 25mA	30-150 75-225	— —	200	— —



SYLVANIA

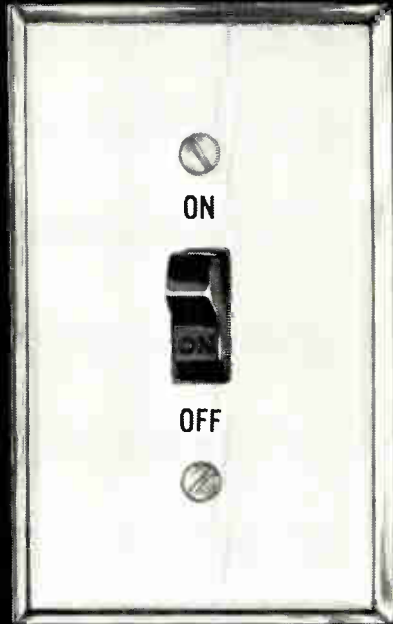
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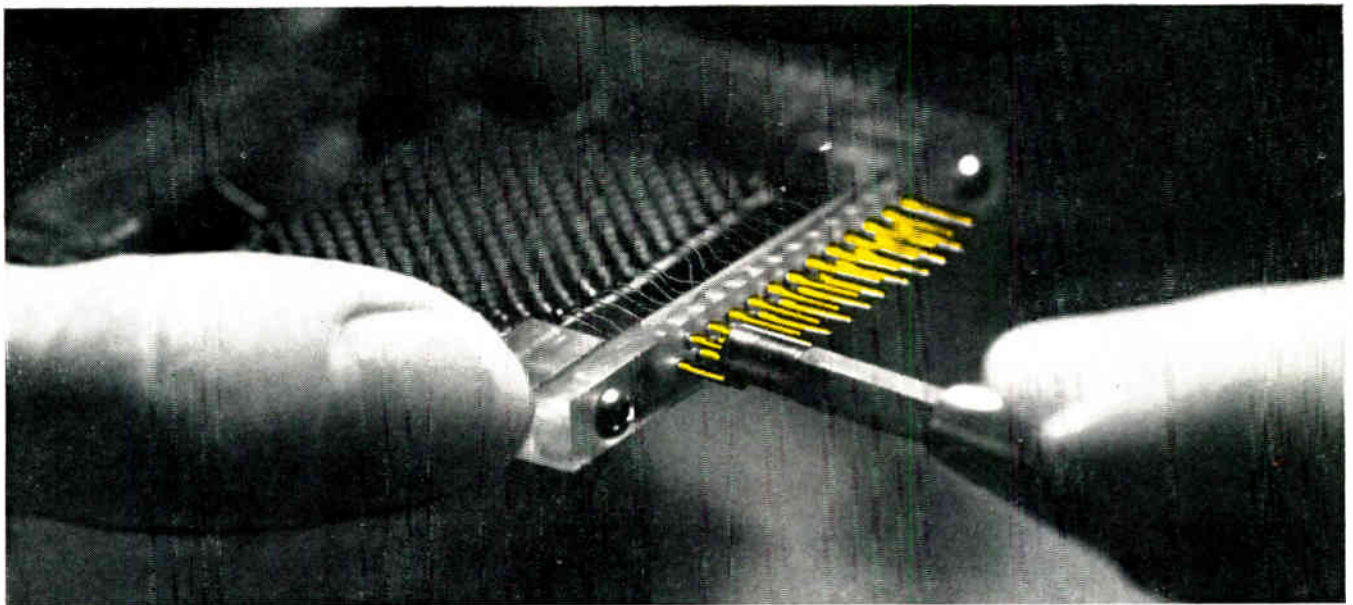


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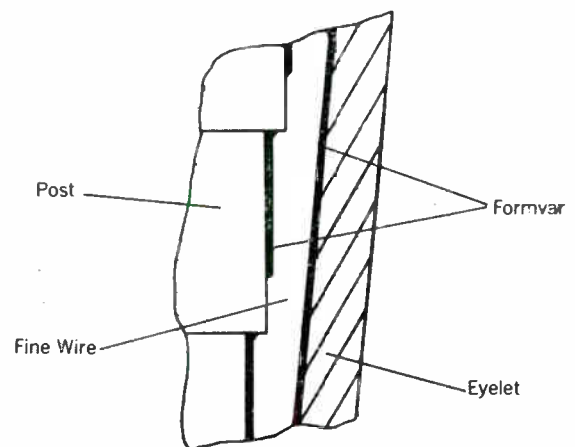
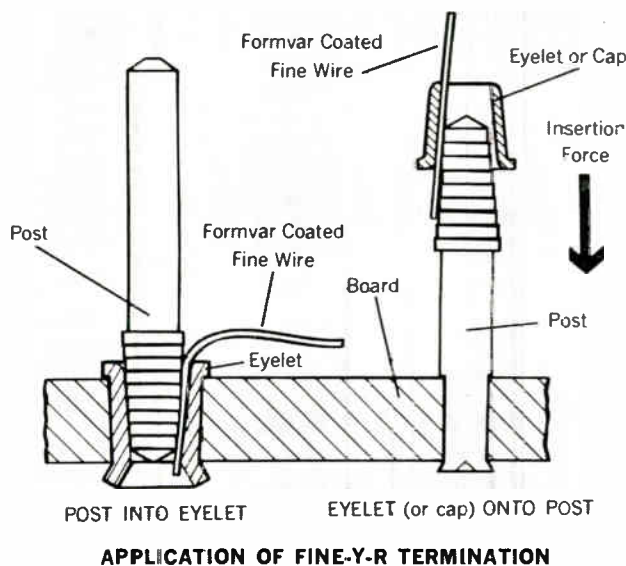
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The AMP FINE-Y-R* Termination's wedge fit does away with time consuming and costly insulation stripping. Makes possible the handling of fine wire, in wire range size #26 through #56 AWG, without burnt insulation, cold solder joints, embrittled conductors and oxide contaminations! You get a reliable, virtually gas-tight connection whose parts can be used again and again... removed and reused up to 5 times, if necessary!

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If you're using fine wire in any type application, you can now make quicker connections and at a fraction of your present cost with AMP FINE-Y-R Terminations.

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SPECIFY

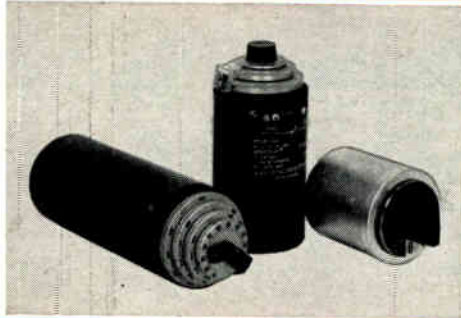


DECADE RESISTORS

... industry - proven leaders in precision adjustable resistance standards for more than 10 years

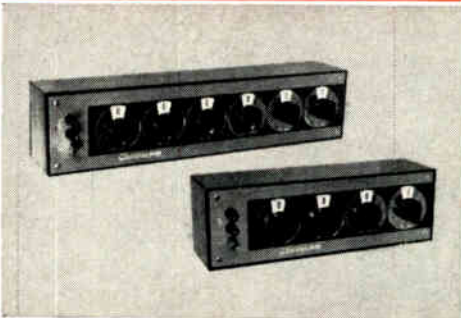
DS MODEL DEKASTATS®

Precision decade resistors for panel mounting. Exclusive ESI Dekadial® concentric dial assembly provides fast, convenient straight line readings. Accuracy: $\pm 0.03\%$. Independently operated dials provide coarse initial steps for quickly approximating the required value and progressively finer steps for exact settings. Single decade units, total resistance values from 0.1 ohm to 10 megohms. Three and four decade units, total resistance values from 1,200 ohms to 120,000 ohms. Immediate delivery. Prices—\$20.00 to \$125.00.*



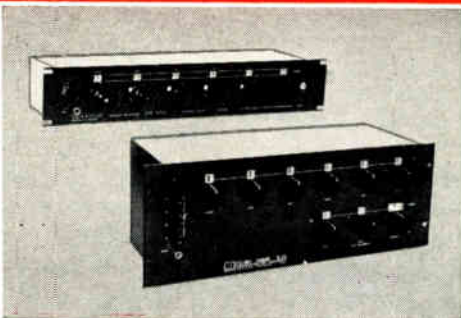
DB MODEL DEKABOXES®

Precision bench mount units providing simplified in-line readout for convenient laboratory use. Accuracy: $\pm 0.03\%$. Four to six decades of resolution. Total resistance values from 1,111 ohms for the lowest value four-dial box to 11,111,100 ohms for the highest value six-dial box. Immediate delivery. Prices—\$100.00 to \$195.00.



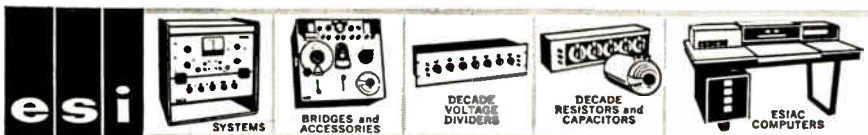
RS MODEL DEKASTATS®

Rack-mounted decade units adjusted to exceptionally close tolerances for use as laboratory resistance units. Accuracy: $\pm .005\%$. Two and four-terminal units. Four-terminal connection permits 0.0001 ohm resolution. Total resistance values to 1.2 megohms. Six to ten decades of resolution. 30-day delivery. Prices—\$600.00 to \$1,200.00.*



*All prices f.a.b. Portland, Oregon.

Applications: bridge slidewires; experimental filter design; secondary resistance standards; special measuring circuits design; critical instrument controls. Send for Catalog Sheet C-18—current ESI engineering bulletins.



Electro Scientific Industries
7524 S.W. Macadam Avenue • Portland 19, Oregon • Area Code 503, 246-3331

LETTERS

to the Editor

(Continued from page 64)

"Understanding Power Supply Voltage Regulators"

"#64 Power Supply Regulator Notes"

"Using Constant Current Power Supplies"

These articles are well done.

Lloyd P. Morris

National Systems Consultant

Motorola Inc.

4545 W. Augusta Blvd.

Chicago 51, Ill.

"Congratulations"

Editor, ELECTRONIC INDUSTRIES:

On page 214 of the September issue you offer a corrected reprint of the NBS Electron Tube Interchangeability List. A copy would be greatly appreciated.

Congratulations on the "new look." ELECTRONIC INDUSTRIES has further reinforced its position as my favorite among the many trade magazines that cross my desk.

H. R. Terhune

Manager of Standards

ITT Federal Laboratories

500 Washington Avenue

Nutley 10, New Jersey

"Improving AGC Amplifier Control"

Editor, ELECTRONIC INDUSTRIES:

May I express my thanks to Electronic Industries for printing Mr. Bradford's article, "Improving A.G.C. Amplifier Control," in the December 1962 issue? Two days after receiving the magazine, I had the unit in operation with gratifying results.

Despite my interest in laser developments and esoteric computer circuitry, I must earn my living as nursemaid to an AM broadcast transmitter. The trade journals have written our group off as antediluvian anachronisms; hence my whoops of delight at being allowed to join the party. I hope it may indicate a continuing practice on the part of Electronic Industries.

Dean H. Elliott

Radio Station KINS

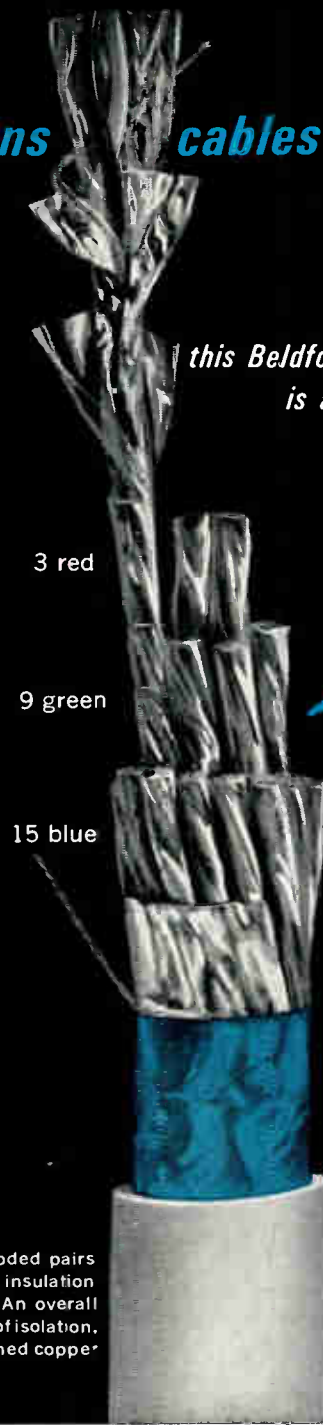
Eureka Broadcasting Co.

P. O. Box 1015

Eureka, Calif.

Complex? No!

BELDEN designs cables smaller...less complicated



this Beldfoil instrumentation cable is a typical example*

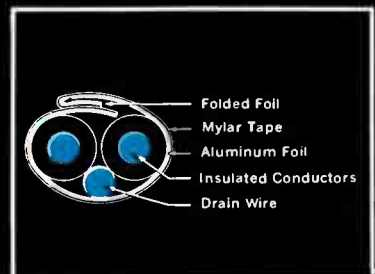
3 red

9 green

15 blue

- 27 Insulated, Isolated, Color Coded, and Beldfoil Shielded Pairs
- Drain Wire
- Double Beldfoil Shield Overall
- Polyvinyl-Chloride Jacket

Individually insulated and color coded pairs are protected by a Mylar** tape insulation under a wrapped Beldfoil shield. An overall Mylar tape adds the final measure of isolation. Each pair has its own stranded tinned copper drain wire for shield grounding.



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.

*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.

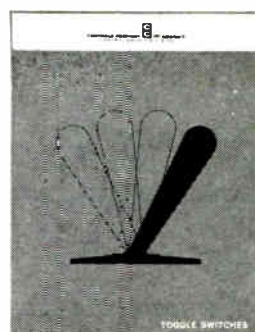


*Belcen Trademark Reg. U.S. Pat. Off. **du Pont Trademark

8-6-2



TOGGLE SWITCHES—in every possible circuit, style, and size . . . especially miniatures. You name it and we'll deliver it (probably right off our factory or distributor shelves). We honestly believe we can satisfy virtually any requirement you may have for toggle switch operating characteristics, front-of-panel appearance, or back-of-panel density. We can't possibly describe our full line here. In fact, it takes a full 24-page catalog with photos, specs, and dimension drawings just to show you our most popular items. If you use toggle switches, you should write today for a free copy of our new *Toggle Catalog #180*.

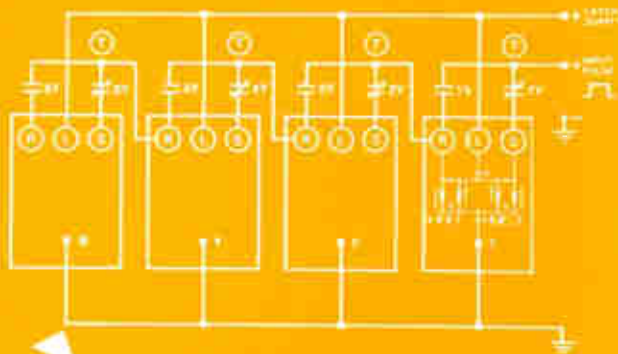
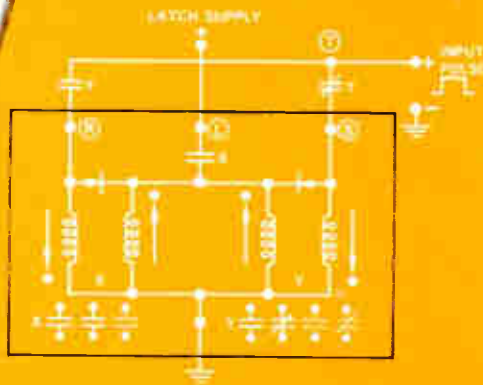


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CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

Clareed
Counting Module

Clareed
Selection Module

Clareed
Logic Module



Which one does this?

If you work with control systems which involve counting, selection, or logic functions, take a look at Clareed Control Modules.

You'll see a system approach providing simpler and often more economical solutions than those offered by solid-state or other techniques. You'll find plenty of speed for most applications, and reliability of a very high order.

Clareed Control Modules use magnetic flux to make decisions. Combinations of flux levels and flux polarities, generated by multiple-wound coils, operate glass-encapsulated Clareed switches. Among the advantages of Clareed Control Modules are:

- Multiple-input and multiple-output capabilities, making possible logic at both input and output.
- Complete isolation between input and output. The output is the contact closure. This contact can handle low-level analog signals, other digital signals, and AC or DC power up to 15 va.

For example, consider the Binary Counter shown in the diagram. This counter uses a single-input (τ) flip-flop in each of its four stages. The flip-flop may be constructed with twelve isolated terminals. Terminals not used for Counter Control are available for isolated multiple output, with normally-open or normally-closed contacts. Each contact is capable of handling 15 va. This flip-flop circuit is provided by one standard Clareed Counting Module. (Which Clareed Control Module is used? If you said, "Counting," you're right.)

Standard Clareed Control Modules offer useful, uncomplicated ways of performing these functions:

- In counting: Three basic flip-flops which provide binary, binary coded-decimal, decimal, radix^(N), ring counters, bi-directional counters and shift register applications.
- In selection: A variety of selection systems, using a single-mode matrix, a single-mode memory matrix, or a two-mode matrix (Mode 1: All cross-

points normally open; Mode 2: All crosspoints normally closed).

- In logic: AND, INCLUSIVE OR, EXCLUSIVE OR, NAND, NOR, EXCLUSIVE NOR, as well as more complex logic in a single module.

Systems using Clareed Control Modules can be easily serviced with a simple multimeter.

For detailed problem analysis and engineering recommendations, write Group F-1, Application Engineering, C. P. Clare & Co., 3101 Pratt Boulevard, Chicago 45, Illinois. For useful manuals, see offers below.

Take your choice!

Concise: For a terse, time-saving explanation of Clareed Control Modules in counting, selection, and logic, get 8-page Manual 400 by circling number 150 on Reader Service Card.



Complete: For detailed information on Clareed Control Modules in counting, selection, and logic, get Manual 400 plus Application Manuals and Data Sheets on all Clareed Control Modules. Circle number 151 on Reader Service Card.

TELSTAR REVIVED

Our first "switchboard-in-the-sky" performed excellently from July to November of last year. Then it went dead. A specially modified command code revived the satellite.

TELSTAR'S FAILURE WAS A SUCCESS. The failure gave engineers and scientists operating data they did not have, and needed. Telstar stopped transmitting in November of last year. Its communications equipment could not be turned on. Now the creators of the world's first ComSat went to work to beat the failure—to make Telstar work, though it was now silent.

Testing showed it was no mechanical failure. What Bell Telephone Laboratories scientists and engineers sketchily suspected had actually happened. Short duration ionization and long term radiation damage had stopped Telstar. The environmental labs became the prober's home. After exhaustive studies and experiments, they localized the failure to transistors in the 2 command decoders. One key transistor out of 1,064, and some 1,464 diodes, had failed.

The probers found that intense radiation collected on the surfaces of the transistor cases. This high-energy radiation penetrated the cases, ionizing gases and other material. This particular transistor type

was a tight tolerance unit. Its gain was very high; its leakage very low. Now conditions were opposite. The gain was low and the leakage high.

Tests by Bell Labs and Brookhaven National Labs in October, 1961 had shown some effects of surface radiation. Component screening tests were accordingly set up. They proved to be insufficient. Recent tests with Explorer 15, launched last October, showed Telstar had received a dose of radiation 100 times greater than expected.

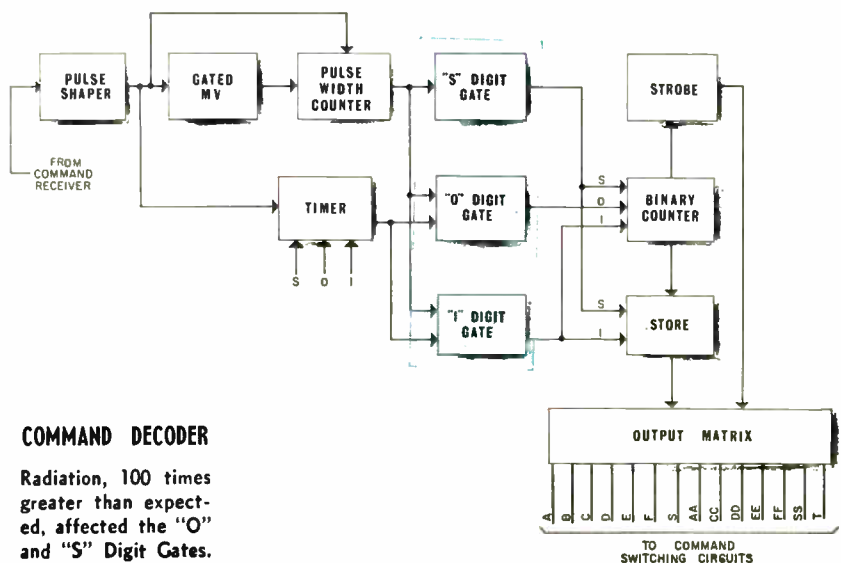
A number of ideas to restart Telstar were explored. One was to find a way to reduce the bias on the decoder transistors. In the lab this was simple. They just disconnected the nickel cadmium batteries. They also altered the circuitry. But how to do this in space, on a satellite orbiting between 593 and 3,503 miles out?

One solution was tried, through NASA's Mini-track station at Johannesburg, South Africa. It failed. But Bell Labs had another solution—

TELSTAR II

When Telstar I went dead, much attention was focused on Telstar II. Bell Labs. originally built 4 "fly" models (one backup for each of 2 planned for orbit). AT&T announced Dec. 31, 1962, it would take up its option for another NASA launch. On Jan. 2, 3, and 4 Telstar began operating again. AT&T's December statement is now held to be tentative.

If the signal is given for a go-ahead with Tel-Star II, plans call for: keeping it out of the Van Allen Belt by going higher (maybe to 6,000 miles); more shielding around the transistors in the command control unit; and subjecting the transistors to an even more intense testing and selection program than for Telstar I.



COMMAND DECODER

Radiation, 100 times greater than expected, affected the "O" and "S" Digit Gates.

Lab simulated tests produced the "notched" command code.

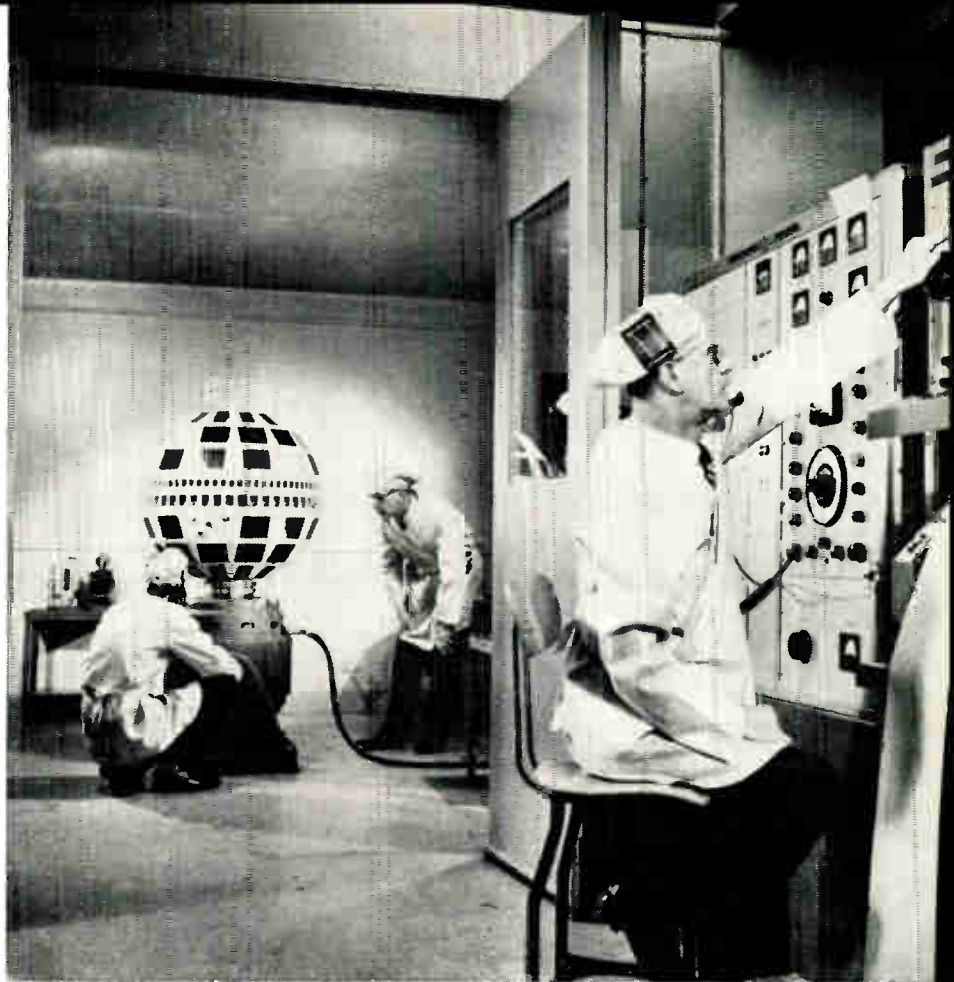
They devised a modified series of command signals. This would by-pass the faulty transistor—starting the decoder. At first it was thought that the radiation-deadened transistor was in the "O" Digit Gate (see drawing). Radiating a decoder, similar to the one which had run through the Van Allen Belt, pointed to this circuit as one of the most sensitive. The "O" gate recognizes the "zeroes" in the "1" and "0" satellite command code.

In the satellite's code a "1" is a long pulse. A "0" is a short pulse. The problem was: how to send a "1" that would register in the equipment following the gates as an "0." The answer was to send a long pulse with a dip (or notch) in the middle. Tried in the lab this proved successful.

Two racks of equipment were built to send "notched" commands. They could only send 2 of the 15 commands Telstar uses. This was enough for a trial test. On the first try (pass 1,492) it worked. The required switch was turned. The satellite affirmed this by return telemetry signals.

The engineers planned to program all 15 modified commands on tape. Cautiously they would send commands, finally having Telstar disconnect its storage batteries. When the satellite had the earth between it and the sun, power would be off. The bias would be removed from the transistor. Actually Telstar misinterpreted the commands and disconnected its batteries ahead of time. This wasn't of great importance. When the full set of modified commands was used, they worked perfectly. The engineers now had full control again. But the "0" gate wasn't the only defective part. Further testing showed the "S" or Start Digit Gate to be the real culprit.

With this information and further lab tests a final



solution was found. This was to disconnect the batteries every time Telstar's orbit included an Earth eclipse. With the bias off, the affected transistors are allowed to return to their normal high gain and low leakage characteristics. Telstar was revived.

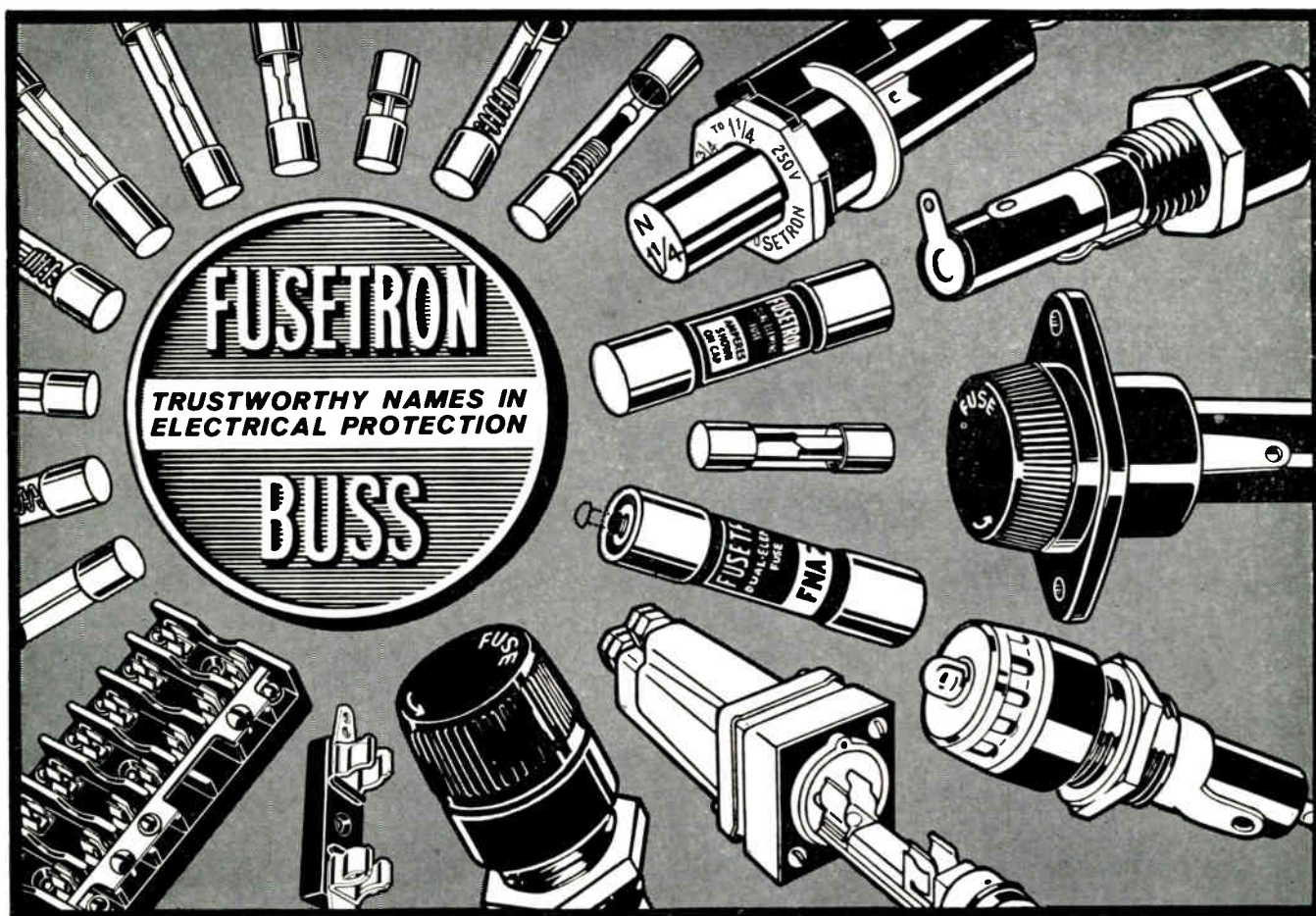
The "notched" command equipment is now a permanent installation. When this trouble comes up in the future, as Bell engineers expect it will, a switch is thrown. The modified command equipment takes over and Telstar will be able, this way, to keep transmitting for a long time to come.

TELSTAR ECONOMICS

The morning Telstar rocketed into space, total cost to American Telephone & Telegraph Co. was approximately \$50 million. This breaks down to about 22¢ per share for AT&T's 2 million stockholders (236,000,000 shares outstanding).

The breakdown runs something like this: for 15 years of research and development—about \$36 million; Andover, Me. ground station—\$10 million; NASA launching — \$3 million; and Telstar itself about \$1 million.

AT&T is looking backwards, as well as forwards. It has found several ways, after extensive evaluation, of improving operations and cutting costs. A major one: a single 2-way voice channel, via Telstar, is possible with simpler, relatively inexpensive ground equipment—compared to the cost of Andover.



Save Time and Trouble by standardizing on BUSS Fuses—You'll find the right fuse every time...in the Complete BUSS Line!

By using BUSS as your source for fuses, you can quickly find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting", and signal or visual indicating types . . . in sizes from 1/500 amp. up—plus a companion line of fuse clips, blocks and holders.

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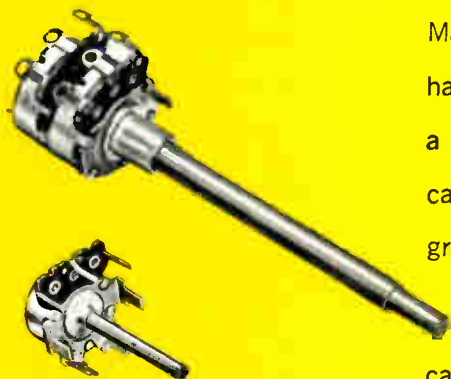
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If you're not getting all these advantages now... switch to Stackpole **STABILITE**TM Controls



Many variable resistors have some of these features, but no other has all these features. Reason: Stackpole STABILITE Controls use a unique new resistance element—the first inherently stable carbon composition element ever developed for commercial grade controls.

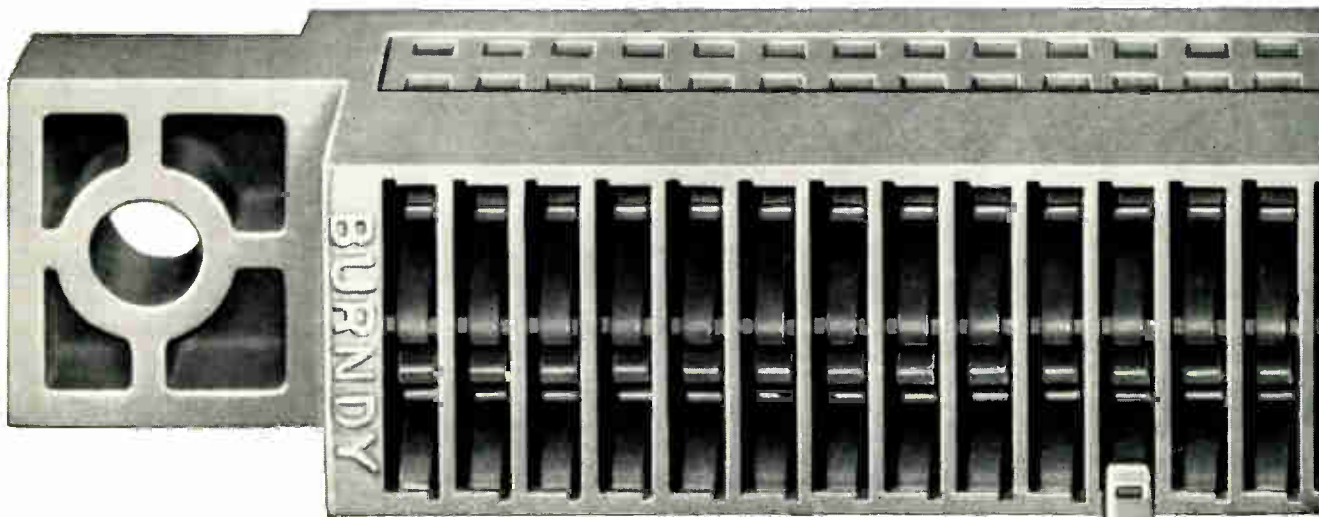
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CARBON COMPANY, *Electro-Mechanical Products Division*
Johnsonburg, Pennsylvania

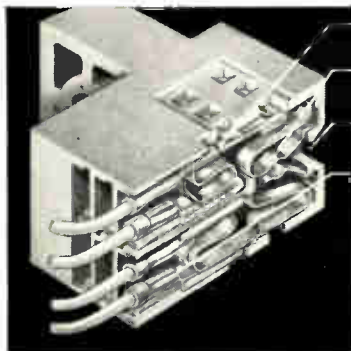
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→ .100" ←

Burndy's new .100" spaced HYFEN® EDGE-ON® series features crimp-type, removable terminations (automatically installed). Tooled for quick delivery of the most popularly specified sizes . . . 15, 22, 30 and 43 positions.



Wire Terminal Lock—holds contact securely in place. Simple extraction tool, inserted from rear, releases terminal.

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Connector body is ruggedly constructed of high impact thermoplastic. Board contact springs are pre-loaded to avoid damage during handling. Contact OMATON division for additional information on new .100" spaced HYFEN EDGE-ON printed circuit connector series.

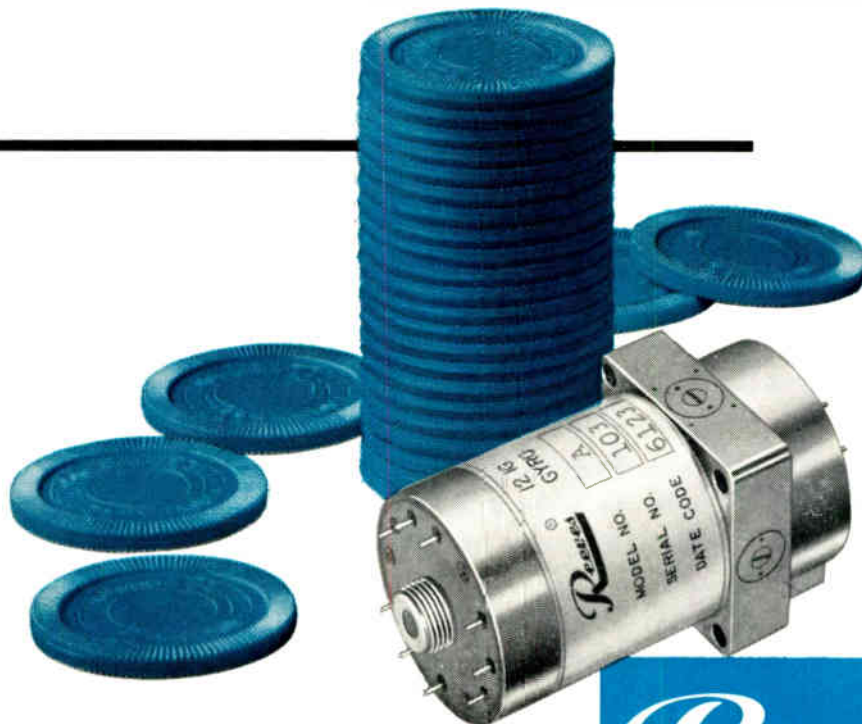


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OF THE MINIATURE GYRO FIELD... AND
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IMPORTANT **NEW** FEATURES

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- 12IG gyro models measure approximately 1.25 inches by 2.5 inches — weigh less than seven ounces. Trimmed drift rate is held below 0.1°/hr.

For specifications on the complete range of 12IG gyro models, write for Data File 301.

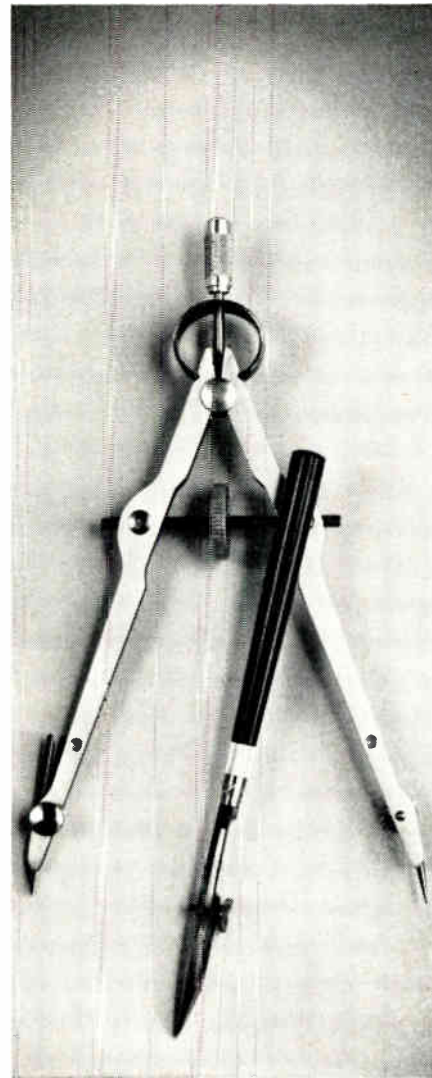
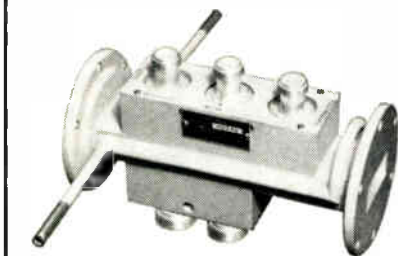
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In this way you get exactly the microwave device you need in no time at all—and at prices that make sense. Typical of our service is the unit shown: a water cooled, pressurized C-band waveguide coupler, compact in design with three incident and two reflected power probes in an overall length of less than seven inches! What more could you ask for?

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Regional offices—Northeast Area (Connecticut Plant), Farmington Industrial Park, Farmington, Conn., Area 203-677-9771; **Middle Atlantic Area** (Headquarters), 1445 Research Blvd, Rockville, Md., Area 301-762-1234; **West Coast Area** (Regional Office), 117 E. Providencia Ave., Burbank, Calif., Area 213-849-3961.

Microwave Devices, Inc.

(Successor to M. C. Jones Electronics Co., Inc.)



BOOKS

Introduction to Automatic Control Systems

By Robert N. Clark. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 467 pages. Price \$10.50.

Book contains enough material to accommodate beginners having a minimum background in calculus and physics. Material is arranged so that only one new concept is presented at a time. Pole-zero methods are developed first, followed by stability analysis on the s-plane, before the real frequency response methods are presented.

Systems engineering viewpoint is developed gradually throughout the book by the utilization of progressively more complex examples of electrical, mechanical, and hydraulic systems.

Electric Circuit Analogies for Elastic Structures

By Richard H. MacNeal. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 262 pages. Price \$11.50.

Book indicates and exploits the similarities between concepts in electric circuit theory and concepts in elastic structure theory.

The book serves the following uses: as an introductory text for those wishing knowledge of the analogies between mechanics and electricity; as a compilation of methods and techniques for users of direct analog computing; and as an exposition of the scope of direct analog computer methods in the solution of structural problems.

Digital Processes for Sampled Data Systems

By Alfred J. Monroe. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 490 pages. Price \$12.50.

Concerned with the use of a digital computer as a data processing device, this book presents analytical methods for constructing digital programs and digital to analog converter weighing functions; illustrates how the resulting analytical expressions for these programs are carried over into "computer language" and how the outputs of the programs are converted to analog converters. It features a composite design criterion that wedes transient behavior design and noise-conscious design.

Servicing Transistorized Two-Way Radio

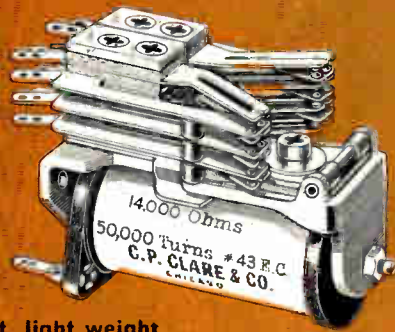
By Patrick M. Craney. Published 1962 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. 128 pages, paperbound. Price \$2.95.

Aerospace Facts and Figures 1962

Edited by Ben S. Lee. Published 1962 by American Aviation Publications, Inc., Publishers, 1001 Vermont Ave., N.W., Washington 5, D.C. 168 pages, paperbound. Price \$3.00.

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For applications which require a conventional telephone-type relay, the CLARE Type J offers a versatility of performance and flexibility of installation that meet the requirements of the widest variety of industrial designs.

Contact failure is precluded by the use of independent twin contacts. Stable operation and adjustment are maintained by the largest possible armature bearing surface. Fine adjustment is also aided by an extremely rigid heel-piece. Tests (discontinued after 70,000,000 operations) showed no contact failure whatsoever.

For more complete information write or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. Cable Address: CLARELAY. In Canada: C. P. Clare Canada, Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: C. P. Clare, Ltd., 70 Dudden Hill Lane, London NW 10, England.

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Operate: 5 to 60 ms
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Heavy-duty contacts riveted to springs. $\frac{3}{16}$ " diameter (silver). Rated current-carrying capacity: 7 amperes, 28 vdc. or 110 vac.

Type J Video relays for switching video and other high-frequency currents.

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C. P. CLARE & CO.

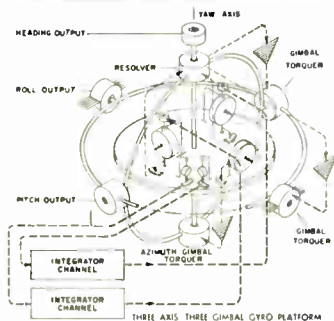
Relays and related control components

kearfott technical information report

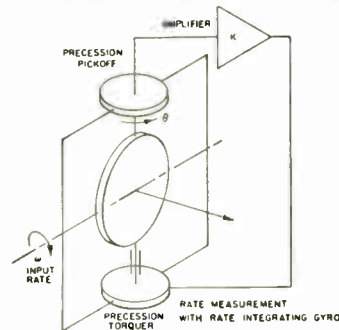
GYROS



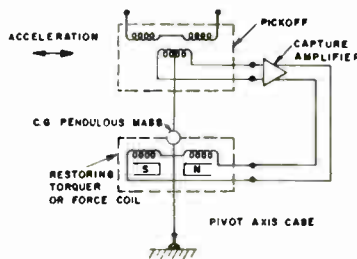
This 72-page reference book describes the theory, application and testing of gyros, platforms and accelerometers. It also discusses, with some reservation to protect our proprietary interest, several sophisticated concepts now being developed at Kearfott. It includes, for your convenience and ours, a tabulation of the equipment we produce in these various product areas. A copy of this book is available to you free of charge. Just drop us a note, requesting your copy.



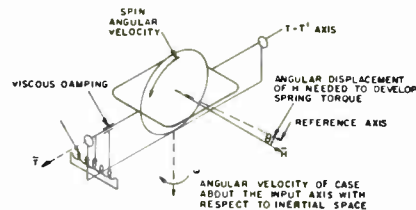
Stable Platforms. Essentially a cluster of gyros mounted within gimbals and utilizing acceleration sensing components, stable platforms perform the important function of having the gyro out-puts control the gimbals by means of a servo loop. By manipulating various arrangements of gimbals and gyros, a variety of platform types can be produced. They are used as reference elements and to stabilize accelerometers, star trackers, and similar devices in space.



Floated Rate Integrating Gyros. Floated Rate Integrating Gyros are used where exceptionally high-level performance is required. Should the rotor mass of a gyro wheel having an angular momentum of 1.0×10^6 gm. cm.²/sec. shift by as little as one micro-inch, a drift of 0.1° /hr. could result. The difficulty in achieving ultra-high precision and accuracy is apparent, and the necessity for obtaining low drift gyros is of paramount importance.



Inertial Accelerometers. A typical force balance pendulous accelerometer utilizing a differential transformer pickoff, a high gain capture amplifier, and a DC permanent magnet force coil is illustrated. This type of accelerometer, together with its amplifier, is a high-gain null-seeking servo in which the current flowing through the force balance coil, measured as voltage across a resistor in series with the coil, is directly proportional to the acceleration applied.



Rate Gyros. A rate gyroscope is constrained to one degree of freedom, and its displacement about the output axis is proportional to the angular rate input to the input axis. The rate gyro utilizes the precession phenomenon in which an angular velocity input produces an output torque. A rate gyro is so called because it is used to measure angular rates of motion about a selected axis. It also provides a means for introducing artificial damping into a vehicle's control system. The exact amount of damping is a function of the vehicle's aerodynamic characteristics.



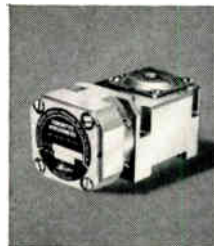
MINS — Inertial Platform.

This miniature four gimbal inertial platform is the heart of our newest Miniature Inertial System (MINS) now undergoing extensive flight testing. Weighing only 14.5 pounds the MINS platform contains three KING II floated gyros and two single axis force balance accelerometers. Through major improvements in platform configuration and floated gyro design, this platform features a rapid warm-up capability — fully operational in five minutes from -65°F . Modular design of gimbal components and azimuth gimbal cluster permit ready modification at minimum cost for a wide range of aircraft, missile or space vehicle applications.



KING II — Floated Rate Integrating Gyro.

Major improvements in the proven KING gyro have made possible this second generation instrument featuring high fixed torque stability, pick-off scale factor of $1.4\text{V}/^{\circ}$ and mass unbalance shift $0.05^{\circ}/\text{hr}$ (1 sigma) maximum spread. This outstanding mass stability eliminates the need for daily trimming. Short term drift in azimuth and vertical is $0.03^{\circ}/\text{hr}$ based on standard deviation in a one hour run. Suitable for storage in a wide temperature range, this KING II gyro is ideally suited for the most severe application. Other KING gyros are also available featuring high torquing rates, high gain and resistance to shock and vibration. Three KING gyros provided the mid-course steering signals for the recently successful Mariner Venus fly-by.



Inertial Single Axis Accelerometer.

This single axis, fluid damped accelerometer is a DC torquer-restrained device possessing a useful dynamic measuring range of greater than twenty g's. The sensitive element consists of a symmetrically - located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis. The high degree of symmetry of both force coils and pick-off coils minimize the resultant errors which might otherwise occur during vibratory inputs. Transistorized amplifiers, such as the Kearfott type S3503-03A, are available.

Typical characteristics include: Range of measurement . . . 20 g when using S-3503 amplifier (100 g possible) . . . Bias and Zero Stability . . . 0.00002 g day to day . . . $2 \times 10^{-7}\text{ g}$. . . Natural Frequency . . . 300 cps.



Subminiature Fluid-Filled Rate Gyro.

This fluid-filled rate gyro combines high performance and reliability with subminiature size and minimum weight. Minimum null uncertainty, low hysteresis, low acceleration sensitivity, and constant damping without use of heaters are achieved without the production difficulty and increased cost usually associated with this type of unit. Inner sleeve design, consisting of a pickoff, float, and damper as the main subassembly, reduces the number of basic components.

This rate gyro can be used in a great many applications, including infrared trackers, torpedo autopilots, ballistic missiles, attitude control systems, radar stabilization, telemetering instruments, and rate measuring devices.

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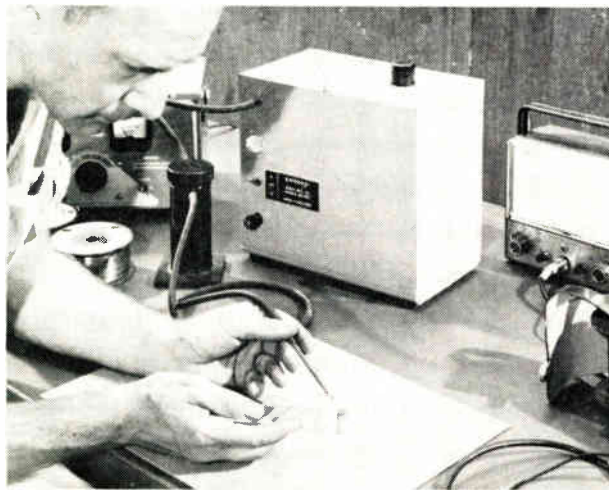
WHAT'S NEW

WELDING WITH WATER

A NEW DEVELOPMENT in high temperature flame production known as the "Water Welder" Gas Generator, electrically generates its own gas and delivers temperatures up to 6000°F. Its tiny flame varies from about 1½ in. long to only about 1/64 in. long. Flame is controlled by varying the line voltage and the size of the hypodermic needle torch tip. Its very hot flame has even made possible the melting of tungsten wire at 6150°F.

Essentially, the welder is an energy conversion instrument, in that it converts electrical energy into

The water welder, with booster attached, is being used to soft solder a glass sealed header assembly into a can.



the form of an extremely high temperature gas flame, i.e., watts into BTU's. Distilled water serves as the ideal medium of energy exchange because of its ability to be electrolytically dissociated into its elemental gases, hydrogen and oxygen. These gases reassociate in a highly exothermic reaction, wherein a useful torch flame is created.

Fundamentally, the instrument comprises an ac to dc converter driving a high efficiency electrolytic reactor. Distilled water and electricity are the only elements needed. The water welder gas generator produces oxygen and hydrogen. It then mixes these gases in stoichiometric proportion and immediately conducts them through a single hose to the hypodermic needle torch, where they are burned just beyond the end of the torch tip.

The water welder apparatus also includes an accessory called the Booster. This Booster is used to reduce flame characteristics when desired and a lower temperature is preferred. It permits a slower combustion rate than the regular flame without the Booster. The welder eliminates gauges, regulators, valves, tanks or cylinders and other apparatus commonly required for gas welding. The largest dimension of the electronic water welder is 10¼ in., while its net weight is only 30 lbs. It draws 250 watts of input power, 110/120vac, 60 cycle, single phase, and consumes only ½ oz. of distilled water per hour.

The instrument is a product of the Henes Manufacturing Co., Electronics Div., 4301 E. Madison St., Phoenix, Ariz.

ULTRA-STABLE REFERENCE ELEMENTS

UNTIL A STABLE temperature compensated zener diode was developed, the most accurate reference available for precision dc equipment use was the portable unsaturated standard cell.* The unsaturated standard cell, under the best conditions, has an accuracy and long term stability of ±0.01% (100 ppm). Now, temperature compensated zeners with certified long term stabilities as

low as ±0.002% (20 ppm) are available.

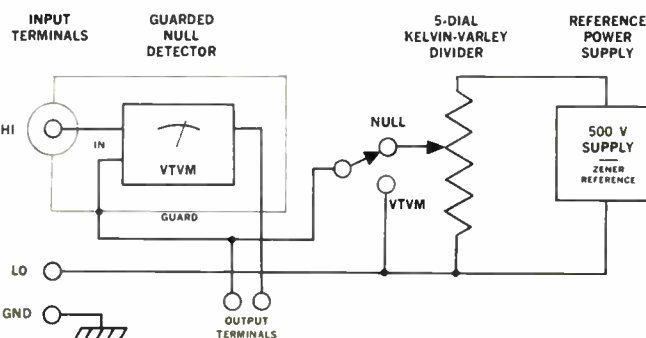
The accuracy of unsaturated standard cells can be maintained only under extremely limited op-

erating and environmental conditions. The following is a list of some of the standard cell's limitations:

(1) Although the cells are por-

A typical application of these new reference elements is the Keithley Model 660 Guarded Differential Voltmeter. In this type of circuit, the reference is an ultra-stable 500 volt supply.

*The portable unsaturated standard cell must not be confused with the saturated standard cell. The saturated cell has a much better accuracy and long-term stability. However, it is not portable and has a very high temperature coefficient (about 40-60 ppm/°C). For further discussion see references 1, 4, 5.



table, they are sensitive to rough handling, shock, vibration, etc.

(2) The widest recommended operating temperature range is from 4°C to 40°C ; however, in use the standard cells should be maintained within about 5°C of the temperature at which they were certified.¹ In storage the minimum temperature is about -16°C . Continuous operation at 40°C will cause a considerable drop in the cell emf and shorten the cell life.² Temperatures below -16°C or above $+50^{\circ}\text{C}$ can permanently damage the cells.

(3) A gradient of only 1°C between the limbs of the cell, as could be caused by internal self-heating of the equipment, can cause an error of 0.02-0.04%.

(4) The cells are subject to hysteresis effects. An abrupt change of only 4°C can cause temporary errors of 0.01-0.03% for periods of a few hours to many days depending on the individual cell.³

(5) Standard cell are meant to be used under zero load conditions. The internal resistance of the normal type of unsaturated cell is typically between 300 and 500 ohms. Therefore, a load current of only $1\ \mu\text{a}$ could drop the cell emf by $500\ \mu\text{v}$. This represents an error of 0.05%, since the cell voltage is about 1.019 V. For this reason the load current should be kept below $0.01\ \mu\text{a}$.⁴ The unsaturated standard cell can only maintain an accuracy of 0.01-0.02% under the best controlled laboratory conditions. Under adverse environmental conditions, errors of 0.1% (1000 ppm) or greater can be expected. Therefore, most precision dc equipment is limited to accuracies of about 0.05%. Equipment manufacturers have long sought a replacement for the unsaturated standard cell.

A temperature compensated

zener eliminates the limitations of standard cells. Some obvious advantages are: the many different voltages available; the small size and lack of position sensitivity; a wide operating temperature range; a capability of operating at high altitudes; the ability to withstand shock and vibration, temperature cycling, thermal shock and vibration, temperature cycling, thermal shock; and the ability to be operated under load or be shorted without damage.

All of these advantages were well known; however, little was known of the ultimate long term stability of temperature compensated zeners. Most of the military requirements for high reliability zeners were met with stabilities of 0.03-0.05%.

One basic requirement for a precision reference element is the need to maintain the reference voltage stable over the long periods between calibrations. For a zener diode, the "stability," sometimes called "time stability," the change in zener voltage over a period of time (either under operating conditions or under shelf life). This change is due to some characteristic in the device itself—it is completely independent of external conditions such as changes in operating temperature or current.

A study of zener long term stability was begun to develop a line with stabilities of 0.01% and better. Because highly accurate measurement equipment was needed for the development and production, it was necessary to set up a standards lab facility. Primary Reference Standards were obtained and certified by NBS. With these Primary Standards and other related equipment,

Based on a report by R. M. MINKE, Applications Engineer, Special Assemblies Dept., Pacific Semiconductors, Inc., 14520 South Aviation Blvd., Lawndale, Calif.

the lab has a capability of making dc measurements with an accuracy of better than 0.0005%.⁵

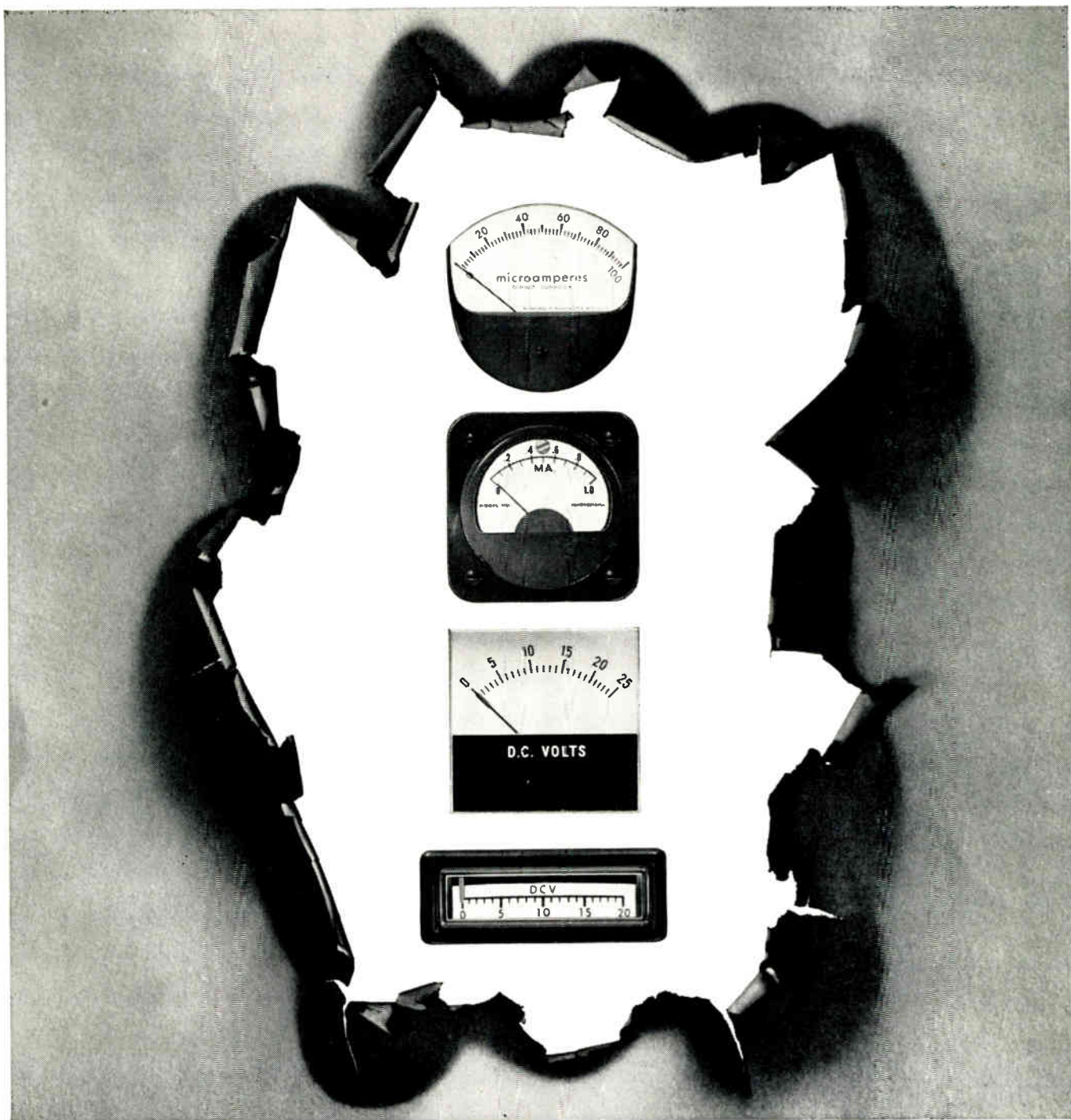
The initial study has been completed. Temperature compensated zeners are now available with certified long term stabilities ranging from 0.02% (200 ppm) down to 0.002% (20 ppm). The individual diodes in each compensated zener unit have been subjected to various power aging and stabilizing processes. After matching the positive temperature coefficient of the zeners with the negative temperature coefficient of the forward diodes, or "stabistors," the diodes are welded together and encapsulated. The assembled units are then tested for stability over a 1000 hour period of operation during which the zener voltage is checked and recorded at periodic intervals.⁵ Each unit is serialized and is supplied with a stability vs. time graph giving a complete certified record of the actual readings. Some of these units have shown stabilities of better than 10 ppm. This is an order of magnitude better than the best available from unsaturated standard cells and with none of the standard cell's limitations.

While we were editing this report another related item crossed our desk—an application of the temperature compensated Zener diode.

The 660 Guarded Differential Voltmeter made by Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, O., is an accurate voltmeter, with maximum stability and sensitivity. It also offers convenience and reliability.

The 660's specifications include 0.02% limit of error, for readings from 100 mv to 500 v, with 0.005% repeatability. A Zener

(Continued on page 88)

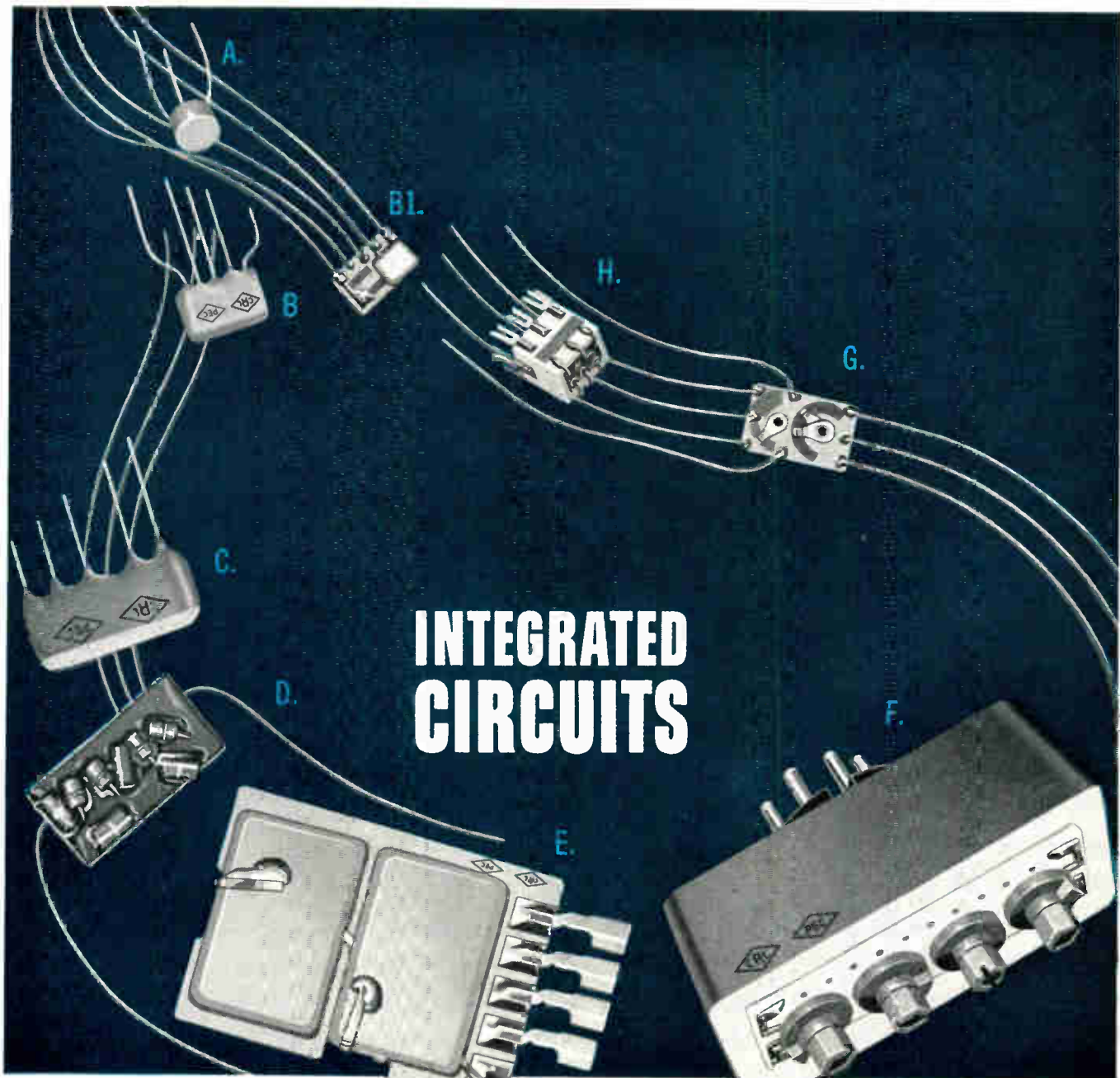


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INTEGRATED CIRCUITS

ALL UNITS SHOWN ACTUAL SIZE

- A.** Subminiature 1 KC tone generator. Contains one transistor, 4 resistors, 2 capacitors. Measures: 0.2" x 0.28" diam.
- B & B1.** Computer mix gate, contains 5 resistors and one capacitor. Repetitive circuit application uses thousands of perfectly matched units. Measures $\frac{1}{16}$ " x $\frac{3}{32}$ " x $\frac{1}{16}$ ".
- C.** High stability computer circuit with $\pm 1\%$ deposited metal resistors. Contains 4 resistors, one capacitor. Measures: $1\frac{1}{16}$ " x $2\frac{3}{16}$ " x $\frac{1}{4}$ ".
- D.** Complete 4-stage amplifier, 78 db gain. Contains 4 transistors, 12 resistors, 5 capacitors. Measures $1\frac{1}{8}$ " x $\frac{5}{8}$ " x $1\frac{1}{4}$ ".
- E.** High reliability arc-suppression circuit. Minimum life of 20,000 hours continuous operation. Potted in case. $1\frac{1}{2}$ " x $2\frac{1}{8}$ " x $\frac{1}{4}$ ", in actual use. Contains 4 resistors, 4 capacitors.
- F.** Twin T network mounted on space-saving octal plug. Contains 4 trimmer potentiometers, 5 resistors, 6 capacitors. Measures $\frac{3}{4}$ " x $1\frac{1}{16}$ " x $2\frac{3}{32}$ ".
- G.** "Two-dimensional" triple trimmer potentiometer for restricted space application—0.1" thick. Contains 6 fixed resistors in addition to trimmers.
- H.** Gate circuit with plug-in mating connectors. Contains 6 diodes, 5 resistors. Measures $1\frac{1}{2}$ " x $1\frac{1}{32}$ " x $\frac{3}{8}$ ".

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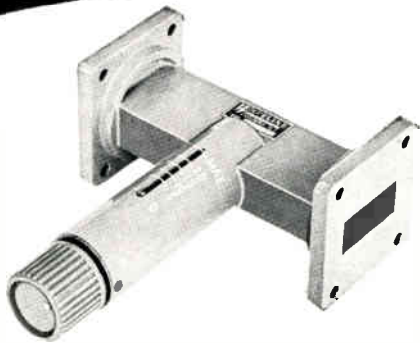
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Power Set Attenuators



Waveline has developed a series of Power Set Attenuators to provide well shielded, efficient, variable attenuation over a frequency range of 2.6 to 18.0 Gc in six standard models. These variable Power Set Attenuators provide a variable attenuation of from 0.5 to 20.0 db over the full waveguide frequency range with an indication of the approximate attenuation value.

Each unit contains an adjusting mechanism with a precision lead screw which enables fine adjustment of power level settings. A marking indicator is provided for visual presentation of approximate attenuation setting. The attenuating element is completely enclosed and special consideration has been given to provide adequate shielding of the adjusting mechanism, thereby resulting in a very effective overall shielding and an absolute minimum of radiation leakage.

Maximum VSWR for each unit is 1.15 over the complete waveguide frequency range. Attenuation can be varied in each model from 0.5 to 20.0 db and rated power is 1 watt average.

Waveline Model No.	Frequency Range, Gc	Waveguide Type
203	2.60 to 3.95	RG-48/U
303	3.95 to 5.85	RG-49/U
403	5.85 to 8.20	RG-50/U
503	7.05 to 10.0	RG-51/U
603	8.20 to 12.4	RG-52/U
703	12.4 to 18.0	RG-91/U

WAVELINE INC.

CALDWELL, NEW JERSEY

Phone: CApital 6-9100

TWX Caldwell, N. J. 703

REFERENCE ELEMENTS

Continued from page 85

reference, stable to 0.002% per year, results in a power supply stability of better than 0.005%—indefinitely. Maximum null sensitivity is 100 μ v full scale with 2.0 μ v resolution.

The convenience features include: in-line digital readout with automatically lighted decimals; 10 mv recorder output; polarity switch; floating operation up to 500 v off-ground 11 VTVM ranges; better than 45 db of 60 cps rejection and fast overload recovery.

These special components insure reliability: a rugged, temperature compensated Zener reference; maintenance-free photo-modulators of indefinite life; ceramic insulated switches with solid silver contacts rated for 100,000 operations.

The temperature compensated Zener diode is used as a basic reference because it will not vary more than 20 ppm per year or 5 ppm per °C. This provides a highly stable reference with respect to both time and temperature. The rugged Zener will also withstand extreme shock and vibration.

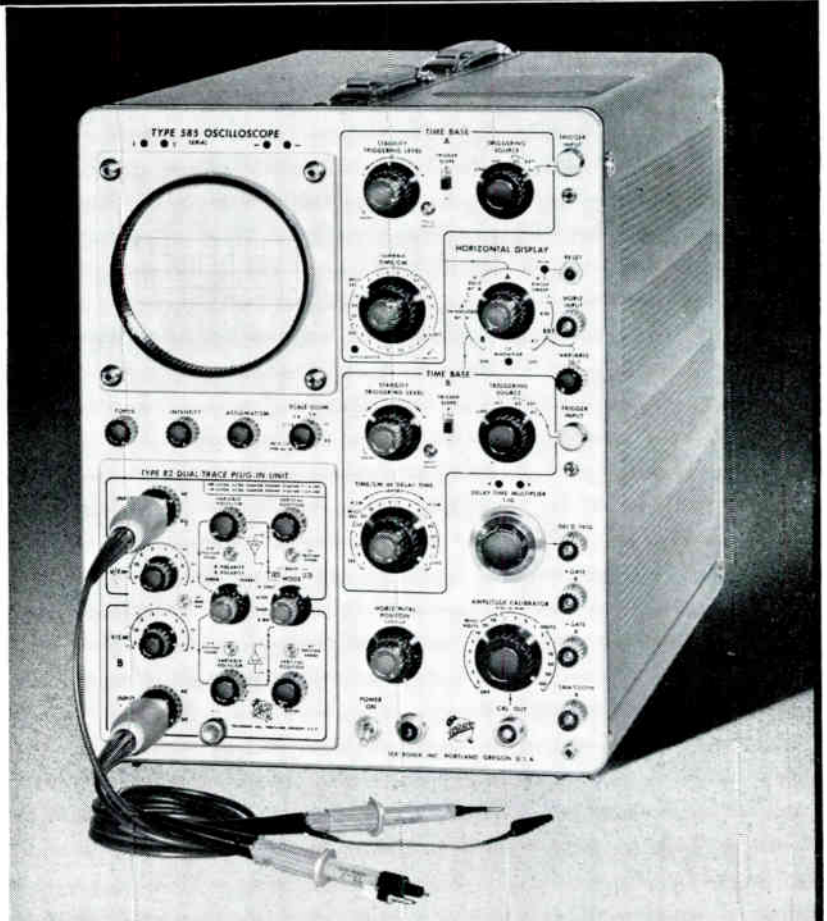
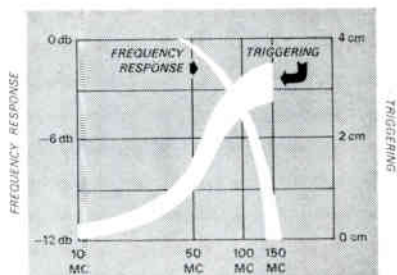
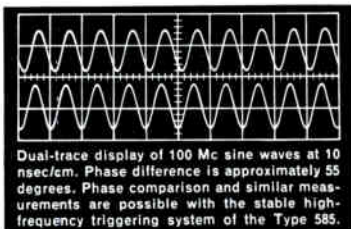
The photo-modulator, unlike a mechanical chopper, is a passive device of indefinite life. In this circuit the use of the photo-modulator virtually eliminates dc drift and assures maximum effectiveness of the highly stable Zener reference.

References

- (1) Eppley, Marion, "International Standard of Electromotive Force," *A.I.E.E. Transactions*, Vol. 50, No. 4 (Dec. 1931), pp 1293-1301.
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- (3) Park, J. H., "Effect of Service Temperature Conditions on the EMF of Unsaturated Portable Standard Cells," *National Bureau of Standards Handbook 77*—Vol. 1 (Precision Measurement and Calibration), pp 252-61.
- (4) Richardson, S. C., "Electrical References," *Industrial Electronics Handbook* (editor—W. D. Cockrell), McGraw-Hill, 1958, pp. 2.2-2.3.
- (5) Minke, R. M., "Test Methods for Zener Stability Measurements," Pacific Semiconductor, Inc., Los Angeles, June 1962.

★ **DC-TO-80 MC** at 10 mv/cm
 ★ **DC-TO-85 MC** at 100 mv/cm

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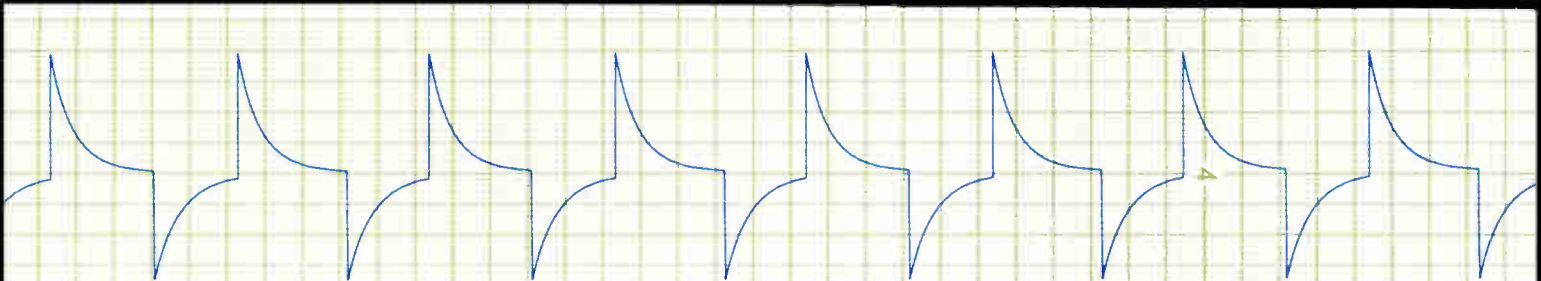
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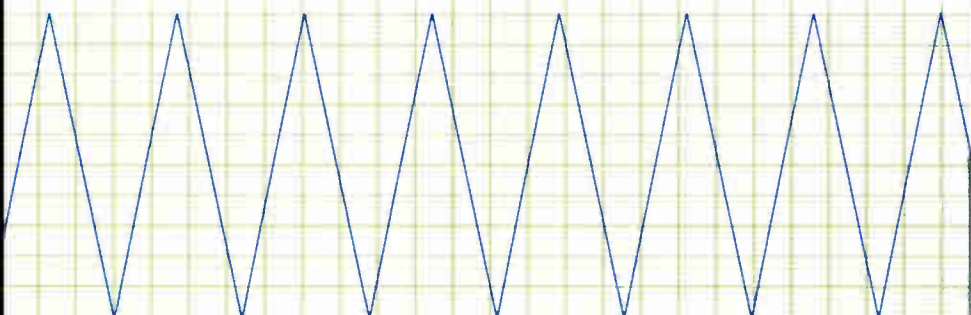
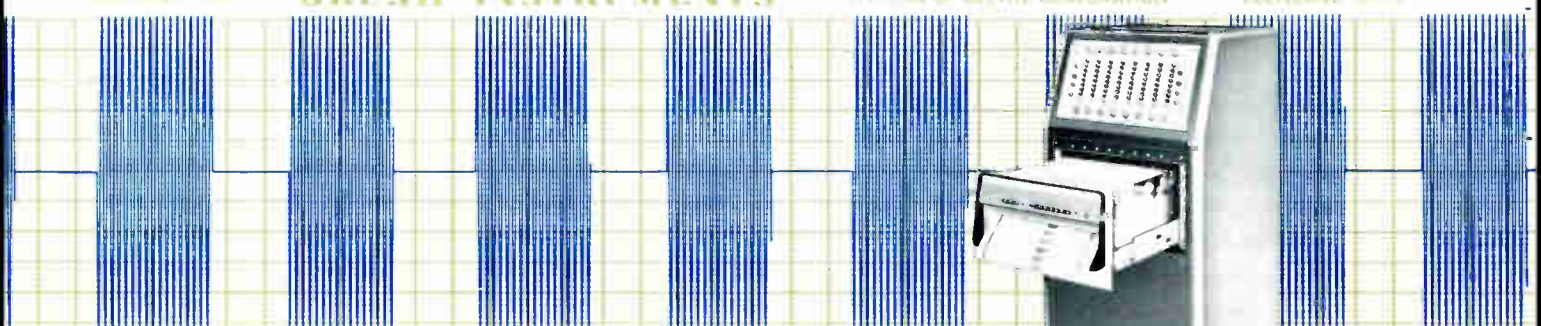


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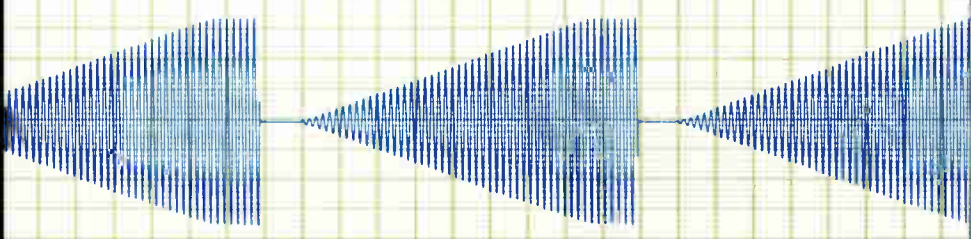
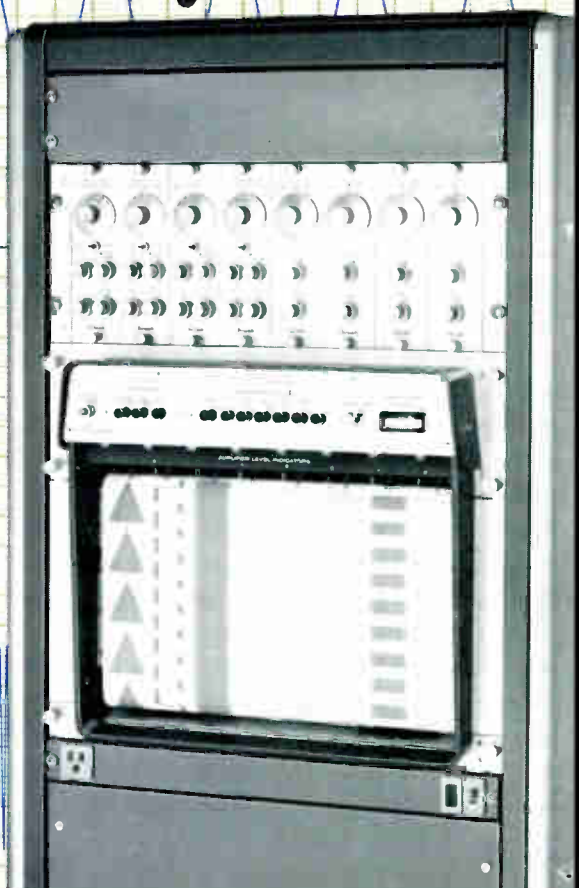
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World Radio History

ELECTRONIC INDUSTRIES

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ELECTRICAL CHARACTERISTICS OF THE UNIPOLAR FIELD EFFECT TRANSISTORS

The increase of availability of high-performance reliable unipolar field-effect transistors has accentuated the need for more information concerning their electrical characteristics and fabrication. How best to introduce field-effect transistors to the design engineer? What data does

he need? How should this data be presented? What are the significant ac and dc parameters? How are channel dimensions related to electrical characteristics? These and other pertinent questions are considered and presented in the treatment of this timely information.

THE NODE METHOD OF CIRCUIT ANALYSIS

In the analysis of any circuit, three laws are used. These laws are known as Ohm's Law and Kirchhoff's Laws. The latter lead to the Loop Method and the Node Method of circuit analysis. Both methods have advantages. However, from observing engineers both just out of school

and those with several years of experience, it appears that the Node Method is not used as often as it should be. In many instances, the Node Method saves time and gives an insight into the circuit that the Loop Method is deficient in clearly presenting.

ALL-MAGNETIC CONTENT ADDRESSED MEMORY

The computer industry has been acquainted with the logical concepts of Content Addressed Memories (CAM) for a number of years. There have been many efforts to organize and program conventional addressed memories, and to develop hardware directly geared to content addressability. The hardware implementation of CAM, however, is far from full system utilization. Content

addressability is being sought through two general avenues of approach. One uses presently available random access storage systems; the other, development of novel storage hardware. The latter, to date, have centered primarily around magnetic and cryogenic systems. This article deals with a particular magnetic approach and is recommended reading for anyone in the computer field.

AN ACTIVE CHEBYSHEV FILTER

There is a class of filters that uniformly pass certain frequencies and will provide a minimum attenuation for another group of frequencies. It is generally desired that the transition from the pass band to the cutoff band require the minimum number of elements. Such a filter may be explicitly synthesized. Gain, input impedance,

output impedance, and stability are further constraints upon the performance. This article presents a study of an m-pole, n-zero Cauer filter. Realization of a given network by RCL elements requires stabilized inductances to maintain linearity. Thus, active RC realizations are of use, especially in the low pass case.

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late Marketing Statistics, Snapshots of the Electronic Industries, EI International, News Briefs, Tele-Tips, Books, Representatives News, New Products, Industry News, Personals, Systems and Circuits, etc.

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These methods can prove of inestimable value in insuring that when the button is pushed, the desired reaction will take place. This article points out how self-verification can be applied, and alerts planners of future systems to its advantages in reducing "no-go's"

SELF- VERIFICATION- NEEDS AND METHODS

MODERN COMMUNICATIONS SYSTEMS tend toward maximum availability, i.e., the assurance of constant, instantaneous operational readiness.

One method of getting the desired availability is through meticulous design and use of highly reliable components. Another method comprises the performance of periodic system testing, which offers some degree of assurance of satisfactory operation. Both methods leave much to be desired.

A more applicable approach which satisfies reliability criteria and supplants much of the maintenance requirements, is Self-Verification (SV). SV is a method which, ideally, achieves continuous system surveillance, immediately detects any malfunction, and reports the fault as a display of GO or NO-GO signals. SV methods apply to both analog and digital systems. However, the discrete GO, NO-GO display suggests digital equipment; in fact, SV is particularly amenable to the latter.

Fig. 1 shows a typical segment of such a multi-link system. Each link comprises essentially similar receive, transmit, and data processing nodes. The interconnection between the receive and transmit nodes can be as complex as required. Additionally, some nodes can be manned or remotely controlled and unmanned.

System Figure of Merit

To evaluate the system impact of SV, the reliability improvement due to SV must first be determined. In turn, a method of evaluating the "degree of assurance" the system affords must first be weighed. Such a "measuring stick" should: (1) weigh all operating modes and determine their contribution to the overall system merit rating; and (2) respond proportionately to the failure rates of critical components so that it reflects the impact of these failures on the system capability. Unfortunately,

ly, the usual measuring sticks, availability and reliability, are generally not applicable to complex systems which consist of a number of independent links.

The Availability (A) of a system equals the time that the system will perform satisfactorily:

$$A = \frac{MTBF}{MTBF + MDT} \quad (1)$$

where:

MTBF = Mean Time Between Failures

MDT = Mean Down Time

Before it can have any significance, Eq. (1) requires the existence of either of the following two conditions.

Condition 1:

If there were a specific operating mode which could be defined as the minimum acceptable mode (with any degradation beyond that point being unacceptable and contributing nothing to the system), then the percentage "up" time could be determined. This condition is not usually present in most large complex systems. It may exist in some particular portions of the system, and the percentage time "up" in these portions can be evaluated. But, these parts cannot be combined in the usual manner to yield an overall system Availability.

Condition 2:

If each individual part of a system were separate and independent, and no component or group of component failures would affect any other part than those in which the failure(s) were immediately present, then the system Availability could be determined by combining single-part Availabilities. If these Availa-

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bilities were all equal, then each would also be the Availability of the system; and the Availability of a single part would be the percentage of the part that would be available at any time (long-term average). But, generally, systems are considerably more complicated, with some component failures affecting one part only and some having considerably broader impacts on the system's ability to perform its functions.

Likewise, the Reliability concept is not applicable to the system in its entirety. Thus, a new figure of merit, termed Relative System Capability, was devised.

Relative System Capability (RSC)

This figure of merit has the following properties :

- a. It is derived from statistical data on component failure rates, and accurate reliability models of the system.
- b. It gives a measure of the long-term-average number of system links that will be functional.
- c. It incorporates suitable weighting factors, equivalent to the effects of failures on the system capability, for all critical elements.
- d. It weighs proportionately all possible modes

Typical example of the need for desired reaction when the button is pushed is stressed as LDCR R. H. St. Clair, Asst.

Range Safety Officer at the Pacific Missile Range, stands ready at the Emergency Destruct control during a Discoverer launch.



SELF-VERIFICATION (Continued)

of operation caused by the varying degrees of degradation that might occur in the system.

- e. It is amenable to calculation by presently available mathematical methods.

RSC is calculated as follows:

Step 1. Using Eq. (1), determine the Availabilities of the system step-wise by removing each independent link in a discrete manner.

Step 2. Multiply each of the Availabilities of Step 1 by the total number of system links remaining operable.

Step 3. Add the products of Step 2.

Step 4. Divide the sum of Step 3 by the total number of links.

The result of Step 4 gives a measure of the number of operable links and is the RSC. All critical components are suitably weighed, because their impact on the system is immediately reflected in the suitable Availability term and weighed by the number of units which remain operable. All other operating modes due to varying degrees of degradation are included, so that a true long-term average is defined without the necessity for defining the "acceptable" modes. The calculations are based on a simple averaging and weighing method, readily derived and performed.

However, due to many reasons, very few systems can, or will, be 100% "self-verified." Thus, it becomes necessary to consider the system as consisting of two parts: The verified portion and the unverified portion.

The former is the system complex whose RSC is determined by reference to the system reliability model. This yields the percentage of the total number of individual system links that will be operable (verified).

The unverified portion's impact on the RSC is determined by the particular portions of the system that are left unverified. The Availability of an unverified portion of the system is given by:

$$\begin{aligned} A(\text{link}) &= \text{MTBF}/(\text{MTBF} + T/2) \\ &= \text{RSC}(u) = 1 - T/2/\text{MTBF}(u), \end{aligned} \quad (2)$$

where:

T = Period of Time over which Availability is determined

RSC(u) = Relative System Capability (unverified)
 MTBF(u) = Mean time between failures of the unverified portion of a single link, and defined by:

$$\text{MTBF}(u) = 2/(2 + LuT) \quad (3)$$

where:

Lu = Failure rate of unverified portion of a single link.

Therefore, the unverified equipment Availability in a single link depends only upon the unverified portion failure rate and the time between routine maintenance

checks. This single link Availability numerically equals the system unverified portion of RSC. The overall RSC equals the product of the capabilities of the verified and unverified portions of the system.

Thus, even with the restrictions of routine maintenance operations, the unverified portion becomes the controlling factor in the overall RSC.

Cost Trade-Off Relationships

To obtain the best combination of maintenance frequency and degree of SV to minimize costs, we must know the exact costs of supplying the necessary verification equipment and the routine maintenance cost.

Were the information available, a suitable plot of the cost trade-off could be made, Fig. 2. The abscissa (MTBF of Unverified Equipment) is a measure of the degree of SV. As the degree of SV becomes greater, the MTBF for the unverified portion of the equipment becomes greater.

Table 1

SV Scheme	Frequency of SV	Percentage of Equipment Self-Verified
1	→ ∞	100
2	→ ∞	0
3	→ 0	100
4	→ 0	0

The overall Routine Maintenance cost is determined by the individual costs of manpower, materials, equipment, and facilities required for each link to maintain the equipment at the required Availability level. The actual frequency of maintenance is:

$$F_d = AT/2 \text{ MTBF} (1 - A), \quad (4)$$

where:

F = Frequency of routine maintenance per year.
 A = Availability requirement for unverified equipment.

T = Period of time considered (usually one year), in hours.

MTBF = Mean Time Between Failures of the unverified equipment of a single link of the system (hours).

The amount that could be saved by having each repair crew perform the checkout on the unverified equipment at each link when repairs are necessary in the verified equipment is P_f (the failure probability):

$$P_f = 1 - P_s, \quad (5)$$

where:

$P_s = \exp(-T/\text{MTBF})$ = Probability of survival of a link.

Since P_f determines the average number of times a link must be maintained in the period T, the curve of annual "Cost of Routine Maintenance," in Fig. 2, approaches a minimum.

The second curve, "SV Cost," is determined by both the design and production costs of the extra equipment required at each site, suitably allocated on an annual basis, plus the cost of maintaining this equipment. The cost increases rapidly for each additional increment of verification. Thus, in attempting to achieve complete SV, the 100% point is approached.

The third, or "Total Cost," curve is simply the arithmetic total of the first two curves.

The complete Cost Trade-Off then, is composed of three steps:

a. For any particular Availability to be achieved, the various combinations of degree of verification (MTBF of Unverified Equipment) versus the associated maintenance program (Time Between Maintenance Checks) must be determined.

b. The cost of accomplishing the degree of verification and the associated maintenance program (taking advantage of the fact that approximately P_f percent of the sites will be visited annually for repairs) must be determined.

c. The minimum point on the summation curve of the two costs involved must be located.

The exact figures necessary for these calculations are generally unavailable. Thus, the extent of SV necessary to get the greatest return in equipment verified, without compromising the MTBF for the entire system, is based on an engineering design approach.

The overall design of a system may be considered from two aspects, viz.:

a. The level of reliability achieved.

b. The simplest functional requirements.

Further, in any system, optimum design is achieved by a perturbation and iteration process of these two factors. To appraise the impacts of SV, this process is evaluated on the basis of the following objectives:

a. Maximization of the time between routine maintenance checks.

b. Maximization of RSC.

c. Assurance of compliance with the system MTBF requirements.

The overall system MTBF and the MTBF of the unverified portions are then used to calculate the RSC. The Availabilities curves of T (time between maintenance) vs MTBF, and of T vs Availability can then be plotted to determine a first approximation to the degree of SV that will be required.

Finally, using the design criteria for the types of SV possible, the final amount of SV incorporated into a system can be determined. The problem then reduces to selecting a given type of SV, as described below, and designing the equipment for it.

System Requirements

Before applying SV, the methods of implementing it must be weighed. From the results, and from the standards for the functions required, a particular SV scheme can be put together.

Considering any link of a system as a two-port, "black box," the link will give a known output when excited by a known input. This test is ideally to give a GO or NO-GO indication of operational capabilities. Such a system is a gross-fault locating method, useful for determining the overall operation of the equipments. If additional nodes are available, it is possible to treat each module as a smaller two-

Fig. 1: Typical segment of a multi-link system. Some nodes can be manned or unmanned.

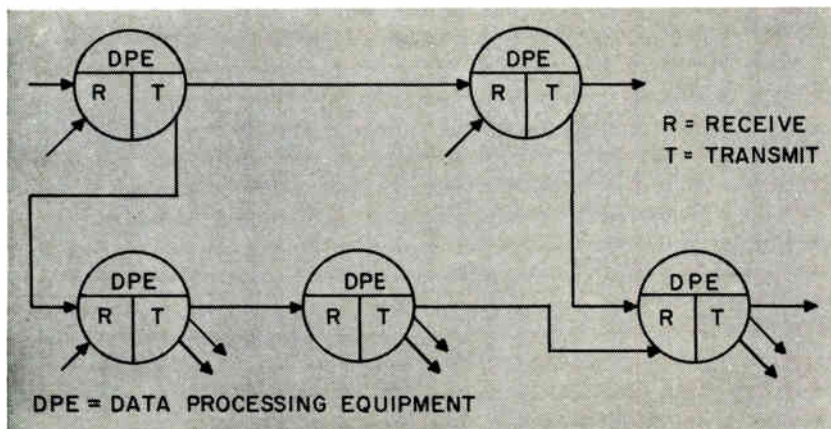
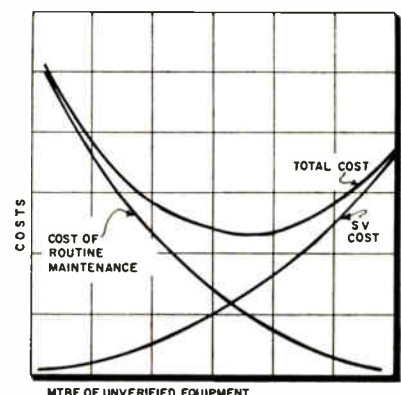


Fig. 2: The characteristic curve which expresses cost trade-off optimization.



SELF-VERIFICATION (Concluded)

port "black box" and, thus, localize a fault to a module or circuit.

The time and frequency of testing must also be considered in any SV scheme. Ideally, verification of vital functions should occur 100% of the time, for 100% of the equipment. Although in practice these goals are seldom realized, close approximations can be made. Several alternatives are possible, Table 1. The figures indicated in the table are limiting conditions only; e.g., "Frequency of SV" approaches 0 in Scheme 3, but does not actually reach it.)

Schemes 2 and 4 are obviously impractical. Scheme 3 is feasible, but not as desirable as Scheme 1. Thus, if SV is to be achieved, the closest possible approximation to Scheme 1 should be adopted. Failing this, Scheme 3, or the best engineering compromise that can be made, will have to be used.

Types of SV

On this basis, the implementation of SV can be divided into four groups:

- a. Automatic Self-Verification (A-SV).
- b. Non-automatic Self-Verification (M-SV).
- c. Dynamic Self-Verification (D-SV).
- d. Static Self-Verification (S-SV).

Each of these, analyzed below, can exist in two forms, Marginal and Non-Marginal.

A Marginal test program is a fault-detection scheme in which different parameters are varied within prescribed tolerance limits to determine the operating capabilities of the system. The method is useful primarily to detect imminent failures, and is intended to check a class of malfunctions not considered in the SV criteria.

A Non-Marginal test program is essentially a fault-detection scheme wherein the system parameters are considered as operating at their nominal values. All types of SV, including those discussed in this report, are basically of this form, and its importance lies in the fact that all existing failures, catastrophic or out-of-tolerance, are detected by this scheme.

Automatic (A-SV)

Automatic Self-Verification is a diagnostic approach that periodically tests the entire system by exercising every function through its normal states. Generally, SV to this extent is not possible.

In lieu of such an extreme test, but to satisfy to the maximum the concept of A-SV, a process can be

adopted that will check all the critical functions. This may, however, introduce too many extra components. Thus, while Automatic SV does, in principle, appear in general to fulfill the needs of verification, its disadvantage is that implementation is extremely complex and may thus lower the system MTBF and the Availability. Also, the testing process may tie up the system.

Non-Automatic (M-SV)

Non-automatic Self-Verification is similar to A-SV, but with one major difference: the test program is operator initiated. M-SV has all of the disadvantages A-SV has, and an additional one in that the method requires complex manual technical procedures and coordination.

Dynamic (D-SV)

Dynamic Self-Verification is a diagnostic procedure in which pseudo-valid operational procedures are used to exercise the links of the system. The procedures used are such that operation of most functions can be checked (but certain critical functions can be left quiescent as required). This method eliminates many of the problems of A-SV and M-SV, but prevents the possibility of achieving a 100% functional check-out.

Special operational procedures are initiated to excite the system into a dynamic operating condition. These conditions are monitored to ascertain the correct response of the various functions. Despite the fact that Dynamic Self-Verification does not check 100% of the system, it has sufficient merit to be the most usable SV method.

Static (S-SV)

Static Self-Verification is a test procedure that is normally used only when the system is quiescent. This test, in contrast to the Dynamic SV, performs verification without using the system operationally. Instead, the principles of logical deduction and the monitoring of logical paradoxes is the underlying mode of this form of SV.

Static SV is never a complete test but is a worthwhile adjunct (in combination, for example, with Dynamic-SV) to enhance the overall degree of system verification.

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CONSTRUCTING BROADBAND R-F SWITCHES

With ordinary computer diodes it is possible to build low power r-f switches. The switches can turn "on" and "off" in a few nanoseconds, and they will operate up to and above a few thousand megacycles. The details are given here.



Fig. 1: Ordinary computer diodes can be used to build this broadband r-f switch.

By using ordinary computer type diodes, it is possible to build broadband, r-f switches that can turn on and off in a few nanoseconds, operating at frequencies up to and above a few thousand megacycles. Below 2000 mc, it is possible to achieve near ideal "switch like" characteristics, i. e. less than one-half db insertion loss in the "closed" position, and as much as 90 db isolation (or insertion loss) in the "open" position. Above the 1000 to 2000 mc range, insertion loss of 1 to 2 db and isolation of 30 to 40 db are typical. Switching speed depends, of course, on driver circuitry. However, the inherent switching speed, limited by the switch itself, is on the or-

der of 10 nsec. Bandwidth of the switches over which the above characteristics may be maintained is typically an octave or more.

Conventional Cavity

Switching is done by controlling (with diodes) the impedance of an r-f network so that power is either passed by or reflected. For example, a simple resonant coaxial cavity may be controlled by a diode short circuiting the center conductor. When the diode is back biased, it appears as a small capacitance in parallel with the high impedance end of the cavity. This capacitance becomes part of the resonant circuit, with the result that power is transferred from the input to the output line with very little loss. Insertion loss is about 1 db.

Forward biasing of the diode causes a drastic impedance mismatch to appear at the input to the cavity resonator. As a result, the incident power is almost totally reflected and very little signal appears in the output circuit. With this arrangement, an insertion loss of about 40 db can be obtained.

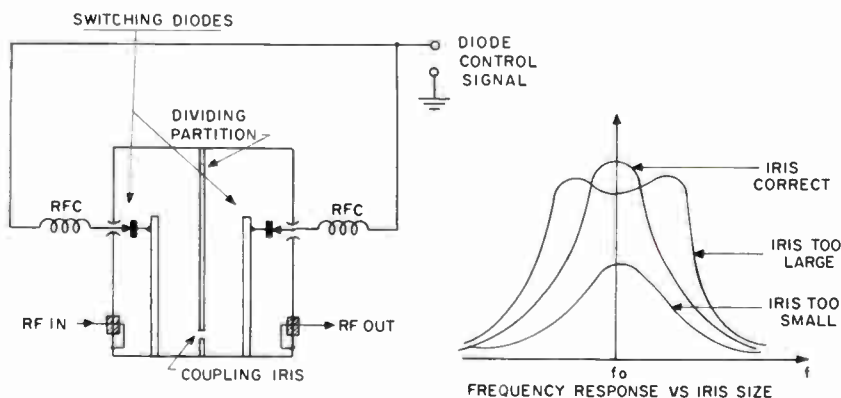


Fig. 2: Better than 40 db attenuation can be obtained with the device shown on the left. Curves on the right illustrate effects of various sized iris openings.

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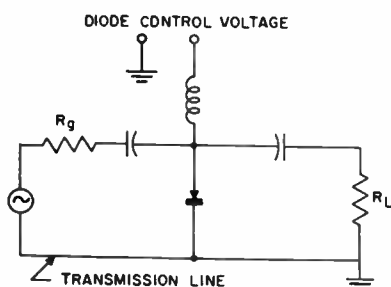


Fig. 3 (above): Simple broadband switch.

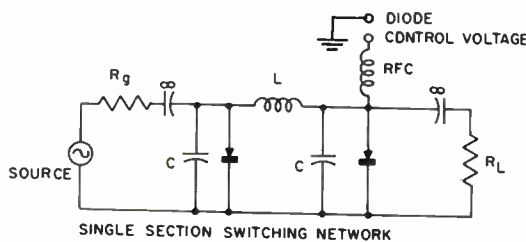
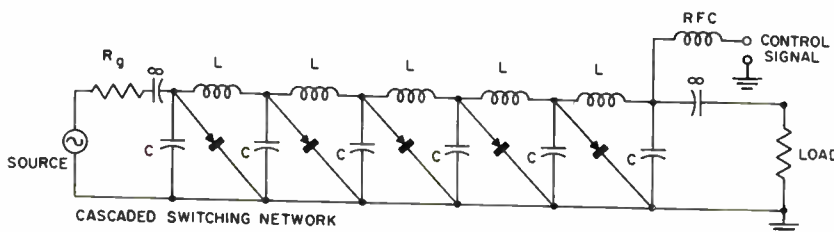


Fig. 4 (right): Shown are some methods for overcoming residual capacitance effects.



R-F SWITCHES (Continued)

Two of these switches may be cascaded for a loss greater than 40 db. One method combines the effect of two cavities in the space normally occupied by a single cavity as shown in Fig. 2. The two split-cylinder cavities are coupled by an iris in the dividing wall. Adjustment of this iris diameter controls the insertion loss of the cavity when the diodes are reverse biased. Too small an opening results in an under-coupled response with consequent high insertion loss, whereas too large an iris results in the familiar over-coupled transmission response, as shown in Fig. 2. With proper iris coupling, a switch open attenuation of 80 db and a switch closed attenuation of 2 db may be obtained.

Distributed Line Type

The resonant cavity switch has a disadvantage. Its characteristics are inherently narrow band, since use is made of the resonant response of the coaxial resonator to obtain switching. Much wider bandwidths can be had if the diodes are used with a transmission line network rather than the coaxial resonator. This is shown in Fig. 3. Again the switching action is by the impedance mismatch at the terminals of the switch when the diode is forward-biased. This simple method is generally unsatisfactory for wide band switching in the form shown. The residual capacitance of the diode in the reverse-biased condition causes an impedance mismatch at the switch terminal so that the minimum insertion loss of this type switch may be too large.

One method by which this capacitance effect may be overcome is shown in Fig. 4. In this setup the diode capacitance is associated with the shunt capacitor in a low pass filter. If the characteristic impedance of the filter properly matches the output impedance of the source, then essentially lossless transmission of the input signal to the output load is

possible. However, if the diodes are forward biased, the impedance mismatch at the filter input is large, and the incident power is reflected from the filter terminals.

Several of these filter sections may be cascaded as in the multisection low pass filter to obtain an increased isolation when the switch is open. The results obtained for a switch operating in the range of 50 to 500 mc are shown in Fig. 5. This switch contains 16 diodes in a cascaded filter arrangement to obtain a very high insertion loss when the switch is open. The diode bias control signal is isolated by two series capacitors which are large enough to effectively short circuit r-f signals at frequencies above 50 mc. The bias control signal is fed through an r-f choke. The choke isolates the control signal circuitry from the r-f portion of the switch. In this switch, the diodes are paralleled by enough capacitance so that the sum of the diode capacitance and the shunt capacitance is the proper value for the desired cutoff frequency and impedance level of the filter. If maximum bandwidth is needed, then the impedance level and cutoff frequencies are determined by the capacitance of the diodes, and no additional shunt capacitors are used.

Diode lead inductance becomes appreciable at frequencies above 2 kmc, so that a simple constant K filter design is no longer possible. At these higher frequencies, this internal diode inductance must be taken into account in the design of the filter. Switches have been made with bandwidths extending from 2 to 4 kmc with insertion loss of 2 db and 35 db in the closed and open positions, respectively. Switches for the 2000-4000 mc range built with these techniques normally occupy less than 1½ cubic inches.

Multi-Throw Configuration

Switches of the same general design may be made

in arrangements other than SPST. For example, to commutate several sources to one load, or several loads to one source. For this use, it is necessary to provide some means of disconnecting the open switches from the common switching line. This may be done over small bandwidths by connecting the switches to the common switching line through short lengths of quarter wave transmission lines. The very low impedance appearing at the input to the open switches is transformed by the quarter wave transmission line section to a high value at the common switching point, effectively disconnecting the switches from the switch that is closed. Since a closed switch presents an impedance match at its output, this matched impedance is transferred to the common switching point unchanged by the length of the cable. Using such arrangements, bandwidths of $\pm 10\%$ can be obtained.

If wider bandwidths are needed, or a large number of switches are to be used in the commutator, then series disconnect diodes can be used to disconnect the open switches from the common switching line. The amount of disconnect action obtained by use of the series diode depends upon the capacitance of the diode when it is in the back-biased condition. At the higher frequencies, this capacitance reactance may become too small. In such an event, two or more diodes may be used in series to increase the capacitance reactance and improve the disconnect action. However, this is done at the expense of increasing the insertion loss of the switch in the closed condition. As a result, a compromise generally has to be made at high frequencies between optimum disconnect action and minimum insertion loss.

Power Handling & Switching Speed

The operation of these switches in a reflective, rather than a lossy mode, greatly increases the power which the switches can handle. If the diodes were perfect shorts in the forward-biased condition, no power could enter the switching network, since its input impedance would be purely reactive. However, the non-zero resistance of the diodes causes the input impedance to have a real part, so that a small amount of power flows into the switching network. Since this power must be dissipated in the diode junctions, the limiting factor in controlling the level of power which can be switched is the dissipation rating of the

diode junction. This dissipation is the sum of that due to the biasing current and the fraction of the incident power that enters the switching network.

Unfortunately, diodes possessing high dissipation rating are usually associated with large values of junction capacitance and slow switching speeds. Thus, the smaller diodes, which must be used at higher frequencies and switching speeds, will restrict the amount of power which can be accommodated. Nevertheless, average power levels approaching one watt can be used without a deterioration in switching speed. As much as 5 watts can be handled, but at the expense of switching speed and isolation.

Switching speed is limited primarily by the input shunt capacitance and the minimum open time (diodes forward-biased) by the storage time of the diodes. By using reasonably simple driver circuits, it is possible to open the switch in about 30 nsec. and close it in about 50 nsec. The inherent switching time of the switch alone is about 10 nsec.

Gating RFI

The switch can be used to "disconnect" a receiver from its antenna during the occurrence of radar or other pulse type (broad band) interference. This has several advantages over other blanking schemes. If blanking is done further down the line, e.g. at late i-f or audio, saturation and ringing may have already been produced by high level interfering pulses. Also, the use of the switch as a retrofix is an external modification and does not need any internal changes in the receiver.

The introduction of a switch in the input r-f circuit does not produce any intermodulation effects, since in the "closed" position the diodes are back-biased and are essentially "not there." In the open position, a high attenuation is inserted between the antenna and the receiver input. Also, there is very little feedthrough from control circuit to output. In some speech system applications using this technique, it is possible to hear the "holes." Although not nearly as objectionable as the interfering pulses themselves, the "holes" may be annoying. This problem has been solved by driving the switch control circuit at a multiple of the interfering pulse repetition rate. This places the gating rate above the audio range. Little degradation results.

When the source of interfering pulses is nearby, a sync line may be used to connect the switch control circuit with the source. When the RFI source is not accessible, a simple, low gain receiver may be used in the switch control circuitry.

Commutating

When it is desired to switch a common load be-

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R-F SWITCHES (Concluded)

tween a number of inputs, or one input between a number of loads, more rapidly than can be done by a mechanical commutator, the solid state switch may be the answer. A typical unit is shown in Fig. 6. Here

the output of 10 r-f sources (antennas) is sampled in sequence and applied to a single receiver input. Many variations are possible, of course, including multi-pole, multi-throw setups. The switch used is basically the same as described above, except that a disconnect diode is used in addition to the usual control circuit input, for the reasons discussed.

Fig. 5: Graph of cascaded switch in open and closed positions.

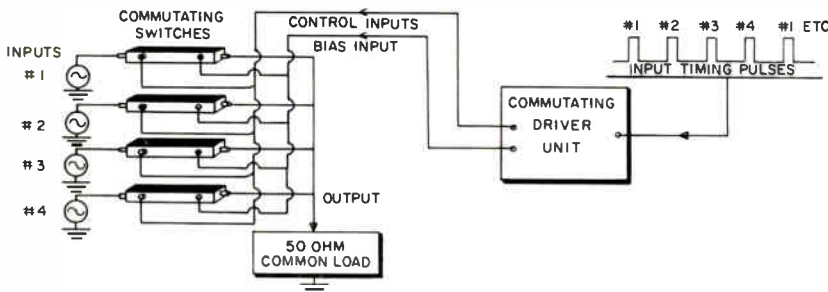
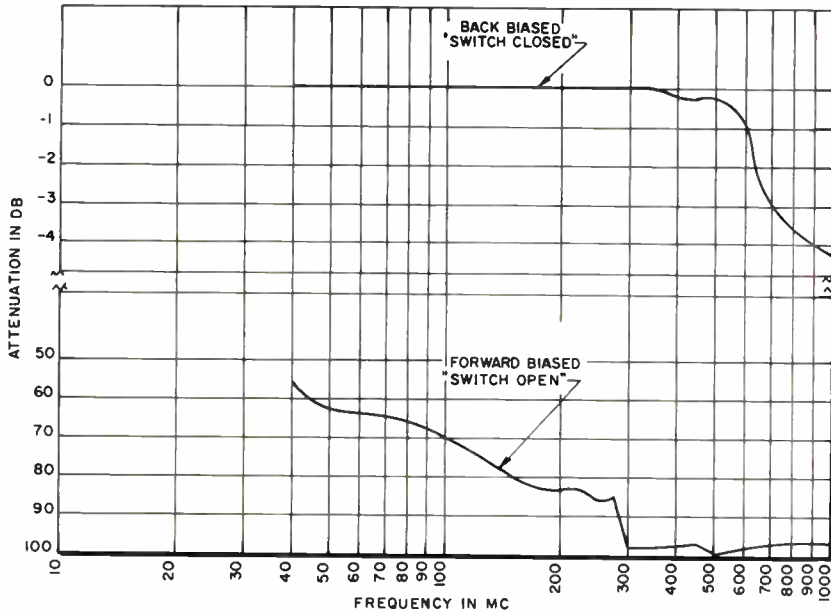
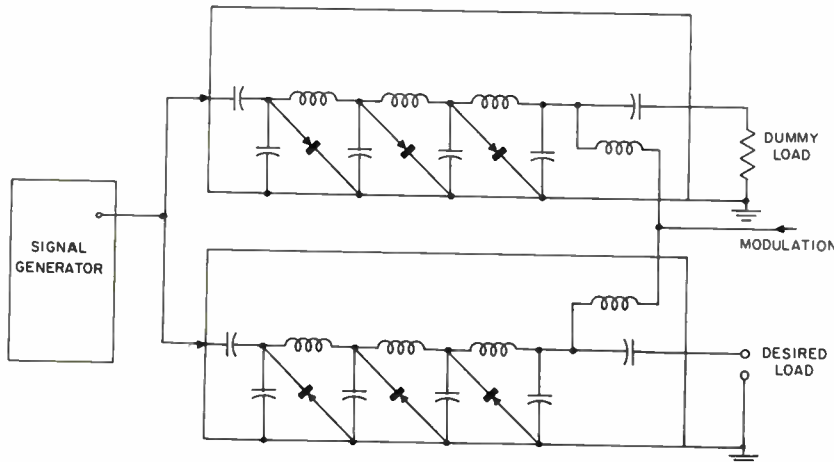


Fig. 6: Diagram shows how r-f switches can be used for commutator applications.

Fig. 7: R-F switch used with signal generator to eliminate CW between pulses.



Modulation

In certain RFI laboratory measurements, it is desired to pulse modulate the output of signal generators. The internal modulation circuits of typical laboratory signal generators leave a residual CW in between pulses. This may be objectionable in the measurements being performed. By passing the output through the r-f switch, as shown in Fig. 7, an additional attenuation of the signal in between pulses, on the order of 60 db, may be obtained. Notice the additional switch containing inverted diodes connected to a dummy load. This arrangement is used to present a constant impedance to the signal generator and to simplify the drive requirements.

In general, the switch makes an excellent low level pulse modulator, where the magnitude of the on-off ratio is of prime concern. Thus far, only those applications involving the switch in either its "closed" or "open" states have been discussed. The insertion loss of the switch in between these two states may be made a reasonably linear function of control current and, hence, the device may be used as a modulator in the usual sense. Typical variation of control current of 0 to 10 ma produce an insertion loss change of 50 db.

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The astable multivibrator is commonly used to operate pulse sensitive circuits. It is sometimes desirable to be able to vary the frequency. Design of a stable solid state oscillator whose frequency can be varied electronically is described.

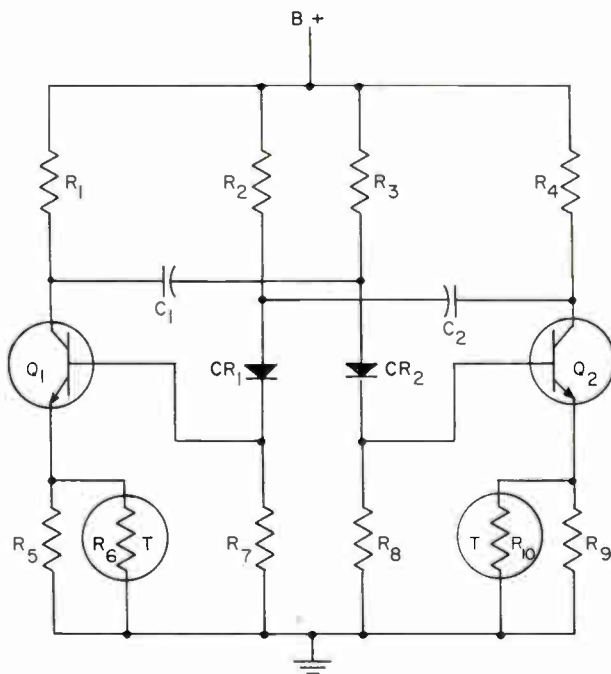
A VARIABLE FREQUENCY MULTIVIBRATOR

IN MOST APPLICATIONS, THE ASTABLE MULTIVIBRATOR is run at a frequency greater than 100 CPS, and probably greater than 1000 CPS. This is especially true for present-day computers. Object of this article is to describe the design and operation of an astable multivibrator whose characteristics are as follows.

- (1) Frequency variable from 6 to 140 CPS.
- (2) Frequency maintained within $\pm 2\%$ of an initial setting from 0°F to $+150^\circ\text{F}$.
- (3) Frequency maintained within $\pm 2\%$ of an initial setting when varying the supply voltage by ± 4 v.
- (4) Output waveshape maintained.

Although the circuit proposed is different from a normal astable multivibrator, basic design equations still hold for determining component values. Therefore, no attempt has been made to confirm the values of the components of the final circuit by equations. Rather, this paper has been written using a mini-

Fig. 1. Main difference between this basic circuit and other common astable multivibrator circuits is the use of R_2 & R_3 and the lack of bypass resistors across C_1 & C_2 .



imum of complex equations in order to emphasize basic changes in the original circuit to achieve the required results.

Basic Circuit

Fig. 1 shows the basic circuit that was used. The main difference between this circuit and other common astable multivibrators is the use of R_2 and R_3 and the lack of bypass resistors across C_1 and C_2 . R_2 and R_3 are jointly used with R_7 and R_8 , respectively to bias Q_1 and Q_2 so that these transistors would operate from cutoff to saturation. In addition, R_2 and R_3 serve as the discharge path for C_1 and C_2 respectively.

This design method was used in lieu of the standard circuit because:

- (1) R_7 and R_8 could be made small so that the effect of I_{co} variations due to temperature would be at a minimum.
- (2) Basic biasing can be set so that the switching action of each transistor is from cutoff to saturation.
- (3) Discharge of the timing capacitor (or the equalization of its voltage) is voltage controlled rather than controlled by transfer of charge through resistors.
- (4) This type of circuit needs fewer components than normally used in variable frequency oscillators.

Operation and Design

To stabilize the multivibrator circuit, a low resistance path was provided for the transistor's I_{co}

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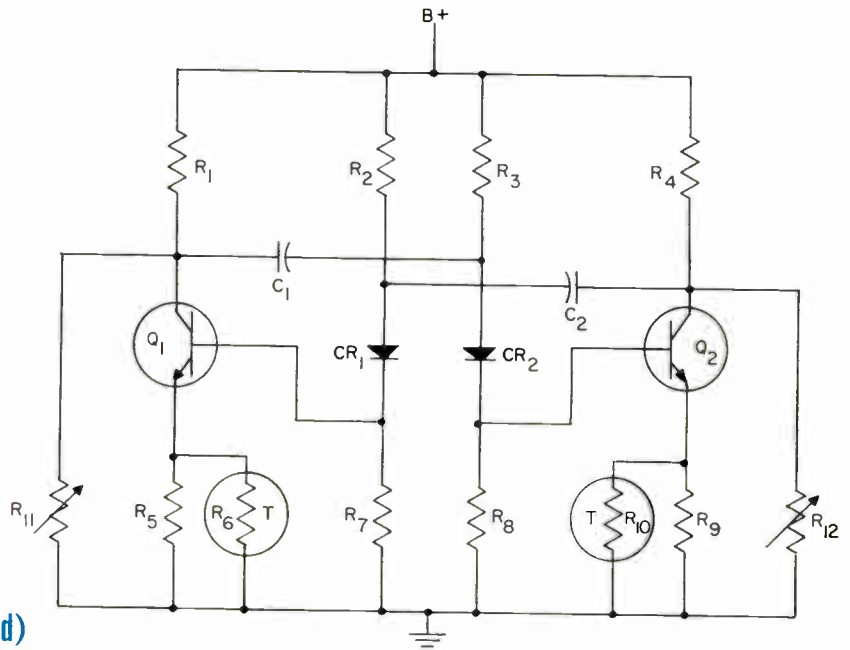
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\$\$\$ for Circuit Designs

Have you come up with any simple or unique circuit designs lately? Do you think that they would be useful to fellow engineers? If so, why not send them to us for possible publication? We pay our usual space rates for those accepted. Please keep them as concise as possible and send to: Circuit Design Editor, ELECTRONIC INDUSTRIES, 56th & Chestnut Sts., Philadelphia 39, Pa.

Fig. 2. Basic variable frequency multivibrator uses R_{11} & R_{12} with R_1 , R_4 , R_5 , and R_9 to change oscillator's frequency.



VARIABLE MULTIVIBRATOR (Continued)

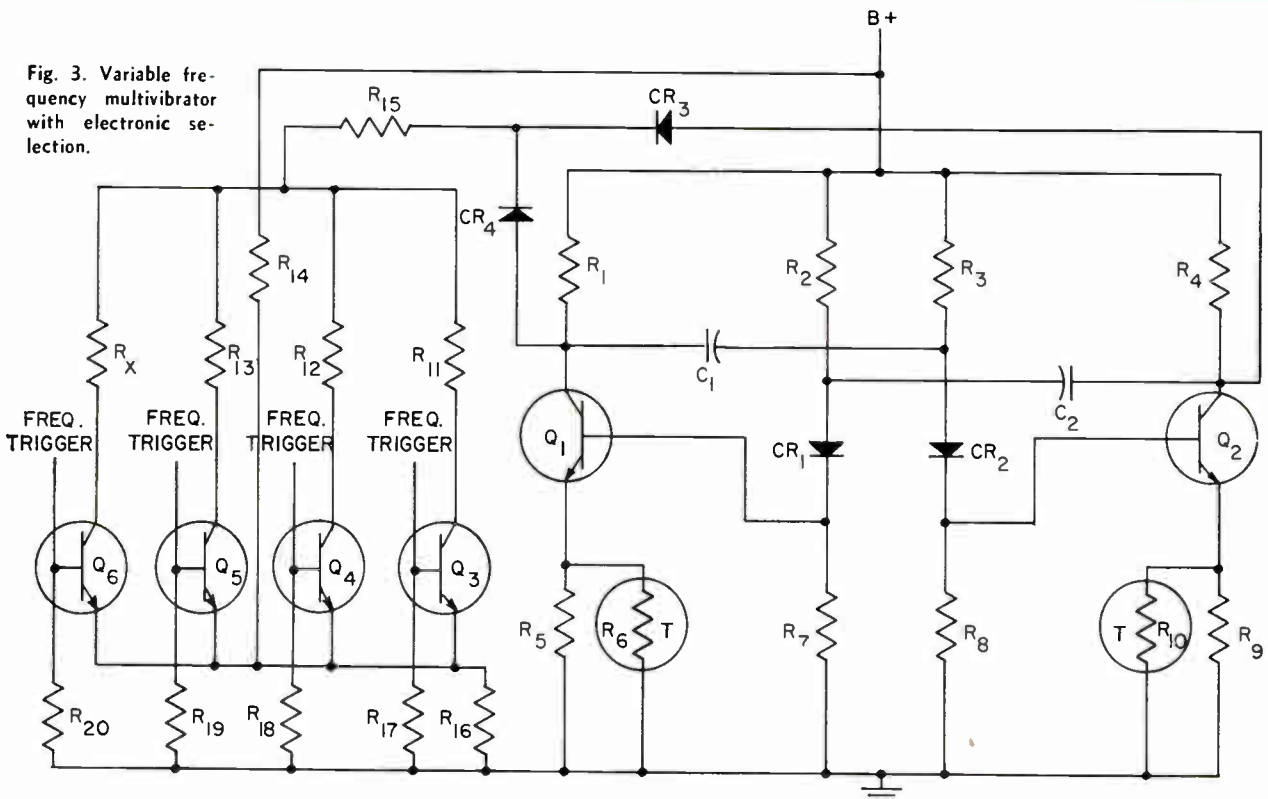
through R_7 and R_8 (Fig. 1). Therefore, R_7 and R_8 were selected to minimize the effect of I_{co} at low temperature. These resistors were therefore fixed.

In order to be able to drive the transistors from cutoff to saturation, the base bias voltage had to be set at an optimum level. (This depended also on the type of transistors used). Since R_7 and R_8 have already been picked, R_2 and R_3 had to be within a

given range. Selection of these resistors therefore fixed the normal reference voltage level of one end of the timing capacitors.

The other ends of the capacitors are connected to the collectors of Q_1 and Q_2 . Therefore, these ends have a varying voltage going from B+ to about the transistor saturation voltage plus the emitter resistor voltage drops. Therefore, the amount of voltage being

Fig. 3. Variable frequency multivibrator with electronic selection.



impressed on the capacitors is fixed.

The purpose of CR_1 and CR_2 can be explained as follows: Let us assume that before any voltage is applied to the circuit, C_1 is uncharged. Now if $B+$ is applied and Q_1 is initially off, then both sides of C_1 will go to about $B+$ (or in this case to $+28$ v.). The voltage divider of R_3 and R_8 will force one side of the capacitor to reduce its voltage to about 2 v. When this occurs, C_1 has about 26 v. across it. When the multivibrator switches turning on Q_1 and lowering its collector voltage to about 4 v. (and since C_1 can not instantaneously change its voltage) the opposite side of the capacitor will seek to bring this voltage back to $+2$ v. This can only be done through R_3 since CR_2 will not allow charge to flow through R_8 .

Because CR_1 and CR_2 do not allow charge to leak back through R_7 and R_8 , the discharge time constant of C_1 or C_2 is about equal to:

$$T_1 \approx C_1 (R_3 + R_1)$$

$$T_2 \approx C_2 (R_2 + R_4)$$

respectively.

In addition $R_3 \gg R_1$ and $R_2 \gg R_4$ giving:

$$T_1 \approx R_3 C_1$$

$$T_2 \approx R_2 C_2$$

respectively. As explained before, R_2 and R_3 are fixed because of other requirements. Therefore, the

frequency of the astable multivibrator can be controlled by changing the size of the timing capacitors.

Stabilization Design

Two requirements of the oscillator made additional sophistication of the circuit necessary: 1) This circuit was to be used in an airborne computer which put a limit on the physical size of the components. 2) Frequency of the oscillator was to be stable within $\pm 2\%$ from 0°F to 150°F . As explained, the frequency was a function of the size of the timing capacitors. Therefore in order to vary the frequency the capacitor values could be changed. However, this is hard to do electronically. In addition, capacitors, especially for the lower frequencies, would be large, taking up a great deal of space. Finally, because of the temperature requirements, all capacitors would require tight temperature stability. These capacitors are hard to find, and are also costly. Therefore a new method had to be used to vary the frequency.

Fig. 2 shows the basic circuit that was used. R_{11} and R_{12} are used in connection with R_1 , R_4 , R_5 , and R_9 to form a varying voltage divider which changes the charge impressed on C_1 and C_2 . The voltage across the capacitors and the voltage being discharged are changed. In this manner the frequency of the oscillator could be varied. Fig. 3 shows how the

(Continued on page 194.)

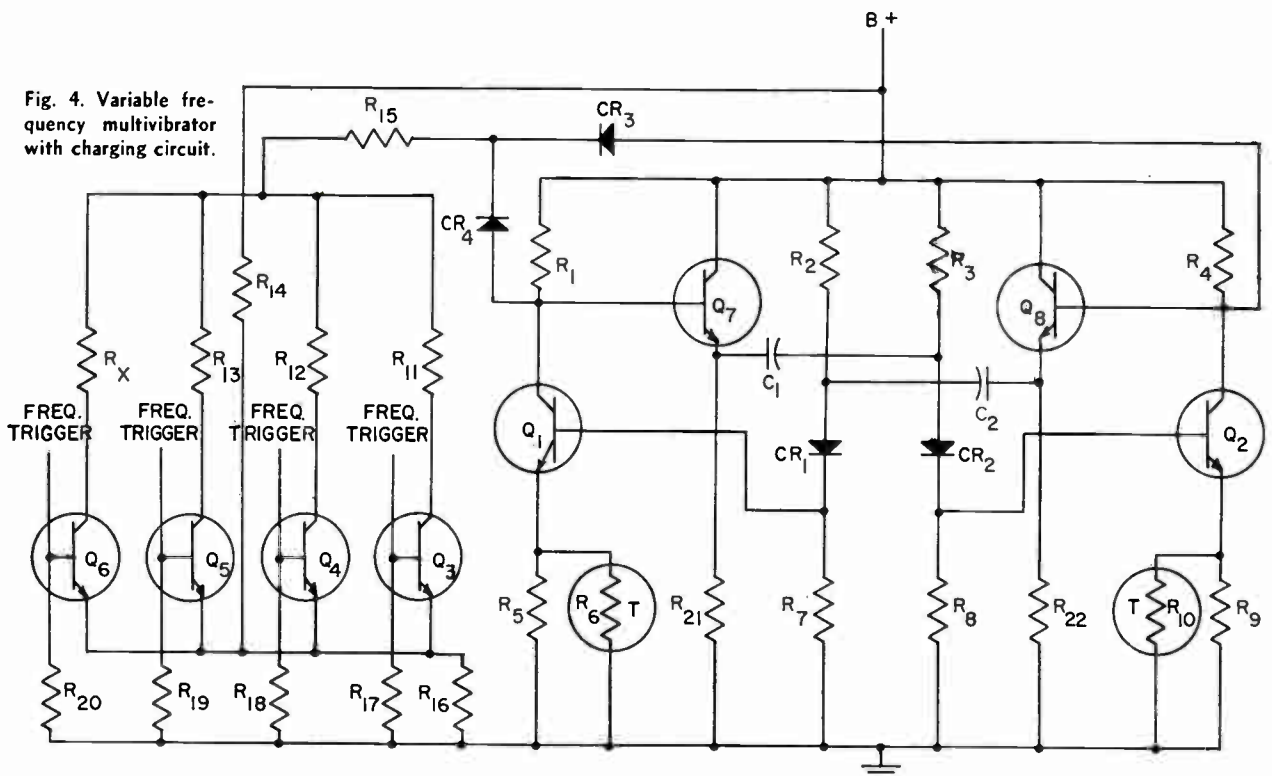


Fig. 4. Variable frequency multivibrator with charging circuit.

DESIGNING ADAPTIVE DIGITAL NETWORKS

Is a machine's ability limited
by the intelligence of its designer?
Or can a machine be designed to learn?
Self-organize?
Here are some thought provoking experiments.

"NEURAL NET" EQUIPMENT WAS DEVELOPED for direct experimentation with the adaptability and reliability of adaptive digital networks.

Neural Net Equipment

The equipment, Fig. 1, consists of a power supply (D), neuron elements (B), threshold adjustments (A), pinboard for the interconnection of the neurons (E), terminal board where the wires are brought out from the cabinet, neon indicators (G), and a switchboard for selecting inputs (H). Pulse generators are used to provide the input pulses.

Fig. 1: For convenience, all of the necessary circuits, the various indicators, and panels were enclosed in a single cabinet.

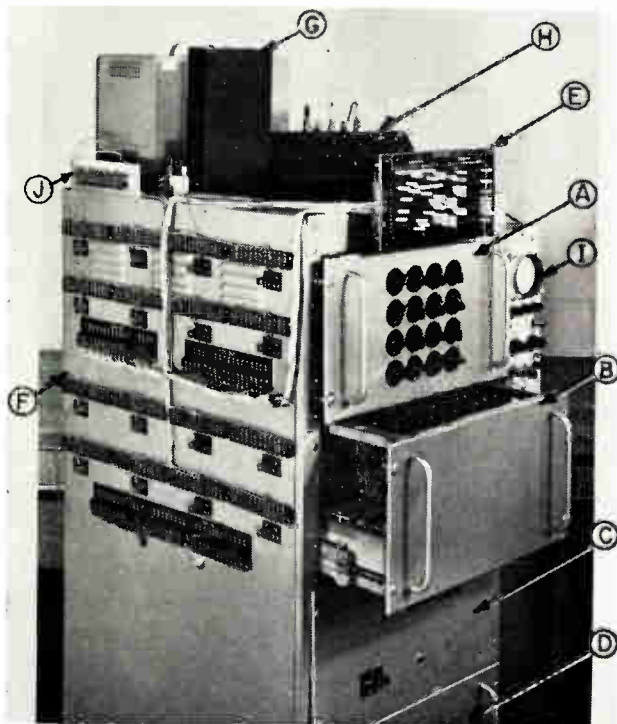


Fig. 2 shows the equipment wiring for one neuron cell. RS and S switches, mounted on (C), connect the neuron element outputs to terminal posts. The posts are connected externally to the CRT Indicator (I), which monitors the outputs.

Neurons

The neuron's characteristics will be discussed later; its circuit is shown in Fig. 3. Most of the components are mounted on a plug-in card, Fig. 4, which is mounted in (B). There are only 16 neurons now, but the equipment can hold up to 55. Not included on the card are: the potential divider used for threshold adjustments (located in A), resistor R1 (on the terminal board F), and the input summing resistors which are inserted in the pinboard (E).

Pinboard

The pinboard has 16 horizontal and 36 vertical connecting strips. The pins, on the bottom in Fig. 4, are inserted at the strip intersections. The resistor, mounted in the pin handle, is thus connected between the two strips. These are the input summing resistors of the neurons.

Neon Indicators

Each neuron's output is monitored by a neon indicator (G). This is an "on-off" type indicator and does not permit time measurements directly, unless a high-speed camera is used.

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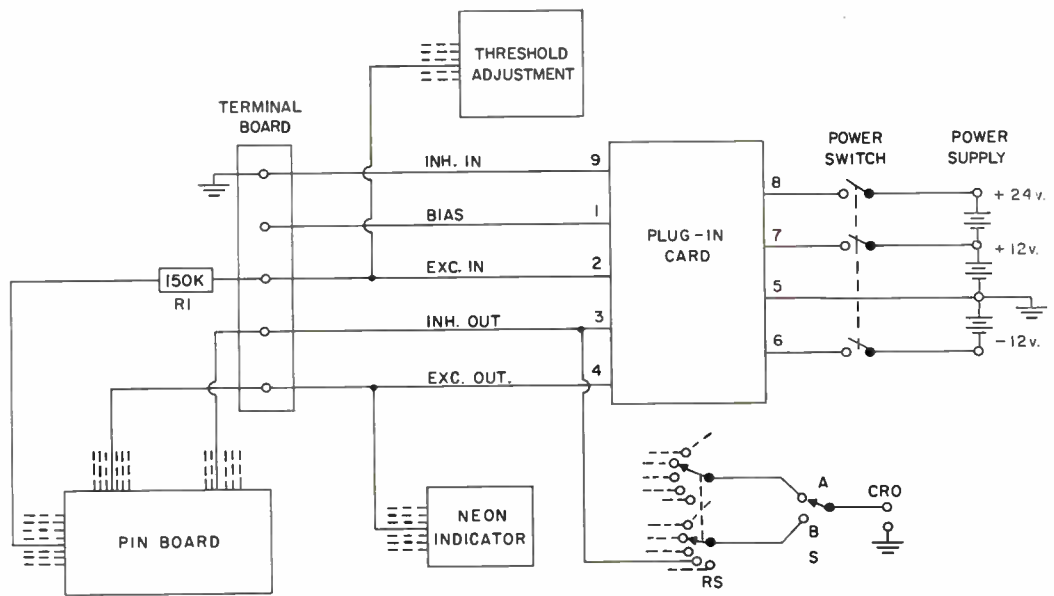


Fig. 2: Wiring diagram of neural net equipment cabinet for one cell.

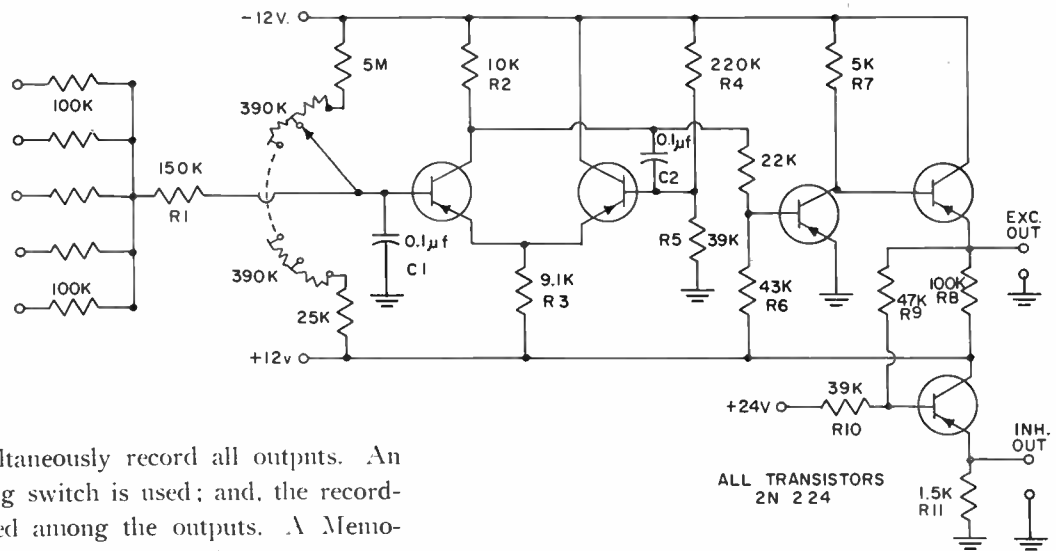


Fig. 3: Circuit diagram of a neuron; most of the components are on a plug-in card.

Recording

We must simultaneously record all outputs. An electronic sampling switch is used; and, the recording channel shared among the outputs. A Memoscope is used to retain the information.

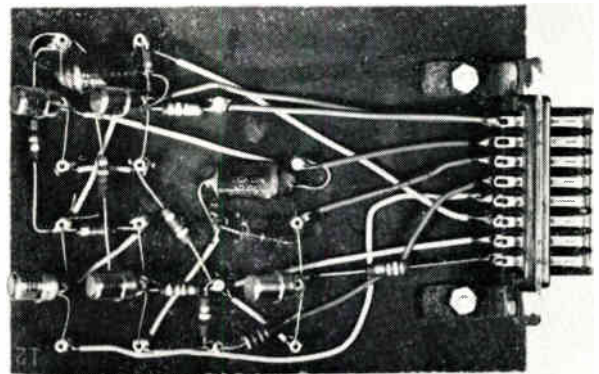
As the electronic switch scans the outputs, the CRT beam is swept horizontally and its trace is blanked by the electronic switch output. On successive sweeps, the trace is displaced vertically by a ramp applied to the vertical input. Thus, the neuron outputs are displayed horizontally; and, each output, in time, vertically. When the neuron is not firing, the trace is bright; when firing, a break appears in the trace.

This recording scheme, Fig. 5, consists of a ring counter using a shift register, AND gates for sampling the neuron outputs, OR gates to mix the other gate outputs, the memory CRT for recording, and a sawtooth generator to provide the vertical deflection and initiate the recording cycle.

Random Net

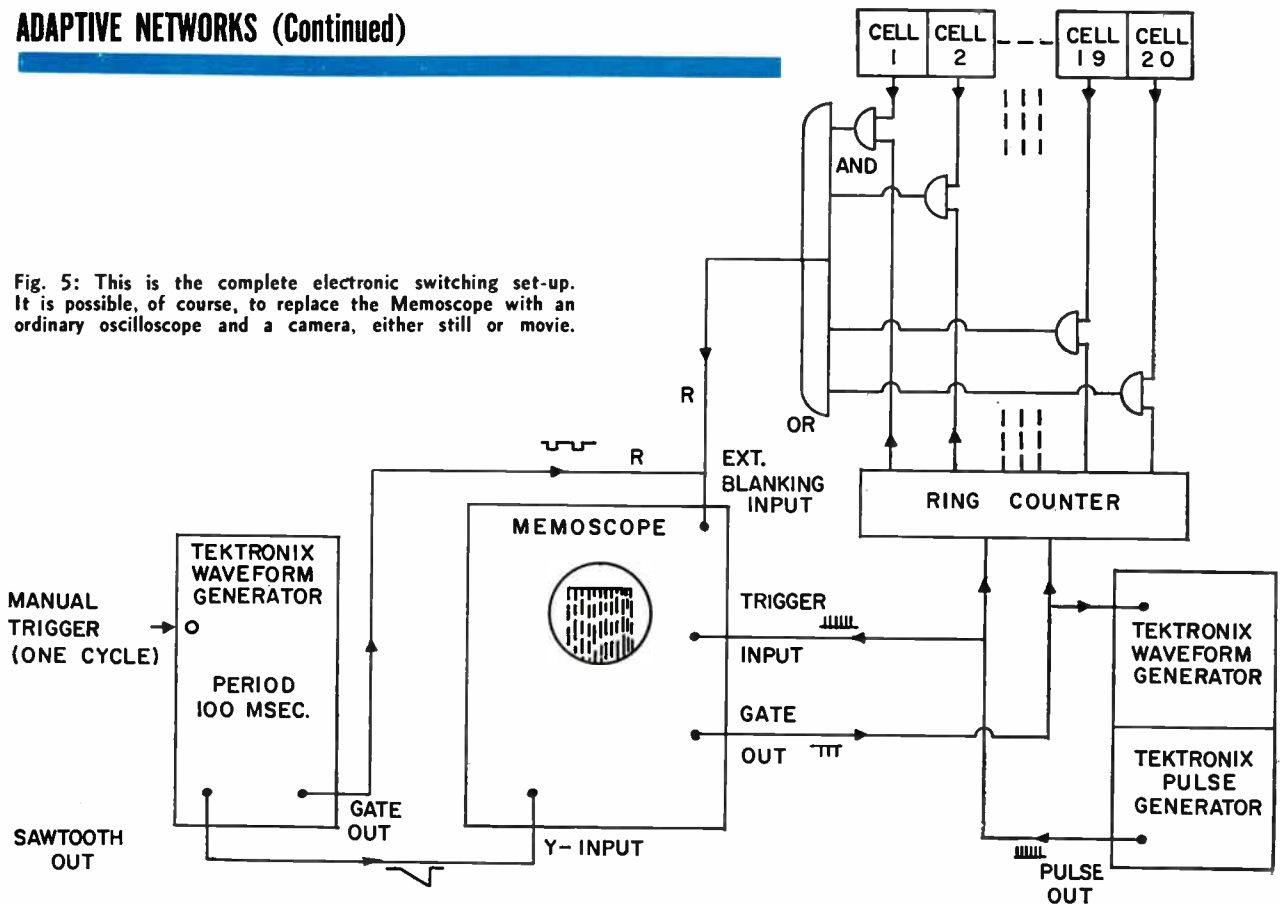
The nets which we used were not completely "random," since some restraints were imposed on

Fig. 4: Neuron plug-in card is made of bakelite and is connected to a 16 connector plug. The threshold potential divider, resistor R1, and summing resistors are not included.



ADAPTIVE NETWORKS (Continued)

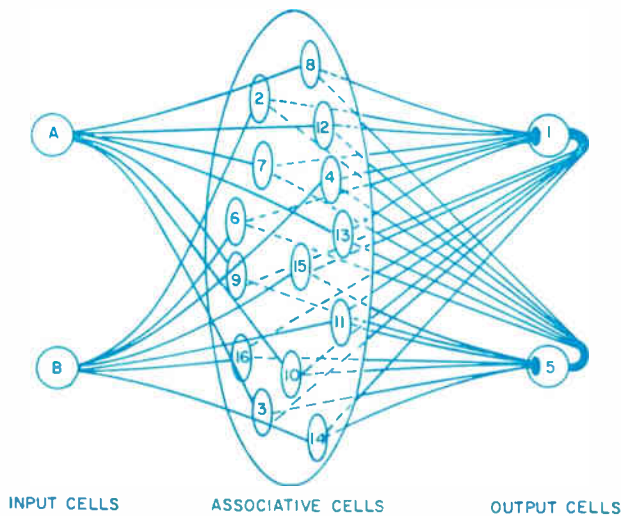
Fig. 5: This is the complete electronic switching set-up. It is possible, of course, to replace the Memoscope with an ordinary oscilloscope and a camera, either still or movie.



connections. In a typical net, Fig. 6, two cells were selected as *input cells*, labeled A and B. The remainder consists of two parts: the *associative cells*, forming the major part, and two *output cells* which show the output of the net.

Each output cell receives connections at random from half the associative cells, and sends inhibitory

Fig. 6: Symbolic representation of a random net shows the relationship of the associative cells to input and output.



connections to the other half. The associative cells receive pulses from the inputs and from the associative cells connected to the same output. The input cells, when activated, excite some of the associative cells. In this net, the connections between the inputs and the associative cells were picked at random.

It is convenient, and instructive, to think of these inputs as patterns of pulses arriving on the layer of associative cells rather than simply two pulse sources. Actually, the two input cells shown can be replaced by a layer of 14 cells, this is also the number of associative cells, called the sensory cells. Each sensory cell is connected to two associative cells selected at random. These connections are picked in such a way that any one associative cell receives connections from two different sensory cells, Fig. 7. Each circle is one sensory cell; the numbers inside show to which associative cells that particular sensory cell is connected.

Patterns are formed on the sensory layer by activating a number of its cells. These patterns are then transmitted to the associative cells through the connections just described. The sensory layer is a convenient way of coding the input patterns. Two such patterns are shown in Fig. 8. The diagrams on the left show the patterns as applied to the sensory

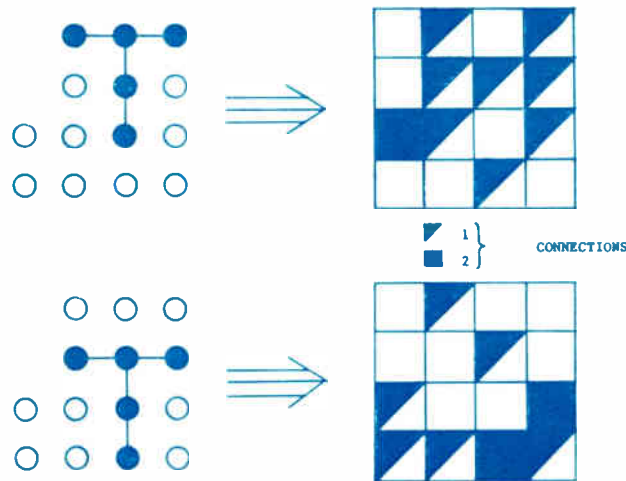
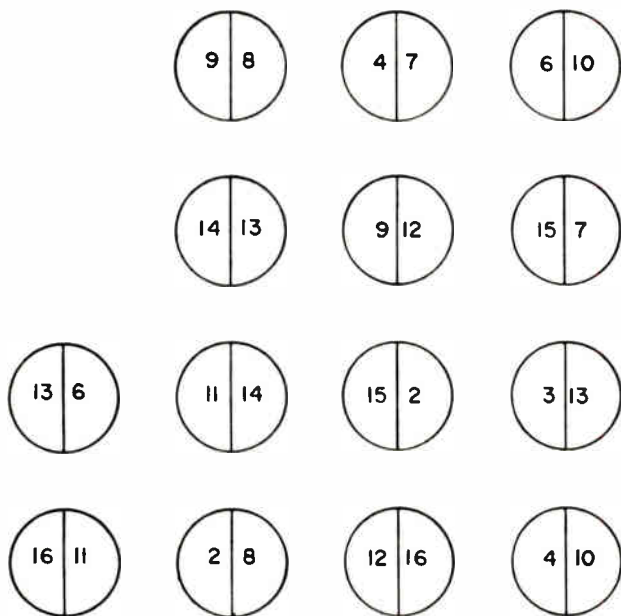


Fig. 8 (above): Typical input patterns and how they are coded.

Fig. 7 (left): The numbers inside each sensory cell in this layer show to which associative cells that cell is connected.

cells; on the right, the same patterns as they arrive at the associative cell layer. Each small square represents an associative cell.

In the experimental set-up, it is not essential to include the sensory cells; we can always code the input pattern and map it directly on the associative cell layer. Changing the input pattern on the sensory layer is the same as picking a new set of connections between the input and the associative cells—as originally described. The sensory layer is a device which gives a convenient way of classifying the input patterns.

Electronic Neuron

The neurons used have the main characteristics of their biological counterparts: all-or-none output, threshold, summation time, delay, reverberatory period, and additive inhibition (as opposed to absolute). The circuit is a modification of that developed by L. D. Harmon³.

The cell output is a 12 volt, 4 msec pulse. It is available with two polarities: one for excitatory and one for inhibitory pulses.

The input pulses arriving at the cell are summed by resistors followed by an RC integrating circuit. The summation time is from 1 to 4 msec, depending on the threshold. The summation time is a period during which overlapping input pulses are summed.

The integrating circuit triggers a monostable multivibrator which produces a 4 msec rectangular pulse. Since the integrating circuit gives an exponential rise to arriving pulses, its output reaches threshold value, triggering level, after a delay of from 0.5 to 4 msec, depending upon the excitation and the threshold value. The threshold is changed by a variable bias at the multivibrator input. This bias is adjusted with a potential divider, controlled by a rotary switch. The switch permits threshold adjustment in 11 discreet steps.

Experiments

Experiments testing the ability of a net to adapt itself to certain tasks, *learning* or *self-organizing*, such as recognition of two input patterns as different, were conducted.

A flow diagram of the system is shown in Fig. 10.

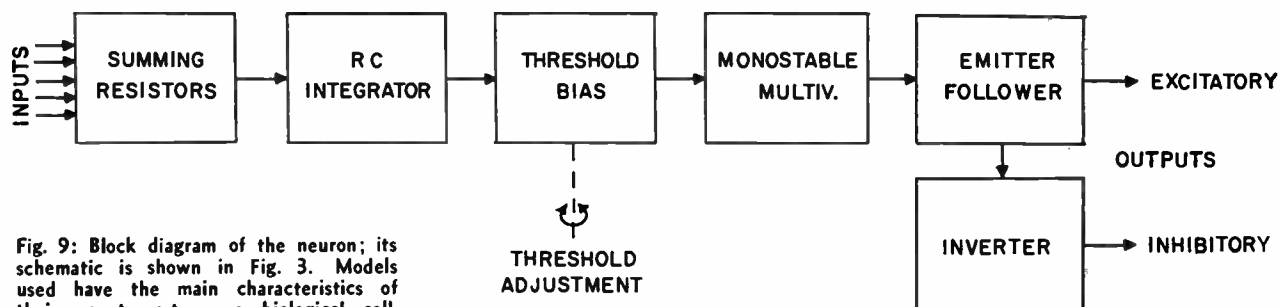


Fig. 9: Block diagram of the neuron; its schematic is shown in Fig. 3. Models used have the main characteristics of their counterpart — a biological cell.

ADAPTIVE NETWORKS (Continued)

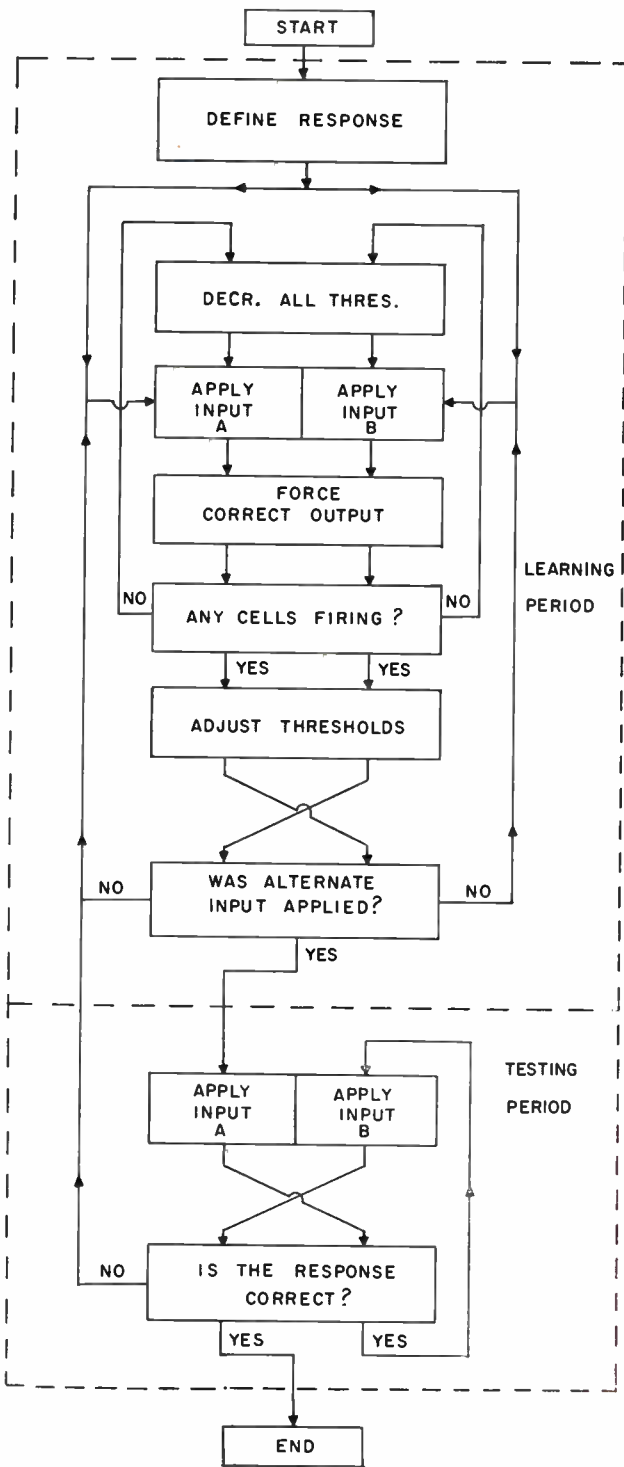


Fig. 10 (above): Flow diagram of the procedure used in the experiment to test the ability of the net to recognize two input patterns as being different has just two basic parts.

Each experiment consisted of two parts: the learning period, when the net is forced to yield the desired correct response; and, a testing period when the net is allowed to respond naturally to the excitation.

To start the learning period, one input pattern is applied and the correct response is forced by firing the selected output cell. This is done by external adjustment of its threshold. If none of the associative cells fire, then all their thresholds are reduced, until some of them do. Since the output cell that is fired externally inhibits the associative cells not connected to it, the associative cells that fire are those that contribute to the firing of the correct output. The thresholds of these cells are decreased and those of the other cells increased. The other input pattern is then applied and the procedure repeated. Next, we go to the test period.

The output cells are now allowed to operate normally; the input patterns are applied, in turn, and the output recorded. Should the response be incorrect, the learning period must be repeated. If it is correct, then the net will successfully distinguish the inputs. But it might happen that the net was able to do so from the very start; therefore, in the second experiment, the task to be performed with the same two input patterns is changed and the net tested once more.

In one experiment, Fig. 11, blocks of 16 small squares are used to record the progress. The first block shows the number of the cell represented by

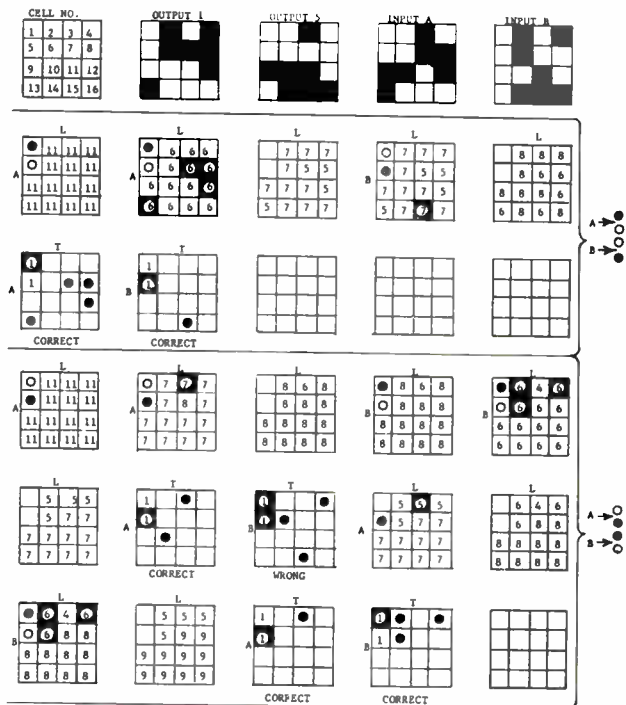


Fig. 11 (right): Progress of the learning experiment is reflected in these blocks. A complete explanation is given in the text. Numbers inside squares are threshold values.

each square. Cells 1 and 5 are output cells; the others are associative. The next two blocks show which associative cells are connected to outputs 1 and 5 respectively; the next two, the associative cells excited by input patterns A and B; and those remaining, the results of the experiment proper. The letter beside the block is the input pattern applied, A or B; the letter above, the period—learning or testing, L or T. The numbers inside the small squares are the threshold adjustment settings.

The first task was that input pattern A should fire output 1, and B should fire 5. Input pattern A was applied, cell 1 was forced to fire. No associative cell fired; so all thresholds were decreased until, at setting 6, four associative cells fired. The thresholds were adjusted, then the input pattern B applied. One associative cell fired; the thresholds were again adjusted. Then, in the test period, the responses were correct. The second task was the reverse: A should fire 5 and B should fire 1. The same procedure was repeated. But this time, in the test period, one response was wrong. So, the

learning period was repeated. In the second test, the response was correct. Thus, the net was able to recognize the patterns under two different sets of conventions.

Although in this experimental setup the threshold adjustments are made manually, they can be automated so that the net adapts itself, or learns, to perform the task required.

Conclusions

We have reported here on the series of preliminary experiments on the adaptability of "random" digital networks. The same equipment can be used to study the effects of the individual neuron failures on the reliability of performance of the learned task. Much more remains to be done in this important and rapidly growing field of adaption and reliability of digital equipment.

References

1. Boshko, O., Glinski, G. S., Therrien, J., "Simulation of Learning Processes," Univ. of Ottawa.
2. Boshko, O., Glinski, G. S., Therrien, J., "Reliable Digital Networks from Unreliable Components," Univ. of Ottawa.
3. Harmon, L. D., "An Electronic Model of a Nerve Cell," *Semiconductor Products*, Aug. 1959.

CIRCUIT-WISE

MONOSTABLE MULTIVIBRATOR

THIS IS A MONOSTABLE MULTIVIBRATOR designed to perform the delay function in a compatible set of digital logic circuits for use in computer, control, and communications equipment operating within the temperature limits of -30 and $+60^{\circ}\text{C}$. Delays between 2 microseconds and 100 milliseconds can be obtained by selection of feedback capacitor C1. The timing resistor, R3, may be replaced by a variable resistor to provide adjustment of the time delay.

Components:

$$C1 \text{ (pf)} = \frac{\text{Total time delay } (\mu\text{sec})}{3.9 \times 10^{-3}}$$

Max. power dissipation (note 2): R1, R7: 180 mw;
R2, R4, R5, R6: <10 mw; R3: 12 mw.

Limits (these are not tolerances see note 3): R5:
 $\pm 20\%$; all other R: $\pm 5\%$. C1: $\pm 5\%$; all other
C: $\pm 10\%$.

Operating characteristics:

Temp. range: -30°C to $+60^{\circ}\text{C}$.
Total time delay (note 4): 2 μsec to 0.1 sec.
Recovery time: About 25% of total time delay.

Input pulse characteristics:

Polarity: Negative
Amplitude: 6 volts $\pm 10\%$ referenced to ground.
Rise time (note 5): $\leq 0.4 \mu\text{sec}$.

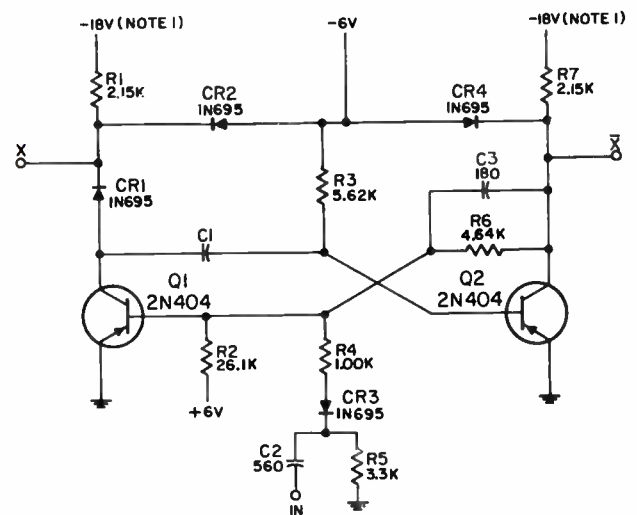
Width at 50% amplitude: 0.5 μsec minimum.

Power requirements:

-18 volts $\pm 10\%$ at 10 ma.
-6 volts $\pm 10\%$ at 10 ma.
+6 volts $\pm 10\%$ at 0.25 ma

NOTES:

1. The -18v supply is obtained by connecting a -12v source in series with the -6v supply.



Unless otherwise stated; R in ohms; $C > 1 \text{ in } \mu\text{mf}$; $C < 1 \text{ in } \text{mf}$; L in μh

2. These are the maximum powers dissipated in the resistors. In determining these values, allowance has been made for variations in component values, power supply voltages, and transistor characteristics.

3. The performance specifications are based on component values which do not deviate from the nominal by more than the limits specified. Thus the term "limits" includes the initial tolerance plus drifts caused by environmental changes or aging.

4. The total time delay is a function of R3, C1 and is the time interval between the points where the leading edge of the input signal and the trailing edge of the output signal have completed 10% of their total amplitude change.

5. Rise time is used in the usual pulse sense to mean the time required for the leading edge of the waveform to change from 10% to 90% of its maximum amplitude; fall time is the time required for the trailing edge of the waveform to decrease from 90% to 10% of its maximum amplitude.

Abstracted from "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment" (NAVWEP 16-1-519-2), Volume II.

IMPROVING SEMICONDUCTOR RELIABILITY

Space activities have emphasized the importance of component reliability.

Here is a basic approach towards improved reliability in semiconductor devices. The simple methods contained here can be used by every manufacturer of these devices.

RELIABILITY IS DEFINED AS: *The probability that a device will operate within given limits for a given time under a given operating condition.*

A. Reliability objective:

Before we start any program, the reliability objective must be completely defined in specific terms. For semiconductor devices, this is usually defined in failure rate per thousand hours, within a given confidence level, for a given time interval and operating conditions, e.g., 0.001%/1000 hrs., in a 4000 hr. time interval at 25°C and 50mw, with 60% confidence.

B. Define required organizational set-up, procedures, and responsibilities:

Evaluate present organization, and if needed make adjustments. Each segment of the organization along with its procedures and assignment of responsibilities should be clearly defined.

C. Set-up control and monitoring systems:

A controlling system should be established to evaluate the progress we make in our reliability effort.

Scope

A reliability program must cover all phases of

design, development, procurement, manufacturing, test, and field evaluation. This can best be shown by the schematic reliability feed back loop in Fig. 1.

This loop can be exploited efficiently only if a lot control system is established on the line. The main objective of lot control is to maintain the production history of each group of devices so that failures from any source may be related to the production process used. The lot control method must be capable of relating control data to individual groups of devices.

In Process Quality Control (IPQC)

A lot control system and IPQC records of the percentage escape of discrepant devices, creates a second full loop in the reliability feedback system; and, it gives us the opportunity to study the effect of assembly failure modes on the failure rate.

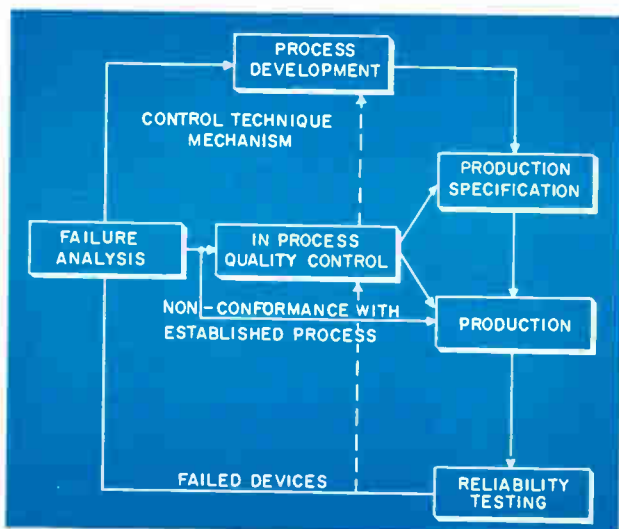
Reliability can be improved because the system enables us to measure the importance of a variable by the magnitude of its effect as compared to the individual effects of all other variables.

Plotting failure rate against the percent escape of discrepant devices per failure mode, Fig. 2, gives us an insight into the inter-relationship of the defect criteria. Knowing the effect a failure mode has on the failure rate, we can reduce those failure modes associated with production by improving processes, controls, or the design of the device itself.

Failure Analysis

The failure analysis group analyzes discrepant devices, assigns the cause of failure, and recommends corrective action. This is a very important link in the reliability loop.

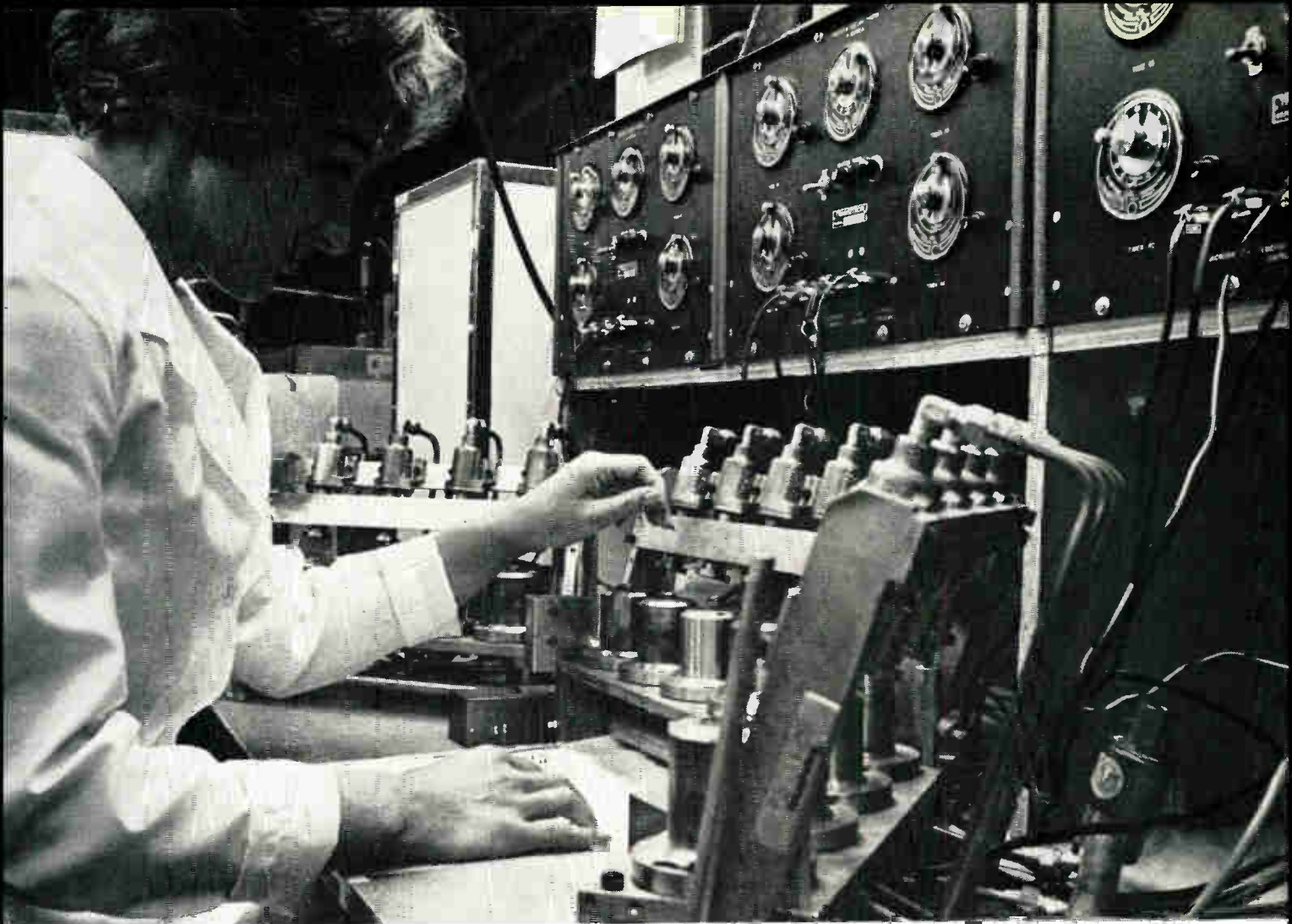
Fig. 1: This reliability feedback loop can be exploited only if a lot control system is established on production line.



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Having achieved process stabilization, mechanization of production steps is undertaken to provide more uniform quality.

This new semi-automatic diode sealing equipment was developed for the reduction of the failure mode at Transitron Corp.

Reliability Testing

A popular form of reliability testing is "Burn-In." This is a short time life test, usually at higher power levels than the regular operating life test conditions. Its main objectives are:

- a. Detect device weaknesses before release to conventional life testing or field use.
- b. Obtain a quantitative estimate of the device reliability.
- c. Monitor manufacturing process improvements.

Optimum burn-in time and power conditions must be determined by experiment; and, must fulfill the requirement that the combined effect of power stress and test time will:

- a. Remove potential failures.
- b. Not produce ill effects on inherently good units.

Often stability can be an indicator of reliable operation at a given operating time. A device that shows parametric stability over a period of time represents the greatest possible assurance of reliability.

Almost all device failures are preceded in time by a significant change in one or more parameters. It is extremely important that all data be analysed in terms of parameter change as well as absolute values.

For diodes, the inverse current parameter at a given voltage is usually the best predictor of parametric stability.

To act as an efficient screen for potential failures, "Burn-In" can only be applied to devices which show a decreasing failure rate with time.

Fig. 3 was derived from germanium diodes and show the change in leakage current as a function of life test hours for a given power level. Case B is not suitable for burn-in, as the inverse current shift increases with time.

Knowing the End of Life (EOL) specifications at a given time, the units can be prescreened to internal manufacturing specifications.

(Continued on the following page)

SEMICONDUCTOR RELIABILITY (Continued)

LOT NUMBERS	% Escape of discrepant devices			FAILURE RATE
	Failure Mode I	II	III	
S_1	a_1 %	a_1 %	a_2 %	F_1 %
S_2	a_3 %	a_2 %	a_6 %	F_4 %
S_n				

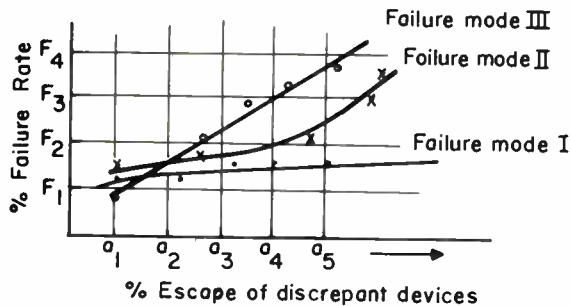


Fig. 2: This plot shows the relationship of defect criteria.

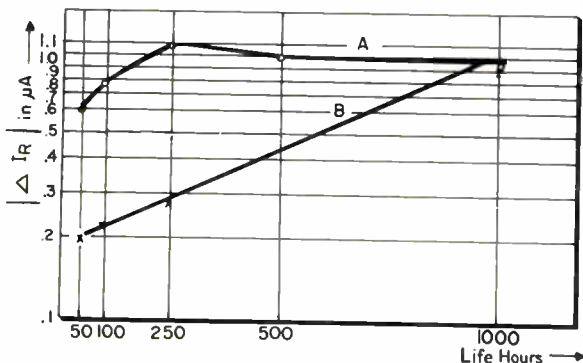


Fig. 3: The change in leakage current as a function of life test hours for a given power level for germanium diodes.

Fig. 4: Frequency distribution form for the inverse parameter.

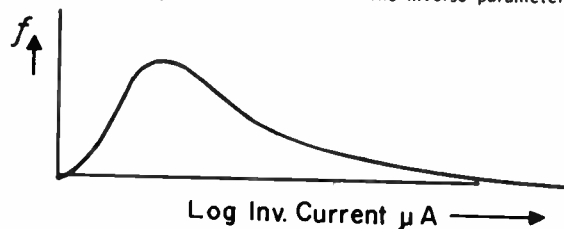


Fig. 5 (below): A matrix of this form is generally used in testing to generate a series of derating curves, which curves also provide a means of relating statistical parameters.

Temp. Stress ↓	Power Stress ↓	A mw	B mw	C mw
		a °C		
b °C				
c °C				

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Chestnut & 56th Sts., Phila. 39, Pa.

As mentioned before, the inverse parameter at a given voltage gives us the best indicator of device stability. This particular parameter has the characteristic of having a value from 0 (open) to infinite (short), and has the frequency distribution form shown in Fig. 4.

There are different mathematical expressions which fulfill the boundary conditions of

$$f(x) = 0, \quad -\infty < x < 0$$

$$f(x) > 0, \quad 0 < x < \infty$$

But a simple method has to be found that can express the inverse current characteristic adequately. The best way is to use the graphical approach. An orthogonal axis system should be found that can represent the inverse characteristic as a straight line or combination of straight lines (multimodal distributions). The logarithmic X^2 paper seems to be a very good approximation.

The practical use of this approach is very broad, especially since more than 80% of all electrical failures in the diode family can be contributed to an inverse failure. The method can be used for:

- Monte Carlo approach for reliability prediction.
- Predicting yield losses at given specification limit changes.
- Establishing proper specification limit for screening prior to life testing.
- Etc.

Exhibit II is an Inverse current plot on log - X^2 paper.

Matrix Testing

Generally, the purpose of a matrix test is to generate a series of derating curves which will give quantitative descriptions of functional relationships between failure rate, stress factors and time. The curves also provide a means of relating statistical parameters to time under different test conditions. The matrix usually has the form shown in Fig. 5.

A matrix must be designed so that the number of devices allocated in each cell yields a sufficient number of failures under the chosen power and temperature stress. This is needed to assure a sufficiently high confidence level. However, if by misjudgment the matrix does not yield enough failures, "failures" can be generated by simply tightening the failure criteria. The greater part of diodes follow a Weibull failure distribution.

A set of Weibull curves can be delivered for each matrix cell. And, the effect of ambient or junction

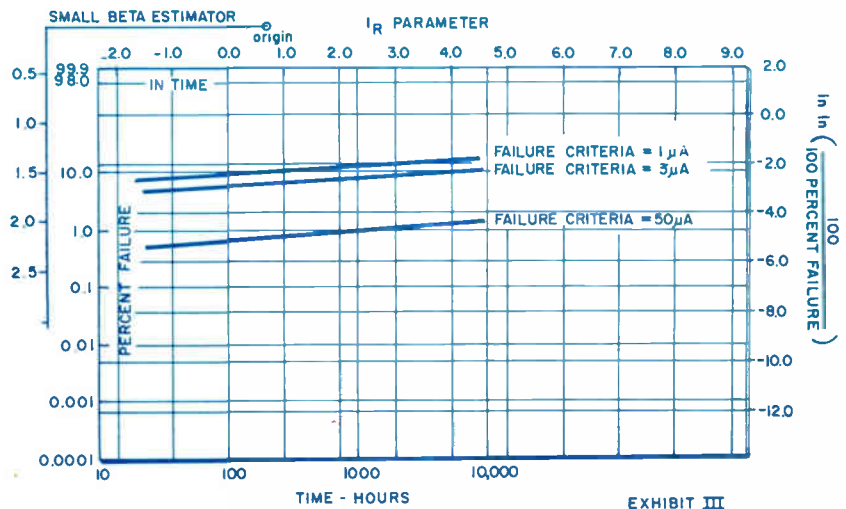


Fig. 6: A Weibull plot for silicon diodes at 3 different failure criteria.

temperature and power stress on the failure rate or the Weibull parameters can be studied and analyzed.

Fig. 6 shows a Weibull plot for silicon diodes at three different failure criteria. With these plots, the interrelationship between different failure criteria can be determined.

High Stress Life Testing

Present requirements (Minuteman requires a three-year operating life test) need a new method of life testing which will show the device reliability in a much shorter time to provide for a short cycle feed back loop to "Production." Test conditions must be designed so that the mechanisms which are dominant in causing device failure will be accelerated. These tests provide us with:

- a. A quick comparative evaluation of new devices, new processing techniques, and production outputs in given time intervals.
- b. A method to predict failures as a function of stress and time.
- c. More "pronounced" failures to perform analysis and to detect new or more sophisticated failure modes.

A form of high stress life testing, "the step stress method," is increasing in popularity. A device is aged for a given time at successively increasing stress, until it fails. Usually, the increase in stress is done in steps. The stress level at which the device fails is then considered as the stress necessary to cause the failure, Fig. 7.

A failure distribution can thus be generated, which can be related back to a functional relationship of failures to stress and time, Fig. 8.

One weak point in this method is that we must assume that at each stress level the effect of previous stresses can be disregarded.

To avoid this assumption, several samples are aged at different fixed stress levels. The 50% points of the life hours from each sample can then be determined by plotting the cumulative failure percentages as a time function, on suitable graph paper. The 50% points are then plotted as a function of the stress.

Another important weak point in using the step stress method is the high probability that at higher stress levels, failure mechanisms can be activated, which will not be present under actual conditions. No general rule can be given for avoiding this problem. Experiments are being run to determine the best approach in reducing this error to a minimum.

Fig. 7 (above): A graphic presentation of the step stress method of life testing which is increasing in popularity.

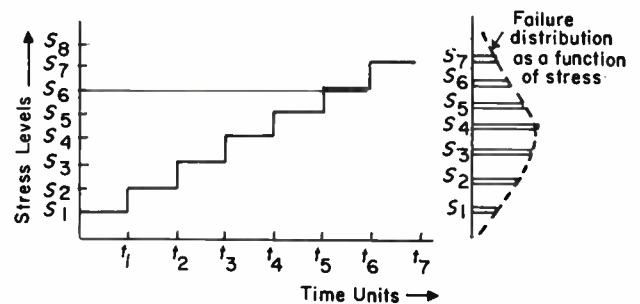
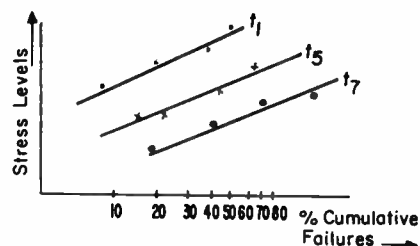


Fig. 8 (below): This failure distribution reveals the functional relationship of the failures to stress and to time.



Many systems need built-in circuitry to supply several frequencies for testing and calibration.

Simplified design information for such circuitry is given here.

The circuits described can supply up to eight frequencies.

The frequency selection can be made automatically.

A Simple Approach to

AUTOMATIC FREQUENCY SELECTION CIRCUITRY

MANY ELECTRONIC SYSTEMS must have circuits built-in that can supply any one of several oscillation frequencies. Also, these frequencies must be selected or changed automatically by a control signal. However, this usually means large amounts of circuitry. Fig. 1 is a block diagram of a simple method for doing the job. It uses a logic control which actuates 3 logic switches to obtain the output frequency. The logic control may be any device such as a relay, a gate circuit, or a tape-controlled stimulus. The 3 logic blocks, which may be any logical switch, permit the wanted frequency elements to be selected.

As an example, the need for this type of circuit may be seen in the testing of computers. Computers must operate at frequencies above and below the design frequency to insure functioning under worst-case conditions. The test equipment must be able to inject each of the 3 frequencies: design, upper-limit, and lower-limit.

*Mr. Leary was with the General Electric Co. when this article was written.

The Test Oscillator

Fig. 2 shows a simple circuit using transistors as single-input NOR gates. It is a logic-controlled, test oscillator that can operate at any one of 3 fixed, stable frequencies in response to input signals from a logic control.

Transistors Q1 through Q3 are used as single-input NOR gates. Any one of the 3 frequencies may be chosen by changing the input voltage state of the NOR gate associated with the frequency-determining components. The two input states are an open circuit and a short circuit. The grounding of an input permits the associated feedback path to be placed into the loop of the oscillator. This results in oscillation at the chosen frequency. The inputs to the others are left in the open state, thus bypassing their frequency-determining components in the "L" pad attenuator.

The oscillator (Q4, Q5, and Q6) is basically a hybrid type and may be considered a linear amplifier with $1/\beta \times$ unity power gain. Q4 and Q5 comprise

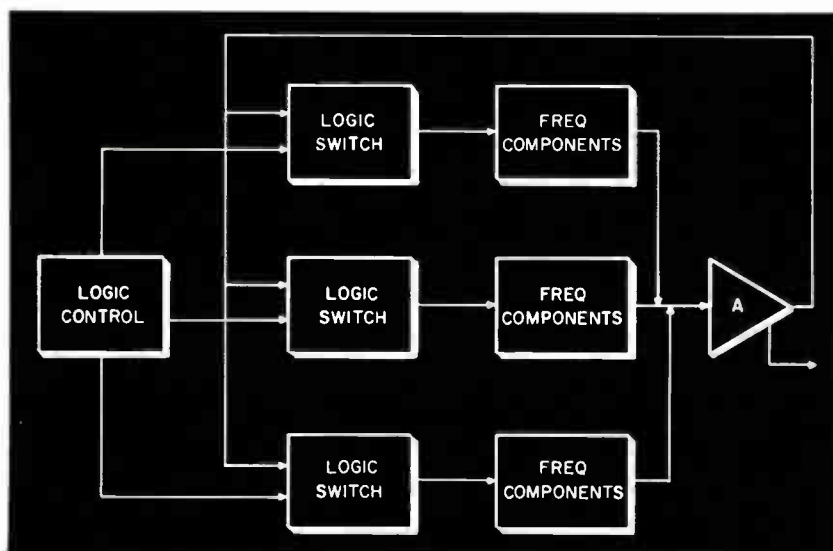


Fig. 1: Block diagram shows a simple method of automatically selecting a frequency. Logic control could be a relay.

By CHARLES E. BRADY

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Undersea Warfare Engineering
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and BURTON LEARY*

Sr. Member of Tech. Staff
Aerospace Communications & Control Dept.
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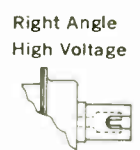
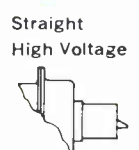
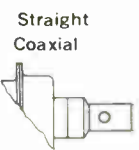
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FREQUENCY SELECTION (Concluded)

a large-gain input stage used to initially excite the natural oscillatory mode. Q6 is used for phase reversal, and to limit and hold the amplitude of oscillation by placing nonlinearity into the system. The positive peaks are limited by high-current, low-voltage saturation, and the negative peaks, by high-voltage, low-current cutoff.

The clipping of the wave shape does create some harmonics, but they are largely filtered out through C4, C7, and C10 to ground. Because the hard clipping is needed for fast oscillation build-up, more loop gain, to compensate for loss of power in the harmonics within the loop, must be provided.

This oscillator has to produce a symmetrical square-wave output at any one of the three frequencies. For this reason, the step-up transformer, T1, is placed in the linear region of the amplifier loop and is loaded. The output of T1 is then symmetrically clipped by Q7, and is amplified by Q8. Since the large voltage output of T1 is clipped at a low voltage level, and since Q8 saturates well before Q7 turns completely off, the gain of Q7 accelerates the changes in input signal and improves the rise and fall time of the output square wave. C13 is used as a speed-up capacitor to give faster switching action. Q9 is a complementary emitter-follower. It is used as a low-impedance drive on both halves of the output cycle: when Q9 is on, it provides a low-impedance output drive; when Q9 is off, CR2 and the saturated Q8 provide the low impedance output drive.

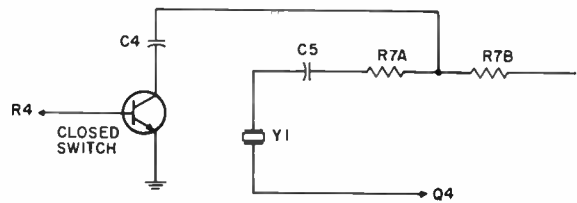


Fig. 3: Frequency tolerances can be tightened by tapping R7.

Basic Operation

The 3 switching circuits operate in the same manner. For example, when Q1 is driven into saturation, the combination of C4 and Q1 form an ac grounding shunt to crystal Y1, thus removing this crystal from the feedback loop. When Q1 is driven to cutoff, the path present does not appreciably attenuate the gain of the amplifier. Thus, the wanted crystal is placed in the feedback loop and oscillation occurs.

In the circuit shown, precision of frequency was less important than having a symmetrical square wave. Frequency tolerances can be tightened (at the expense of square-wave symmetry) by improving the isolation of the crystal and trimming capacitor from the shunting effect of C4. This can be done by splitting R7 into two resistors, and tapping off C4 between them at the node in a "T" pad attenuator (Fig. 3).

A greater number of output frequencies may be obtained from the circuit by the use of LC networks, instead of crystals, as the frequency elements. This change would enable eight different frequencies with logic control to be obtained.

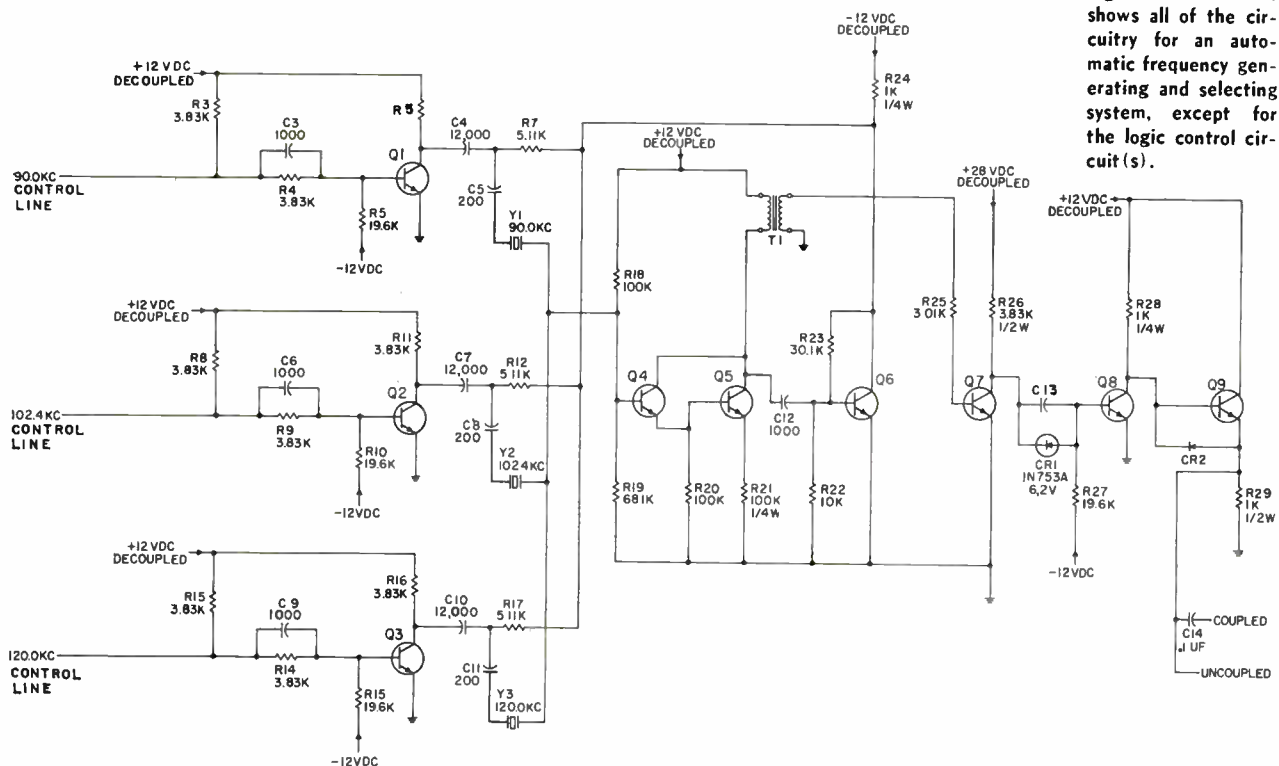
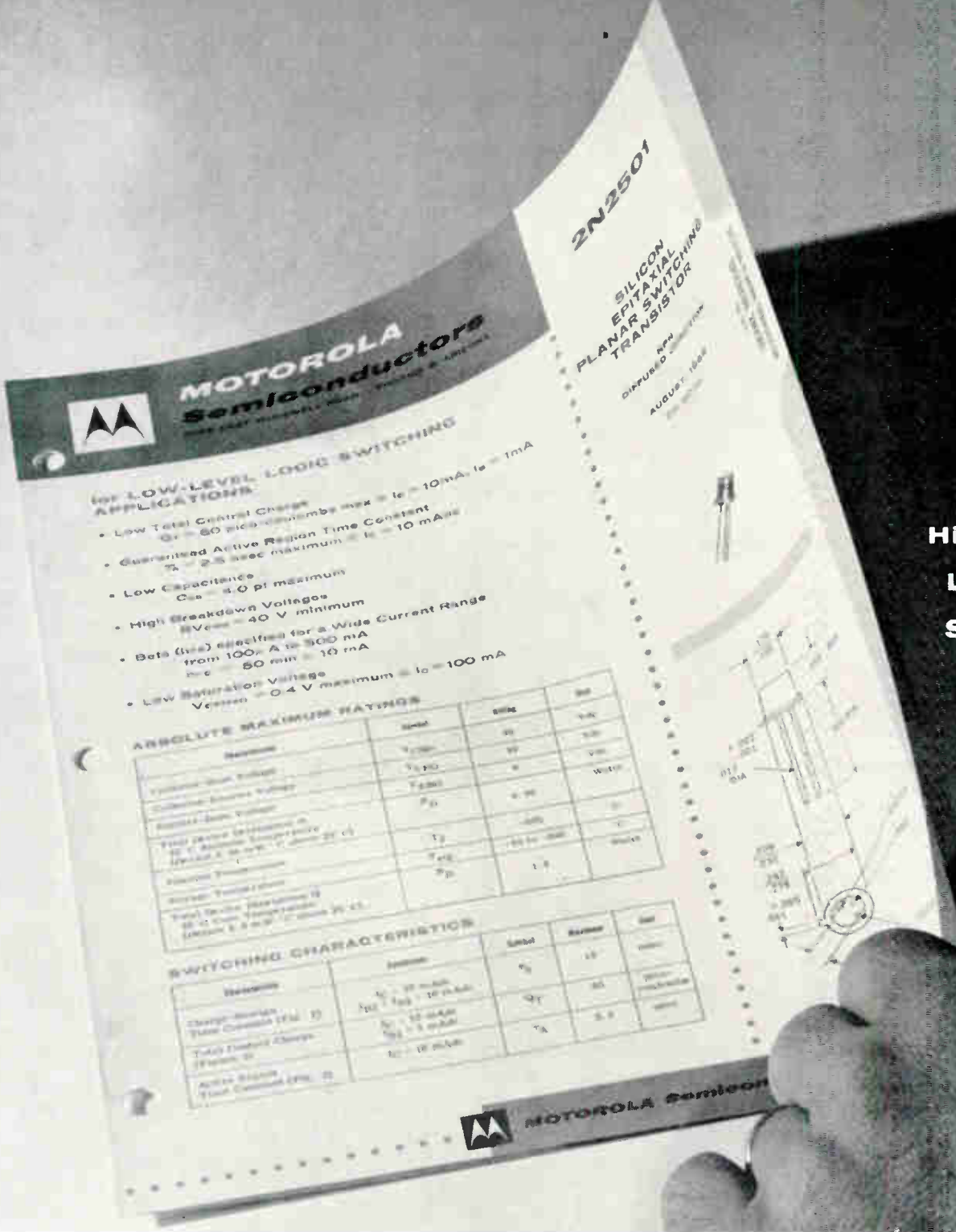


Fig. 2: Schematic shows all of the circuitry for an automatic frequency generating and selecting system, except for the logic control circuit(s).



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Diode Guides

The subminiature Glass Diode Reference Guides are available from National Transistor, a subsidiary of ITT, 500 Broadway, Lawrence, Mass. The 4-page publications give the characteristics and test specs. for over 400 diodes currently registered by EIA. The diode guides are published in two parts, one devoted to germanium and the other to silicon types. Characteristics covered include, PIV, forward current and voltage, reverse current and voltage, high temp. reverse current, reverse recovery time, test circuit and capacity.

Circle 190 on Inquiry Card

HV Power Supplies

An engineering paper titled, "Design Information for Regulating HV Power Supplies," 9 pages (well illustrated) with schematic diagrams of typical circuits using Corotrons, corona type high voltage regulator tubes. It covers both fundamental theoretical concepts and gives practical solutions. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 191 on Inquiry Card

Low Noise TWT Catalog

Catalog RW101, 8 pages, illustrates and gives complete tech. details on a compact lightweight permanent magnet focusing TWT with less than 6.5db noise figure, over 27db gain, a 300v collector voltage, 260v helix voltage and 2900 to 3300mc freq. range. Warnecke Electron Tubes, Inc., 175 W. Oakton St., Des Plaines, Ill.

Circle 192 on Inquiry Card

Transistor Amplifiers

"Design of Wideband Transistor Amplifiers," describes the design considerations for using the RCA 2N697 and similar types in wideband transistor amplifier circuits. Application Note SMA-7 explains the use of negative feedback to shape the loop gain to attain desired bandwidths. The design of a 3-stage 1mc carrier amplifier, also useful as a 4mc video amplifier, is discussed in detail. Radio Corp. of America, Commercial Engineering, Sommerville, N. J.

Circle 193 on Inquiry Card

Switch Circuits

This 40-page brochure is illustrated with over 58 schematic diagrams, photographs and charts, and furnishes detailed specs. and theory of operation on latest modules and circuit information on the BEAM-X module and circuits. It is divided into 6 sections covering transistorized decade counters; binary decoder modules; low frequency decade counters; and the Universal module. A section on general applications for BEAM-X switch circuits is included. Brochure No. 405 is available from Burroughs Corp., Electronic Components Div., Plainfield, N. J.

Circle 194 on Inquiry Card

Touch Control Switch

This 6-page brochure describes the "Touch Control Switch," a capacity operated device that can be turned on and off with the touch of a finger. Circuitry is designed around the Dynaquad. Illustrations, electrical and physical specs., block diagram and also 6 types of Dynaquads having different operating characteristics are included. Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J.

Circle 195 on Inquiry Card

Magnetic Core Blocks

This 14-page catalog illustrates a line of transistor and magnetic core digital building blocks. Complete specs., simple rules for logic and loading, and full information on assembling these units into systems, is included. Various aids are described, such as "Sew-A-Circuit" cards for mounting modules, racks, power supplies, layout, and logical symbol sheets. Magnetics Research Co., Inc., 179 Westmoreland Ave., White Plains, N. Y.

Circle 196 on Inquiry Card

Bernoulli Disk Memories

Tech. data bulletin series 2200 describes specs. and applications of lightweight, compact Bernoulli Disk rotating magnetic storage devices. Thirty-eight pages of information includes numerous illustrations on simplicity of design, storage capabilities and environmental range of stock-and-vibration-insensitive units. Also included is an article entitled "The Development of the Flexible-Disk Magnetic Recorder." Laboratory for Electronics, Inc., Computer Products Group, 1079 Commonwealth Ave., Boston 15, Mass.

Circle 197 on Inquiry Card

Cryogenic Data Cards

Latest data on physical properties of cryogenic gases is available in both wallet size cards and 8½ x 11 in. size charts. Information includes low temp. physical properties of 34 various gases and the weight and volume equivalents of oxygen, nitrogen, air, helium, argon and hydrogen. Air Products and Chemical, Inc., Allentown, Pa.

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Wire Markers

This 16-page Wire Marker catalog lists over 4700 different stock products. Illustrated and described are the Brady standard ¾ in. or 1½ in. long self-sticking Wire Markers in 4 standard materials. Other stock marker sizes for specialized uses include ½ in. long and 5/16 in. markers for small diameter electronic wires, and extra large 3½ in. long cable markers. The entire page is devoted to the IPCEA - NEMA number-color sequence specs. for control cables. A wire marker kit containing the catalog and testing samples is available from W. H. Brady Co., 130, 726 W. Glendale Ave., Milwaukee 9, Wis.

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Heat Sink Catalog

This condensed catalog features a complete line of more than 30 types of Thermalloy aluminum heat sinks. Included is a concise summary of pertinent information necessary for designing in and packaging, dimensional cutaway drawings, performance curves, weight of devices, and other specs. Also included are heat sinks for all TO-5, 8, 9, 18 and all popular power transistor case types. Thermalloy Co., 4417 N. Central Expressway, Dallas 5, Tex.

Circle 200 on Inquiry Card

Clean Room Glossary

A glossary of terms used in Clean Rooms with special emphasis on fabrics and employee uniforms includes 57 definitions to remove confusion about filaments and yarns, and make clear such terms as micron, denier and particle counter. Angelica Uniform Co., 1427 Olive St., St. Louis 3, Mo.

Circle 201 on Inquiry Card

Evaporated Silicon Films

A technical paper on the preparation of Vacuum Evaporated Silicon Films reports the results of an investigation to determine the degree of electrical stability attainable with silicon films prepared by vacuum evaporation. It also describes the method developed for deposition of micron-thick polycrystalline films at elevated temps. and the characteristics obtained of these films. Speer Carbon Co., St. Marys, Pa.

Circle 202 on Inquiry Card

Hall Effect Devices

This 8-page, 2-color catalog, No. H-20014 discusses Hall effect theory, design parameters, construction and applications. The catalog provides detailed engineering specs. and application data on over 60 HALL-ISTOR devices and components available from stock. Included are probes, multipliers, modulators, tape heads, signalers, current measuring rings, and pick-ups. Instrument Systems Corp., 111 Cantigue Rd., Westbury, L. I., N. Y.

Circle 203 on Inquiry Card

RFI Design Guide

This second in a series of Design Guides on Radio Frequency Interference control is offered to assist in solving problems combining RFI shielding and fluid sealing. The design parameters folder covers dual-purpose gasket selection for RFI leakage and fluid control. The guide concisely defines the combined problem of RFI and fluid sealing, lists requirements for the seal, describes the methods of positioning gaskets, and presents sealability problems along with their solution. The guide is accompanied by a Mechanical Selector which indicates materials recommended for each design requirement. Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J.

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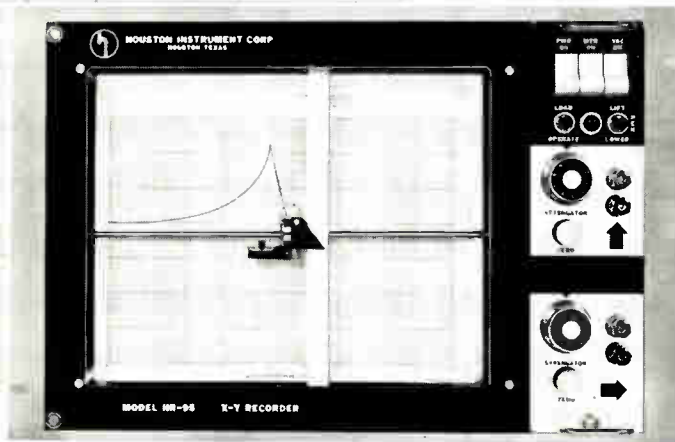
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"Strap Frame Grid Subminiature Tube Manual" details characteristics of 10 Sylvania strap frame grid receiving tubes, designed for industrial and military uses. The first section contains a brief description of each type, circuits for a number of basic building block applications and performance data. The second section is comprised of data sheets, defining each type in terms of mechanical and electrical ratings, average characteristics, and basing connections. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 242 on Inquiry Card

Silicone Developments

"Silicones Digest," Vol. 1, No. 1, 20 pages, 2 colors, (CDS-238) is the first of a series of comprehensive reports on current developments, new products, applications and literature of interest. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Circle 243 on Inquiry Card

Panel Meters

Bulletin 2063, 16 pages, 2 colors, features over 1300 panel meters of various sizes, styles, types and ranges. Voltmeters, ammeters, microammeters in sizes from 1½ in. up through 6 in., as well as special application meters such as meter relays used as control devices, clapsed time meters and segmental (expanded scale) voltmeters plus a glossary of terms are included. Simpson Electric Co., Dept. MK, 5200 W. McKinzie St., Chicago 44, Ill.

Circle 244 on Inquiry Card

Mica Capacitors

Engineering Bulletin MC-1, 12 pages, contains comprehensive electrical performance data on GE's entire commercial mica capacitor line, as well as the recently revised mil. specs. on mica capacitors (Mil-C-5B). Subminiature molded mica capacitors are covered, as well as an up-to-date listing of mica color codes, both EIA and mil. spec. Mil-C-5B. General Instrument Corp., Capacitor Div., 65 Gouverneur St., Newark, N. J.

Circle 245 on Inquiry Card

Low-Contour SCR Line

Tech. data is available on Types 2N2573 thru 2N2579 which are rated at 25a RMS. Also included are Types MCR649-1 thru 649-7 which are 20a RMS devices. Both lines are available in a range of from 25 to 500v and are offered in the TO-3 "diamond" power transistor package. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 246 on Inquiry Card

Semiconductor Material

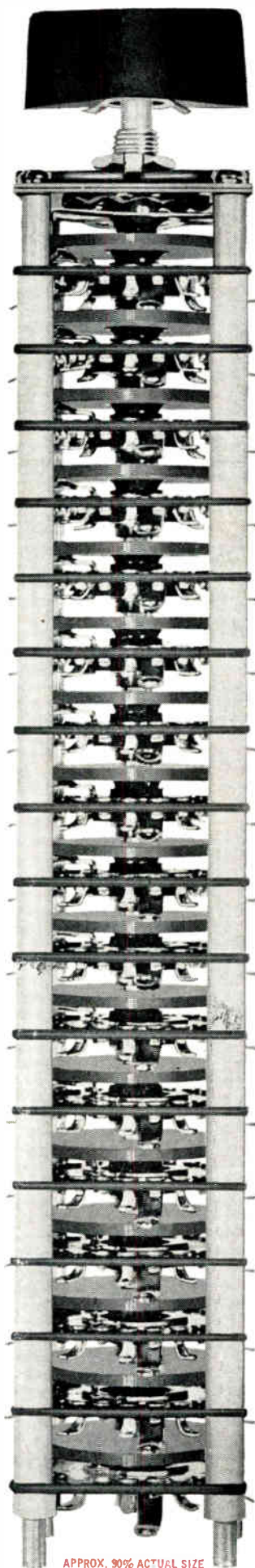
Information is available on 2 new III-V materials — boat-grown, non-oriented, single-crystal gallium arsenide and oriented indium arsenide. The boat-grown gallium arsenide has been produced in research quantities with resistivity of 10⁹Ω-cm. Indium arsenide single-crystal material features mobilities up to 60,000cm²/V-sec at liquid nitrogen temps. Texas Instruments Incorporated, MRDL, P. O. Box 5474, Dallas 22, Tex.

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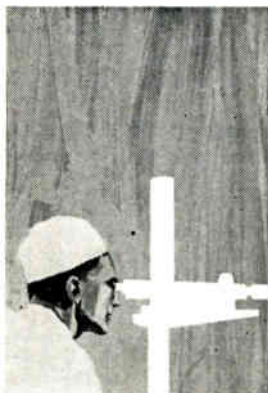
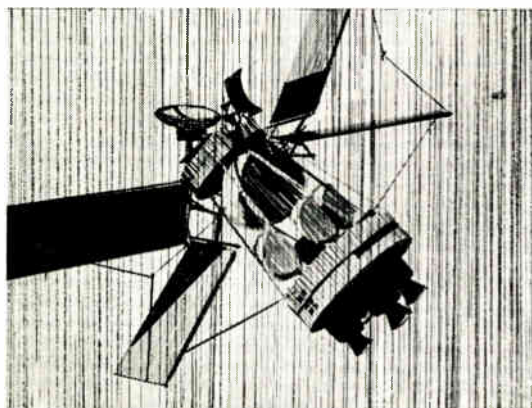
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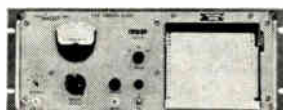
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- with high accuracy.

High-Frequency Standards Receiver — an all transistorized superheterodyne receiver designed for reception of WWV and other high-frequency standard transmissions. Ideal in precision time measurements, reception of standard audio frequencies, pulse code modulation, and radio propagation notices transmitted at these frequencies. Local frequency standards comparisons accurate to 1 part in 10^7 . Operates from either a 115/230-volt power line, or a 12-volt battery. Send for Bulletin RHF-1.

Phase Comparison Receiver — used with local frequency standards accurate to 1 part in 10^7 or better. Instrument utilizes the propagation stability of low-frequency waves, allowing comparisons to an accuracy of 5 parts in 10^{10} to be made in one hour. Higher accuracies, proportionately longer. This all solid-state unit also includes a built-in, servo-driven, strip-chart recorder. Front-panel frequency selection permits rapid switching of up to 4 frequencies within the range of 10 to 100 KC. Send for Bulletin PCR-1.

Gertsch

GERTSCH PRODUCTS, INC.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • Upton 0-2761 • Vermont 9-2201

Digital Delay Line Design

This 12-page manual outlines history, theory, design and application of glass ultrasonic delay lines for digital uses. Performance characteristics of 3 glass delay media are included. "Digital Delay Lines" contains data which defines terms, describes data rates and attenuation, and examines delay line response for units that are used at freqs. from 2.5 to 30mc or higher, and exhibit access times up to 15 times smaller than high speed magnetostrictive lines with comparable storage. Corning Glass Works, Corning Electronic Components, Raleigh, N. C.

Circle 205 on Inquiry Card

Microwave Phototubes

This 7-page, 2-color brochure contains information on microwave phototubes that receive light-transmitted microwave modulation in the 1.5 to 4.5gc band wave. Low noise figure, medium-noise traveling wave tubes and backward-wave oscillators, a typical one featuring 80w CW over 14.9 to 18.1gc range. Comprehensive specifications and easy-to-read characteristic charts are included. Sylvania Electric Products Inc., Electronic Tube Div., Seneca Falls, N. Y.

Circle 206 on Inquiry Card

AC Measurements Survey

Tech. bulletin TB-102, presents a basic description of ac signal measurement by ratiometric techniques. A portion of the bulletin is devoted to a discussion of measurement parameters and inherent ratiometric measurement errors. North Atlantic Industries, Inc., Terminal Drive, Plainview, N. Y.

Circle 207 on Inquiry Card

Gettering Alloys

A tech. brochure describing the characteristics and uses of titanium-zirconium gettering alloys, including available forms and gettering rates, is available from Oregon Metallurgical Corp., P. O. Box 484, Albany, Ore.

Circle 208 on Inquiry Card

High Purity Metals

This comprehensive 30-page catalog describes a complete line of ultra high purity metals, rare metals, compounds, platinum group metals and alloys, and mercury. Purities ranging from 99.00% to 99.99999% in various forms such as ampoules, bars, foil, lump, powder, rod, sheet, shot, single crystals, turnings and wire, depending on the material described. Leytess Metal & Chemical Corp., 500 Fifth Ave., New York 36, N. Y.

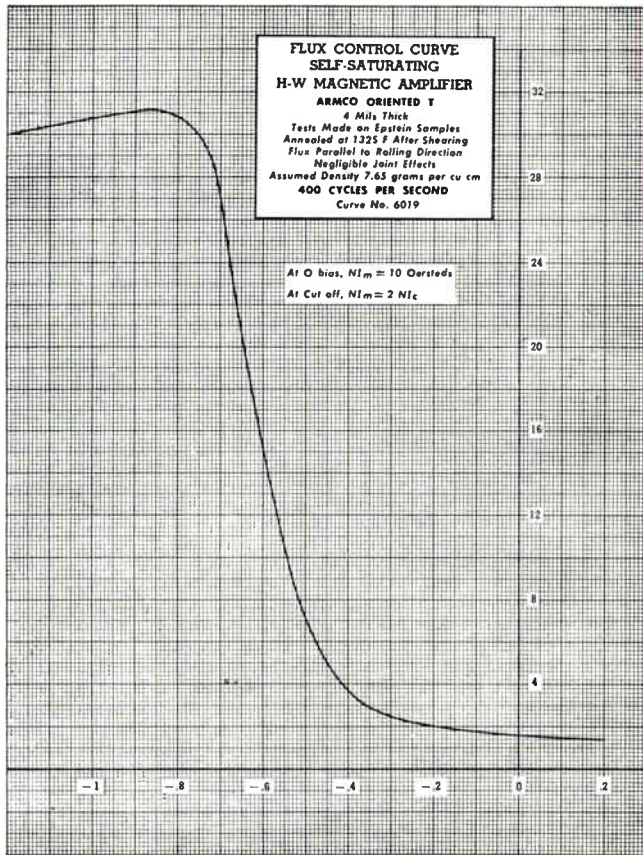
Circle 209 on Inquiry Card

Magnetostrictive Delay

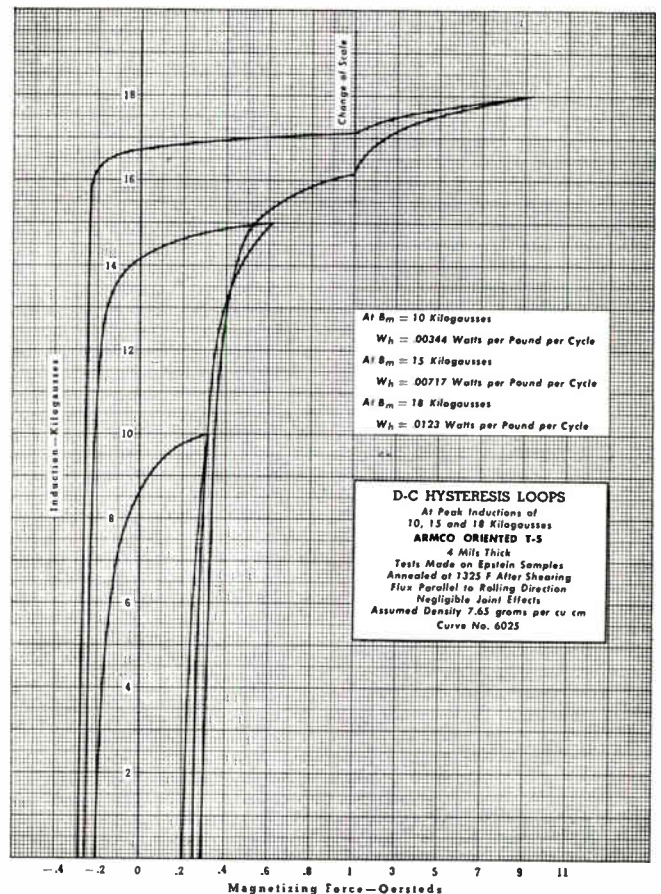
"How to Specify Magnetostrictive Delay Lines," 20 pages, is part of a comprehensive data package on 3C Soniline delay lines capable of delays from 4 μ sec. to 20,000 μ sec. and delay-to-rise-time ratios as great as 30,000 to 1. Information includes features of 12 models together with an introduction to magnetostrictive delay lines. Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass.

Circle 210 on Inquiry Card

How Armco Thin Electrical Steels Help You Design Low-Cost, Efficient Apparatus for 400 Cps and Higher Frequencies



D-C Control Bias—Oersteds



Armco TRAN-COR T, Oriented T, and Oriented TS provide all the advantages of high quality, low-loss electrical steels plus a wide range of magnetic properties and thicknesses. You can design more precisely and produce reliable components at least cost.

Thin Armco Electrical Steels offer all these advantages:

- Exceptionally high permeability
- Low hysteresis loss
- Minimum interlaminar loss
- High lamination factors
- Properties fully developed at the mill
- Unexcelled uniformly high quality

Armco TRAN-COR T, a nonoriented grade, is produced in 7 and 5 mil thicknesses; Armco Oriented T in 6 to 1 mils; and Armco Oriented TS, a super-oriented grade, 4 mils thick.

Use the multiple advantages of Armco Thin Electrical Steels for radio and television transformers as well as magnetic amplifiers, reactors, pulse generators and other components that operate at 400 and higher cps. Write us for complete information, including design curves. **Armco Division, Armco Steel Corporation, Dept. A-383, P. O. Box 600, Middletown, Ohio.**



Armco Division

Why so many?

We admit it.

Amphenol, more than any other connector manufacturer, accepts responsibility for confronting you with a seemingly endless selection of rack and panel connectors.

There's a good reason.

For some uses, a ten-contact connector the size of an Idaho potato will do just fine. In others, ten connections must be squeezed into a space no bigger than a jelly bean. Still other applications have unique requirements that relate to environment or mating force—even the technical skill of the operator.

WHY WE DO IT

We make a lot of different rack and panel connectors because it takes a lot to satisfy the wide range of applications.

For example: the Amphenol Blue Ribbon® rack and panel connector is widely used in "blind" mating applications. Part of Blue Ribbons' popularity is due to the fact that they mate with a smooth and gradual wedge-like force. Because they mate so smoothly, the "feeling" of correct alignment is unmistakable.

Another advantage of the Blue Ribbon design is the wiping action that occurs as connectors mate. Each time Blue Ribbons are mated, contact surfaces are wiped clean. Combine wiping action with high mated contact pressure, and the result is an extremely low-resistance connection.

THINKING SMALL?

As fine a connector as we know the Blue Ribbon is—it's just not right for the real tiny stuff. Thus, as miniaturized

electronic equipment became popular, Amphenol engineers developed the Micro Ribbon®—a rack and panel connector utilizing the ribbon contact principle, but in as little as one-half the space. Further development produced a circular Blue Ribbon connector which crammed 50 contacts into a diameter just under 3 inches.

Also, there's the question of terminating rack and panel connectors. Often, confined quarters or complex wired harnesses can tax the dexterity of even the most skilled worker

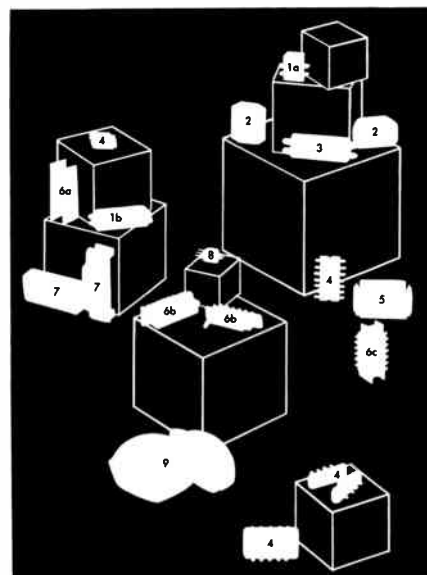
To solve this problem, Amphenol engineers developed rack and panel connectors with Poke-Home® contacts. Poke-Home contacts make it possible to terminate conductors independent of the connector. Contacts are crimped, soldered, or even welded to conductors, then inserted into the connector. Besides simplifying assembly, Poke-Home contacts can be easily removed *after* assembly should circuit changes or repairs later become necessary. Needless to say, Amphenol rack and panel connectors with Poke-Home contacts (Min-Rac 17®, 93 and 94 Series, for example) are popular items with engineers who are forced to think small, spacewise.

BEATING THE ELEMENTS

There's a need for environmentally resistant rack and panel connectors, too. High performance aircraft, missiles and space craft led to the development of Amphenol 126 and 217 Series environmentally sealed rack and panel connectors. (The 217 offers the added feature of Poke-Home contacts.) Other Amphenol rack and panel connectors

can accommodate coaxial connectors; many can be supplied with hermetically sealed contacts. There are rack-to-cable connectors available in every series. There are super-economy types and super-reliable types.

So, when you have a rack and panel connector problem, contact an Amphenol Sales Engineer (or an authorized Amphenol Industrial Distributor). With the broadest line of rack and panels in the industry—if he can't solve it, no one can. If you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



Amphenol connectors shown on the opposite page are: **1**—Min-Rac 17 with (a) crimp-type contacts and (b) solder-type contacts **2**—94 Series **3**—Micro-Ribbon **4**—126 Series Rectangular **5**—93 Series **6**—Blue Ribbon with (a) barrier polarization, (b) pin polarization and (c) keyed shell and barrier polarization **7**—126 Series "CNI" **8**—126 Series Hexagonal **9**—Circular Blue Ribbon



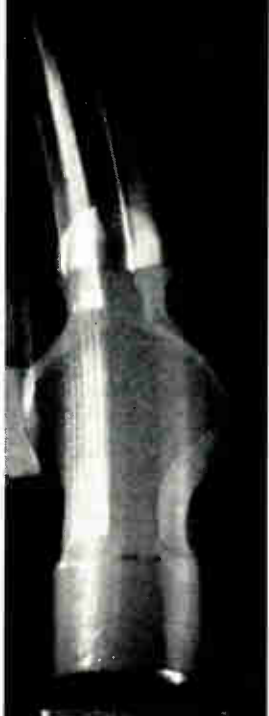




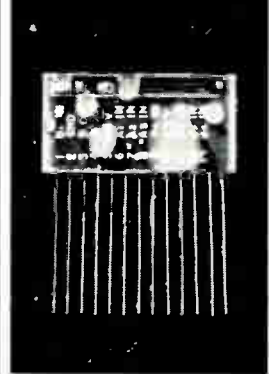
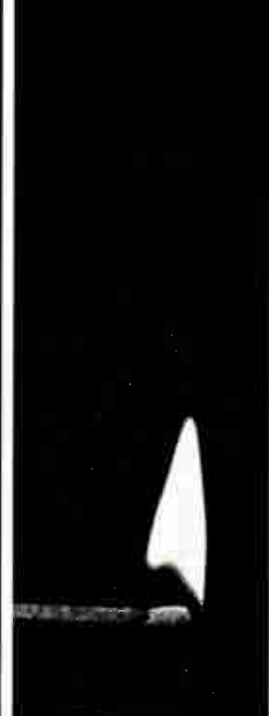
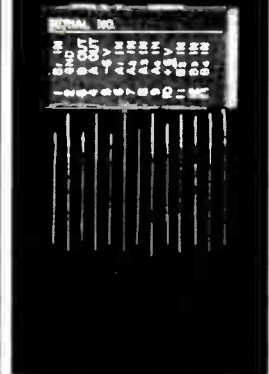
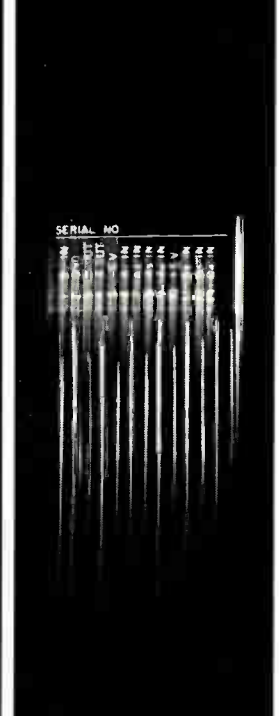
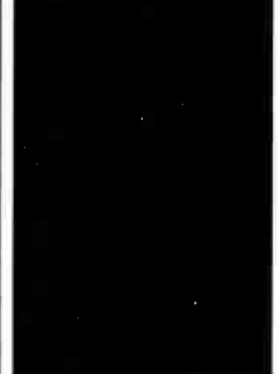
Connector Division / Amphenol-Borg Electronics Corporation



LOW POWER SILICON DIGITAL MODULES

ENVIRONMENTALLY PROVED . . . AVAILABLE NOW!

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

<p>SHOCK 1,000G's in all planes</p>  	<p>VIBRATION 15G's at 10 to 2,000 cps</p>  	<p>HUMIDITY 95% at max. temp.</p>  	<p>OPERATING TEMPERATURE RANGE -40°C to +100°C</p> <p>STORAGE OR STERILIZATION TEMPERATURE -65°C to +125°C</p>  	<p>ACCELERATION 20G's</p>  
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Data sheets are available. Just write or call our Military Sales Department.

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

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

Division of General Motors • Kokomo, Indiana

**DELCO
RADIO**

NEW TECH DATA

Silicone Rubber Design

"Engineering With Silastic Silicone Rubber," 20 pages, is an engineering manual of tech. data, tables and graphs on performance characteristics of the Silastic compounds, including general purpose, extreme high temp. service, extreme low temp. service, low compression set, high tensile-high tear strength, oil and fuel-resistant stocks. Also included is a guide to finished goods specs. for silicone rubber; a section on bonding Silastic; and data on finished parts. Literature 09-036 is available from Dow Corning Corp., Midland, Mich.

Circle 211 on Inquiry Card

UHF Translators

An 8-page paper titled, "UHF Translators for Expanding Television Coverage" describes technical and economic advantages of using UHF translators to extend coverage of VHF and UHF originating stations. Available from Adler Electronics Inc., One Leicvre Lane, New Rochelle, N. Y.

Circle 212 on Inquiry Card

Ferrite Switch Cores

Three 4-page specification sheets are available featuring small, medium and large-sized ferrite switch cores. The cores: #101-101 (small), #141-101 (medium) and #181-101 (large), offer good temp. characteristics and are for use in switching and current steering applications. Electronic Memories, Inc., 9430 Bellanca Ave., Los Angeles 45, Calif.

Circle 213 on Inquiry Card

Microwave Diode Burnout

This 60-page brochure is a comprehensive compilation of burnout ratings and test procedures involving point contact silicon diodes. Included is a discussion, a comprehensive listing of microwave mixer diodes, and video detector diodes. Sylvania Electric Products Inc., Semiconductor Div., 100 Sylvan Rd., Woburn, Mass.

Circle 214 on Inquiry Card

Microwave Tubes

Microwave tube brochure features tubes and components for heavy radar, radar astronomy and linear accelerator applications. Illustrated with photographs and drawings, the 16-page brochure gives detailed specs. on klystrons, TWT's, magnetrons, gas switching tubes and duplexers. Also included are multi-megawatt klystrons for linear accelerator uses. Varian Associates, Tube Div., 611 Hansen Way, Palo Alto, Calif.

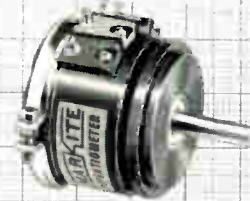
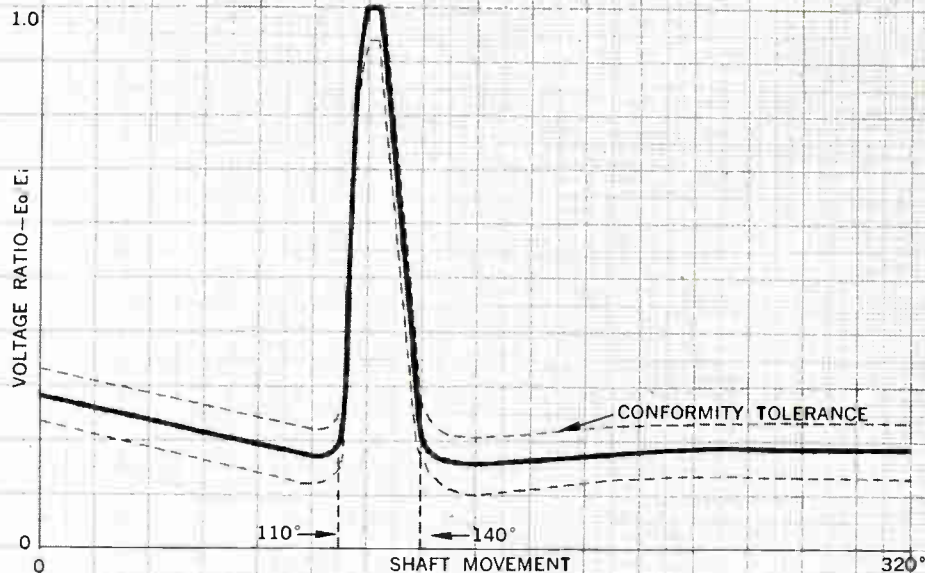
Circle 215 on Inquiry Card

Illuminated Switch/Fuse

The FC series is a single 1 x 1 x 2½ in. device combining a switch, a pilot light and a fuseholder. The FC is mounted through any ½ in. round hole and tightened by a hex nut on the inside and a knurled nut on the outside. Rowan Controller Co., 30 Bridge Ave., Red Bank, N. J.

Circle 216 on Inquiry Card

No pot delivered this unusual output—
and met all system requirements—until...



Markite made it!

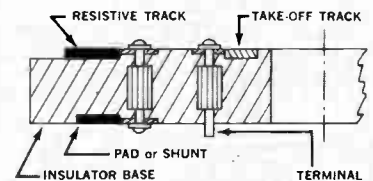
Meeting conformity specs for this unusual pot output was not the major problem. Making it work—with a high level of confidence—was. Why? The useful-life specs for this ultra-sensitive, heavily loaded control system demanded consistently low and predictable noise levels!

Markite's pioneering experience in conductive plastic pot technology solved the problem: this single cup 1¼" dia. pot provides a +2860% slope and a -1980% slope, all within 30° shaft displacement. What's more, the +2860% slope is achieved in only 8° displacement (0.05") with 13K resistance!

This conquest of "Pike's Peak" (as we call this curve) helped breed a new generation of infinite resolution conductive plastic precision pots. They can meet these and even more stringent characteristics without compromising your performance specifications. Available with non-linear (or linear) outputs, Markite pots exhibit long wear-life, freedom from catastrophic failure, unsurpassed reli-

ability... predictable performance under environmental extremes.

Send for detailed data on Markite pots...that do more, and do it more reliably. Write for Bulletin 632 today.



The Markite 1-piece resistance element... smooth, continuous resistive track of Markite conductive plastic, integrally molded with taps, terminals, series and/or parallel resistors (pad or shunt as shown).

MARKITE®

Markite Corporation • 155 Waverly Place
New York 14, New York • ORegon 5-1384



READ-WRITE PACKAGE

for INFORMATION RECORDING STORAGE TUBES

YOKES

+

DEFLECTRONS

+

FOCUS COILS

+

DEFLECTION DRIVERS

=

MORE

INFORMATION

PER UNIT AREA

PER UNIT TIME

Celco Solid State Amplifiers, Deflection Yokes and Focus Coils make a complete Package for your Display applications.

— write or call:



CONSTANTINE ENGINEERING LABORATORIES COMPANY

Mahwah, N. J. Area Code: 201 Davis 7-1123 Ed Ryder	Miami, Fla. Area Code: 305 PLaza 1-1132 Walt Faust	Upland, Cal. Area Code: 714 YUkon 2-0215 Bob Reese
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Circle 63 on Inquiry Card

NEW TECH DATA

Random Noise Handbook

Technical Review 261, is a technical handbook on applications and generation of audio-freq. random noise. The 22-page booklet covers the subject in detail including application, generation, measurement, analysis and recording of random signals. Both freq. spectrum analysis and probability density analysis of the amplitude is discussed in detail. Instrumentation hookups and lab equipment arrangements are also included, along with the bibliography of random-noise literature. B & K Instruments, Inc., 3044 W. 106th St., Cleveland, 11, Ohio.

Circle 217 on Inquiry Card

Output Driver Handbook

"Handbook of Output Driver Applications," 24 pages, covers a design, functions and use of Output Drivers describing the application of these electronic modules to control systems. Solutions to a variety of switching, logic and transducer detection problems are fully explained and graphically shown with particular emphasis on the use of pnpn semiconductor controlled switches. Sectron, Inc., One Pingree St., Salem, Mass.

Circle 218 on Inquiry Card

Avalanche Rectifiers

Information is available on the entire line of silicon rectifiers of the avalanche type composed of Series 20, 21, 31, 32, 33, 40, 41, 50, 51 and 53, ranging from 3 to 250a. These units have the same price as Syntron's former conventional diodes. Syntron Co., 263 Lexington Ave., Homer City, Pa.

Circle 219 on Inquiry Card

White Room Data

Bulletin 238-P2 discusses the development of the "white room" and the need for super-clean air. It illustrates a typical layout of a "white room" and explains the need for isolation of various operations. Also included is a summary of the Functional Criteria for the Design of Clean Rooms, as listed in the Air Force Manual on the subject. American Air Filter Co., Inc., Dept. PD, 215 Central Ave., Louisville 8, Ky.

Circle 220 on Inquiry Card

Digital Modules

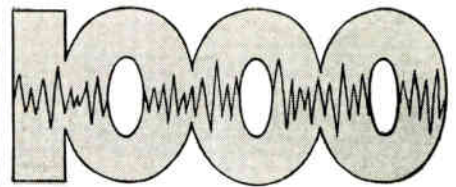
A revised 8-page catalog covers silicon and germanium circuit modules, analog-to-digital and digital-to-analog converters, commutators, and multiplexers, new high accuracy differential amplifier and the PB250 computer as a data systems component. Catalog SP-117A is available from Packard Bell Computer, 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 221 on Inquiry Card

Pressure-Sensitive Tape

This tech. bulletin entitled, "What is Pressure-Sensitive Tape" is a glossary of terms with illustrations describing the construction and performance of pressure-sensitive tapes. Arno Adhesive Tapes, Inc., P. O. Box 301, Michigan City, Ind.

Circle 222 on Inquiry Card



ANSWERS TO YOUR SUB-MINIATURE CERAMIC CAPACITOR problems

MUCON THINLINE CAPACITORS



CAPACITANCE RANGE: 1 pF-150,000 pF
VOLTAGES: 25 WVDC-500 WVDC

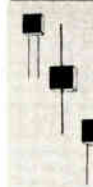
TEMP. CHARACTERISTICS: Any of 9 temperature-compensating and 4 general-purpose materials.

SIZES: Starting at .100" square max. by .090" thick max.

LEADS: Tinned copper, nickel or dumet.

SHAPES: Square or rectangular, single or multiple-element.

MUCON MU-CAPS



CAPACITANCE RANGE: 10 pF-56,000 pF
VOLTAGES: 200 WVDC and 500 WVDC

TEMP. CHARACTERISTICS: Within $\pm 15\%$ of 25°C capacitance, between -55°C and +150°C.

SIZES: 5 sizes from .200" sq. x .100" thick to .500" x .600" x .150" thick.

LEADS: #22 tinned copper, axial or radial. Nickel or dumet also available.

MUCON NARROW-CAPS

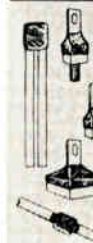


CAPACITANCE RANGE: 5 pF-10,000 pF
VOLTAGES: 10 WVDC-50 WVDC

SIZES: .095" max. wide x 1/4" max. long x .095" max. thick thru 750 pF. Larger values 5/16" max. long.

LEADS: #26 tinned copper. Nickel or dumet also available.

MUCON UHF CAPACITORS



STANDOFFS:
S1 - Tapped hole in base, 3/16", 5/16" and 7/16" square bases.
S2 - Male stud for mounting. 3/16" square base.
S4 - Tapped hole in base. 1/4" hex. base.

RIBBON-LEAD UNITS:
RLA-axial ribbon leads
RLR-radial ribbon leads

TEMP. CHARACTERISTICS: Any of 9 temperature-compensating and 4 general-purpose materials.

MUCON'S broad experience in manufacturing a wide variety of constructions, ceramic bodies and leads will give you the one right capacitor for your electrical and physical requirements. Ask for Bulletin M-1 or send us your requirements.

MUCON CORPORATION

9 ST. FRANCIS ST., NEWARK 5, N. J.
201 Mitchell 2-1476-7-8

Circle 64 on Inquiry Card

NEW TECH DATA

Galvanometer Theory

A comprehensive report on galvanometer theory, construction, and operation is included in a 20-page "Galvanometer User's Handbook." The handbook is an introduction to specification terminology, data recording needs, and a guide for selecting the proper galvanometer. High-performance and standard galvanometers are listed on a separate plastic pocketcard. Bulletin 7300A and 1584D are available from CEC, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 223 on Inquiry Card

4-Layer Diodes

Specs., price and tech. information, describing a new series of fast-switching, Shockley 4-layer diodes offering guaranteed parameters (V_s and I_h) across carefully pinpointed operating temp. ranges, is available from Clevite Transistor, Palo Alto Unit, 1801 Page Mill Rd., Palo Alto, Calif.

Circle 224 on Inquiry Card

Electronic Blocks

Two new series of functional electronic blocks, the first featuring 6 linear devices and the second featuring 3 digital devices described in tech. data available from Westinghouse Molecular Electronics Div., Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. The linear devices are an oscillator-mixer; an i-f amplifier; an r-f amplifier; a low-level audio amplifier; a video amplifier; and a wide-band audio amplifier. The digital series includes a double-nand gate; a single-nand gate; and a set-reset flip-flop. Included are photographs, block diagrams, characteristic curves and comprehensive specs.

Circle 225 on Inquiry Card

Neon Lamp Circuitry

Neon glow lamps for use in electronic circuits such as computer and memory circuits are described in Tech. Bulletin No. 110 B available from Signalite Inc., Neptune, N. J.

Circle 226 on Inquiry Card

When to Mold

"Plastic Parts—When to Mold and When to Machine," 6 pages, reveals specific breakeven points for 10 different categories of thermoplastic parts. This detailed study of the factors determining when to mold and when to machine a plastic part, lists 11 factors which may raise or lower the molding breakeven points. Some general rules for calculating breakeven point are included. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Circle 227 on Inquiry Card

Microminiature Relay

"A Microminiature Relay with High Reliability," a paper delivered before the NARM Relay Symposium covers design considerations to achieve a high level of consistent reliability, and also the controlled-environment "clean room" processes. Request C-1017 from Automatic Electric Co., 400 N. Wolf Rd., Northlake, Ill.

Circle 228 on Inquiry Card

Announcing...

COLD HEADED ROLLED THREAD

subminiatures

... now available in specials and standards, made from most cold heading wires—brass, steel, copper, 18-8 stainless steel, Monel, 18% nickel-silver.



mass produced at substantial savings in time and labor . . . with vast improvements in quality over similar parts and fasteners made on a screw machine.



Smallest diameter—approx. .020

Maximum length— $\frac{3}{4}$ "

Slots (minimum)—.010 wide, .010 deep

Threads—00.90

(other sizes will be considered.)

Knurling—dependent on wire diameter

Collar studs can be made and knurled depending on location of collar to length of stud.

Parts may be supplied with die chamfer point or straight cut off.

Hubbell cold headed, rolled thread subminiatures set a new standard for quality and economy. Heads are unusually well formed with deep, clean slots. Threads are exceptionally clean and sharp and lead threads are tapered for easier, faster starting.

Compared to screw machine operations, Hubbell cold headed, rolled thread parts and fasteners are more uniform and can be produced at faster speeds, resulting in lower costs. Product uniformity also contributes to lower costs through faster, trouble-free assembly operations, fewer rejects and more reliable end products.

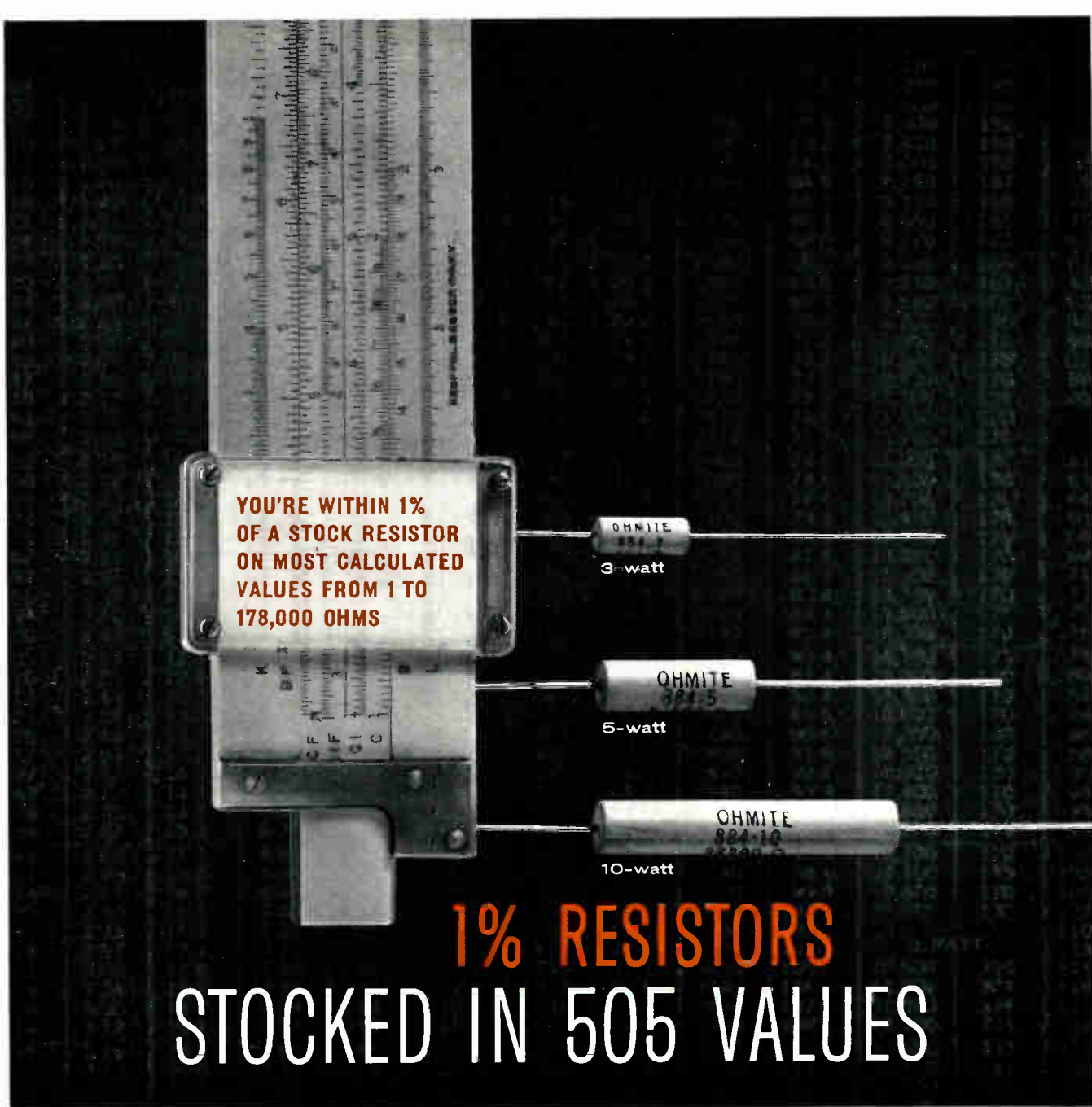
HARVEY

HUBBELL

INCORPORATED

Machine Screw Department, Bridgeport 2, Connecticut

Write, or call
EDison 3-1181



**YOU'RE WITHIN 1%
OF A STOCK RESISTOR
ON MOST CALCULATED
VALUES FROM 1 TO
178,000 OHMS**

OHMITE
334.5
3-watt

OHMITE
361.5
5-watt

OHMITE
924.10
10-watt

1% RESISTORS STOCKED IN 505 VALUES

INSULATED WIREWOUND SILICONE-CERAMIC MOLDED RESISTORS PRECISION POWER TYPE 884

■ No need to wait for production lines to crank up on 1% resistors. Ohmite stocks resistance values shown in MIL MS90169 (also known as MIL-Bell system), which can supply a majority of requirements. For fast delivery on sizeable quantities, just call your distributor or the factory.

RESISTOR CONSTRUCTION: Single layer wirewound on a ceramic core; all connections welded; precision molded in Ohmite's tough silicone-ceramic material. Aged and conservatively rated for long term stability. Meets 1000V dielectric strength test of MIL-R-26C.

TEMPERATURE COEFFICIENT: Only 20 ppm/°C.

UNIFORM PHYSICAL SIZE: Trouble free in automated assembly equipment.

PERMANENT MARKINGS: Meet many solvent resistance requirements for printed circuit board applications.

LEADS: Tinned nickel stocked. Bare nickel (weldable), as well as other special leads also available.

RELIABILITY DATA: Supplied on request.

WRITE FOR BULLETIN 153 . . .

COVERING ALL OHMITE MOLDED RESISTORS
INCLUDING MILITARY AND COMMERCIAL

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS
TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R.F. CHOKES • GERMANIUM DIODES



OHMITE
MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

OHMITE DIODES

Germanium, Gold Bonded

Standard
Glass Envelope
(Enlarged)



Quad in
1/2" submin.
case



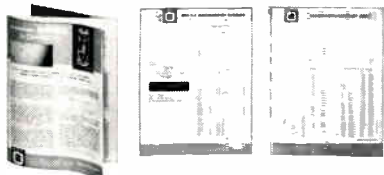
Quad in
3/4" submin.
case



In 6H6
tube shell
and base

**One of industry's largest
off-the-shelf selections;
90% of orders shipped
same day.**

IS YOUR DIODE DATA UP-TO-DATE?



Catalog 801 Stock Price List, SR819 Interchangeability Tables, 803

OHMITE

MANUFACTURING COMPANY

3662 Howard Street, Skokie, Illinois

Circle 67 on Inquiry Card

NEW TECH DATA

Power Transistors

Four spec. data sheets describe physical and electrical characteristics of npn Silicon Mesa High Power Transistors, and are available from AMP Semiconductors, Vandalia, Ohio.

Circle 229 on Inquiry Card

Function of Engineering

"The Function of the Engineer & the Scientist" contains the comments of a number of eminent engineers and scientists on the function of engineering and science. Available from the National Society of Professional Engineers, 2029 K St., N. W., Washington 6, D. C.

Circle 230 on Inquiry Card

Indicator Light

Information is available on the TML Series MEMO-LITE Solid-State Transistor Controlled Indicator Lite, Using an incandescent lamp, standard mid-gate flange base, it replaces latching relays and tubes to indicate one-time pulses. TML Series Catalog Sheet No. 269 is available from TEC-LITE Div., Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 231 on Inquiry Card

Planar Transistors

Bulletin SS-500, 6 pages, describes silicon planar transistors which combine high breakdown voltage and high beta in a single unit. Listed in catalog form are characteristics of pnp and npn planar transistors and related complementary npn/pnp types. Dimensional drawings and illustrations are included. Sperry Semiconductor Div., Sperry Rand Corp., Norwalk, Conn.

Circle 232 on Inquiry Card

Positive TC Resistor

This 4-page brochure describes Positive Temperature Coefficient Resistors including detailed information from an application standpoint as well as the theory. Characteristics, and charts are included. Ferroxcube Corp. of America, Saugerties, N. Y.

Circle 233 on Inquiry Card

Short-Slot Hybrids

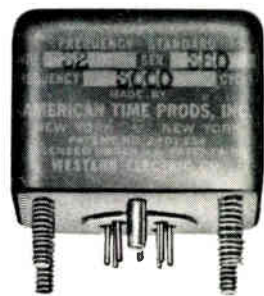
This 24-page catalog, HS62, describes over 160 Short-Slot Hybrids and Couplers including 3db, 4.1db, and 4.8db in E1A waveguide sizes from WR15 to WR2100. Illustrations of the various styles and terminations available, as well as photographs showing various applications are also included. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Ctr., Natick, Mass.

Circle 234 on Inquiry Card

Micro-Miniature Tools

This 24-page brochure contains information on the latest in precision electronic pliers, super-fine tweezers and other items. Over 100 stock items are listed. Bulletin #B1, "Micro-Miniature Assembly Tools" is available from Techni-Tool, Inc., 1216 Arch St., Philadelphia 7, Pa.

Circle 235 on Inquiry Card



AMERICAN TIME PRODUCTS

240 to

20,000 cps

FREQUENCY STANDARD

Whatever the frequency, 240 to 20,000 cps, the type 32 American Time Products standard assures an uncompromising balance between stability and reliability.

A compact, lightweight and highly reliable audio range unit, the 32 employs a temperature compensated tuning fork and its associated oscillator circuit. Hermetically sealed, this all silicon semi-conductor oscillator provides stability up to $\pm 0.02\%$ from -65°C to $+125^\circ\text{C}$. In narrower temperature ranges, such as 15°C to 35°C , $\pm 0.002\%$ is possible.

Other specifications include: Power — 28v at approx. 6 m.a. or calibrated for any other available voltage; Output — 5v r.m.s.; Wave — limited Sine; Loading — up to 20K; Mounting — 4 studs; Termination — 7 pin header.

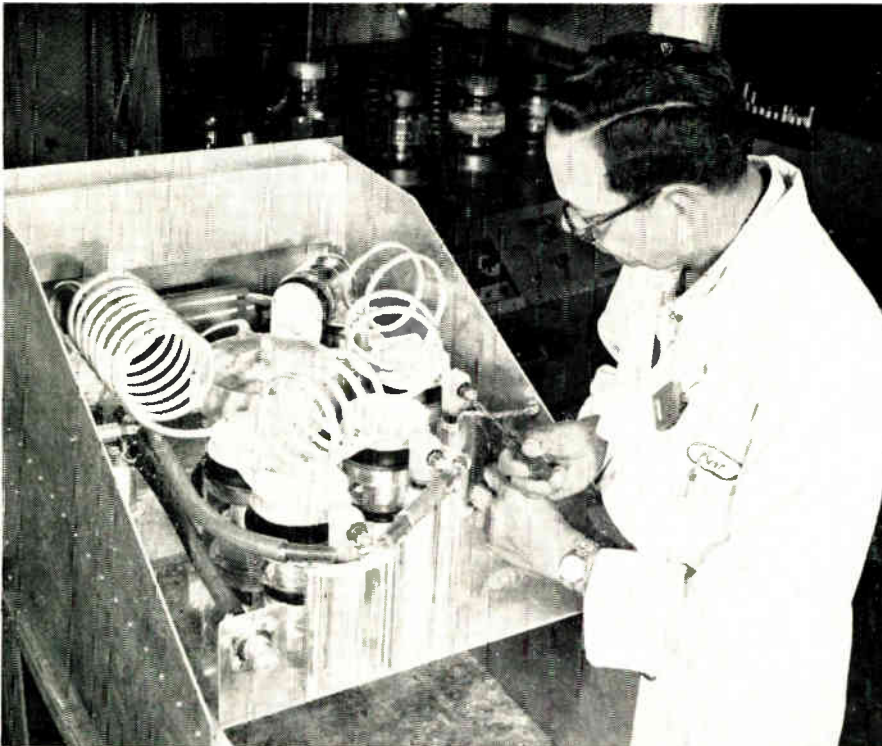
For more information on American Time Products' type 32 standard, line of fork standards or oscillators, filters, inverters, power supplies, timers or light choppers, write Bulova, American Time Products, 61-20 Woodside Avenue, Woodside 77, New York. Area Code 212 NE 9-5700.

INDUSTRIAL/DEFENSE GROUP

BULOVA

AMERICAN TIME PRODUCTS

Circle 68 on Inquiry Card



EXCEPTIONAL DESIGNS START WITH JENNINGS VACUUM CAPACITORS

This electronics engineer is just completing a 17.5 kw, all band, continuous tuning power amplifier to be used for test purposes. It has a range of 2 megacycles through 34 megacycles yet only occupies 2' x 2' x 3' of space!

Can you imagine this amplifier being designed or even dreamed of with anything but vacuum capacitors? Every circuit design presents different problems but this application illustrates the range of design possibilities available with Jennings vacuum capacitors. Here are some of the exclusive advantages of these capacitors that make it possible to extend your range of design ideas:

WIDE FREQUENCY RANGE . . . Jennings vacuum capacitors offer the widest capacity change ratio available anywhere. Some capacitors have ratios as high as 150 to 1.

RELIABILITY . . . Sealed plates never become contaminated.

EFFICIENCY . . . Vacuum dielectric results in very low dielectric losses.

COMPACTNESS . . . High strength vacuum dielectric results in much smaller capacitor with the additional advantage of lower inductive losses.

WIDE SELECTION . . . Jennings offers over 400 types of fixed and variable vacuum capacitors to meet your circuit requirements.

Write today for more detailed information about Jennings complete line of vacuum fixed and variable capacitors.

RELIABILITY MEANS VACUUM / VACUUM MEANS *Jennings*[®]

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYPRESS 2-4025

Circle 69 on Inquiry Card

NEW TECH DATA

Receiving Tubes

"New Receiving Tube Developments for Entertainment" are described in a 19-page loose-leaf folder available from Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass. The 38 tubes described are multi-function, 9-pin (novar) and 12-pin (compactron) types, including T-9 and T-12 standard envelopes and T-5½ and T-6½ miniatures. Included are tubes designed with integral, all-glass button bases for use as high-voltage rectifiers, full-wave rectifiers, remote and sharp cut-off i-f pentodes, VIIF single and double triodes, video, audio and twin pentodes, and separate and combined horizontal amplifiers and damper diodes.

Circle 236 on Inquiry Card

Adhesives and Coatings

"Easy 1-2-3 Way to Adhesive and Coating Selection" pinpoints the most commonly used insulation weathercoatings, mastics sealers, and adhesives. Simplified reference chart includes color, permeability, fire resistivity, chemical resistivity, and the military specs. these products meet. Insul-Coastic Corp., Dept. ICA, 42-23 54th Rd., Maspeth 78, N. Y.

Circle 237 on Inquiry Card

Adhesive Brochure

This revised 12-page, 2-color, 8½ x 11 in. illustrated catalog (Z-S11F-20S) describes properties and typical uses of elastomeric adhesives, coatings and sealers for electrical manufacturing and appliance applications. Adhesives, Coatings and Sealers Div., Minnesota Mining and Mfg. Co., 2501 Hudson Rd., St. Paul 19, Minn.

Circle 238 on Inquiry Card

Magnetic Counters

"Miniature Magnetic Counters and Count Limiters," 26 pages, illustrates the various standard models with tech. data and outline dimensional drawings plus basic units for custom modification. Form ATC-1048 is available from Abrams Instrument Corp., Dept. 109, 606 E. Shiawassee St., Lansing 1, Mich.

Circle 239 on Inquiry Card

Silent Fan

Bulletin No. E-2801, 4 pages, covers complete specs. on the very silent Whisper Fan used for cooling electronic equipment. Included are performance curves, design features, a noise curve, application and mounting information, dimensional drawings, and O.E.M. selling prices, on this precision fan. Rotron Mfg. Co., Woodstock, N. Y.

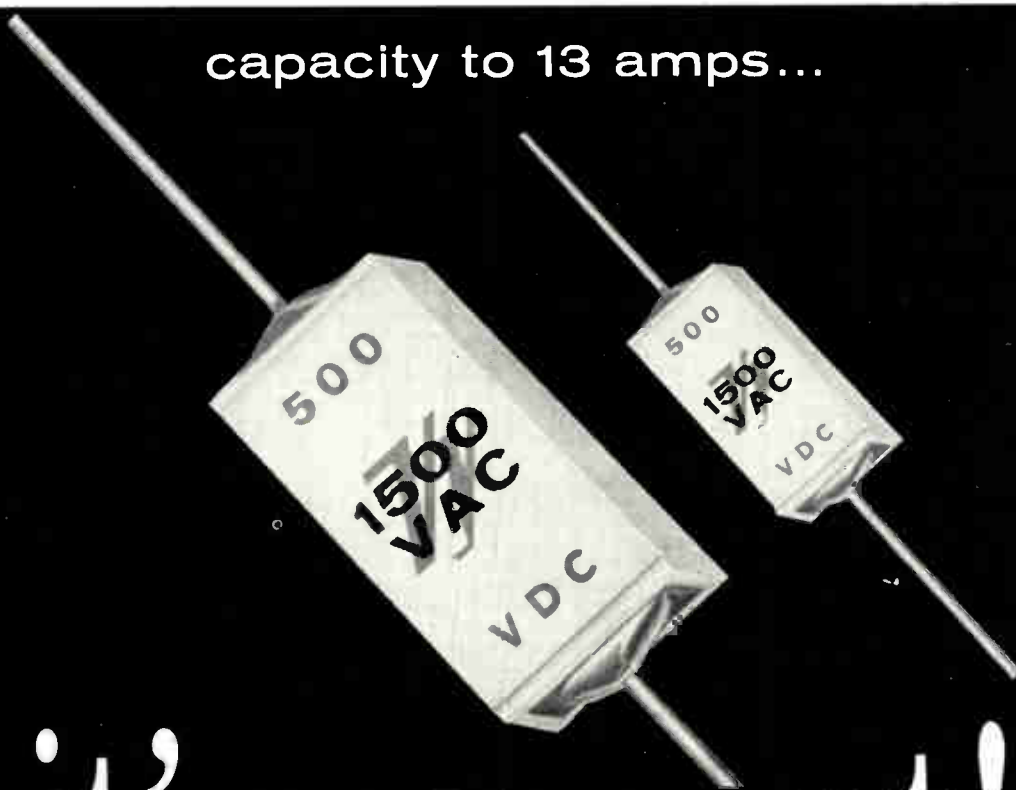
Circle 240 on Inquiry Card

Capacitor Selection

This 17 x 22 in. wall chart shows 7-step specifying procedure for Mil-C-25 capacitors. The chart's main table shows terminal types, circuits, temp. characteristics, voltage, capacitance and capacitance tolerance for each of the 17 illustrated case styles of the Mil-C-25 units. Ten additional tables, graphs and diagrams are included. Cornell-Dubilier Electronics, 50 Paris St., Newark 1, N. J.

Circle 241 on Inquiry Card

capacity to 13 amps...



it's current!

NEW [®]

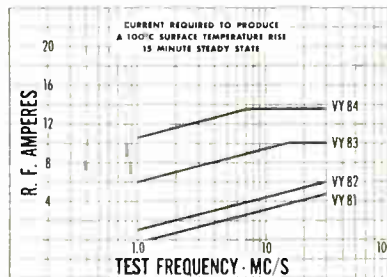
solid state PORCELAIN CAPACITORS

- * low loss
 - * low noise
 - * greater stability
- * wide temperature range
 - * impervious to humidity

—55°C to +125°C operation
10 pf to 2000 pf
1500 VAC RMS volts

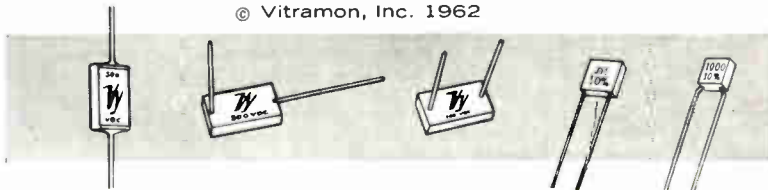
Typical curves under laboratory conditions. For specific applications consult factory. Write for data sheet.

These unique miniature high current capacitors, capable of handling up to 13 amps of current and ranging from 10-2000 pico farads, permit drastic reduction in the size of equipment, such as transmitters and other applications requiring high current operation.



Extremely stable and reliable, these parts maintain the environmental requirements of MIL-C-11272B with a capacitance drift of only .05% or .05 pf, whichever is greater.

© Vitramon, Inc. 1962



Vitramon

INCORPORATED

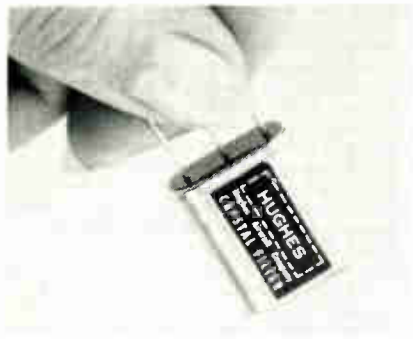
Box 544 • Bridgeport 1, Connecticut

NEW PRODUCTS

...for the Electronic Industries

SMALL CRYSTAL FILTER

Package is less than one-fifth of a cubic inch in size.



For use in radar, communications and missile guidance systems. The bandpass filter, called "Micro-X," uses new "S-L" cut crystals and a subminiature transformer, in an overall filter package that fits within a standard HC-6/U crystal container, with its height dimension increased only 0.14 of an inch. Typical unit has a center freq. of 550kc, 3db bandwidth of 110cps, 30/2 selectivity of approx. 8 to 1, and insertion loss of 3.5db. Hughes Aircraft Co., Electronic Products Div., Newport Beach, Calif.

Circle 160 on Inquiry Card

GaAs LIGHT SOURCE

The SNX-100 is an experimental device for engineering evaluation.

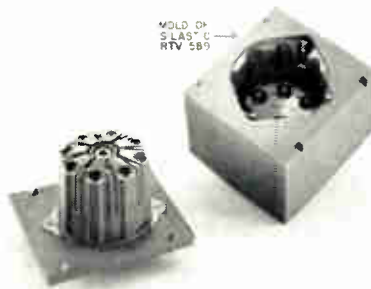


Designed as forward biased diode emitting light of relatively narrow spectral width in near infrared. Successfully modulated at freq. from dc through 900mc. Quantum efficiency typically 0.3% at liquid nitrogen temps. (-195°C) and 0.03% at room temp. (25°C). Wavelength of peak emission 0.90 microns at 25°C case temp. and 0.84 microns at -195°C . Available in hermetically sealed TO-18 package with glass window in top. Texas Instruments Incorporated, Semiconductor-Components Div., P.O. Box 5012, Dallas 22, Tex.

Circle 161 on Inquiry Card

SILICONE RUBBER

Features heat stability to 600°F , toughness and thick section cure.

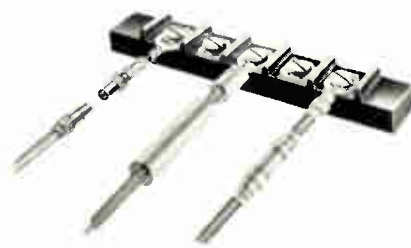


Room-temp.-vulcanizing silicone rubber for uses including the making of flexible molds for casting parts in plastics and low melting metals. Silastic RTV 589 is supplied as a low viscosity silicone fluid. With the addition of a catalyst, the material cures to a tough, firm, yet flexible silicone rubber. Curing takes place in unlimited thicknesses without de-airing. Fully cured within 24 hrs., it is resistant up to 600°F , and remains flexible to -70°F . Dow Corning Corp., Midland Michigan.

Circle 162 on Inquiry Card

SHRINKABLE TUBING

Semi-rigid, irradiated, heat shrinkable; gives high stress strength.



Very strong, heavy-wall, abrasion-resistant extruded material. FIT-295 (colored) and FIT-290 (clear) tubings available in expanded form and slip easily over the object to be covered. When a temp. of approx. 275°F (135°C) applied, the tubings immediately return to predetermined diameter, approx. $\frac{1}{2}$ smaller, forming permanent, secure mechanical bond. Resist fuel, oil, hydraulic fluids, solvents, acids, and alkalis. Available in 10 sizes, from 3/64 to 1 inch before shrinking. Alpha Wire Corp., 200 Varick St., New York 14, N. Y.

Circle 163 on Inquiry Card

TAPE HEAD TRANSISTOR

Specifically designed for magnetic tape head preamplifiers.



The AC107, a Germanium pnp, is also suited for uses characterized by high source impedance and very low signal level with stringent noise requirements. The noise figure for the type AC107 is based on measurements over the entire audio bandwidth, duplicating actual conditions. So measured, the AC107 has a typical noise figure of only 3db from 30 to 15,000cps ($V_{ce}=4v$, $I_c=0.3ma$; $R_s=1500\Omega$). Amperex Electronic Corp., Entertainment Semiconductor Dept., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 164 on Inquiry Card

HIGH STRENGTH ADHESIVE

Two-component synthetic resin adhesive with high peel strength.



Produces bonds with very good flexibility characteristics. SCOTCH-WELD Brand Structural Adhesive EC-2216 cures at room temp. under contact pressure, for high strength similar and dissimilar metal and plastic structural bonding applications where heat and/or pressure are not feasible in the bonding operation. Maintains high strength properties from -67° to 180°F . The adhesive has good resistance to water, hydraulic oil and aromatic fuels. Adhesives, Coatings and Sealers Div., 3M Co., 2501 Hudson Rd., St. Paul 19, Minn.

Circle 165 on Inquiry Card

MR. RELAY *by Allied Control*

1. **I SEE ASTOUNDING THINGS ABOUT YOUR SON, T-154.**

TELL ME! WHAT'S HIS FUTURE GOING TO BE?



2. **FIRST, HE'LL HAVE AN AMAZINGLY LONG LIFE.**

THAT'S FINE. WHAT ELSE?



3. **WELL, HE'LL BE THE CHAMPION IN THE BANTAM WEIGHT DIVISION.**

SURE, HE'S SMALL BUT RUGGED.



4. **GOSH, WHAT A VISION! I SEE A BIG T-154 AND A SMALL \$.**

NATURALLY, T-154'S ABILITIES ARE GREAT. HE OFFERS SO MUCH FOR SO LITTLE.



There are *many more* good reasons why the Allied T-154 "cradle" relay has a BIG future. The T-154 is versatile . . . especially suited for long life applications. It features no internal wiring; contact arms are extended to form combination solder and plug-in terminals. The T-154 is simple to install because it mates with easy-to-plug-in solder and printed circuit-type sockets. And this popular relay is sensitive, too . . . down to 50 milliwatts for 1C. Want the T-154 fast? Just call your nearest Allied distributor. Also, write for Allied's complete 4-page Cradle Relay Bulletin which contains a helpful socket guide.



AL-226-T

© 1963 BY ALLIED CONTROL COMPANY, INC.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, N. Y.

OPERATING CONDITIONS	
Contact Rating:	Available with low level, 2 or 5 ampere contacts for resistive loads up to 29 volts d-c
Contact Arrangement:	Up to six pole double throw
Ambient Temperature:	-55°C to +71°C Higher temperature available
Operate Time: (at +25°C)	15 milliseconds maximum at nominal coil voltage
Release Time: (at +25°C)	8 milliseconds maximum at nominal coil voltage
Weight:	From 0.80 to 1.0 ounces maximum



NEW PRODUCTS

...for the Electronic Industries

MICRONOISE AMPLIFIER

Integrated noise under $8\mu\text{v}$ RMS over 50kc bandwidth.

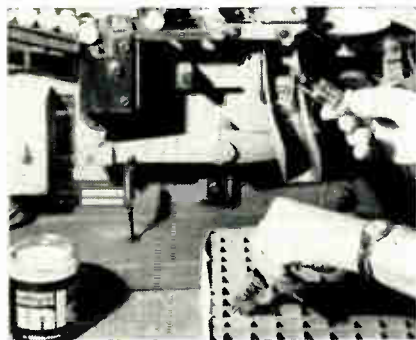


Micronoise Amplifier Series 600 is a solid state amplifier with input resistance of over 60 megs, shunt capacitance under 100pf. The integrated noise is under $8\mu\text{v}$ rms over 50kc bandwidth with input terminals open or shorted (typical broadband noise referred to shortened input is 4 to $5\mu\text{v}$ rms.). Model 600 (shown) available with UHF or BNC connectors; Model 600B with panel mounted UHF or shielded banana plug output connectors for direct coupling to oscilloscope, etc. Denro Lab, 2801 15th St., N.W., Washington 9, D. C.

Circle 166 on Inquiry Card

QUICK DRYING INK

Permanently marks glass, rigid phenolics, epoxies, and ceramics.

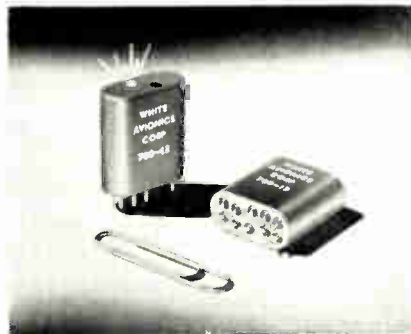


Available in 10 colors, the ink requires no catalyst and can be applied by rubber stamp, silk screen, and conventional branding machines. For many uses the ink dries satisfactorily in several minutes at room temp. It also can be heat-cured at moderate temps. to a degree of permanence which is resistant to commercial solvents, salt spray, humidity, abrasion, and fungi. Exceeds the permanency requirements of military spec. Mil-E-1E for marking electron tubes. Industrial Components Div., Raytheon Co., 55 Chapel St., Newton 58, Mass.

Circle 167 on Inquiry Card

SOLID STATE RELAYS

Series 700 sub-miniature relays will switch 250 ma up to 50v.

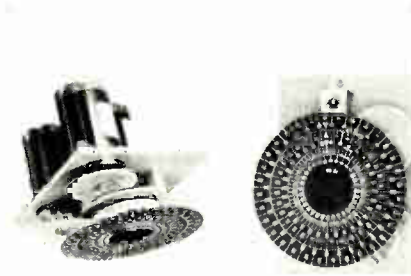


Complete isolation between input and output circuits. Input 5vac or dc (output can be ac or dc with an ac input). SPDT and DPDT versions. Size: standard crystal can. Temp.: to 85°C. Life: 100 million operations. Applications: Power and dry circuit switching in transistor circuits. Available also as logic circuit elements. Special features: indicating lights in top of can indicate position of relay to simplify trouble shooting of large systems. White Avionics Corp., Terminal Dr., Plainview, L.I., N. Y.

Circle 168 on Inquiry Card

SYNCHRO DIAL ASSEMBLY

Operate 3 remote controlled units quickly and easily.

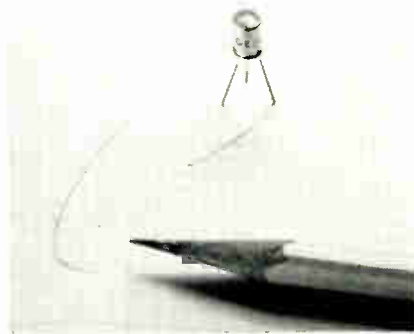


The Concentric Synchro Dial Assembly enables an operator to point 3 instruments in a common direction quickly and easily by simply matching dial indicator marks (bugs). The assembly features a precision gear train and a mechanism which enables independent rotation of all 3 dials. Dials are of a transparent plastic. Markings are engraved through black coating into white translucent coating. All 3 dials can be back lighted. Standard size 23 synchros are used in this assembly. Metric Systems Corp., 736 N. Beal St., Ft. Walton Beach, Fla.

Circle 169 on Inquiry Card

GaAs LIGHT SOURCE

Light generated by passing electric current through crystal.



Housed in a transistor package with a window in the top capable of passing infra-red light. Bough type LED-1, the non-coherent light source, and type LED-2, the coherent light source, can be furnished in package with removable cap for fitting directly into optical system. Directional and coherent beam with wave-length near 8400 Å emitted from junction-plane edges at parallel sides of device. General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

Circle 170 on Inquiry Card

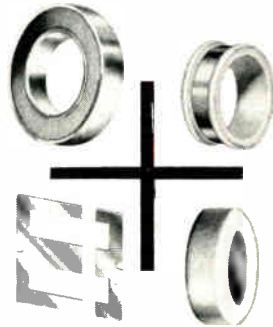
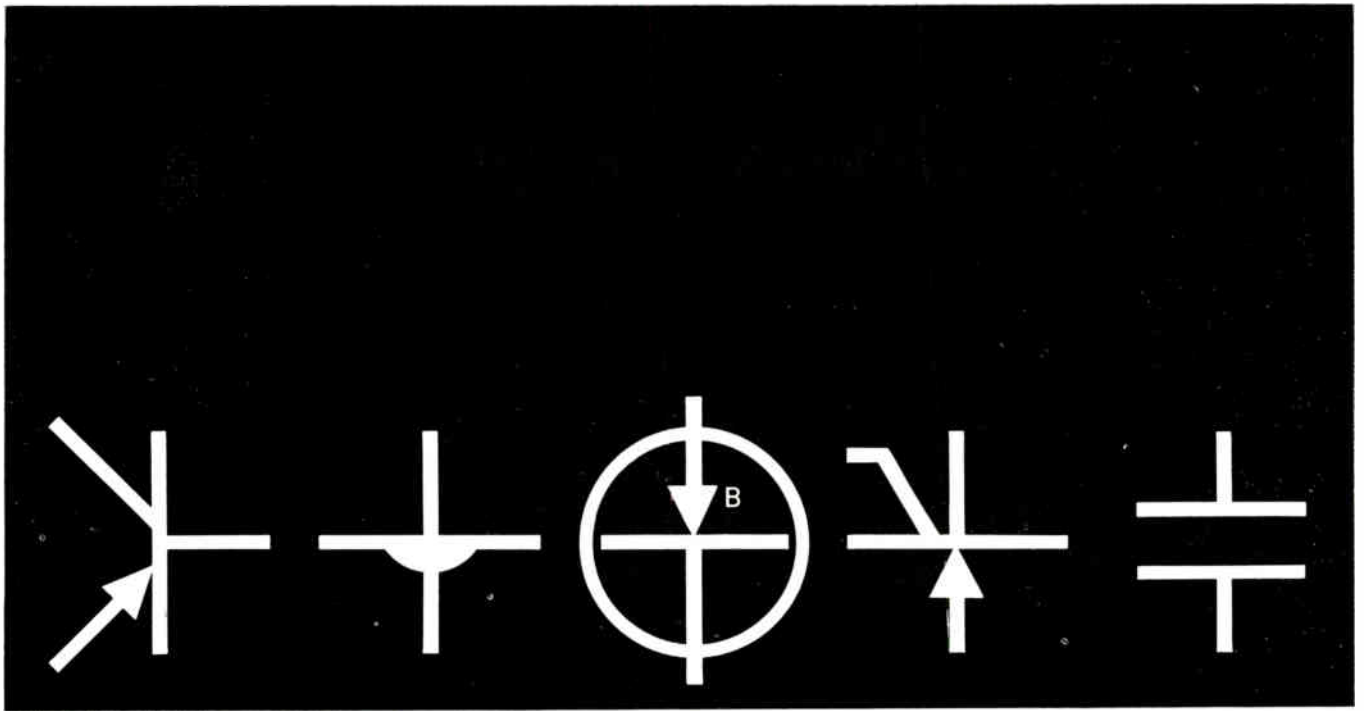
GENERAL TESTER

TPL-1000 is a general purpose instrument for portable operation.



Fully transistorized, weighing under 16 lbs, it includes the functions of dc standard voltmeters, dc standard current meters, potentiometers, dc standard voltage references, dc VTVMs, nanoampere meters, ac standard voltmeters, ac standard current meters, ac wideband VTVMs, high accuracy resistance meters, portable multimeters, VOMs and portable VTVMs. Full scale accuracy 0.6% maintained for dc functions. In rugged cabinet approx. 6 x 9 x 11 in. Solid State Instrument Laboratories, 30 Bridge Ave., Red Bank, N. J.

Circle 171 on Inquiry Card



Want component compatibility in complex circuits? Get more from magnetics

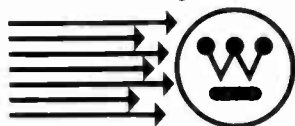
THE CORE: properly matched with transistors, tunnel diodes, or Zeners, tape wound cores of Orthonol or Square Permalloy 80, for example, have the square loop characteristics that make for highly efficient converters/inverters, timing elements, or circuits for long time delay. In the latter, circuit output can be used to drive high impedance relays or SCR's. The compatibility of linear permalloy powder cores and polystyrene capacitors makes for frequency stability over a wide range of temperatures in audio filter networks. How do you capitalize on the advantages of 8 material types in tape cores, the 60 mu to 200 mu range of powder cores, the 550 mu characteristic of flake cores, or the alloy vs shape advantages of laminations? Simple. Ask the *man from Magnetics Inc.* for specific information next time he's around.

THE MORE: using tape cores with transistors to achieve time delay, for example, often results in greater accuracy and simplified circuitry. Combining conventional components with high mu laminated cores instead of ordinary steel lams in filter circuits often means better frequency control, greater efficiency and smaller over-all size. We design, produce and stock hundreds of powder cores with 60 to 200 permeability tape cores in 8 material types, flake cores and laminations with dozens of shapes and sizes. And we've spent a lot of time learning what's most compatible with what, as a matter of good business (yours and ours). Helping you select what's right for your application is the service offered by the *man from Magnetics Inc.* Problems can't wait? Write details on your letterhead to Magnetics Inc., Butler, Pennsylvania.

TOTAL ASSISTANCE, SERVICE, SELECTION/GET THE MORE FROM MAGNETICS

MAGNETICS inc.

Electronic Components
from Westinghouse



For your needs . . . one source

RIGHT DRESS...



...for military power semiconductors

Here's proof of Westinghouse reliability. Delta's 7.5 amp transistors, Minuteman's 240 amp rectifiers, and Titan's 50 amp silicon controlled rectifiers all came from Westinghouse. They are the most powerful semiconductors used on these projects. This experience and capability is no further away than a phone call or a letter. Next time, let the new group at Westinghouse fill your needs.

Six mil specs

1. 7.5 amp transistor.* USN 2N1016BM-1016CM (Mil-S-19500/102.)
2. 50 amp silicon controlled rectifier.* 2N1910W-1915W (Mil-S-19500/204A.)
3. 120 amp rectifier.* USA 1N3263 and 1N3267 (Mil-S-19500/212.)
4. 12 amp rectifier. USAF 1N1200-1206 (Mil-E-1/1108.)
5. 20 amp rectifier. USA 1N249B and 1N250B and 1N2135A (Mil-S-19500/134.)
6. 35 amp rectifier. USAF 1N1184-1N1188 (Mil-E-1/1135.)

*New mil specs recently added to the line.

Only source for all three product types

Another indication of Westinghouse capability . . . this is the only line of silicon power semiconductors with military types in all three families. . . rectifiers, transistors and silicon controlled rectifiers. Whether your project calls for one, two, or all three, Westinghouse is your most dependable source.

Prompt delivery

Here are three things to keep in mind when you need prompt delivery of military power semiconductors—in production quantities. The Westinghouse experience in silicon technology; the high volume manufacturing capabilities; the large in-plant environmental test facilities.

Send for free reprints

We have reprinted a limited number of the new mil specs, listed above. For a complimentary copy of one or more, write to us on your company letterhead. The address is Westinghouse Semiconductor Division, Youngwood, Penna. SC-1088



You can be sure . . . if it's

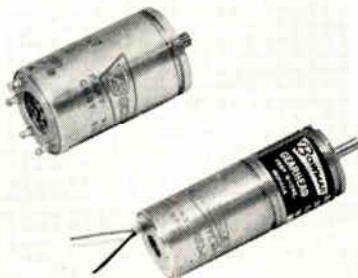
Westinghouse

Circle 73 on Inquiry Card

NEW PRODUCTS

SIZE 8 SERVO MOTORS

Feature low rotor inertia of 0.27 Gm-Cm² for all 4 types.



M82 series have 115v, fixed phase windings and plain or center-tapped control phase windings for 115 and 32v, 400 cps operation. Types M82-000 and -002 have 12 in. wire leads; the -500 and -501 have high compression, shock resistant glass-molded terminals with internal connections secured by high temp. solder. No-load motor speeds are 6,000 RPM. No-load output speeds of the motor-gear combination (motors available individually or assembled to match gearheads having ratios from 7:1 to 2,000:1) range from 3 to 787 RPM. Bownar Instrument Corp., 8000 Bluffton Rd., Ft. Wayne, Ind.

Circle 172 on Inquiry Card

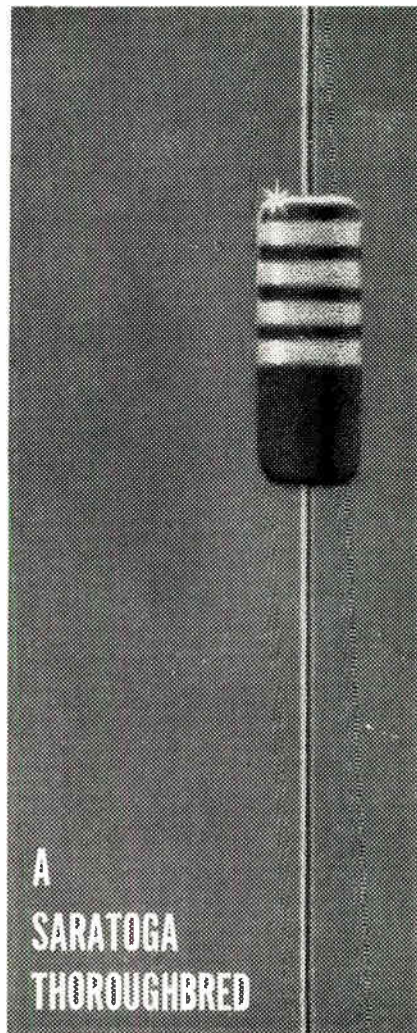
FERRITE CORE MEMORY

Large capacity; performs a complete memory cycle in 1μsec.



The Model LZ stores twice as much data in half as much space as the 1.5μsec. Ampex LQ. Like the LQ, the LZ is completely compatible with current computers for data processing and control applications. LZ storage capacity is 4,096 to 16,384 words with word lengths from 18 to 72 bits. Operational modes are read-restore and clear-write. Its read access is 0.5μsec. after read request. Weighs 700 lbs. and measures 25 x 32 x 60 in. Ampex Corp., Computer Products Co., Culver City, Calif.

Circle 173 on Inquiry Card



250MW and 400MW SILICON ZENER DIODES

Reliability — assured by 100% load testing and burn-in. All units meet the requirements of MIL-E-1 and MIL-S-19500C.

Availability — from stock in the 250MW 1N713-1N745 series and the 400MW 1N960-1N992 series.

Zener Voltages — from 9.1 to 200 Volts (5%, 10%, 20% tolerances).

Military Types:

1N716, 1N718, 1N720, and 1N722 — per MIL-E-1/1238 (Sig. C.)

Also 400MW units—USN 1N962B through USN 1N973B — per MIL-S-19500/117 (Navy).

For additional information on Saratoga's complete line (standard and special) of silicon diodes, write:



Saratoga Semiconductor

A Division of Espey Mfg. & Electronics Corp.
Saratoga Springs, N. Y. • Telephone 4100
Circle 74 on Inquiry Card

SOLID STATE POWER CONVERSION

for a broad range of power requirements

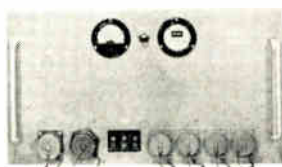
Unitron can meet exacting requirements with custom-engineered Inverters, Frequency Converters, DC/DC Converters, and Power Supplies, with the reliability of semiconductor circuitry and *no moving parts*. Units can be designed for a broad range of power requirements in airborne and ground support systems.

Unitron has compiled a valuable background of design and production experience by specializing in solid state power conversion equipment. This background provides Unitron with a unique ability to furnish custom-designed equipment with almost off-the-shelf timing and economy.

Unitron's capability is reflected by *delivered units*, such as the three examples of custom-designed Frequency Converters shown below.



3.5 KVA
Freq. Converter



1.5 KVA
Freq. Converter



8.0 KVA
Freq. Converter

These 400/60 cps Converters share exceptional performance characteristics, such as better than 90% efficiency ... regulation to $\pm 1.0\%$... less than 5.0% distortion ... frequency stability from 0.001%. Their environmental and RFI characteristics are compatible with applicable military specifications.

UNITRON INCORPORATED

1624 N. First • Box 1331 • Garland, Texas

NEW PRODUCTS

ILLUMINATED SWITCH

Offers replaceable lamp and snap action switch.

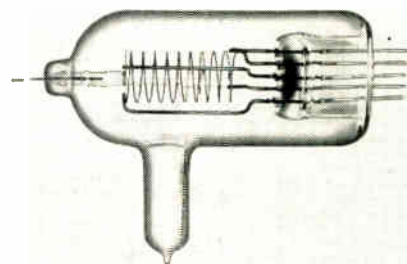


RBL Series Replaceable Button-Lite offers replaceable neon or incandescent midget flange base lamps operating independently of snap action switches. Two types of momentary action switches: form "C" (SPDT) for dry circuits, or currents to 1a and Form "C" (SPDT) for currents to 5a. Switches rated at 115vac, resistive. Thirteen button-lens colors available. Housed in a 9/16 in. dia. body: projects 1 3/8 in. behind panel. Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 174 on Inquiry Card

VACUUM GAUGE

Designed to measure pressures as low as 10⁻⁹ mm. Hg.



The type WL-8057 gauge operates on the ionization principle. It is 5 in. long and about 2 in. in dia. made of hard glass, and has 3/4-in. tubulation and leads fitting standard 5-pin in line socket. Normal air cooling. Recommended values are: filament voltage 7v, ac or dc; filament current 2.5a; ion collector voltage -30v; and electron collector voltage +150v. Outgassing simplified since it uses a Bayard-Alpert electrode structure with a min. of metal surface. Westinghouse Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

Circle 175 on Inquiry Card

SYNTRON

MARK 5

SELENIUM RECTIFIERS

A NEW DEVELOPMENT IN SELENIUM RECTIFIERS

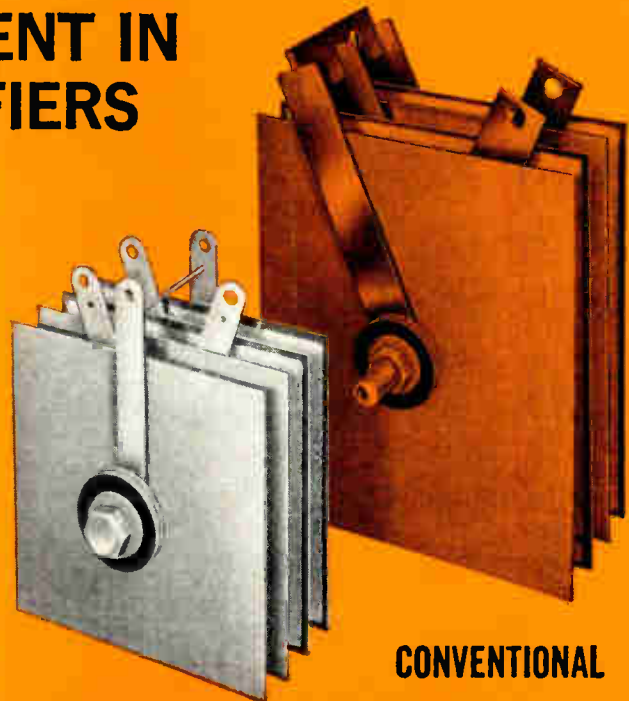
Why use the
conventional selenium
rectifier when
you can use the
MARK 5?

This advanced
product will —

Reduce Size
Improve Efficiency
Reduce Cost

The New Mark 5 High Density Selenium Rectifier is now available to you from Syntron. This new development in high density selenium cells and stacks offer the same degree of reliability with greater efficiency, smaller size and lower cost than conventional selenium rectifiers.

Why settle for less—see the new Syntron Mark 5 Selenium Rectifier.



MARK 5

CONVENTIONAL

Visit the SYNTRON display suite — Mayflower Hotel, 61st and Central Park West—when you're in New York for the IRE Show.

**Literature and Specifications
available on request.**

63R104

SYNTRON

SYNTRON COMPANY

SEMICONDUCTOR DEPT. 63R104

263 Lexington Avenue • Homer City, Pa.

Leaders in the Field!



Prodelin... Single Source Responsibility for

SEMI-FLEXIBLE COAXIAL CABLES AND MATCHING CONNECTORS

Low-loss, broadband performance, simple field assembly and reliable trouble-free service are proven features of all Prodelin coaxial cables and companion connectors. Truly matched performance is guaranteed by Prodelin, a single-source responsibility for the design and manufacture of "job-packaged" antenna and transmission line systems for over 16 years.

Spir-O-line. Semi-flexible, Aluminum Sheathed Coaxial Cables for Broadband Services up to 16 Kmc.

Spir-O-foam. Semi-flexible, Aluminum Sheathed, Polyethylene-foam Insulated Coaxial Cables for Broadband Services up to UHF Frequencies.

Spir-O-lok. Solderless Coaxial Connectors for Simple, Fast and Reliable Installations without Special Tools.

SPIR-O-LOK
U.S. PAT. 3,010,747

SPIR-O-LINE
U.S. PAT. 2,990,472

Write Dept. V for Catalogs

- 591—Spir-O-line and Spir-O-foam Semi-Flexible Coaxial Cables, and Spir-O-lok Connectors
- 595—Rigid '800' Coaxial Transmission Line
- 598—2-Way Mobile Antennas
- 603—Microwave Parabolic Antennas and Accessories



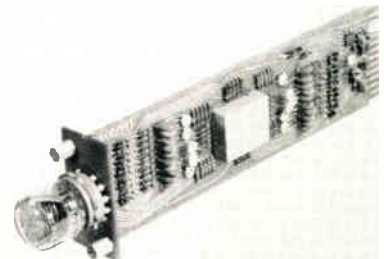
PRODELIN, INC., Hightstown, N.J. • 448-2800 Area Code 609

In California: Prodelin, Inc., 901 American St., San Carlos

NEW PRODUCTS

REVERSIBLE DECADE COUNTER

Counts in both forward and reverse directions at 10KC rate.



Both solid state counters, BIP-8002 and 8051, consist of a BIPCO module, 12 transistors, and associated circuitry mounted on a printed circuit board. The BIP-8002 is a high voltage version (+170v) with an integrally mounted NIXIE® for visual count indication. BIP-8051 operates from 28v for use where integral readout not required. Both counters have 10 electrical outputs available at edge connector, Burroughs Corp., Electronic Components Div., Plainfield, N. J.

Circle 176 on Inquiry Card

SCR LINE

Features blocking voltages to 500v, current capacities to 25a.



These 18 silicon controlled rectifiers are designated EIA numbers 2N681 thru 2N689 (high current), and 2N1842 thru 2N1850 (medium current). The 2N681 series I_F is 10a at 180° conduction and 65°C case temp. I_{SM} is 150a. Peak gate power 5w. Average gate power 0.5w. Peak gate current is 2a. The 2N1842 series I_F is 10a at 180° conduction and 35°C case temp; I_{SM} 125a. Measures 1.615 in. max. including stud, and 0.562 in. max. in dia. Mallory Semiconductor Co., Div. P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

Circle 177 on Inquiry Card



Beckman 210 high-speed, solid-state, data processing system shown with cathode ray oscilloscope monitor.

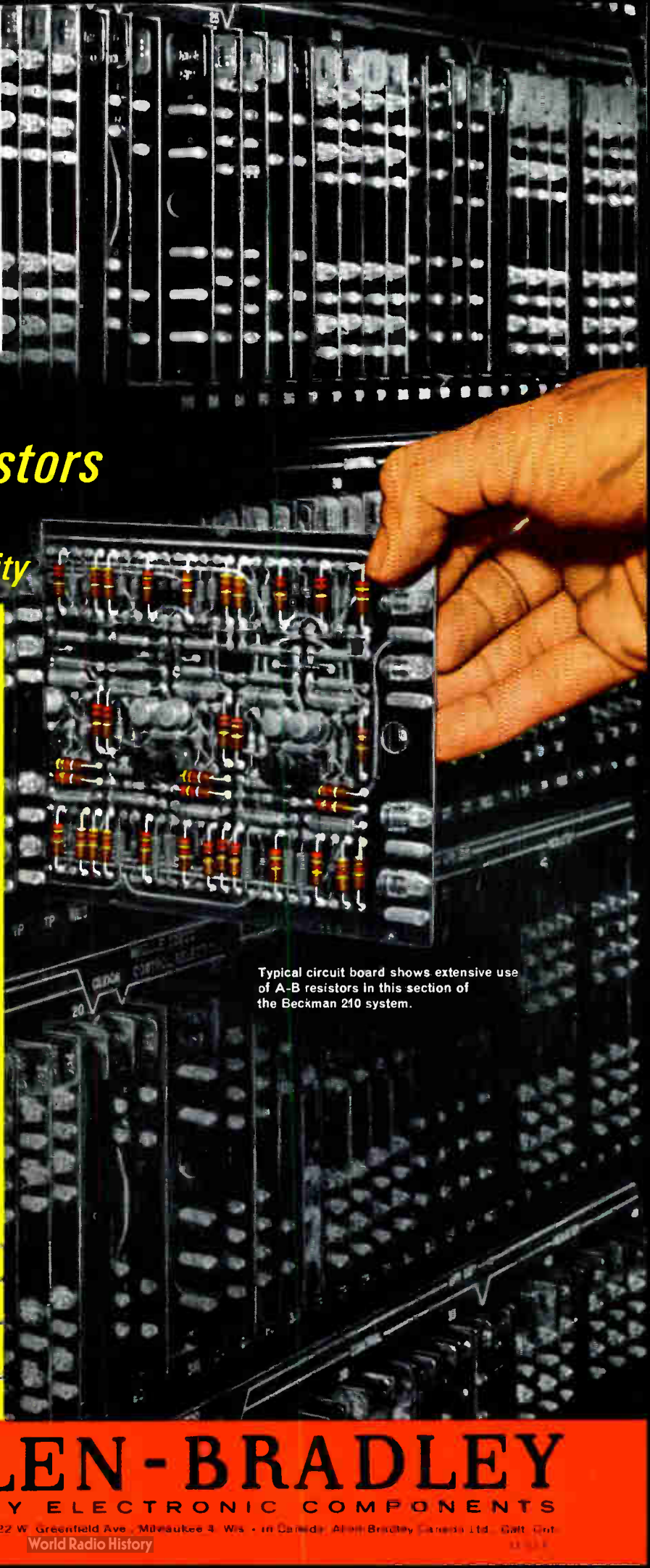
Allen-Bradley Hot Molded Resistors Help Beckman Engineers Achieve Maximum Reliability

■ In designing utmost reliability into their 210 high-speed data processing system, Beckman engineers—from the very start—insisted on components of the highest reliability. Thus, A-B hot molded resistors fitted ideally into this development program.

For more than three decades, A-B resistors—by the *billions*—have been delivering superior performance in high quality equipment of all types. Allen-Bradley has developed and perfected a unique hot molding process which assures such consistent year-in and year-out uniformity that long term performance can be accurately predicted . . . and there is complete freedom from catastrophic failures.

When performance takes priority over all else, be certain to begin the planning of your equipment with the built-in reliability that *only* Allen-Bradley hot molded resistors can deliver. For full details on all Allen-Bradley *quality* electronic components, please write for Publication 6024.

Type TR 3/10 Watt		MIL Type RC 36
Type CB 1/4 Watt		MIL Type RC 37
Type EB 1/2 Watt		MIL Type RC 38
Type GB 1 Watt		MIL Type RC 39
Type HB 2 Watts		MIL Type RC 40



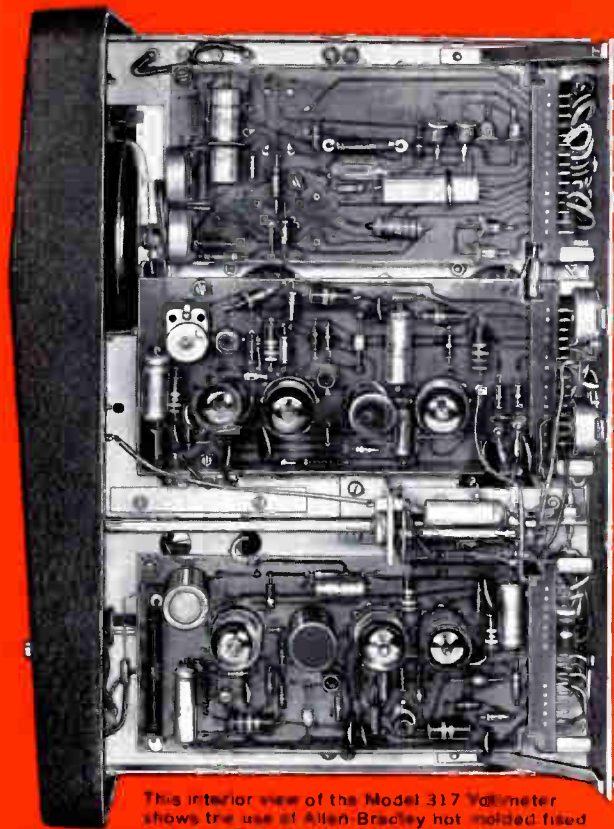
Typical circuit board shows extensive use of A-B resistors in this section of the Beckman 210 system.



ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

Allen Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen Bradley Canada Ltd., Galt, Ont.
World Radio History



This interior view of the Model 317 Voltmeter shows the use of Allen-Bradley hot molded fixed resistors, Type J potentiometers, and discoidal feed thru capacitors.



BALLANTINE Model 317 Sensitive Wide Band Voltmeter features a voltage range from 300 μ v to 300 v over the frequency from 10 cps to 11 mc.



"ALLEN-BRADLEY RESISTORS ... ARE THE MOST RELIABLE WE HAVE BEEN ABLE TO PURCHASE"

A compliment such as this must be earned through years of reliable performance. Allen-Bradley fixed and variable resistors have delivered that kind of performance for nearly thirty years. In fact, it's almost "standard" for Allen-Bradley resistors to be used in test equipment of the highest quality and precision—equipment such as Ballantine Laboratories' sensitive wide band voltmeter.

And here are the reasons: Allen-Bradley fixed resistors—made by an *exclusive* hot molding process—have such uniform and stable characteristics that performance can be predicted over long periods of time, and they have never experienced catastrophic failure in service.


A-B variable resistors have an *exclusive* solid hot

molded resistance element that assures exceptionally long life and smooth control. There are never any abrupt changes in resistance during adjustment. And, while the "noise" factor is exceptionally low initially, it actually decreases with use.

Then there are A-B's ceramic feed-thru capacitors that provide unusually effective filtering at VHF and UHF frequencies. Their unique discoidal design eliminates all parallel resonance effects at frequencies up to 1000 mc.

You can obtain this same reliability and superior performance only when you specify Allen-Bradley quality electronic components. Please write for Publication 6024, today.

Here are the Allen-Bradley components that provide the accurate and precision measurements of voltage that characterize the Ballantine line.

Type TR 1/10 Watt		MIL Type RC 06
Type CB 1/4 Watt		MIL Type RC 07
Type EB 1/2 Watt		MIL Type RC 20
Type GB 1 Watt		MIL Type RC 32
Type HB 2 Watt		MIL Type RC 42

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



TYPE J POTENTIOMETERS Rated 2.25 watts at 70°C. Available in standard tapers and in standard resistance values to 5 megohms, as well as special tapers and resistance values. Resistances up to 1000 megs available on special order.



FEED-THRU CAPACITORS Available in standard values of 470 mmf \pm 20% and 1000 mmf G.M.V. Special values from 6.8 to 1000 mmf. Rated to 500 v DC max.

12-62-E

ALLEN-BRADLEY

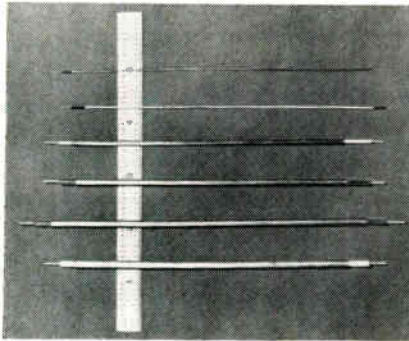
Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

**QUALITY
ELECTRONIC
COMPONENTS**

NEW PRODUCTS

COAXIAL CABLE

Miniature, solid-jacketed, in a full range of standard sizes.

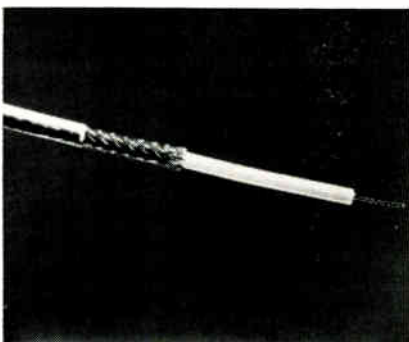


MicroCoax gives total shielding and is environmentally stable. It is of close-tolerance construction, for use with strip-line of waveguide. Standard sizes range from 0.141 to 0.020 in. O.D. (solid copper), and users can select a cable to fit the application by loss and size. Dielectric is TFE Teflon; center conductor is silver-plated copperweld wire. All standard types have a nominal characteristic impedance of 50Ω. Solid jacketing is easy stripping. MicroDelay Div., Uniform Tubes, Inc., Colleagueville, Pa.

Circle 178 on Inquiry Card

HIGH TEMP. "FOAM" CABLE

Line of high temp. miniaturized coax. for high freq. uses.



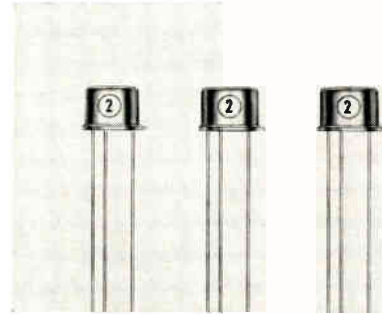
Feature dielectrics of cellular FEP (fluorinated ethylene propylene). Advantages of cellular constructed cables include: low capacitance; low attenuation; low weight; good flexibility; and large (higher strength) center conductors. These advantages are combined with 200°C continuous service temp. Foam construction results in dielectric constant of 1.5 providing good electrical properties; i.e., 13pf/ft nominal capacitance for 95Ω cables. Microdot Inc., 220 Pasadena Ave., S. Pasadena, Calif.

Circle 179 on Inquiry Card

ELECTRONIC INDUSTRIES • February 1963

← Circle 79 on Inquiry Card

Wide Selection of Silicon Chopper Transistors Now Available in Production Quantities



High speed Silicon Precision Alloy Transistors specifically designed for use as low-level choppers and developed by the Sprague Electric Company are now available in a broad range of types and performance characteristics.

Sprague Silicon Chopper Transistor specifications have been tailored to meet specific circuit requirements. Superior in performance to ordinary alloy devices, they offer low offset voltage, low dynamic resistance, low output capacitance, low I_{CBO} , and high frequency response. The wide selection of types includes a variety of matched pairs.

2N2162 2N2165	Guaranteed 30 volt rating. Typical f_T of 20 Mc and low offset voltage make these transistors ideal where high voltage is required
2N2163 2N2166	Have 15 volt rating and same high frequency performance and low offset voltage as 2N2162
2N2164 2N2167	Highest frequency P-N-P Silicon Choppers available as standard types
2N2185	Extremely low leakage current of 1 nano-ampere at 10 volts. Has 30 volt rating
2N2274	Similar to 2N2185 but has lower inverted dynamic saturation resistance
2N2276	Low-cost version of 2N2274
2N2278	Very low offset voltage of 1.75 mV at $I_B = 1$ mA
2N2187	Matched pair of 2N2185 with $\Delta V_{OFF} = 50\mu V$ max. from +25 C to +85 C
2N2275	Matched pair of 2N2274 with $\Delta V_{OFF} = 100\mu V$ max. from +25 C to +65 C
2N2277	Matched pair of 2N2276 with $\Delta V_{OFF} = 100\mu V$ max. from +25 C to +65 C
2N2279	Matched pair of 2N2278 with $\Delta V_{OFF} = 50\mu V$ max. from +25 C to +85 C

These transistors are inherently stable. Every Sprague Chopper undergoes a rigid production conditioning of 40 temperature cycles from -55 C to +140 C, a 200 hour bake at +140 C, and a two hour 125 mW operational burn-in!

For application engineering assistance without obligation, write Product Marketing Section, Transistor Division, Sprague Electric Company, Concord, New Hampshire. For complete technical data write Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Circle 80 on Inquiry Card

new!

NANOSECOND PULSE TRANSFORMERS IN TO-5 TRANSISTOR CASES!

Sprague Type 45Z Subminiature Pulse Transformers are especially designed for use in low-power, ultra-high-speed computer circuitry.

Their TO-5 transistor cases offer several distinct advantages:



1. Another step forward in minification
2. Welded hermetic seal on high-density package
3. Increased uniformity and reliability
4. Compatibility with transistor mounting techniques

In order to suit various installation and packaging techniques, Type 45Z Pulse Transformers are available with standard length wire leads. Weldable or solderable leads can be furnished. Short pin-type leads for use with subminiature sockets are also available.

For complete technical information on Type 45Z Pulse Transformers, write for Engineering Data Sheet 40210 to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.



45-441

Circle 81 on Inquiry Card

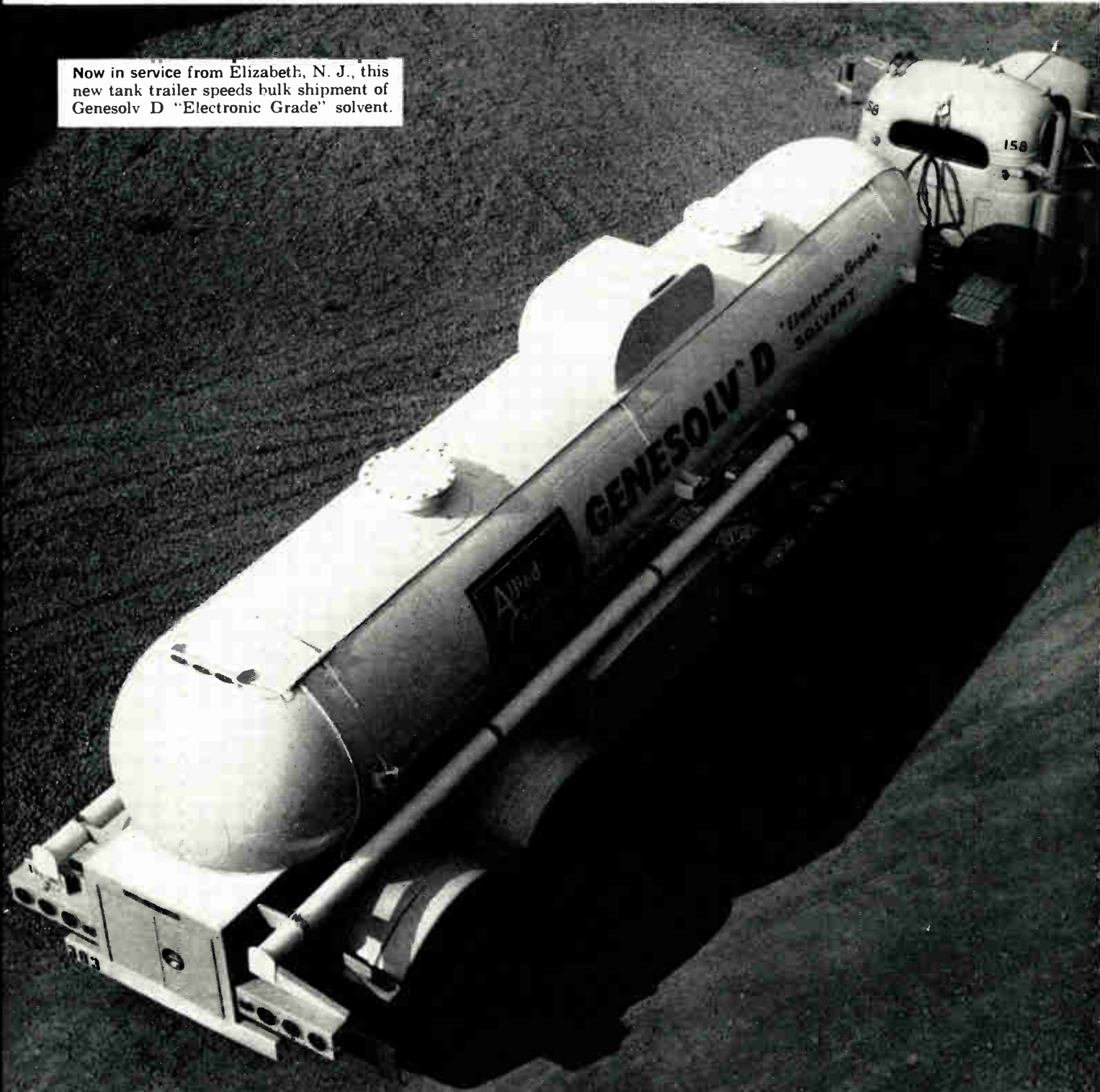
145

Allied Chemical
announces

NEW EAST COAST PLANT

for **GENESOLV^{*} D**

Now in service from Elizabeth, N. J., this new tank trailer speeds bulk shipment of Genesolv D "Electronic Grade" solvent.



NEW TANK TRUCK EQUIPMENT

"Electronic Grade" fluorocarbon solvent

To meet the electronic industry's exacting cleaning requirements, a new General Chemical plant is now on line, producing Genesolv D "Electronic Grade" solvent—the ultra-pure fluorocarbon solvent.

Located at Elizabeth, New Jersey, the new plant is in perfect position to provide rapid service to eastern and midwestern electronic centers. Together with General's Baton Rouge, La., producing works, it will provide enough ultra-pure Genesolv D to serve the most critical cleaning needs of the electronic industry.

Maximum residue:
(soluble plus insoluble) 1 ppm. by weight

General Chemical first introduced its line of "Electronic-Grade" solvents (Baker & Adamson®) in 1957. With this background of experience, manufacture of Genesolv D "Electronic Grade" was a logical next step in this field—another high purity solvent for special applications.

Hermetic handling system safeguards purity

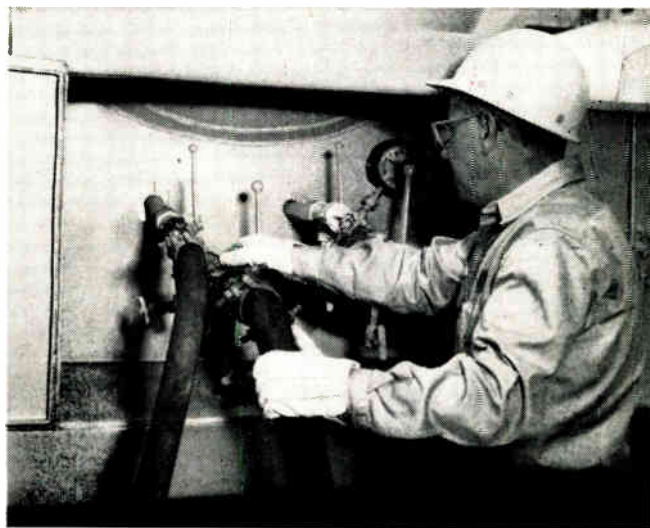
A hermetic handling system makes contamination of Genesolv D "Electronic Grade" virtually impossible. Lines are completely sealed—from production through shipping right to your storage tank. Here's *real* protection for your purity requirements.

Convenient bulk delivery in new trailer

A sleek new stainless steel trailer hauls bulk shipments (up to 3800 gallons) to our customers. Genesolv D is also available in 690, 200 and 100 lb. lined, non-returnable drums.

Technical service at your service

To help you take full advantage of the economies possible in bulk shipments, General Chemical's engineering service staff will be glad to assist with design of



General Chemical technician checks hermetically sealed line on new "compartmented" trailer. The new trailer is part of a hermetic handling system for Genesolv D "Electronic Grade" which assures highest purity—from our plant to yours.

bulk storage equipment...and General's technical service group will be glad to advise on methods of recovery.

If precision cleaning can mean the difference between success or failure in your work, it's time to get full information on Genesolv D "Electronic Grade" solvent. Just contact General Chemical.

TYPICAL APPLICATIONS for precision cleaning:

gyroscopes for guided missiles	electrical contacts
printed circuits	films
semiconductors	precision bearings
micromodules	motors in place
magnetic tapes	motors by immersion



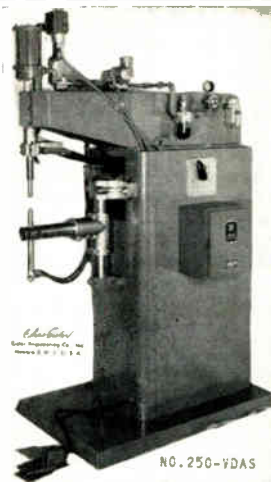
GENERAL CHEMICAL DIVISION

40 Rector Street, New York 6, N.Y.

*Allied Chemical Corporation Trademark

EISLER manufactures a complete line of resistance butt welders, band saw welders, spot welders, soldering & brazing machines, bench or pedestal type, foot or air operated . . .

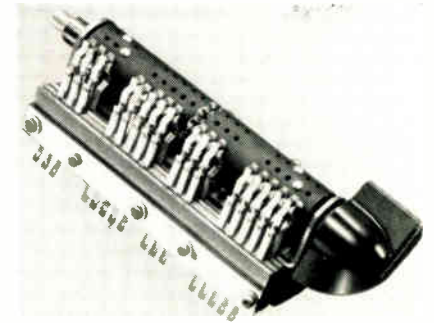
EISLER MAKES THE LARGEST ASSORTMENT OF SPECIALTY STANDARD WELDING TIPS, ACCESSORIES & WATER COOLED HOLDERS



NEW PRODUCTS

PROGRAMMING SWITCH

Miniature programming switch features relay-type contacts.



Line features relay-type contacts and a rotating drum action. Using a barrel actuator the switch may be set up in any prescribed sequence of switching events by placing the actuating pins in desired pre-drilled holes on periphery of drum. Standard switch to 16PDT operation, but may be ganged for 32 PDT on a single shaft. Contact life claimed in excess of 100 million cycles. Temp. range -65°C to $+125^{\circ}\text{C}$. Actan Electronics, Div. of Sealectro Corp., 130 County Courthouse Rd., New Hyde Pk, N. Y.

Circle 180 on Inquiry Card

MEDIUM POWER TRANSISTOR

Capable of linear operation at collector currents in excess of 1a.



This germanium alloy junction transistor (2N2648) has a useful frequency range in excess of 10MC. As a lamp driver, the min. gain of 80 at 1a was used for driving high intensity, low voltage lamps. The min. alpha cut off freq. of 10MC combined with a saturation resistance of less than 0.5Ω at 1a allows the device to be used in computer systems as either core drivers or magnetic drum and tape head drivers. General Instrument Corp., Semiconductor Div., 600 W. John St., Hicksville, N. Y.

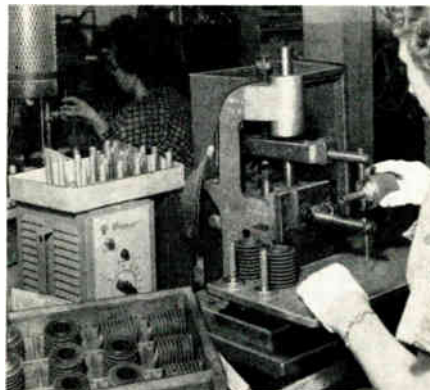
Circle 181 on Inquiry Card

WIRE BUTT WELDER WITH HYDROGEN JET



We also carry in stock welding tips, holders and other welding accessories

Write for full details



EISLER ENGINEERING CO., INC. / 770 So. 13th St., NEWARK 3, N. J.

Circle 83 on Inquiry Card




Powertron

AC POWER SUPPLIES

A complete line of single phase, two phase and three phase electronic power supplies with output power ranging from 3 watts to 9 KVA.

Featuring:

- Precision 400 C.P.S. output (other fixed or variable frequency ranges available).
- Regulated output voltage.
- Low distortion.
- Many standard optional features to suit your requirements.

WRITE FOR OUR NEW POWERTRON SPECIFICATION CATALOG

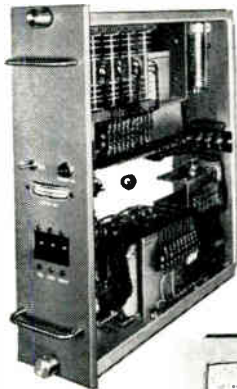
INDUSTRIAL TEST EQUIPMENT CO.
55 EAST 11th STREET • NEW YORK 3, N. Y.

Circle 84 on Inquiry Card

HAS ANYONE TOLD YOU ABOUT

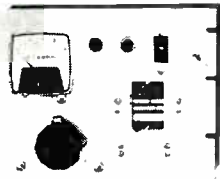
Aeme Electric POWER SUPPLIES?

The hundreds of Power Supply types and designs that we have engineered and produced gives us a wealth of experience and "know-how" that can be put to your advantage. Whether your need is for custom-designed units to meet a specific application or standard stock models, there will be a definite advantage in checking your requirements with Acme Electric. The following illustrated units indicate our wide range of production.

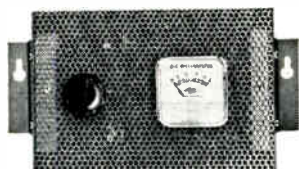


This custom designed unit, which is produced in production quantities, features modular construction and advanced circuitry.

This sturdily built design, for the manual regulation of saturable core reactors, features silicon rectifiers for full-wave d-c output. Available in 300, 500, 1000, 2000 watts; 0-100 volts d.c.



High efficiency, regulated power supply. Less than 1% ripple. Negligible thermal drift. Tubeless circuitry achieves maximum reliability. Output voltage maintained under varied conditions of input and load. Six other big features described in Bulletin 174.



This Signal Developer Power Supply provides the necessary d-c for the signal control circuit of a magnetic amplifier. One-eighth watt, 0-25 volts.

SAA 3574-2022A

ACME ELECTRIC CORPORATION
892 WATER STREET CUBA, N. Y.
In Canada: Acme Electric Corp. Ltd., 50 Northline Rd., Toronto, Ont.

Aeme  Electric

Circle 146 on Inquiry Card

ELECTRONIC INDUSTRIES • February 1963



What Can You Do With a SIRKITTM WAFER?



ACTUAL SIZE

**The First Successfully Mass Produced Micro-Miniature Integrated Circuits.*

Looking for an integrated, thin film micro-miniature circuit that meets your specific requirement? Just name your application . . . DIGITAL LOGIC CIRCUITRY . . . LINEAR AMPLIFIERS . . . ANALOG PROJECTS . . . MATCHED NETWORKS . . . RC NETWORKS . . . IF STRIPS. Hand us your specifications and National does the rest . . . on a SirKit wafer. Quantities? You name them too . . . we can deliver up to 12,000 per day.

"Utterly Fantastic!" you say? True, but there's no magic involved here . . . just the use of National's patented thin film techniques for producing passive componentry . . . combine with proven semi-conductor devices . . . add strict standardization of formulation, atmospherics and time. The result . . . reliable, lottery-free integrated circuits. National's exclusive design, tooling and processing assures quantity deliveries of SirKit wafers within five weeks from receipt of an order . . . savings in cost are worthy of note too.

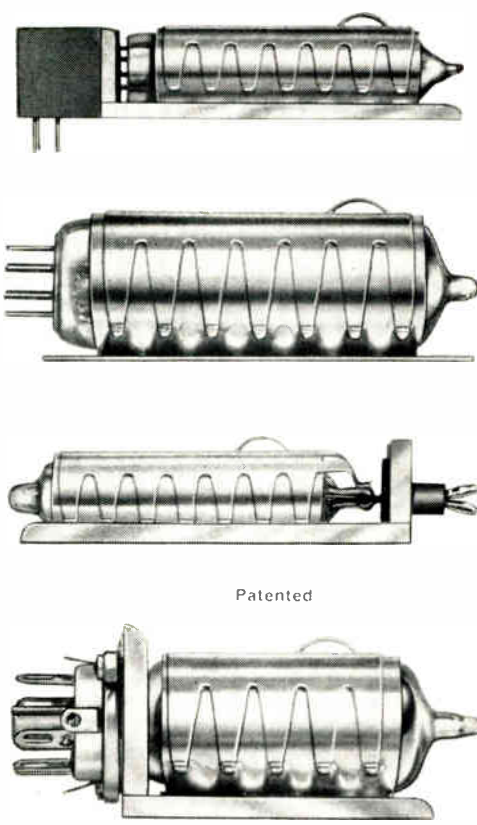
Send today for the Utterly Fantastic story of SirKit wafers, supported by Applications Sheets and Test Data Results.

Don't forget to attend the symposium on Integrated Circuits at the SirKit Suite, Plaza Hotel, during the IEEE (IRE) Show . . . Send for free reservation on company letterhead.



National Resistronics INC.
56 WALTER STREET PEARL RIVER, NEW YORK

Circle 147 on Inquiry Card



Patented

COMPLETE THERMAL DESIGN IS A TUBE SHIELD MATTER, TOO!

Thermal design in tube-circuited equipment, to be complete, needs IERC Heat-dissipating Tube Shields. They assure maximum cooling, 2 to 12 times longer tube life and reliability. Equipment buyers want IERC Tube Shields—recognized as a sign of perceptive thermal design engineering in the equipments they buy.

NEW PRODUCTS

POWER AMPLIFIER

This solid state unit features a one-watt output.



Differential dc amplifier for meeting the driver requirements of wide range of process and machine control applications. Model 2023 has sufficient output to drive heavy instrument systems and small dc servos. The 30 oz. unit, measuring approx. 5½ x 4 x 1¾ in. offers the following typical specs.: open loop gain, greater than 100,000; gain-bandwidth product, 200kc; output, ±10v at ±100ma; and power supply requirement, ±18v at ±100ma. Weston Instruments Div., Daystrom Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 250 on Inquiry Card

ADJUSTABLE SHORTS

Eight standard waveguide sizes covering 2.60 to 40.0gc.

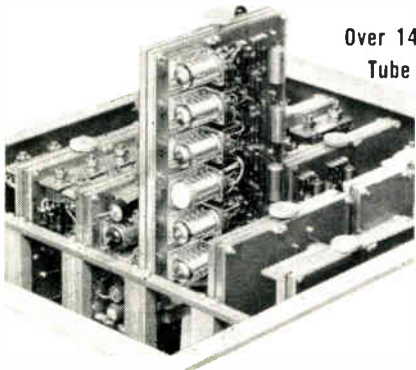


Most of the standard models use a non-contacting, folded half-wave trap type short circuit, except the lower freq. models which are equipped with a spring finger short circuit. Used for terminating a waveguide transmission line at various points of the short circuit. When in combination with a waveguide tee section they form a stub transformer that can be used as a tuner in a transmission line. They may also be used as a short circuit reference plane in connection with impedance or admittance measurements. Waveline Inc., Caldwell, N. J.

Circle 251 on Inquiry Card

IERC DIVISION

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION
 135 West Magnolia Boulevard, Burbank, California • Victoria 9-2481
 Foreign Manufacturers: Europelec, Paris, France. Garrard Mfg. & Eng. Co., Ltd., Swindon, England



Over 1400 sizes and types of IERC Heat-dissipating Tube Shields to meet every design requirement!

IERC Horizontal Hardmount Series Shields are shown in a combination printed circuit and heat sink modular application by Remanco, Inc., Santa Monica, California. Excellent thermal control from maximum heat transfer in space-saving arrangement is obtained on eleven back-to-back modules in Remanco's Radar Target Simulator.

Write for complimentary IERC Heat-dissipating Tube Shield Catalog today!

**MODEL CFI
TRANSISTORIZED
CALIBRATED
MICROWAVE
FIELD-INTENSITY
(RI/FI) METER
—1,000 to 10,000 MC.**



Category A Air-Force Approval For MIL-I-26600 and MIL-I-6181. Transistorized, portable, compact, ruggedized.

Combines an impulse calibrator, field-intensity meter, and calibrated antenna system. Provides accurate measurements of the frequency and the absolute power level of conducted or radiated microwave energy. Choice of 12V battery or line-power operation.

FEATURES: UNIDIAL® tuning; Direct-reading digital frequency dial; ±1% frequency accuracy; Choice of 3 impulse bandwidths — 1 MC, 5 MC, wide band; Direct reading output level, microvolts, db above 1 microvolt and db above 1 microvolt per MC; Image and spurious response rejection better than 60 db; Max. RF input, 3 volts. Audio, video, recorder outputs. AM, FM, CW, and Pulse Reception Capability. Four interchangeable plug-in tuning units cover 1,000 - 2,040; 1,900 - 4,340; 4,200 - 7,740; and 7,300 - 13,000 MC.

**MODEL FIM-2
CALIBRATED
MICROWAVE
FIELD-INTENSITY
(RI/FI) METER
—1,000 to 10,000 MC
(Extension to 21,000 MC
nearing completion)**



Category A Air-Force Final Approval For MIL-I-26600 and MIL-I-6181. Widest frequency range ever offered in a microwave RI/FI meter!

Combines internal CW signal generator, field-intensity meter, and calibrated antenna system. Provides accurate absolute power level and frequency measurements. The signal level indication is in microvolts, db above 1 microvolt, and db above 1 microvolt per MC.

- Only microwave Field Intensity Receiver with self-contained CW signal generator which calibrates entire system under test at any level.
- First single microwave test system to determine radiated r-f interference and susceptibility.
- Front-panel meter directly reads average, peak, slide-back peak or quasi-peak value of r-f signals.
- Six interchangeable tuning heads cover 1,000 to 21,000 mc.
- Outputs for video, audio and recorder.
- Single UNIDIAL® tuning control simultaneously tunes the receiver and signal generator.
- Calibrated antenna system includes an omni-directional broadband antenna and separate directional antennas to match each tuning unit.
- Frequency Dial Accuracy: ±1%.
- Maximum RF Input: 3 volts
- Sensitivity: —81 dbm minimum
- Impulse Bandwidth: 5 mc
- Image and Spurious Response Rejection: Better than 60 db
- Attenuation: 0 to 80 db in steps of 1 db

HAVE YOU MADE RESERVATIONS YET?



Polarad's new "Project Mohammed" will be bringing the "Mountain" (our new Mobile Microwave Calibration Laboratory) to "Mohammed" (your microwave instruments) starting next month. Be sure to take advantage of this opportunity to have your gear checked — at your doorstep. Save weeks of delay and needless expense. Call your Polarad field engineer for details and schedules!

How To Select An RI/FI Meter

In noise-and-field-intensity measurement, Polarad has three major competitors. They are all competent. They build good equipment. Give or take an adjective, they describe and rate their equipment accurately. We respect their designs, their equipment, and their integrity as manufacturers. We believe they return that respect.

As an engineer, you know that no two design groups ever produce exactly the same instrument for a specific purpose. Experience and backgrounds differ. Approaches differ. Even basic concepts differ. Then, too, each group has its own view of the needs of the user. In a complex design, one approach will favor sensitivity over bandwidth, or, perhaps, cost over durability. We all must draw the line somewhere, in reaching each design decision. In an RI/FI meter, there are dozens of such decisions. The final "mix" of characteristics is, at best, an intelligent compromise . . . never the ultimate.

We believe that the two instruments described on this page represent by far the best "mix" of performance, economy, and versatility for the majority of applications.

You don't buy an RI/FI meter every day. Once you buy it, however, you may use it every day, for many years. Therefore, we urge you to consider the "mix" carefully. Limited range or restricted utility may seem tolerable now, but what about next month, or next year? Initial cost may dominate your thinking now, but how much does an extra man-hour a day (or one questionable result a week) cost . . . over five years?

Consider the "mix". We think you'll choose Polarad.

We can't resist listing the outstanding features of our "mixes", below — but don't decide until you have the complete technical data in front of you.

Call your Polarad Field Engineer.

- CFI "mix"**
- Portable, Rugged, Compact
 - Battery and AC Operation
 - Direct Reading without Charts
 - Directly Calibrated Long-Life Impulse Calibrator
 - Digital Frequency Display
 - —85 dbm Minimum Sensitivity
 - 70 db Dynamic Range
 - Standard Calibrated Horn Antennas
 - Air Force Approved

- FIM-2 "mix"**
- Integral CW Generator for Accurate Calibration & Direct Substitution Measurements
 - Separate Generator Output for Susceptibility Measurements
 - Direct Reading without Charts
 - —81 dbm Minimum Sensitivity
 - Standard Calibrated Horn Antennas
 - Air Force Approved

Which one is just right for you?

POLARAD
A Division of Polarad Electronics Corporation
World Leader in Microwave Instrumentation
34-02H Queens Boulevard
Long Island City 1, New York

NOW!
from
**MESUR
MATIC**



**THE MODEL VDC-2BR
SELF-CALIBRATING DC VTVM**

The Model VDC-2BR combines in one portable cabinet a chopper-amplified DC VTVM (accurate to $\pm 0.25\%$ full scale) and a precise zener reference. This reference source supplies ± 1 volt (accurate to $\pm 0.05\%$) which allows exact calibration on the ± 1 volt range. By rotating the selector switch through successively higher ranges, the tracking accuracy may be easily observed. Ranges are ± 0.5 , 1, 3, 10, 30, 100 and 300 VDC. Send today for complete technical data.

Single unit price **\$355.00**



MESUR-MATIC ELECTRONICS CORP.
WARNER, NEW HAMPSHIRE

Circle 87 on Inquiry Card

FREDDY

by *ROPE*



What you need, Freddy, in order to screen out those unwanted signals, is a **REEVES-HOFFMAN CRYSTAL FILTER** (or maybe in your case just the container would be good enough). Like Freddy, perhaps you have a need for a good filter system. If so, why not get the facts now about Reeves-Hoffman crystal filters, available in frequency ranges from audio to 30 mc to meet commercial or military specifications. Are we coming through loud and clear? Then write for bulletin QCF.



**REEVES-
HOFFMAN**
CARLISLE, PENNSYLVANIA

DIVISION OF DYNAMICS CORPORATION OF AMERICA

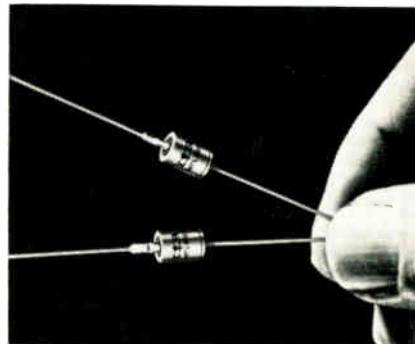
PRODUCERS OF PRECISION
FREQUENCY CONTROL DEVICES...
crystals • crystal-controlled
frequency sources, standards,
filters • component avens.

Circle 88 on Inquiry Card

NEW PRODUCTS

SILICON RECTIFIERS

Series of 5 JEDEC registered units cover from 0.75 to 1.5a.

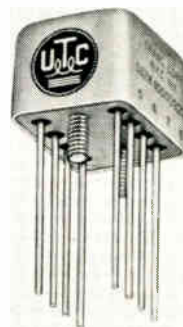


Forward and reverse polarity types, the devices cover a PRV range from 50 to 1000v. JEDEC type 1N1907-1N1916 cover PRV from 50 to 900v; types 1N2103-1N2108 range from 50 to 500v; 1N2610 to 1N2617 from 100 to 1000v; 1N3189 to 1N3191 cover 200 to 600v, and 1N3639 to 1N3642 range 200 to 800v PRV. Operating temp. range from -65 to 185°C . DO-13 case, hermetically sealed and welded. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 182 on Inquiry Card

TINY AUDIO TRANSFORMERS

Case measures $\frac{7}{8} \times 2\frac{3}{32} \times \frac{9}{16}$ inches; weight is 0.8 oz.



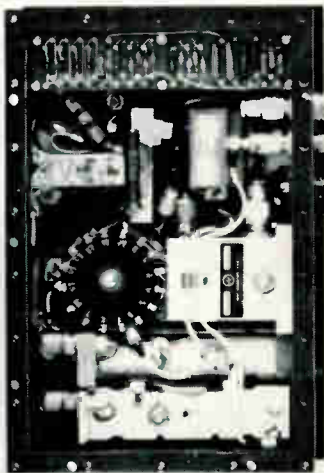
FH series subminiature audio transformers and split inductors guaranteed to Mil-T-27A. Units meet Grade 4, Class R, Life X military requirements. Flat type hermetically sealed steel case with mounting studs and straight pin terminals for welding or printed circuit use. The transformers have operating level of 100mw with impedance range 50Ω to $20\text{k}\Omega$; response under 2db over abroad audio freq. range. Split inductors allow series or parallel connections with ranges from 15mh @ 64ma, 1.5Ω to 2.4h @ 2ma, 16Ω . United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 183 on Inquiry Card

NEW WAVE IN MICROWAVE INSTRUMENTS

Microdot's revolutionary approach to the design and fabrication of high-power coaxial cavities has produced an integrated line of components, subsystems and equipments that represent true technological advancement—delivering performance/size/weight ratios well beyond those previously available. Examples:

AIRBORNE VHF AND UHF TRANSMITTERS by Microdot have been proven in history's most demanding environmental laboratories: satellites, ICBMs and supersonic test sleds. All are miniaturized, pressurized and feature a solid-state power supply immune to input variations and output overloads. Covering frequencies from 100 to 5000 mc, their power outputs range from 100 mw to 10 watts or more depending on application. Details in Bulletin ATC-1.

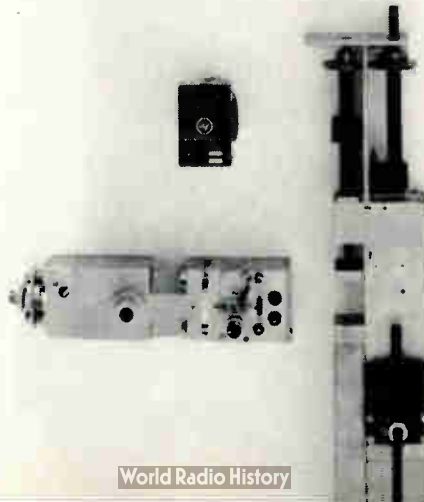
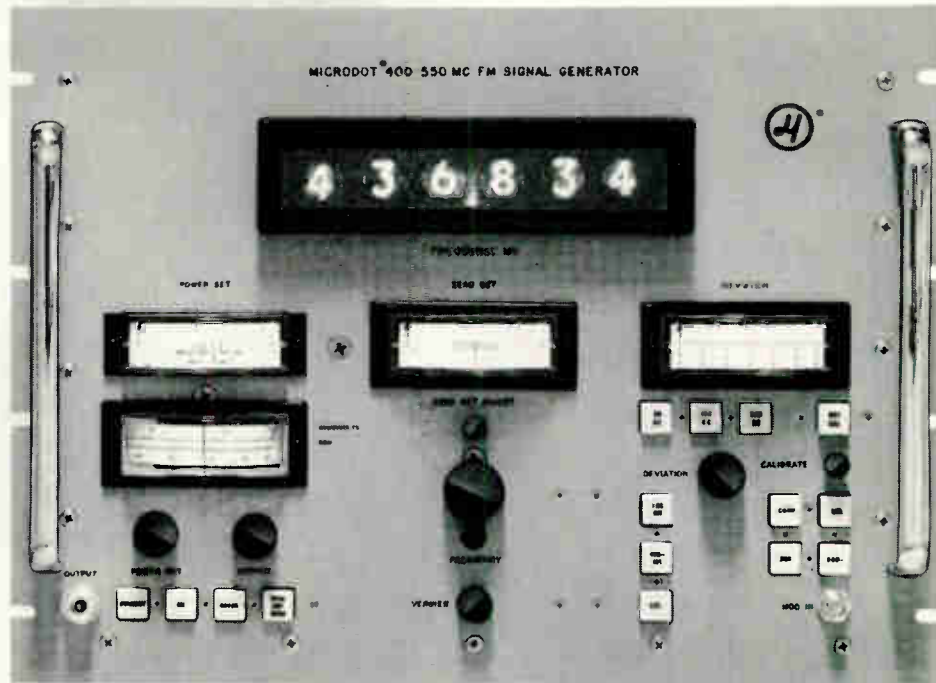


RF COAXIAL CAVITY MODULES by Microdot are high-power, off-the-shelf building blocks for quick assembly of unusual prototypes. These power amplifiers, oscillators and frequency multipliers assemble in a wide variety of configurations to cover the 10-5000 mc range and all are miniaturized, ruggedized and conservatively rated. Typical modules weigh about 1 pound. Write for Bulletins ATC-1, JSC-1 and PTM-1.



VHF AND UHF POWER OSCILLATORS by Microdot are portable, precision laboratory equipments covering frequency ranges of 200-550 mc and 500-1050 mc with single-knob tuning. Power supplies regulated to 1% insure power and frequency stability, while variable power control permits wide range output level adjustment. Resettability of up to 0.002% is achieved via high ratio dials with negligible backlash and logging scales with four-place accuracy. Ask for Bulletin PO-1A.

FM SIGNAL GENERATOR by Microdot delivers 0.0003% accuracy and 0.0005%/hr stability in an instrument that needs only 13 inches of rack space. Direct 400-550 mc digital readout and lighted push-button switching minimize human error and operator training while single-knob tuning gives continuous coverage and permits fast frequency search. 95% solid-state, with lone, ruggedized ceramic vacuum tube operating at 4% of rated power. Write for detailed specs in Bulletin FSG-1.

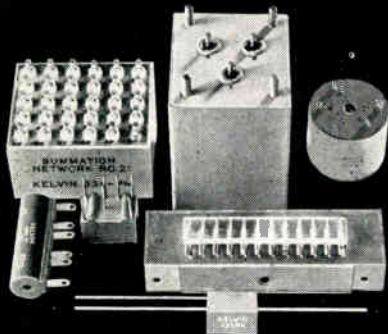


For applications anywhere in the spectrum from spacecraft telemetry transmitters to command receiver checkout, consider Microdot's new wave in microwave instruments. Contact your nearby Microdot sales office, rep or distributor. Or, write us direct and tell us what you need.



MICRODOT INC.
220 Pasadena Avenue, South Pasadena, Calif.
Overseas: Microdot AG, Zug, Switzerland

THE PERFECT PACKAGE



FOR HIGH PERFORMANCE APPLICATIONS

KELVIN CUSTOM DESIGNED RESISTANCE NETWORKS

Our experienced engineers will answer your application inquiries accurately and promptly. Send specifications or requirements to:

PRESENT APPLICATIONS:

VOLTAGE DIVIDERS	REFERENCE OR RATIO STANDARDS
COMPUTER APPLICATIONS	LADDER TYPE CONVERTERS
SUMMING NETWORKS	MISSILE CHECKOUT SYSTEMS

DIGITAL TO ANALOG CONVERSION

Kelvin has specialized for years in the custom design and production of resistance networks to suit individual customer requirements.

Recognized, high quality Kelvin precision wire-wound resistors are used to obtain the ultimate in high accuracy and stability. Units perform in airborne and missile environments involving altitude, shock, vibration, humidity and wide temperature ranges. Networks are packaged in hermetically sealed cases or encapsulated in epoxy resin to meet exact mechanical specifications.

Electrical Characteristics Available:

- Nominal resistance tolerances to $\pm .005\%$.
- Resistance ratio tolerances as close as $.002\%$.
- Long term resistance stability of $\pm .002\%$ per year.
- Low reactances to provide rise times as low as 50 nanoseconds.
- Temperature coefficients of resistors track as close as 1PPM/°C from -55°C to $+125^{\circ}\text{C}$.

NEW PRODUCTS

FREQUENCY MULTIPLIERS

Bandwidths from 1 to 10%; efficiencies from 25 to 80%.



Line of solid state frequency multipliers using varactor diodes, offer advantages of high stability, small size and light weight. Typical efficiencies of freq. doublers are 80%, triplers 75%, quadruplers 50% and quintuplers 25%. Spurious freqs. are down more than 20db for all types. Series VM Multipliers cover from 70mc to 6gc. Bandwidths obtainable from 1% to 10% of output freq. for all types. Designed for 50 Ω input and output impedance. Remanco Inc., 1805 Colorado, Santa Monica, Calif.

Circle 186 on Inquiry Card

COAXIAL SWITCH

Six-position coaxial switch with in-line oriented connectors.



Compact unit can be used for transferring signals to various elements of CC-TV system, switching signals from test set-ups to scopes, changing antenna leads or dummy loads on radio transmitters or receivers, and other uses requiring switching of coaxial leads from dc up to 150mc. Designed for panel mounting, the switches (Models 335, 336, 341) are inexpensive, compact and easily installed (standard $\frac{3}{8}$ in. bushing). Power capacity: 1000w. Also in SPDT and DPDT. Waters Mfg., Inc., Wayland, Mass.

Circle 187 on Inquiry Card



KELVIN ELECTRIC COMPANY

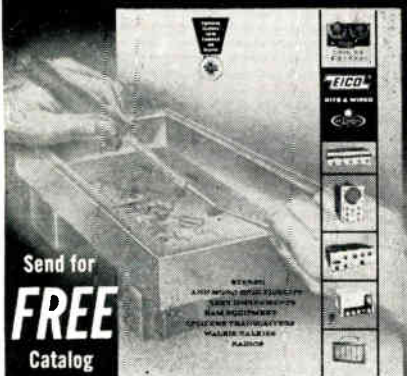
5907 Noble Ave., Van Nuys, Calif., TRiangle 3-3430
New York: Yonkers, 916 McLean Ave., BEvery 7-2500

Representatives in principal cities

Circle 90 on Inquiry Card

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PUTS THE BEST IN
CREATIVE ELECTRONICS
INTO YOUR HANDS



Send for
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28 pages of professional electronic equipment in kit and wired form—for Lab . . . Line . . . Home

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SEE US AT IRE BOOTH 3101
Circle 91 on Inquiry Card

SHOCK STOP PACKAGING

Possible?

Yes.

Competitive?

No.

You can, however, package to eliminate damage caused by shock and vibration, save with less handling, have greater packing control, at comparatively lower costs.

pak/control™

Molded Cushion Packaging offers you a complete service in development and production of bonded and virgin foam packaging elements. Relatively new, these materials have gained wide recognition as the protective packaging for precision equipment and sensitive instrumentation. Request literature and samples.



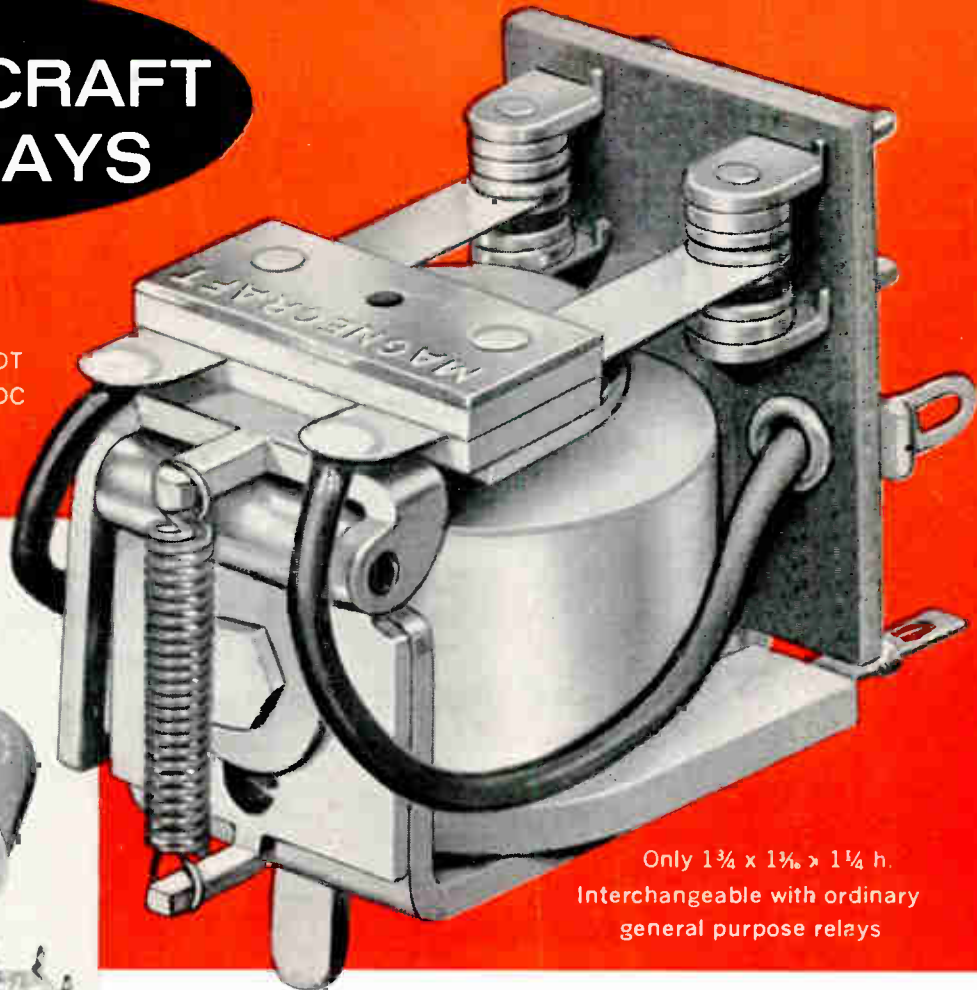
™

INDUSTRIAL PACKAGE DIVISION
DELVALTEX CORPORATION
34 Parker Avenue, Trenton 9, New Jersey

Circle 92 on Inquiry Card

MAGNECRAFT 88 RELAYS

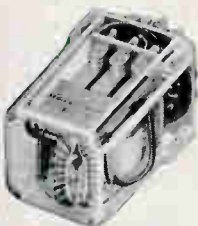
Available with 10 amp contacts to 3PDT for standard coil voltages, AC and DC



Only $1\frac{3}{4} \times 1\frac{1}{2} \times 1\frac{1}{4}$ h.
Interchangeable with ordinary
general purpose relays



MAGNECRAFT 88CP available with 10 amp contacts to 3PDT, AC and DC

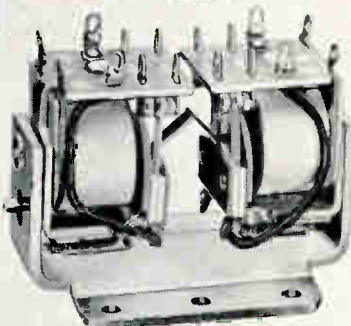


MAGNECRAFT 88HP hermetically sealed 4 amp contacts, DPDT, AC and DC.

MAGNECRAFT 88ANCP with circuit indicators light, 10 amp contacts to 3PDT for 115 VAC



MAGNECRAFT 88D Power 10 amp SPST-NO Double Break Contacts, AC and DC



MAGNECRAFT 88L Latch-in 10 amp contacts to 6PDT, AC and DC



MAGNECRAFT 88R 15 amp contacts DPDT for AC and DC

Extra Reliability at a Saving

MAGNECRAFT Class 88 Relays provide the high standards of reliability users have learned to expect from MAGNECRAFT Telephone Type Relays at general purpose relay prices.

Unique in a relay of this type MAGNECRAFT 88 Relays have precision-built hinge-pin armature bearings with oversize bearing surfaces — the same construction used in the finest telephone type relays for lowest friction and maximum contact effectiveness with stabilized adjustment over long life.

Glass insulation provides great dielectric strength unaffected by humidity and temperature changes.

Ruggedized, independently riveted coil terminals make connections you can depend on.

Molded Nylon bobbins with coil terminal inserts eliminate any possibility of shorts.

Built-in contact wipe with riveted contacts further advance reliability through long life.

Modular construction provides flexibility to meet varied specifications at low cost through use of standardized sub-assemblies.

The many refinements plus MAGNECRAFT Quality Control and Inspection Standards make Class 88 Relays so outstanding you can actually SEE the great superiority.

Investigate BEFORE you decide! Send for literature or phone the number nearest you.

Stocked by Leading Distributors
Call number nearest you for addresses

Phone numbers of Sales Representatives.

CALIF	Los Angeles, NO 3-8236	N H	Manchester, 472-4091
COLO	Littleton, 798-0422	N J	Livingston, IN 3-5000 Orange, OR 4-4100
CONN	Farmington, 677-9025 Trumbull, AM 8-9631	N Y	Buffalo, TF 9-0200 Fairport, BR 1-4370 Fayetteville, NE 7-3851
FLA	North Miami, WI 7-5080	ORE	Portland, CA 6-3903
ILL	Chicago, JU 8-3738	PENN	Philadelphia, PI 2-5476
IND	Fort Wayne, ANTHONY 2083	TEXAS	Dallas, FL 7-5713 Houston, MO 7-1256
IOWA	Burlington, PL 2-3186	VA	Arlington, JA 5-5898
KANS	Kansas City, JO 2-4108	WASH	Seattle, AT 2-7200
MASS	Boston, FA 3-1008	WISC	Milwaukee, UP 1-2933
MICH	Belmont, GL 1-1449		
MINN	Minneapolis, 866-36 39		
MO	St. Louis, WO 2-5627		

In CANADA—Scarborough, Ontario, PL 7-3253

MAGNECRAFT
The relays you can rely on

MAGNECRAFT ELECTRIC CO.,

5577 N. Lynch, Chicago 30, Ill.

Area 312—AVenue 2-5500

NEW PRODUCTS

TELEMETRY CALIBRATOR

Model 613, high stability, 18 channel oscillator for calibration.

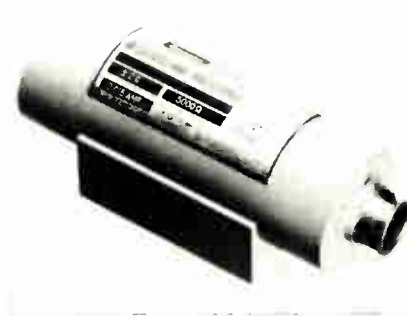


All 18 IRIG subcarrier channels including channels A through E are provided with individual control of gain for each channel for presetting any taper desired. Each channel is turned on or off by front panel switches allowing the elimination of unneeded signals. Channels 1 through 18 may be deviated $\pm 7.5\%$ for 3 point calibration and channels A through E may be deviated $\pm 7.5\%$ and $\pm 15\%$ for 5 point calibration. Output impedance of the calibrator is 400 Ω . Dytronics Co., Inc., 5485 N. High St., Columbus 14, Ohio.

Circle 252 on Inquiry Card

AXIAL ACCELEROMETER

Gas-damped, high performance, potentiometer-output accelerometer.

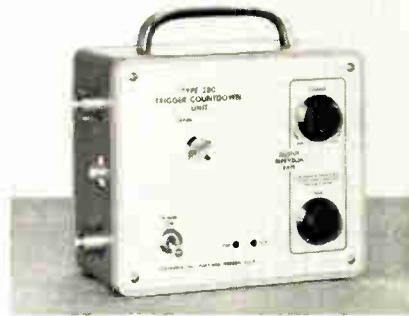


Model 24171 potential applications include airborne stabilization, fire control and telemetering systems. Range of measurement is ± 2 to 50g's and typical dynamic error band is $\pm 0.75\%$, including linearity, hysteresis, repeatability friction and temp. Natural freq. is 9 to 45cps depending on range. Temp. ranging from -54° to 100°C . The non-servoed, open-loop accelerometer weighs 10 oz., is 1.37 in. in height and 3 in. long. Gianini Controls Corp., Transducer Div., 1600 S. Mountain Ave., Duarte, Calif.

Circle 253 on Inquiry Card

SAMPLING SCOPE TRIGGER

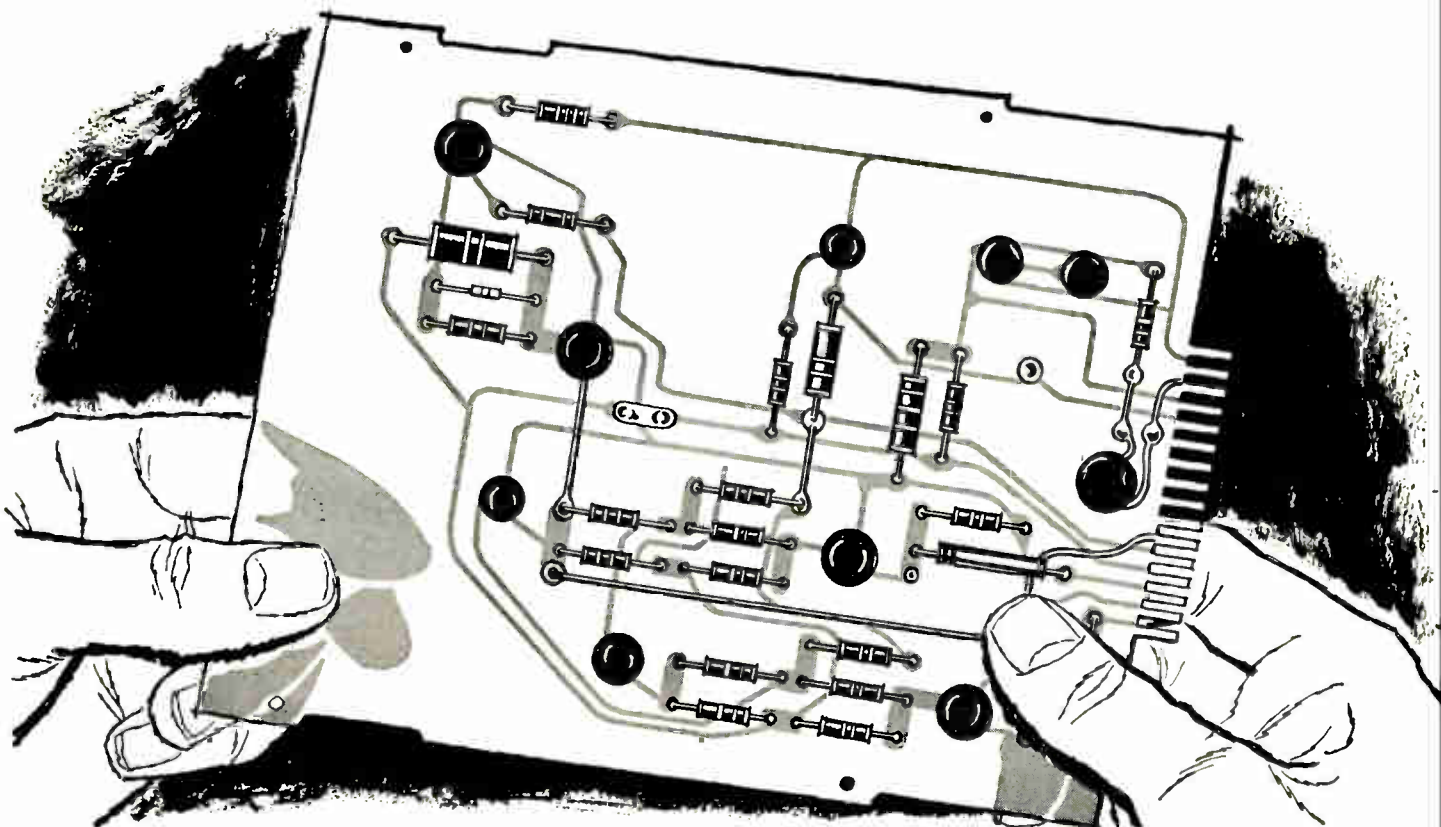
Trigger countdown unit for direct observations of signals to 5gc.



The Type 280 Trigger Countdown Unit extends the high freq. triggering capability of Tektronix sampling systems and permits the trigger circuits to synchronize on freq. as high as 5gc. The device lowers the trigger signal freq. to a range from 15mc to 45mc by counting down, enabling the scope to lock in solidly at the lower freq. Input freq. range of the Type 280 is 30mc to 5gc. Output freq. is continuously variable from 15 mc to 45mc with coarse and fine controls. Tektronix, Inc., P.O. Box 500, Beavertown, Ore.

Circle 254 on Inquiry Card

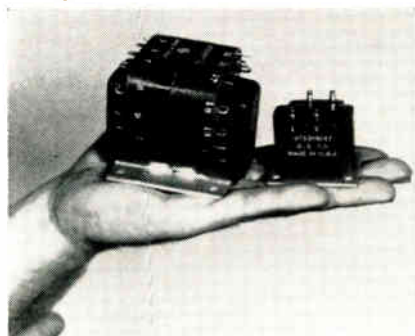
Taylor works magic



NEW PRODUCTS

TRANSFORMERS

High thermal shock characteristics; improved moisture resistance.

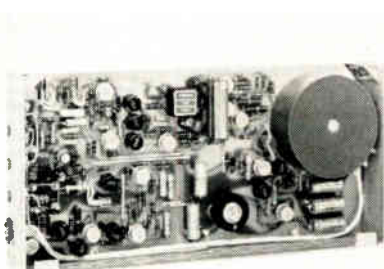


In addition, the new line has standardized dimensions to aid system design and layout. G-E contour cast transformers surpass -62°C storage temp. requirements. Fifteen size steps covering a wide range of 1 and 3 Φ applications available. Terminals are timed for ease of soldering. Contour cast transformers have been designed to meet or exceed the performance requirements of Mil-T-27, Grade 5, Class R, Life X or Class S, Life Y. General Electric Co., Schenectady 5, N. Y.

Circle 255 on Inquiry Card

WIDEBAND DC AMPLIFIER

For wideband, highly accurate amplification and buffering.

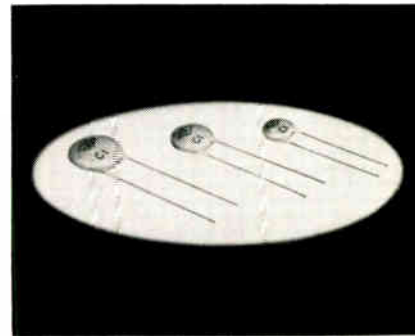


Solid-State dc Amplifier Model 259 includes all transistorized choppers. Other features are: bandwidth: down 3db at 200kc min.; settling time—full-scale step input, 10 μ sec. to within 0.01% of final value; gain accuracy is $\pm 0.02\%$ at dc; input resistance is 100k Ω $\pm 0.02\%$ for gain -1, 10k Ω $\pm 0.02\%$ for gain -10; Output: $\pm 10\text{v}$, ± 10 milliamperes. The dimensions are 8.44 x 4.06 x 1.53 inches. Redcor Corp., 7760 Deering Ave., P.O. Box 1031, Canoga Park, Calif.

Circle 256 on Inquiry Card

CERAMIC CAPACITORS

Line of ceramic capacitors designed for ac line bypass uses.

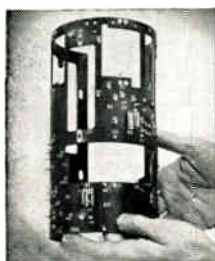


Carry U. L. approval. They are suitable for continuous operation at 220vac RMS 60cps and will operate under intermittent higher voltage. Designated as CI series Hi-Kaps[®], they are available in 6 standard values ranging from 470 to 10,000p μ . Rated at 1,000vdc min. Sizes range from 0.400 to 0.850 inch in diameter and 0.180 to 0.240 inch thick, depending upon capacity. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 257 on Inquiry Card

with glass-base laminates

Which grade has the unusual combination of properties you need?



Almost magical combinations of resin formulations and glass reinforcements have enabled Taylor to develop a number of glass-base laminates that have outstanding characteristics for electrical and mechanical applications. For example, the glass silicone grades offer very high heat

resistance combined with excellent mechanical and electrical properties plus the highest arc resistance. If you require extremely high strength, excellent chemical resistance, low moisture absorption and high strength retention at elevated temperatures select one of the glass epoxy grades. These grades are ideally suited for high reliability printed circuitry. Other grades have equally important characteristics.

• Write to us for complete technical data.

Taylor corporation
ENGINEERED PLASTICS

Valley Forge 53, Pa. • West Coast Plant: La Verne, Calif.
(Formerly Taylor Fibre Co.)

TAYLOR GLASS-BASE LAMINATES

Taylor Grade	NEMA Grade	Military Specification	Resin Used	Principal Characteristics
GSC	G-7	MIL-P-997 Type GSG	Silicone	High heat resistance. Excellent electrical properties, highest arc resistance. Will not support combustion.
FIREBAN 1011	G-10 G-11 FR-4 FR-5	MIL-P-18177 Types GEE and GEB	Epoxy	Combines all desirable properties of G-10 (GEE) and G-11 (GEB), plus flame retardance in one grade.
GEC-500	G-10	MIL-P-18177 Type GEE	Epoxy	Extremely high flexural, impact and bond strength. Low moisture absorption. High insulation resistance.
FIREBAN 600	FR-4	MIL-P-18177 Type GEE	Epoxy	Self extinguishing. Excellent electrical properties under high humidity conditions. Extremely high flexural, impact and bond strength.
GEC-111	G-11	MIL-P-18177 Type GEB	Epoxy	High mechanical strength retention at elevated temperatures. Will not support combustion.
G-5	G-5	MIL-P-15037 Type GMG	Melamine	High mechanical strength. Excellent arc resistance and electrical properties. Will not support combustion.
G-3	G-3	None	Phenolic	Good mechanical strength. Good heat resistance.

NOTE: Taylor Glass-Epoxy, Copper-Clad Grades are available to meet MIL-P-13949B, Types GE, GB and GF.

NEW PRODUCTS

POWER TRANSFORMERS

Compact 400cps units meet the requirements of Mil-T-27.1.



Units feature extremely high wattage in a small package. A typical 235w unit measures less than $1\frac{1}{2} \times 2\frac{1}{2} \times 3\frac{1}{8}$ in., and weighs only 23 oz. Called "Thin-trans," these steel-clad transformers are hermetically sealed, and epoxy encapsulated to conform to environmental conditions of Mil-E-5272C. High-temperature class "S" operations is standard in all units. Ratings up to several hundred watts, and optional multiple-secondaries up to 2000v can be supplied. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 248 on Inquiry Card

CRYSTAL OVEN

Temp. stability of $\pm 2^\circ\text{C}$ over an ambient range of -55° to 65°C .



R-H oven V1425 has an internal size of $2\frac{3}{4}$ in. long x 1.5 in. dia., and will contain 1 T5 $\frac{1}{2}$ glass-bull crystal holder or similar component. Operating temperature may be held as required to $\pm 2^\circ\text{C}$. External dimensions are $3\frac{1}{2}$ in. long x 2 in. dia. The oven is mounted in an octal plug-in base, and internal connection is made to a 7-pin miniature socket. Standard voltage is 115vac. Other units available to specific requirements. Reeves-Hoffman Div. of Dynamics Corp. of America, Cherry and North Sts., Carlisle, Pa.

Circle 249 on Inquiry Card



A Brand New STRIP TYPE!

LEL-LINE strip type components are real traffic stoppers. What's more they're the most available you'll find. How do we deliver LEL strip type components so fast? Easy . . . we make your time our business by delivering the goods —on the line . . . LEL-LINE that is. LEL-LINE is potted . . . gives superb environmental reliability under severe stress conditions . . . adapts to special packaging requirements without sacrificing electrical performance. LEL-LINE components are inexpensive, compact, light . . . have broad bandwidth. Normally fitted with standard TYPE-N connectors, they can be furnished with special connectors as required to achieve total compatibility with any type of system. A complete range of LEL-LINE Strip Type components, designed for breadboard or in-system uses, is manufactured in our own plant and can be speedily delivered.

LEL-LINE products include:



FSB-1-2000
Bandpass Filter



CSM-1-2000
Monopulse Comparator



DSB-1-5402
Low Frequency Binary Power Divider
(3 octave coverage; 2, 4, 8 or 16 outputs)



HSD-1-2650
High Isolation Hybrid

- SSB Suppressed Carrier Modulators
- High Frequency Binary Power Dividers
- Broadband High Isolation Mixers
- Fixed-Tuned Preselectors and Low Pass Filters

FOR A DETAILED LEL-LINE BROCHURE WRITE:

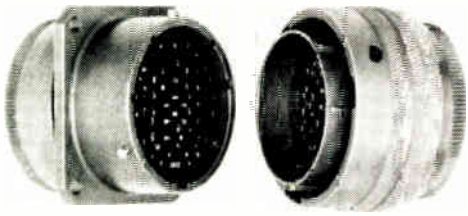
LEL INC.

75 AKRON STREET, COPIAGUE, L. I., N. Y.

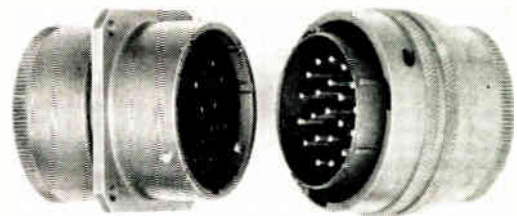
(516) AMityville 4-2200 • (516) PYramid 9-8200

SEE US AT BOOTHS 2106-8 IEEE SHOW

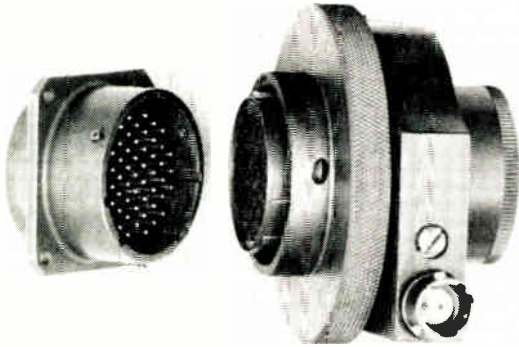
Circle 97 on Inquiry Card



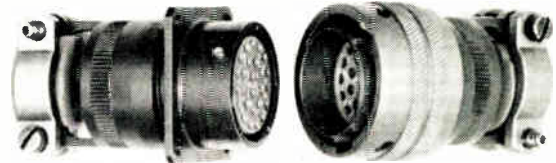
PYGMY SE



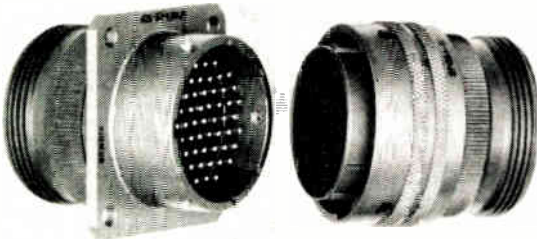
PYGMY PT



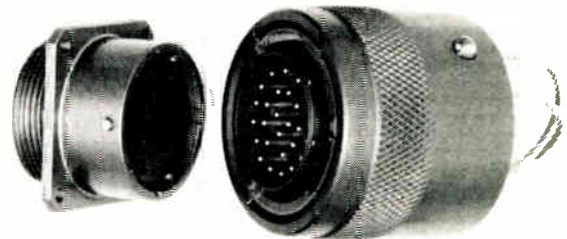
PYGMY SPIN-OFF (SQUIB ACTUATED)



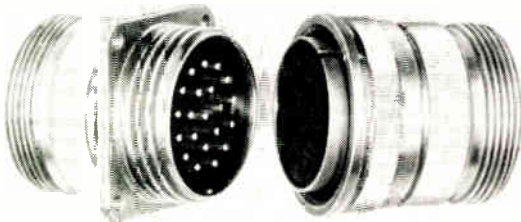
PYGMY PTS-SE (HIGH TEMPERATURE)



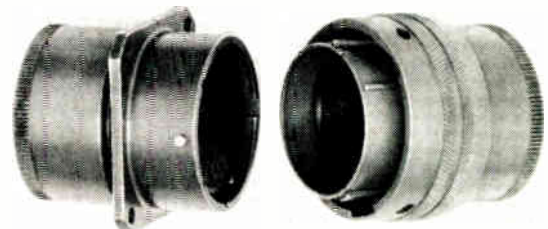
PYGMY SP



PYGMY TWIST-PULL (QUICK DISCONNECT)



PYGMY PC



PYGMY CE

World's finest line-up of miniature electrical connectors. (They're all Bendix Pygmies.)

Here is the most versatile and widely accepted group of miniature cylindrical connectors offered by any manufacturer today. They're light weight and compact, have resilient inserts and closed entry sockets. Many types are available in either solder or crimp contact styles. But you won't really appreciate them until you use them.

Specify Bendix Pygmy® electrical connectors for the minimum space and weight required to serve the most critical circuitry. We're in Sidney, N. Y. Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

Scintilla Division



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Airwork Corporation, Miami, Fla.



Robert Avnet
Avnet Corporation, Los Angeles, Calif.



Harold H. Powell
Powell Electronics, Inc., Phila., Pa.

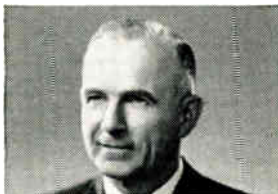


Lester Avnet
Avnet Electronics Corporation
Westbury, L. I., N. Y.



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Contact Electronics, Inc., Dallas, Texas

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Aviation Electric Limited, Montreal, P.Q.

World's finest distributor line-up.

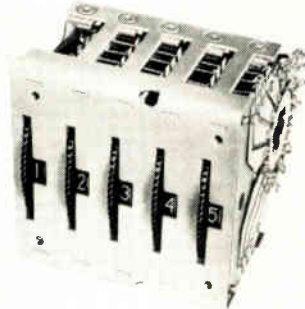
This team supplies an incredible number of connectors through a system pioneered by Scintilla Division: the component assembly technique. It anticipates connector needs and permits overnight deliveries.

Don't hesitate to call on them when you need high-quality connectors. They're at your service.

NEW PRODUCTS

THUMBWHEEL SWITCHES

For computers, data recorders, and ground support equipment.

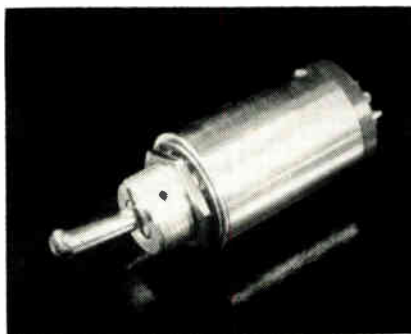


Meet commercial requirements and applicable parts of Mil-S-3786A. Special features include firm and positive mechanical indexing; recessed numerals for continuous legibility; and double-wiping, self-cleaning contacts requiring no maintenance under normal operating conditions. Amb. temp. is commercial, -25° to $+85^{\circ}\text{C}$ and military -65° to $+85^{\circ}\text{C}$. Insulation stator is of phenolic (type PBE-P) and thumbwheel and rotor, phenolic (type Mil-M-14E, Grade CFG). Oak Mfg. Co., Switch Products Div., Crystal Lake, Ill.

Circle 188 on Inquiry Card

TOGGLE SWITCH

A 4-circuit, momentary action; can be converted to maintained contact.



This is done by means of a built-in holding coil. When the toggle operated, holding coil is energized and holds lever in operated position. Switch can be manually or electrically disengaged. Rated 4a @ 28vdc resis.: 2a @ 28vdc ind. Holding coil rating $165\Omega \pm 20$; min. hold-in voltage is 8vdc. Requires $\frac{5}{8}$ in. mounting hole; has moisture and fungus proofed base. Cadmium plated steel case; nickel plated brass toggle. Controls Co. of America, Control Switch Div., 1420 Delmar Dr., Folcroft, Pa.

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- high heat transfer
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SF₆ offers all of the above. This dielectric gas has found successful application in heavy electrical units, miniaturized electronic devices and X-ray equipment. If the unusual properties of sulfur hexafluoride suggest other potential applications to you, mail the coupon for our 22-page technical bulletin.

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MICRO-MINIATURE RELAY STYLE 6A

For Printed Circuits

Less Space

Lower Mounting Height

Terminals & Mounting
Conform to 0.2" Grid Spacing

For reliable switching of low-level as well as power loads. Style 6A will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT.

Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specifications MIL-R-5757D and MIL-R-25018 (USAF) Class B, Type II, Grade 3.

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PRICE ELECTRIC CORPORATION

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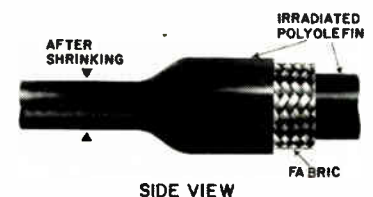
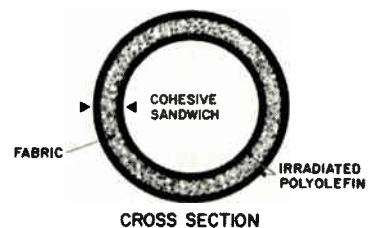
Heat Shrinkable Tubing By Irradiation

SMILE—TAKE A STRANDED ROPE. Tie tough elastic bands between the parallel rope fibers. Raise the temperature—the elastic bands stretch, allowing the fibers to stretch or twist. When the material cools, the fibers keep their stretched shape. Reheat the material at 275°F—the elastic bands immediately snap the fibers back to their original smaller shape.

The above is similar to the molecular cross-linking irradiation process Bentley-Harris Manufacturing Co., Conshohocken, Pa., uses to make FIBERFIT—a fiberglass reinforced, irradiated polyolefin tubing. The fiberglass is "sandwiched" between two layers of modified, fire-proof polyolefin. The sandwich is then subjected to a high voltage electron beam. The electron bombardment causes the molecules of polyolefin and fiberglass to cross-link.

The results is a tough, one-piece, heat shrinkable, insulating tubing with a 12kv min. specified short-time dielectric breakdown voltage (typical is 21,700kv). It is also fungus-proof. Time for shrinking varies from 3 sec. for smaller tubings, to 1 minute for the large 2 inch dia. type. Shrinking coefficient is 50%—a 1/8 in. tubing shrinks to 1/16 in., etc. Designed for continuous use up to 130°C.

Polyolefin and fiberglass sandwich bombarded with electrons. Molecular cross-links form cohesive, fire-proof tubing.





How Sylvania's LIFE-BOOST* Cathode puts more time in receiving tubes

Early death for a receiving tube can come from unwanted elements in the cathode material. Copper, for instance, can vaporize and settle as troublesome leakage paths between tube parts. Sulfur harms electron emission by "poisoning" the cathode coating.

Sylvania metallurgists found a way to achieve alloy purity far greater than is possible with melting, the usual method.

Powdered ingredients, purer to begin with, are blended and immediately cold-rolled into thin-gauge strip. No more hot melt, with its tendency to draw impurities from anything it touches.

Results? Sylvania tubes with the new cathode (90 types already have it) show significant improvement in life, stability throughout life, tube-to-tube uniformity, and cathode strength. In short, the cathode

we've named LIFE-Boost is a real achievement in terms of greater value for tube users.

Isn't a company with broad capabilities—from powder metallurgy to electron optics—more likely to have the answer to your problems?

Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

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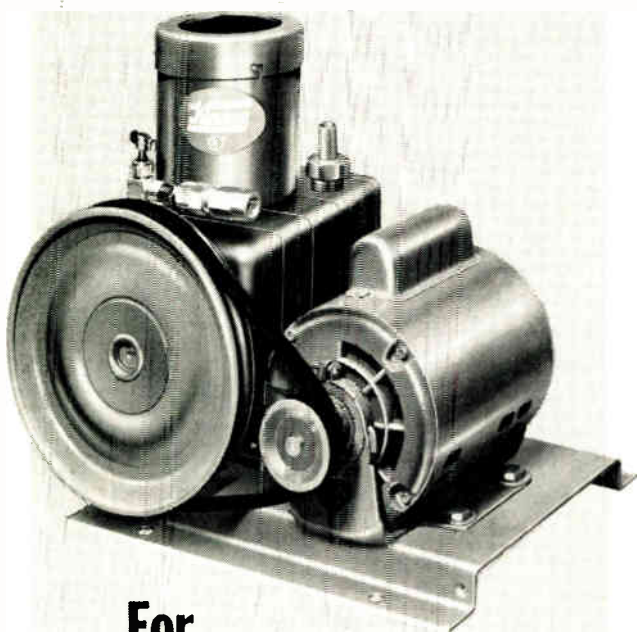
GENERAL TELEPHONE & ELECTRONICS



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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

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**For
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KINNEY COMPOUND HIGH VACUUM VANE PUMPS SERIES KCV

The KCV Series of two-stage, vane-type, compound high vacuum pumps has a range of free air displacements from 2 to 7 cfm and attains ultimate pressures of 0.2 micron. Gas ballasting, a standard feature of all Kinney Pumps, reduces oil contamination and consequent poor vacuum caused by condensable vapors. The series has been developed specifically to provide quiet, vibration-free operation, and includes long-lasting filter elements to eliminate smoke and fumes from the discharge.

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KINNEY VACUUM DIVISION

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Boston, Massachusetts

"MASKLESS" THIN FILM PRODUCTION

A "MASKLESS" PROCESS for producing thin film circuits has been developed by General Dynamics/Astronautics.

It is believed to offer distinct advantages over any other thin film process. The process removes the need to make masks and to change tooling within the vacuum chamber when a new circuit is required; first tooling is simple. This permits low cost for small quantity runs.

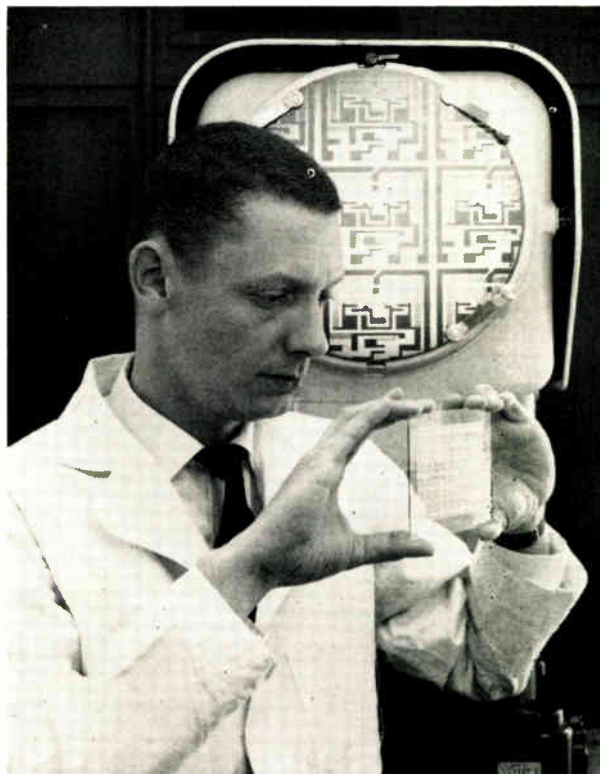
One worker and one vacuum station can produce up to 2,000 passive circuits per day. This is about 10 times the rate using the masking process. Cost is about \$1 for the thin film portion of a flip-flop; \$40 for a complete circuit with the active devices.

Continuous films of three metals are deposited on a substrate within the vacuum chamber. All other processing is done outside the chamber by photochemical methods. This eliminates mask holding and jib realignment within the chamber. It also allows a high degree of refinement in the apparatus because it is not subject to change.

A camera, combining a precision optical system with a step and repeat back, permits preparation of special multiple circuit plates and makes possible high accuracy registration with simple methods.

General Dynamics' scientists have developed selective etching solutions and anodization methods which
(Continued on page 166)

Researcher examines a plate containing 63 film circuits. Detail of test plate, embodying resistor and conductor patterns, is shown on comparator screen in background.

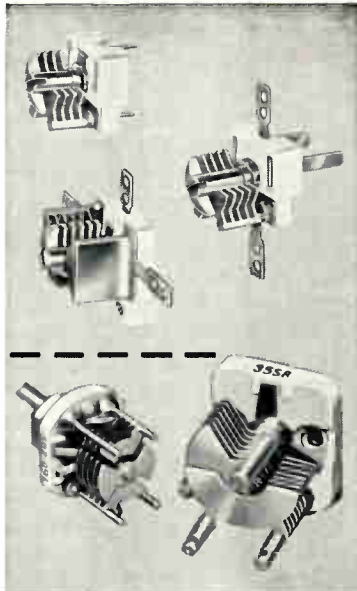


"M" AND "S" MINIATURES

Slightly larger than the "U" and "UB" 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.

TYPE "M"—Requires only $\frac{5}{8}$ " x $\frac{3}{4}$ " panel area. Peak voltage rating: 1250 volts on .017" spaced units; 850 volts on 160-130, spaced .013"; mounting bushing, $\frac{1}{4}$ "-32.

TYPE "S"—Slightly larger than Type "M". Peak voltage rating: 850 volts—plate spacing .013", other spacings available on special order. Mounting studs tapped 4-40 on $\frac{17}{32}$ " centers.



SUB MINIATURE "U" AND "UB" TYPES

These tiny, sub-miniatures require less than 0.2 or 0.3 square inch mounting area, depending on type. Unique, precision machined design from one piece of solid brass delivers outstanding reliability, with exceptionally uniform delta C and voltage characteristics.

All metal parts silver-plated—ceramic is steatite Grade L-4 or better. Virtually impervious to shock and vibration damage—provides freedom from moisture entrapment found in trimmer capacitors of enclosed or solid dielectric type. Voltage breakdown ratings to 1,300 volts DC. Extra heavy rotor end plate is slotted for screwdriver adjustment. Choice of 3 fast, easy mounting types: "LocTab", Printed Circuit or 2-Hole.

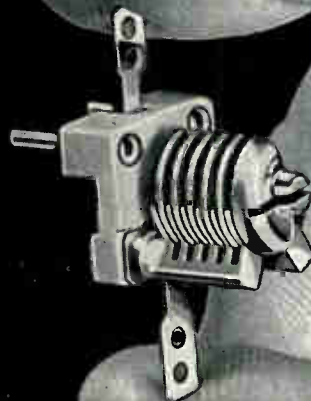


E. F. JOHNSON COMPANY
3002 TENTH AVENUE S.W. • WASECA, MINNESOTA

- Outstanding reliability—exceptional mechanical stability!
- High "Q"—greater than 1500 at 1 mc!
- High torque-to-mass ratio—2 to 7 inch ounces!
- Low temperature coefficient—approx. 35 PPM/°C positive!

"U," "UB" AIR VARIABLES

*Available in Butterfly, Differential,
Dual and Single Section Types*



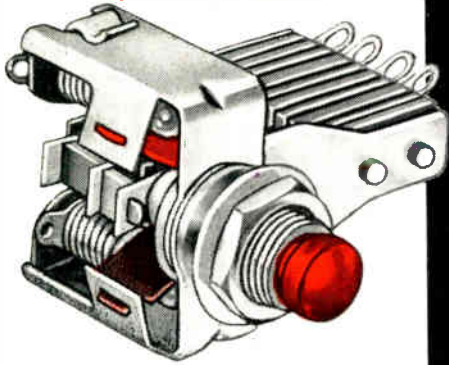
DETAILED COMPONENTS CATALOG AVAILABLE—Write today on company letterhead





● CAPACITORS ● TUBE SOCKETS ● CONNECTORS ● PILOT LIGHTS ● INSULATORS ● KNOBS AND DIALS ● INDUCTORS ● HARDWARE

SWITCHCRAFT LIGHTED SWITCHES

A NEW SWITCH IN LIGHTING!

SEE IT IN BOOTHS 2312-2314—IEEE SHOW




 Use with

 Any Circuitry

 to Color Code

 Any Function

SWITCHCRAFT "NF-LITE" PUSHBUTTON SWITCHES

THE NEW APPROACH TO LIGHTED PUSH-BUTTON SWITCHES

... Switchcraft's push-button design experience, proven in the reliable "NF-Switch" Series, has been extended to illuminated push-button switches covering a wide range of control panel and "Press-to-Test" applications.

The dual-lamp "NF-Lite Switch" Series 4200, is a flat-frame, illuminated, momentary-action push-button switch. Investigate these "NF-Lite" Switch advantages: • Lower switch cost • Wider range of multiple and complete switching circuits • Greater reliability • Two lamp voltages, 6V and 28V • Five colors, Red, Amber, Green, Yellow, White • Colors can be changed at any time in the field • Lamp circuits independent of switching circuits • Two lamps provide a margin of safety against lamp failure • Two color indication • Fast, single hole mounting in panels up to 1/4" thick.

There are several other types to choose from. The "NF-Lite" Switch Series 4100 has all the advantages of the dual-lamp Series 4200, except utilizes only one lamp. The "Littel-Lite" Switch Series 210, momentary action, single-lamp switch.



"Littel-Lite Switch"
Momentary Action Single Lamp
Series 210



"NF-Lite Switch"
Momentary Action Single Lamp
Series 4100

"NF-Lite" and "Littel-Lite" switches are available at your local authorized Switchcraft distributor for immediate delivery at factory prices. Write for complete engineering specifications.

SWITCHCRAFT®

5599 N. Elston Ave., Chicago 30, Ill.

Canadian Representative: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto, Ont., Can.

"MASKLESS" THIN FILM (Continued)

permit the processing of each material without affecting other materials on the substrate.

The etching process defines resistor and conductor patterns; anodization defines capacitor electrode patterns and forms capacitor dielectrics. Direct etching of films holds the error in value of resistors to less than 5% without trimming and permits resistor values up to one megohm per 1/4-inch square.

Anodization permits a capacitor figure of merit 50 times higher than that obtained with a vacuum-evaporated silicon monoxide dielectric. Capacitor tolerance also can be controlled to better than 5% without trimming.

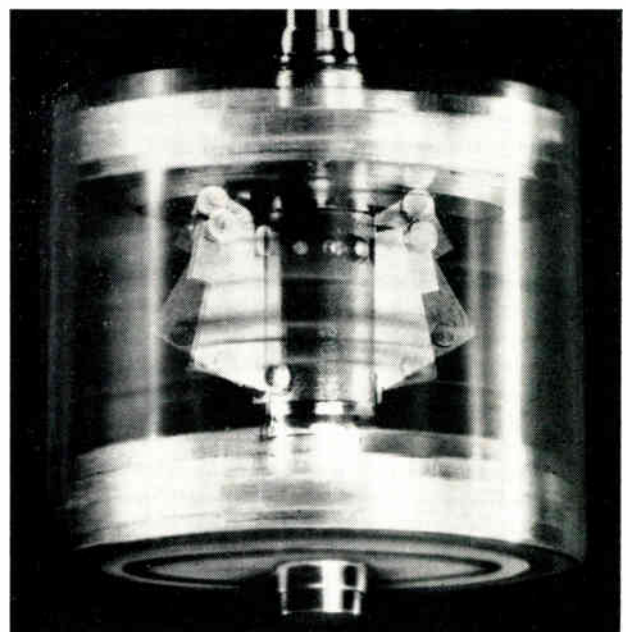
AUTOMATIC LIFT SAVES COMPUTER DRUM SURFACE

THE SELF-STARTER signalled the end of manual cranking and introduced leisurely, comfortable driving. Likewise, a new drum system ends the tin lizzy stage of magnetic drum evolution and paves the way for automatic, fail-safe computer memory operation.

"Fixed" and "flying" head drums have allowed the user to get where he was going but not without some operating inconvenience and chance of accident.

Auto-Lift Drum Systems developed by Bryant Computer Products, 852 Hadd Rd., Walled Lake, Mich., feature a "self-starter." This consists of a
(Continued on page 168)

Fig. 1. Lifting motion of a representative drum/head spacing mechanism used in Bryant's new system (the heads are not shown) is captured in this multiple-exposure action photo.



No BCD*



in this counter



*Binary Coded Decimal

The 1150-A Digital Frequency Meter uses ring counting circuits.

The advantages are many. The ring counter can readily be made into a decade device without need of fussy feedback circuits and complex decoding matrices. Furthermore, the ring counter is capable of driving readout devices directly; additional stages of amplification are not needed and circuit voltages are not critical.

Summing it up, the G-R 1150-A Digital Frequency Meter is straightforward and reliable.

You get dependability, in-line Numerik® readout, and a crystal-controlled time base in this low-cost counter.

CONDENSED SPECIFICATIONS

Frequency Range: 10 cps to 220 kc

Accuracy: ± 1 count ± time-base stability

Time-Base: Internal 100-kc crystal oscillator with ½ ppm stability.
Provision for external 100-kc time base

Sensitivity: Better than 1 volt, peak-to-peak.
For pulses, duty ratio should be between 0.2 and 0.8. Input impedance is 0.5 MΩ shunted by less than 100 pf.

Gate Times: 0.1, 1, and 10 seconds. Also manual start/stop.

Reset: Automatic or manual

Display Time: Adjustable from 0.1 to 5 seconds, or infinite.

Self Check: Has provision for counting own 100-kc frequency.

Small Size: Only 3½" x 19" x 10"

Price: \$915 in U.S.A.

- All solid-state construction.
- Totalizes events or measures frequency to 220 kc.
- Oven-controlled 100-kc crystal oscillator with ½ ppm stability. Temperature stability better than 5 ppm over an ambient range of 0° to 50°C.
- New, brilliant, always in focus, NUMERIK® in-line indicator 120° viewing angle . . . 5000-hour lamp life in counting service.



- **Build NUMERIK® indicators into your equipment.** One-third the volume and uses one-half the power of comparable units. Prices start at \$32.20. Quantity discounts available. Write for complete information.

Write for 1150-A Counter Bulletin

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World Radio History

CLARE

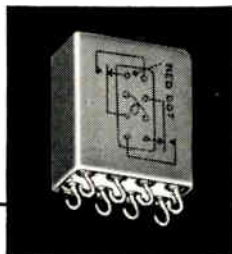
Crystal Can Relays offer **PROVED** reliability plus design flexibility

■ CLARE Crystal Can Relays, available with either latching or non-latching circuitry, offer the designer a constantly higher norm of *proved* reliability.

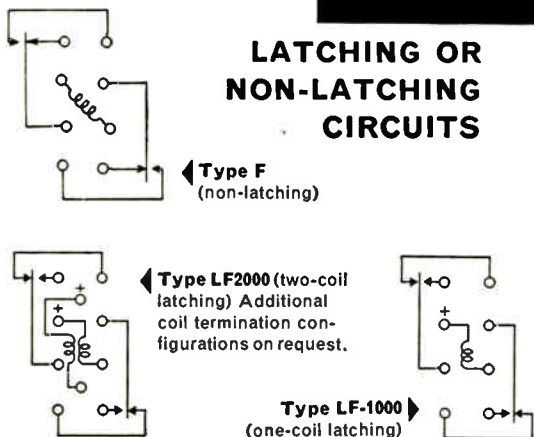
The CLARE Quality Assurance Program tests these relays to provide check of a broad cross section of the materials, the processes and the individual skills which contribute to their fabrication. Sample lots are selected, tested in general accordance with MIL-R-5757D (par.4.6.1.4., Group B), then tested to failure, to discover the cause of final breakdown...and take steps toward increasing reliability.

Information on how these tests are performed is available on request.

Type F and Type LF
(both one-coil and two-coil) relays in one-sized enclosure.



LATCHING OR NON-LATCHING CIRCUITS



For complete information send for Catalog 203 and Bulletin CPC-12. Address: C. P. Clare & Co., 3101 Pratt Boulevard, Chicago 45, Illinois. Cable Address: CLARELAY. In Canada: C. P. Clare Canada, Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: C. P. Clare, Ltd., 70 Dudden Hill Lane, London NW 10, England.

C. P. CLARE & CO.

Relays and related control components

AUTOMATIC DRUM LIFT

(Continued from page 166)

simple, automatic drum/head spacing mechanism working together with an adjustable flying head that truly "flies." Different in concept and design, these devices have been operationally integrated to assure the peak in fail-safe performance by completely eliminating the prime cause of drum failure—inadvertent head-to-drum contact.

Flying heads were devised to minimize temperature shock problems; and, to reduce the large drum/head gap required for safe operation of fixed heads.

Unfortunately, flying heads can "fly" only when drum speed is sufficient to produce a laminar film of air capable of supporting them. Therefore, the heads rub on the drum surface during stop/start cycles and remain in contact throughout down periods. Obviously, the tension of the heads against the surface and the resultant friction varies with temperature.

Auto-Lift's drum/head spacing mechanism overcomes these disadvantages by bringing the recording surface into close proximity of the heads only when the drum has reached a speed high enough to provide proper air bearing support.

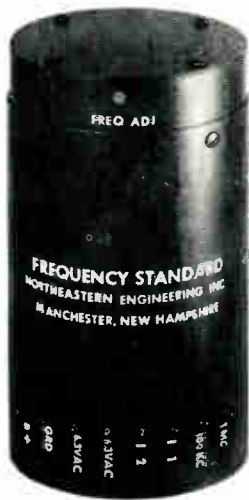
An essential design feature is the tapered drum, a proprietary structural arrangement which has long permitted technicians to adjust fixed heads by manually positioning the drum rather than the heads. In Auto-Lift Drum Systems, however, flying heads are used and the drum is automatically moved up and down by the self-regulating drum/head spacing mechanism which is contained entirely within the drum itself.

When the drum picks up speed, the centrifugal force exerted on pivoted steel governor plates cause them to swing outward, Fig. 1. The upward force brought to bear on the drum by the governor plates lifts the drum to the up position. In the static, or down position, the drum surface is 0.010 inch or more from the heads; by the time the drum rises to the up position, the heads have gone into a flying attitude approximately 0.0001—0.0003 inch from the surface.

A latching mechanism, which also is actuated by centrifugal force, holds the drum in the up position. With appropriate shock mounts, Auto-Lift drums will withstand the effects of shocks ranging up to 5Gs on commercial units to 50 Gs on military units.

When the drum is shut down, the centrifugal force decreases with drum speed causing the latching mechanism and then the governor plates to swing downward. This action lowers the drum back to its static position.

(Continued on page 190)



High Stability 1 mc and 100 kc Clock Standard

The new Model 18-10 Oscillator has double oven vacuum-insulated construction and dual temperature control operated by a high resolution mercury thermostat to insure a high degree of reliability and stability.

Specifications:

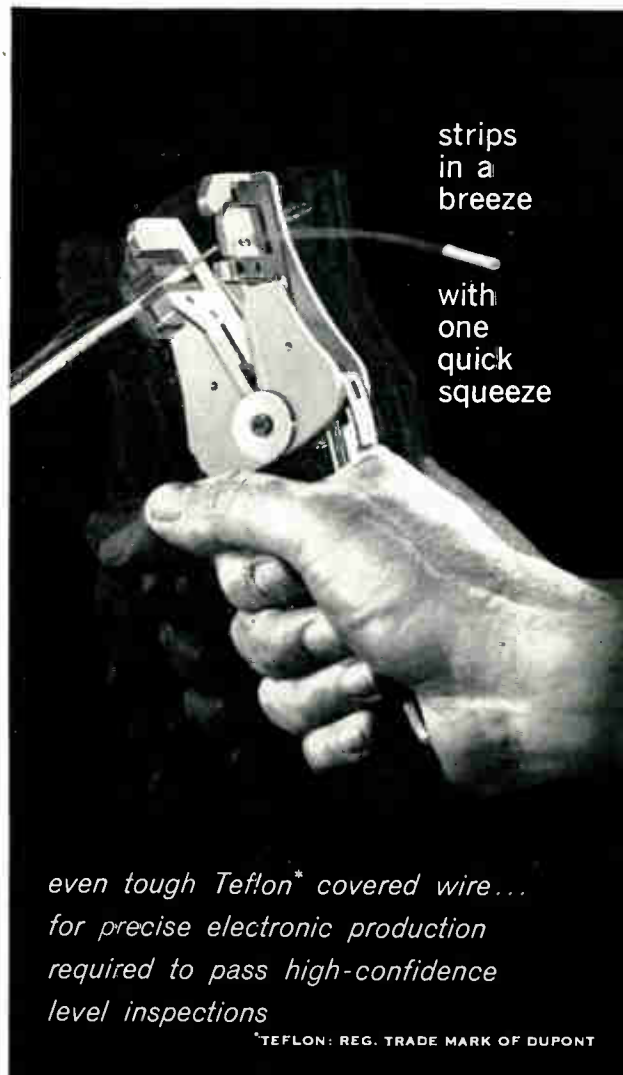
- Output frequencies
1 mc and 100 kc @ 1 volt rms
(phase locked)
- Stability, long term
±1 part in 10⁸ per day;
±5 parts in 10⁸ per week
- Stability, short term
±3 parts in 10⁹ per 5 minutes
- Input voltage, oscillator
-35v to +210v at 15 ma
(specify voltage)
- Oven voltage @ 25° C
6.3 v, AC or DC, (floating) at 2.5a.;
1a. after 30 min. warmup
- Ambient temperature range (operating)
-40° to +55° C
- Frequency change with B+ (+210 volt input) ... Approx. ±½ part in 10⁹ over the range 185 to 235 volts
- Output signal distortion
5% total harmonic distortion
- Trim range
±5 parts in 10⁶ minimum
- Setting resolution
On the order of parts in 10¹⁰; ±1 part in 10⁸ per turn on the shaft
- Weight 28 ounces
- Size 6" x 3 3/8"
- PRICE \$295

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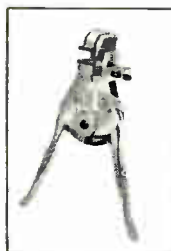
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required to pass high-confidence
level inspections*

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IDEAL CUSTOM *Stripmaster*[®]



Strip solid or stranded wire easily—with no wire nicks, insulation scratches—no waste or rejects. Unique matched blades, drilled to exact wire size on watchmaker's equipment, plus colleting action, help you meet high-confidence standards even on toughest insulation. Three models—for Type E Teflon, Type EE Teflon and general purpose plastic and fibre-glass insulation. Sizes for 10 to 14, 16 to 26, or 26 to 30 wire. Optional transparent wire stop adjusts to strip exact insulation length. Send coupon for full information.

IDEAL INDUSTRIES, Inc., 5127-B Becker Pl., Sycamore, Ill.

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For Military and Commercial Applications

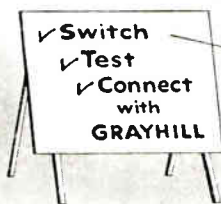
Grayhill Miniature Rotary Tap Switches

These switches are designed to meet military and commercial specifications and ruggedly built to precision standards.

Grayhill No. 5000, No. 12, and No. 24 Series. 1.01" dia. Break 1 amp., 115 VAC, resistive. Carry 5 amps. 1 to 10 decks, 2 to 10 positions per deck—1 or 2 poles per deck—shorting or non-shorting. Life 100,000 cycles. Also No. 24 Series, spring return switch.

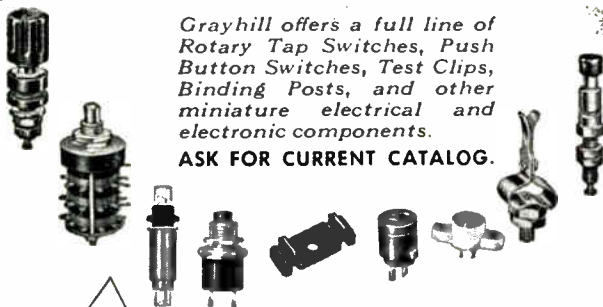
Concentric Shaft. No. 6 (1 to 3 decks per shaft—Total 6 decks) and No. 36 Series (1 or 2 decks per shaft. Total 4 decks). 1.01" dia. 2 to 10 positions per deck. Break 1 amp., 115 VAC, resistive. Carry 5 amps. Two switches in one. 1/4" shaft controls 1/2 of the decks, 1/8" shaft controls the other half.

No. 45 Series Midget. .640" dia. Single deck only. 60° indexing. Break 1 amp., 115 VAC, resistive. Carry 5 amps. Life 100,000 cycles.



Grayhill offers a full line of Rotary Tap Switches, Push Button Switches, Test Clips, Binding Posts, and other miniature electrical and electronic components.

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"PIONEERS IN MINIATURIZATION"

AUTOMATIC DRUM LIFT (Continued)

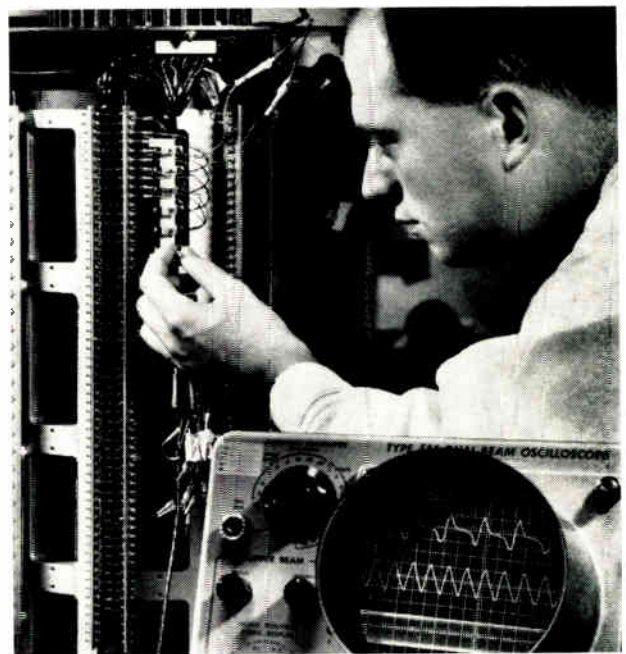


Fig. 2 Technician trims a Uni-Just flying head for desired playback signal level and resolution for a pattern of ONES (top waveform) and ZEROS (middle waveform) on an oscilloscope. Absence of nodes on modulation envelope (bottom waveform) indicates head is not "bouncing" or "skipping" along.

Besides the inherent reliability it offers during stop-start periods, these systems equipped with Uni-Just flying heads also assure fail-safe, high-level performance throughout the operating period. Proper head-to-drum aspect for producing a reliable air bearing is assured in each Uni-Just head by precision lapping the head pad to just the right contour. Because of this aerodynamically sound construction, Uni-Just heads always stay in the flying mode and can never dip through the laminar air film on which they ride and dig into or skip along the drum surface. Also, the low-mass flying portion of the head responds instantly to drum runout thereby virtually eliminating unwanted modulation of the playback signal caused by the variations in drum/head spacing.

The importance of this feature is best shown by an example. A non-flying or part-time flying head spaced 0.0001 inch from the drum has a 100% head-to-drum spacing variation even with a truly precise drum which has only 0.0001 inch runout. This means, in effect, that there is a 2:1 modulation of the playback signal received from the head. Looked at another way, the head can be in contact with the surface at the high point of the drum and at the 0.0001 spacing at the low point.

Positional accuracy relative to the drum is achieved in Uni-Just heads by adjustably securing the head brackets in precision slots of a mounting bar which is then fastened across a window in the drum housing.

LOWER YOUR READOUT COSTS MORE THAN 40%

WITH

BINA-VIEW BINARY INPUT SELF DECODING READOUTS

ACTUAL SIZE DISPLAY

The Bina-View one plane readout combines a built-in decoder with a light-interference type display to give you the industry's most economical long life readout package... as low as \$65.25 in 1-9 quantities!

Decoding is accomplished electromechanically from binary input to display without relay contacts or electronic circuitry. Floating decimal point now available by lighting separate lamp.

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- **Translates Binary Codes Direct to Decimal or Alpha-Numeric Display.** Any 6-bit binary code can be used for full alpha-numeric presentation. Pure binary numeric display can be accomplished up to 38 characters using 6 bits; beyond 38 characters, BCD and multiple units must be used.
- **Reduces Number of Conductors in Cables.** As few as 7 wires are required to operate the first of a series of Bina-View readouts. Only 1 wire for each additional unit is necessary.
- **Low Power Requirement.** Transistor circuitry can drive Bina-View readouts directly; only 100 mw signal input per bit and 4 watts for set-up are required.
- **Human Factors Consideration.** All characters displayed on one plane... bright distinct characters visible over 170° viewing angle... de-energized characters completely invisible.
- **Automatic Memory.** In case of power interruption, the last character shown re-appears when operation resumes, and remains until the next character is set-up.
- **Optional Check Back.** Binary electrical outputs corresponding to characters being displayed can be used to verify input signals or to operate remote readouts. Signals can be stored until the unit resets providing electrical data storage.

BINA-VIEW READOUT SPECIFICATIONS

Maximum Character Size: 1 3/8"
Operating Voltage: 6, 12, 24, or 48 vdc
Dimensions: 3 1/2" H x 1 7/32" W x 6 27/32" L
Number of Characters Available per Unit: Up to 38
Codes: Standard 4, 5, or 6-bit codes available
Lamp Voltage: 6 or 28v, both ac or dc

ONLY IEE ONE-PLANE READOUTS GIVE YOU SUCH VERSATILE DISPLAYS!



Up to 38 characters available for true alpha-numeric display.



Word messages can be used singly or in combination on the same character plate.



Virtually any symbol can be displayed.



Red and green color emphasis can be added; other colors available.



Write for complete Bina-View specifications. For your copy of the new IEE Readout-Message Designer's Kit, write on your company letterhead.

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AT THE IEEE SHOW WE'D LIKE TO SEE . . .

—*Booth personnel wearing large badges, or insignia, so we don't have to go around squinting at IEEE name cards to find out who can answer our questions.*

—*Displays clearly identified so we can tell what they are selling. Much of the equipment is so miniaturized—such as integrated circuits—that it can take 4-5 minutes to determine what we're looking at.*

—*Knowledgeable booth personnel, not just junior trainees. A little advance training, with well-defined objectives, would go a long way here.*

—*More use of operating models and animated displays to explain complex concepts, techniques and operational details.*

—*More attention to education. Engineers are also at the show to learn, not just to look at products. Explanations of how the devices work would go a long way toward leaving the engineer with a favorable impression of the exhibitor and his products.*

—*Browsers left alone. We are constantly looking for new developments but also we'd like to avoid wasting time on those items we already know about. We like to browse and having someone sidle up and say, "Can I help you?" is just disconcerting. If we have a question, all we ask is that there be someone there, easily identified, to whom we can turn. The IEEE Show is no place for huckstering, nor for the huckster techniques.*

—*Better policing of booths; Hats and coats tossed on display cases, and empty coffee containers, strewn on counters do little to enhance the attractiveness of the booth.*

—*More discussions inside the booth area. When discussions overflow into the aisle, traffic has to go around the booth. Everyone is the loser, the exhibitor and the engineers going by.*

—*More attention to personal appearance on the part of those attending. Engineers, whether they are aware of it or not, play an important public relations role for their firms at these conventions.*

SINGLE-FIRM UNIONS exist only among one type of professional—the engineer in industry—according to a recent survey published by Princeton University. Tracing the history of the labor movement among engineers, the report notes that most of the present unions of engineers were formed immediately subsequent to World War II as a defense measure to avoid inclusion in bargaining units of blue collar workers. The author of the study, A. B. Shostak, points out that, "one of the chief reasons of questioning the ability of the unions to survive is the unrelenting opposition of professional engineering societies."

FORCE ENCODING AND NUMBERING UNITS FOR ELECTRONIC SCANNING SYSTEMS

Look to Force for the design and manufacture of numbering and encoding equipment in the very latest optical or magnetic printing systems. Rely on Force, a leader in the engraving and marking machine field for over 85 years for precision units.

Electronic scanning systems are changing the production techniques of industry and require the finest engraved assemblies available. That is why industry calls upon the experience and capacity of Wm. A. Force & Co. in the early stages of research and development. Here are some of the recent encoding units developed by Force for either optical and/or magnetic scanning systems:

EMBOSSING TYPE, ENGRAVED WHEELS AND COMPONENTS

Used to imprint accounting records and similar documents for scanning.



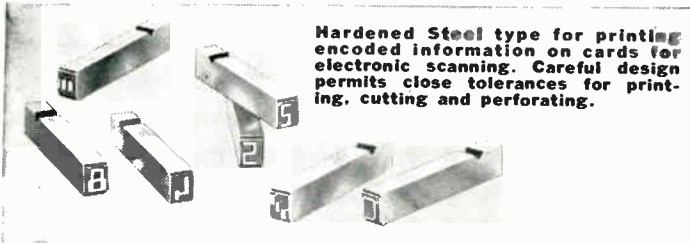
FLAT BASE MALE DOVETAIL STRAIGHT ROTARY HEADS

A versatile numbering head that mounts on a removable adapter block and can be used on rotary presses of any circumference. It accepts from 2 to 9 or more wheels containing E13B Bank Automation Figures or other special shapes or designs. Straight or Convex Heads available on order.



NUMBERING HEADS

Numbering heads for platen and flatbed cylinder presses. Available with a special Bank Automation Figure ... Forward or Backward.



Hardened Steel type for printing encoded information on cards for electronic scanning. Careful design permits close tolerances for printing, cutting and perforating.

Write for more information on the Force numbering and encoding solution applicable to your problem.

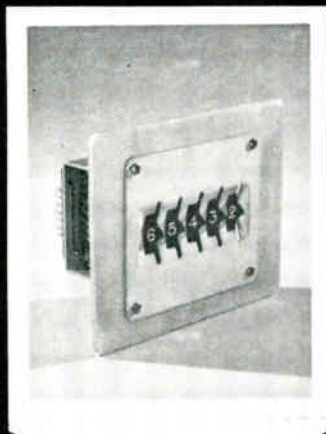


WM. A. **FORCE** & CO., Inc.
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Brooklyn 8, N. Y.

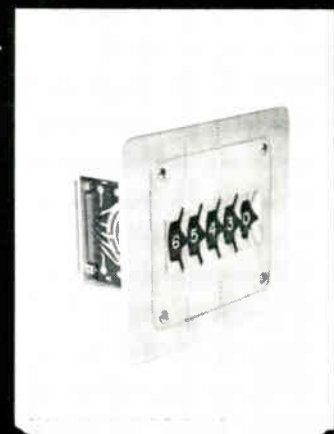


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MA-FUNCTION + (60 sec.) = FUNCTION



U.S. Patent 3,010,101
Other Pat. Pend.

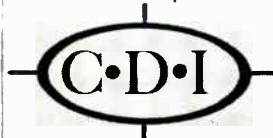


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8 and 10 positions available with single or multiple wafer

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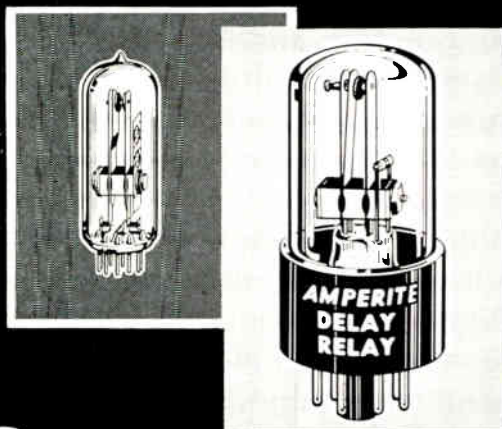


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Only a glass seal
offers true hermetic sealing
.. assuring maximum stability and life!

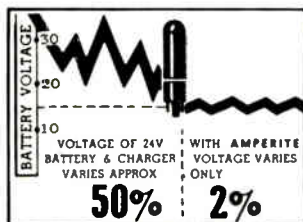
Delays: 2 to 180 seconds . . . Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being hermetically sealed, they are not affected by altitude, moisture, or climate changes . . . SPST only—normally open or normally closed . . . Compensated for ambient temperature changes from -55° to $+80^{\circ}$ C. . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are rugged, explosion-proof, long-lived, and—inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, \$4.00.** Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

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Write for 4-page Technical Bulletin No. AB-51

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In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

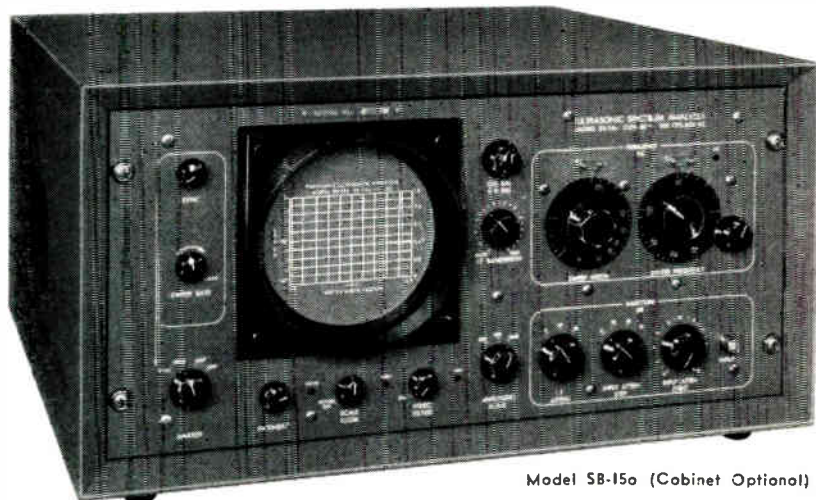
SATELLITE CORP. PLANS MOVING—The new Communications Satellite Corp. hopes to have its first international radio-TV satellite system in operation by January, 1965. This system is expected to be a number of relay stations in medium-altitude orbits. The system may cost \$2 billion. More advanced systems will be developed later.

PRO-UNION LAWS MAPPED—Labor is pressuring congressmen to push through pro-union legislation that died in past sessions. An unemployment compensation reform program, including higher benefits and longer periods of unemployment pay, is sought. The unions also want to add fringe benefits to minimum wage determinations made on government manufacturing and construction contracts. Such minimum wages are determined by the Sec. of Labor under the Walsh-Healey and Davis-Bacon Acts, respectively.

MORE INFORMATION RETRIEVAL—The Government wants better exchange of information between industry and federal agencies. Commerce Dept. is looking to catalog government information so industry can get it quickly. The Patent Office is setting up its own automatic data processing program to speed up information retrieval. The Pentagon is attacking the problem in several areas. Among them is a joint industry-military plan for exchanging data on accounting, design change, contract management, packaging and transportation. This program, under development for several years, is 50% complete. The Defense Dept. is now completing an integrated scientific and technical information program for the whole department.

AN ELECTRONIC PRINT READER which reads a number of different fonts of type and converts the readings into data on punched cards or tape at a rate of 700 characters per second, has been developed by Sylvania. Dr. James E. Storer, Director of Sylvania's Applied Research Lab., said that speeds up to 20,000 character conversions per second are feasible. The reader has a number of military uses including machine translation of foreign language documents, proof reading, accounting, and an optical pattern recognition applications. With modification the machine can be used for photo interpretation and for map reading. The machine will read up to 20 different type faces from 1/12 of an inch to 1/2 in. in height. It will read either printed or typewritten documents.

measure / analyze, 100 cps - 600 kc signals quickly, easily, with one compact instrument



Model SB-15a (Cabinet Optional)

PANORAMIK* SB-15a ULTRASONIC SPECTRUM ANALYZER

Advanced Panoramik's Model SB-15a automatically and repetitively scans spectrum segments from 1 kc to 200 kc wide through the entire range (100 cps to 600 kc) . . . plots frequency and amplitude along the calibrated X and Y axes of a long persistence CRT, or on a 12 x 4 1/2" chart (optional RC-3b). Sweep rates are adjustable from 1 to 60 cps.

Adjustable resolution enables selection and detailed examination of signals as close as 100 cps. Self-checking internal frequency markers every 10 kc. Also internal amplitude reference. Only 8 3/4" panel height. The SB-15a is completely self-contained, uses no external power supply or line regulator.

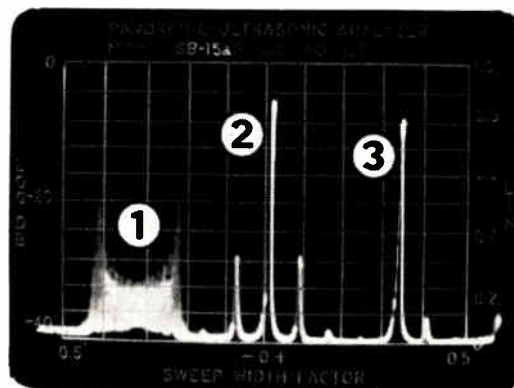
PANORAMIC PRESENTATION MEANS

- Quick signal location, minimum chance of missing weak signals or holes in spectrum
- Faster measurements—no tedious point-by-point plots
- Reliable spotting for low level discrete signals in noise
- Positive identification and dynamic analysis of all types of modulation

ALL THESE APPLICATIONS . . .

- Noise, vibration, harmonic analysis
- Filter & transmission line checks
- Telemetry analysis
- Communication System Monitoring
- Frequency Response Plotting (with Model G-15a Companion Sweep Generator) provides rapid and accurate swept band test for filters and other networks

Write now for specifications, other applications of Model SB-15a. Get on our regular mailing list for New Product Bulletins.



Lab setup shows SB-15a versatility. (1) FM display measures dynamic deviation. (2) & (3) are AM and SSB signals, respectively, with sine wave modulation.

SUMMARY OF SPECIFICATIONS

Frequency Range: 100 cps to 600 kc.
Sweepwidth: Adjustable, calibrated from 1 kc to 200 kc.
Center Frequency: Adjustable, calibrated from 0 to 500 kc.
Markers: 10 kc intervals throughout band. Crystal controlled. Level reference also provided.
Resolution: Automatic optimum resolution plus adjustable I-F bandwidth from 100 cps to 4 kc.
Sweep Rate: Adjustable 1 cps to 60 cps with line synchronization provision.
Amplitude Scales: Linear, 40 db log (extendable to 60 db) and 2.5 db expanded.
Sensitivity: 200 uv to 200 v full scale deflection.
Accuracy: ±0.5 db from 200 cps to 525 kc.
Input Impedance: 55 k ohms.



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ELECTRONIC INDUSTRIES • February 1963

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175

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Now — JFD Hi-Life piston trimmers guarantee a 500+ cycle adjustment life — 600 per cent more than that called for by Mil-C-14409A specs. The reason? — The exclusive new anti-backlash adjustment mechanism that offers unprecedented reliability and design freedom.

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Panel mount and printed circuit type Hi-Life trimmers may be obtained in four different series, NVC, NMQ, NSC and NQS, offering the same mounting facilities as the already famous and widely used Miniature, Sealcap and Max-C series.



Model NVC 10GW
0.8 to 4.5 pf.
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- Mfr. of non-military electronic computers, data processing, analysers, business machine.
- Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- Mfr. of electronic components, parts, tubes and like products.
- Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- Broadcasting or telecasting station.
- Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
- Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- Wholesaler, mfg. representative, service firm.
- University (educational) Public Library.
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- Mfr. of non-military electronic instruments, measuring, control and test equipment.
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- Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- Mfr. of electronic components, parts, tubes and like products.
- Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- Broadcasting or telecasting station.
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- Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
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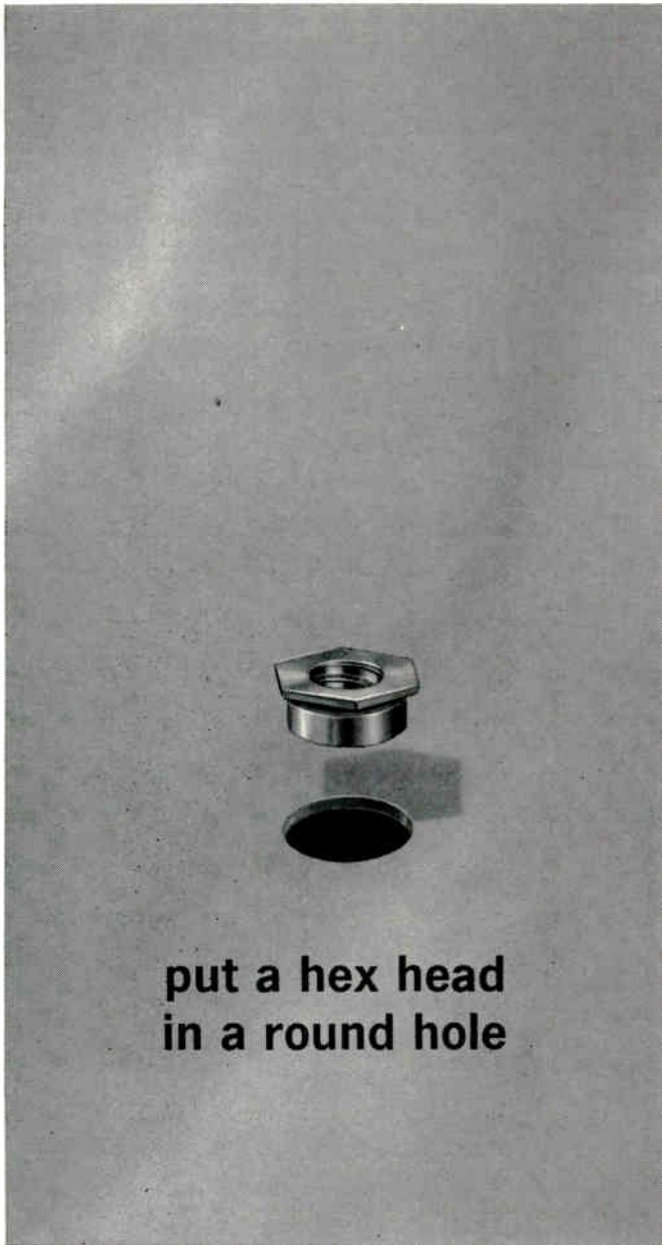
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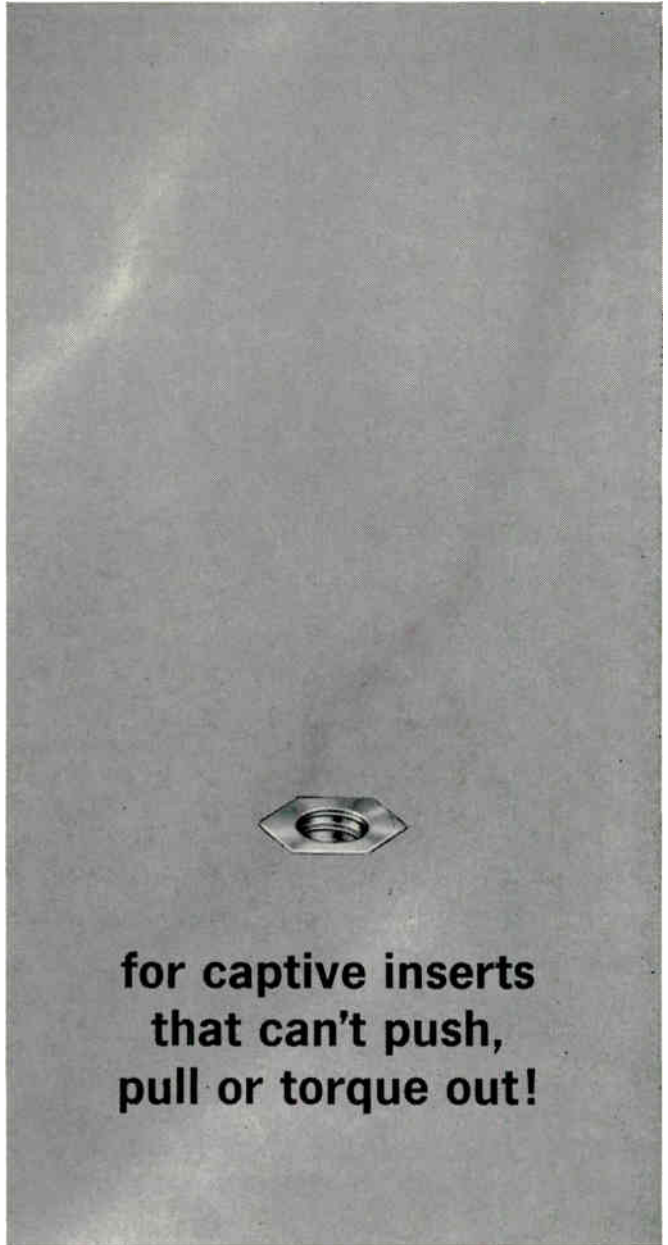
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in a round hole**



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that can't push,
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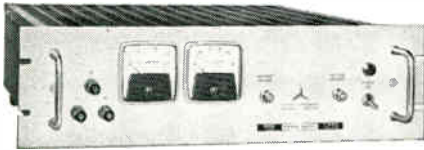
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RESPONSE TIME: Better than 50 μsec

- Automatic Overvoltage Protection
- Automatic Adjustable Short Circuit Protection
- Turn-on/Turn-off Transient Elimination

Model	Volts	Amps	Panel Ht.	Price*	Model	Volts	Amps	Panel Ht.	Price*
MS6-30AF	4-8	0-30	5¼"	\$585	MS36-15A	0-36	0-15	5¼"	\$595
MS12-30AF	11-13	0-30	5¼"	\$600	MS36-20A	0-36	0-20	5¼"	\$645
MS15-10	0-15	0-10	3½"	\$450	MS60-2.5	0-60	0-2.5	3½"	\$430
MS15-20A	0-15	0-20	5¼"	\$510	MS60-5A	0-60	0-5	5¼"	\$525
MS18-30AF	17-19	0-30	5¼"	\$615	MS60-10A	0-60	0-10	5¼"	\$650
MS36-2.5	0-36	0-2.5	3½"	\$355	MS160-1	0-160	0-1	3½"	\$470
MS36-5	0-36	0-5	3½"	\$385	MS160-2A	0-160	0-2	5¼"	\$595
MS36-10A	0-36	0-10	5¼"	\$495	MS160-3A	0-160	0-3	5¼"	\$645

*Meters and overvoltage protection optional extra.

†(Models with Suffix A or AF) • 0.05% or 15mv (All other models)

Also available as Mercury instrument series with complete range remote programming.

CENTURY SERIES



DYNAMIC REGULATION: 0.03% or 10 mv
RIPPLE: 1mv RMS max
RESPONSE TIME: Better than 100 μsec

- Constant Voltage/Constant Current
- Automatic Overvoltage Protection
- Automatic Adjustable Short Circuit Protection
- Complete Range Remote Programming
- Turn-on/Turn-off Transient Elimination

Model	Volts	Amps	Panel Ht.	Price*
C15-50	0-15	0-50	8¾"	\$1250
C15-80	0-15	0-80	8¾"	1925
C36-30	0-36	0-30	8¾"	1120
C36-50	0-36	0-50	8¾"	1690
C60-15	0-60	0-15	8¾"	1120
C60-25	0-60	0-25	8¾"	1395
†C160-8	0-160	0-8	8¾"	1250
†C160-16	0-160	0-16	10½"	1945

*Includes ammeter, voltmeter, complete range remote programming, variable current limiting and constant current operation. †Constant current not included in these models. Overvoltage protection optional.



TRYPACK SERIES MODULAR SUPPLIES

DYNAMIC REGULATION: 0.05%
RIPPLE: 0.5 mv RMS max.
RESPONSE TIME: Better than 50 μsec.

- Adjustable Overcurrent Protection
- Complete Range Remote Programming
- Turn-on/Turn-off Transient Elimination
- Modular Construction

- Four Trypacks mount in standard rack with 7" panel
- Rack adapters available with complete controls and output connections.

Model	Volts	Amps	Price
P20-2	0-20	0-2	\$184
P32-1.5	0-32	0-1.5	\$184
P50-750	0-50	0-0.75	\$184



TRYLAB SERIES

DYNAMIC REGULATION: 0.05% or 15mv
RIPPLE: Less than 0.5mv
RESPONSE TIME: Better than 50 μsec

- Adjustable Overcurrent Protection
- Complete Range Remote Programming
- Turn-on/Turn-off Transient Elimination
- Constant Voltage/Constant Current

Model	Volts	Amps	Price
T20-2	0-20	0-2	\$199.50
T50-750	0-50	0-¾	199.50
*T50-2	0-50	0-2	249.50

*Constant voltage only. Optional extra: This is a bench supply unit; Rack Panel Adapters extra.

Also available as modular supplies in the "Trypack" series. Four units occupy 7" rack space.

"300" SERIES



DYNAMIC REGULATION: 0.02%
RIPPLE: 3mv RMS max; 1 mv on * units
RESPONSE TIME: Better than 100 μsec

- Complete Solid State Design
- Lower Heat Dissipation
- Solid State Reliability
- Minimum Panel Height

Model	Volts	Amps	Panel Ht.	Price†	Model	Volts	Amps	Panel Ht.	Price†
S300-200	110-325	0.2	3½"	\$395	*S100-3F	95-105	3	5¼"	\$675
S300-400	110-325	0.4	3½"	450	*S100-4F	95-105	4	5¼"	795
S300-800	110-325	0.8	3½"	495	*S150-1F	145-155	1	5¼"	485
S300-1500	110-325	1.5	5¼"	685	*S150-2F	145-155	2	5¼"	575
*S100-1F	95-105	1	5¼"	470	*S150-3F	145-155	3	5¼"	775
*S100-2F	95-105	2	5¼"	525	S300-1F	295-305	1	5¼"	540
					S300-2F	295-305	2	5¼"	645

†Includes Meters



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SYSTEMS WISE

"PERSONALIZED" LETTERS BY COMPUTER

Writing "personalized" letters to delinquent credit accounts, a touchy business, is now being done by computer. Tidewater Oil Co., Los Angeles, Calif., is using an IBM 1401 to analyze: amount of debt; length of delinquency; current balance; amount overdue; and amount currently owed by customer. The computer then automatically selects and writes the appropriate letter, from a choice of over 25 available types. The time: 2 seconds.



A majority of the FCC commissioners ruled that prospective UHF TV station owners will have to live up to the letter of their permits. Seems the petitioners are getting construction permits, with no intention to build till the market is there. FCC ruled: construction will begin and be completed within the permit period; no extensions of time will be granted; scarcity of receivers or slowness of conversion receiver rate, or limited revenue potential of a given market is no excuse for waiting. Chairman Minow dissented, saying, it was neither realistic or fair to seek to limit new UHF permits only to applicants with money for operation in the immediate future.

Educational and commercial TV stations, in the same community will jointly tackle community problems, under a pilot program approved and planned by representatives of commercial and educational broadcasting. Under the plan each station will use the approach best suited to its own resources, and will complement the work done by the other.

The Canadian Government has installed a Bendix G-20 high speed computing system at Montreal, to analyze and predict weather for the whole country. It will also be used in meteorological research, particularly for mathematical calculations in radiation and energy studies.

Half-speed operation of RCA TV tape recorders, saving 50% in tape, and able to be used for both color and mono programs has been announced by RCA Broadcast and Communications Products Div., Camden, N. J. Through development of a transistorized, modification narrow recording head (covers a transverse track 5 mils wide), moving at $7\frac{1}{2}$ instead of 15 ips, users will save in tape, storage space and shipping costs.

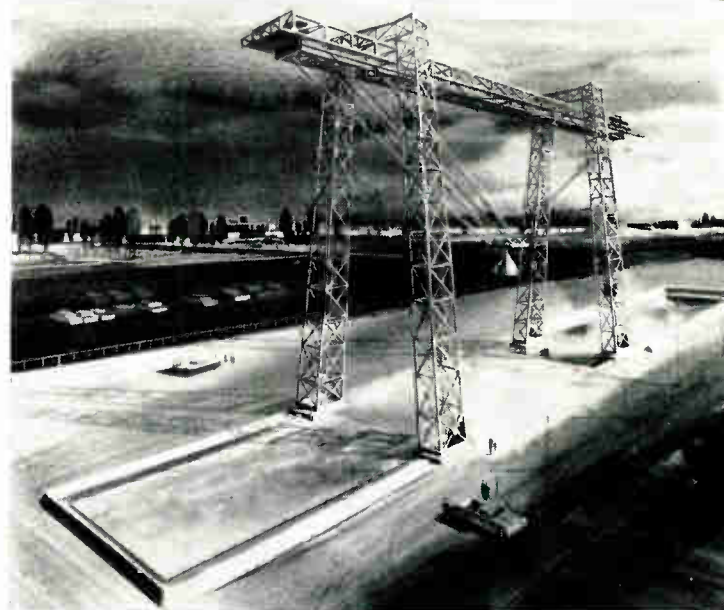
Year by year TV commercials get louder. Now the public has been loud enough to be heard. Senator Clifford P. Case (R-N.J.), long time advocate for FCC ruling on loudness, has finally gotten the commission to make a study. Chairman Minow informed the senator, he favors limiting loudness of commercials to the volume of adjacent program material. The FCC staff is making its study and will present its report to the commission in the near future.

Hughes Aircraft has ordered 16 Accutron "satellite silencers" for Syncom, from Bulova Watch Co., Inc. Based on the wrist-watch, the transistorized timer, self-contained, operates on an elapsed-time switch, shutting down the transmitter after a specified time lag. It has been used on Explorer, Telstar and Tiros.

Canada and the U. S. have agreed to jointly build a Nimbus meteorological satellite data acquisition ground station, at Ingonish, Nova Scotia. It is expected to be completed by 1964. Nimbus, successor to Tiros, will record meteorological data, including TV pictures, on tape and relay the information back to earth. Nimbus will cover the whole world in a 24 hour polar orbit. Tiros sees only about 20% of the earth in one day.

GIANT PENDULUM TO TEST APOLLO CAPSULE

This steel structure, 143 ft. high, with a 90 ft. pendulum, will swing 8,500 lb. full-scale Apollo capsules at controlled speeds and angles, dropping them into either water (right) or land (left) impact areas. Data from capsule instruments will tell impact intensity, aiding in design of equipment able to withstand landing shock. Being built by North American Aviation's Space and Information Systems Div., Downey, Calif., for NASA.



Interest in standards-level measurements continues to grow. Here's a new approach to the problem of furnishing calibrations where they are needed - bring the laboratory to the instrument.

CALIBRATION LABORATORY ...ON WHEELS

A MOBILE LABORATORY, equipped to perform standards-level calibration on a broad range of microwave instruments, has just started a projected 20,000-mile journey. Because it "brings the mountain to Mohammed," it has been dubbed *Project Mohammed*. Several thousand man-hours of engineering, and well over \$100,000 worth of equipment went into its design and construction. It will calibrate microwave receivers, signal generators, field-intensity (RI/FI) meters, and spectrum analyzers, up to 40 gc.

Where possible, calibrations are referenced to traceable primary standards. Frequency calibration is standardized against primary-standard VLF transmissions emanating from the NBA Canal Zone transmitter.

Specifications

The most difficult design decision in specifying the capabilities of the laboratory was not where to start, but where to stop. We were continually influenced because our in-plant Calibration Standards facility can calibrate from dc to 100 gc. Many of the test setups and reference standards, however, do not "travel" well. They are too bulky, too complex, or too expensive for mobile use in a program that must perform economical, wide-range calibrations on hun-

By **ROBERT SAUL**

Polarad Electronics Corp.
43-20 34th Street
Long Island City, N.Y.

The calibration laboratory is housed in this 30 foot long vehicle. The van is air-conditioned over broad ranges of external ambients. Telephone service has been provided for with standard Bell System Mobile Radiotelephone installation.

Thus factory records, too bulky to store in the van are readily and continuously available to the test engineers and technicians, regardless of the location of the van. Calibration certificates are issued on the spot with a complete report.



dreds of different parameters, ranges, and instruments.

The most important decisions were:

1. To establish the upper frequency limit at 40 gc.
2. To accept a limit-of-error uncertainty of $\pm 3\%$ on the absolute power reference, and that only up through X band.
3. To limit the attenuation (relative power) measurement range to 100 db from any absolute reference level.
4. To control the "climate" in the van, and to fully shock-mount all instruments.
5. To install well-regulated electrical power, self-generated by an integrally-mounted engine-alternator set.
6. To employ direct-reading transfer instruments, wherever possible.

Each of these decisions was supported by the analysis of hundreds of test records from our Calibration Standards department. Each decision involved a balancing of the state-of-the-art limitations, equipment cost, its probable stability, its compatibility with the van (size, weight, shape, power requirements), and the ease and speed with which a calibration could be performed.

The specification finally evolved is embodied in three classes of decision: tests to be performed (Test Programs), ranges over which they would be performed (Range Capabilities), and accuracies to be maintained (Calibration Accuracies).

Test Programs

Table 1 does not delineate the complete range of calibration capabilities, but it summarizes them in the form in which they would be applied to testing the four major classes of microwave instruments.

The most important characteristics of just about every instrument to be calibrated—and, certainly, those that are most likely to demand frequent and precise recalibration—fall into only two parameter classes: frequency and power level/ratio.

Range Capabilities

Table 2 lists the ranges over which each of the parameter classes were to be measured, as the specification was set up.

All ranges are covered continuously, with adequate overlap between ranges, and between instruments, to minimize "scale-factor" errors.

Calibration Accuracies

The accuracies stated in Table 3 are "worst-case," or "limit-of-error" (sometimes called "algebraically-summed") uncertainties. In every case, they are conservative. But, mobile equipment must be pessi-

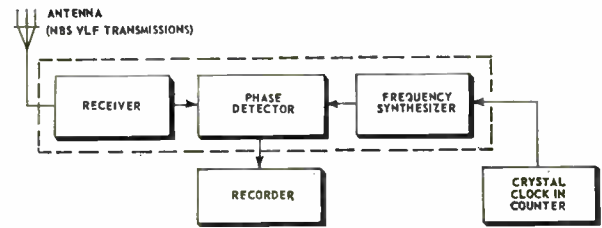


Fig. 1: Frequency equipment is directly tied by a special receiver to NBA's primary-standard frequency transmissions.

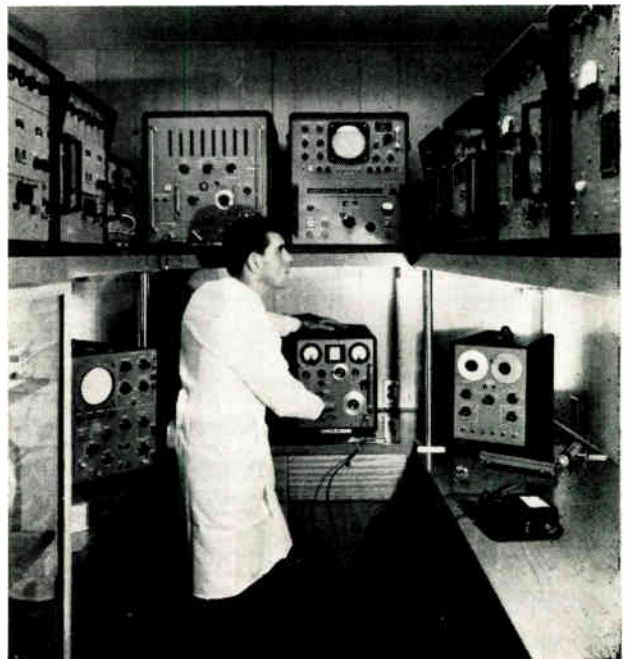
mistically rated, until at least a year of operating experience has been gained. Often, the accuracy achieved will exceed that required in normal service by an order of magnitude. The exception is absolute power level, but here we are limited by the current state-of-the-art.

So no confusion exists about the nomenclature used here, we define limit-of-error uncertainty as the worst possible simultaneous combination of the effects of the following:

1. Reference Calibration (as independently established).
2. Long-term drift (constant ambient).
3. Environmental responsiveness (thermal drift, effects of humidity, effects of ambient light, noise, radiation, etc.)
4. Repeatability of reading (estimated by evaluating "worst-case" sum of effects of: scale presentation, resolution of indicators and scales, and interpretation and estimation errors.)

(Continued on following page)

This standards engineer is operating in the calibration area of mobile laboratory; it is separated from the rest of van.



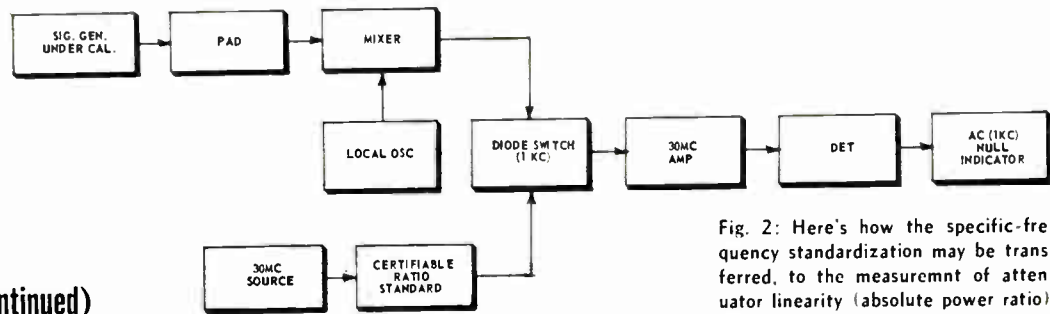


Fig. 2: Here's how the specific-frequency standardization may be transferred to the measurement of attenuator linearity (absolute power ratio).

CALIBRATION (Continued)

5. Resetability (estimated from such factors as control resolution and random short-term drift.)
6. Transfer - equipment uncertainties and non-linearities, including estimated maximum drift between reference checks, deviations from non-linearity between reference checkpoints, scale factors, and interaction effects, such as loading, mismatch, etc.

Equipment Selected

It was obviously preferable, cost and van capacity aside, to minimize the number of instruments employed in the entire set-up, as well as the number used in any one test. How well this has been done is best shown by Table 4.

The "Auxiliary Equipment" list comprises devices that do not effect overall calibration accuracy to any significant degree; hence their separation from the equipment listed in the first three columns of the table.

Standardization

The frequency test equipment used is directly tied by a special receiver to Station NBA's primary-standard frequency transmissions, Fig. 1. All other precise calibrations are performed by traceable secondary-referenced means, periodically checked and certified against primary references. Calibration records of each instrument will be compiled, so that long-term characteristics (aging and drift rate) may be established.

Frequency Standardization

In Fig. 1, the NBS transmission is fed to a receiver, and its frequency compared with one derived (in the frequency synthesizer) from the crystal oscillator (clock) in the digital electronic counter. A phase detector develops a non-anomalous signal proportional to the difference between the two signals. By monitoring this difference on a direct-writing recorder, precise "trimming" of the crystal clock frequency is readily accomplished.

Almost all tests involved in a calibration are

actually performed by use of a transfer standard, such as a wavemeter, which is calibrated against a transfer-oscillator-counter combination, and is much more convenient, hence faster and more economical.

Since the transfer-oscillator-counter-combination is standardized frequently against NBA transmissions, and has excellent stability, it is a true secondary reference. The wavemeter also has good stability, so that it is a valid choice as a transfer standard.

Power Standardization

Absolute power is standardized calorimetrically. The calorimeter used is certifiable at specific frequencies and power levels. By using a potentiometric (or "differential") electronic voltmeter (monitoring the dc "substitution" power), the inherent stability and absolute accuracy of a standard cell is referenced by transfer in the calibration process. The standard cell used is certifiable at NBS.

Once a power level of convenient magnitude has been established by calorimetric means, a stable bolometer-bridge power meter may then be calibrated as a transfer standard in that range. If this calibration process is done at several points on each

Interior view of the mobile laboratory shows the clear separation of the calibration area from the area devoted to preliminary alignment and minor repairs and adjustments. Both are separated from the combination office/reception area.



range, the bolometer-bridge power meter may then be used for all measurements for which a satisfactory bolometer mount of demonstrably low VSWR is available.

Relative Power Standardization

Relative power level, or power ratio, is standardized by reference to an electromagnetic ratio standard of the cut-off-attenuator type. This device is standardizable at specific frequencies only—typically, 30 mc.

Fig. 2 shows how this specific-frequency standardization may be transferred, provided the associated equipment is carefully selected, to the measurement of attenuator linearity (absolute power ratio) over a wide frequency range, at consistently high levels of accuracy.

In Fig. 2, the attenuator of a microwave signal generator is to be calibrated. The frequency of the signal generator is beat against a stable local oscillator to produce a 30 mc signal. A 30 mc source is fed to the secondary-standard attenuator. The attenuator output is then compared, by means of a 1 kc electronic switch, with the 30 mc signal from the mixer. By adjusting the signal generator attenuator for best null output, it can be made to "track" the standard attenuator. By careful design, this system may be given excellent sensitivity, broad bandwidth, and very low offset, down to quite low power levels.

Modulation—Signal Standardization

The mobile laboratory is equipped with a standard-cell-referenced ac/dc potentiometric voltmeter of high stability and linearity. Therefore, it can calibrate the sensitivity of broad-band oscilloscopes at both dc and low-frequency ac to levels of accuracy higher than those useable (readable) with the best oscilloscope. Further, the secondary-standard crystal clock used in the digital counter previously mentioned may be used to establish a very accurate time-scale on the CRO sweep—particularly since it provides "divided-down" standard frequency signals from 10 mc to 0.1 cps in decade steps.

It is, therefore, possible to employ a broadband oscilloscope as the transfer instrument to measure modulation-signal parameters to practical accuracies, higher than required by modulation specifications, with confidence in the CRO calibration.

Impedance Mismatch Measurement

The least critical of the tests required of the mobile laboratory is the measurement of impedance match (input or output.) This is fortunate, for microwave impedance is difficult to standardize at high accuracy over broad bandwidth. (Continued)

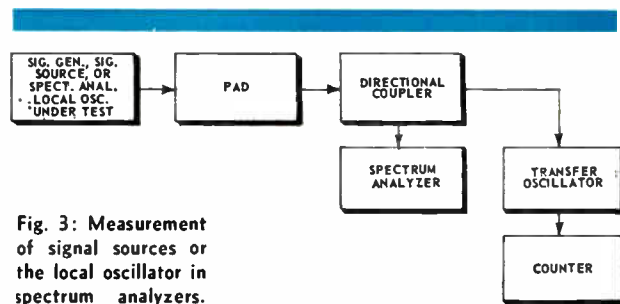


Fig. 3: Measurement of signal sources or the local oscillator in spectrum analyzers.

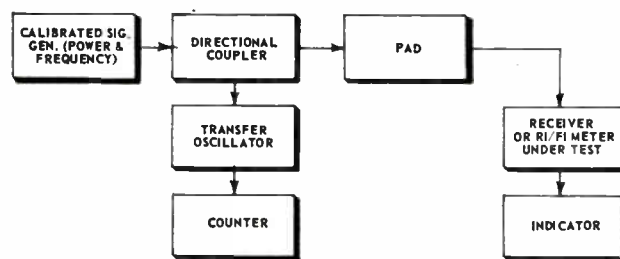


Fig. 4: CW bandwidth calibration of receiver or RI/FI meter with a signal generator calibrated in frequency and power.

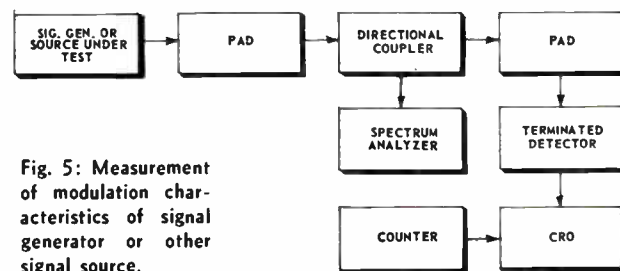


Fig. 5: Measurement of modulation characteristics of signal generator or other signal source.

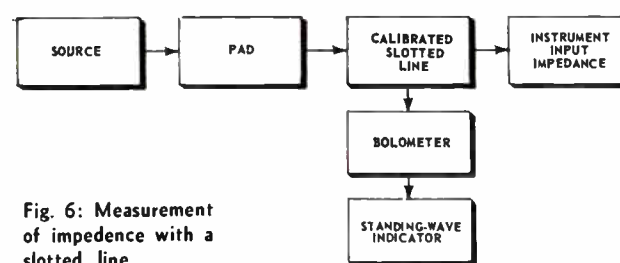
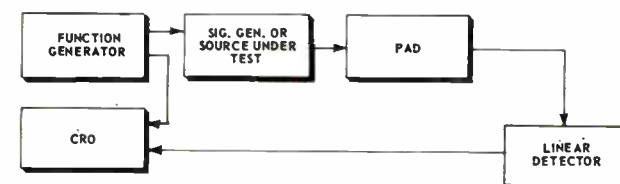


Fig. 6: Measurement of impedance with a slotted line.

Fig. 7 (below): Measurement of external modulation capabilities of signal generator or signal source by comparison of modulating signal with the linearly-demodulated output.



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CALIBRATION (Concluded)

The method used is to establish the true impedance of a slotted line at a number of discrete frequencies in the region of interest, and then observe the effect (on the VSWR of the line) of terminating that line in the impedance to be measured.

Van Design

The Mobile Microwave Calibration Laboratory is housed in a 30 foot long vehicle. There is a clear separation of the calibration area from the area devoted to preliminary alignment and minor repairs and adjustments. Both are separated from the office/reception area.

The van is air-conditioned over broad ranges of external ambients. Full shock-and-vibration protection of all instruments is ensured by the generous use of load-iso-

lators, each equipment rack being fully "floated," and located strategically with respect to the main shock absorbers serving the trailer itself. Factory records, too bulky to store in the van, are readily and continuously available to the test engineers and technicians, regardless of the location of the van, through mobile radiotelephone.

Certificates are issued on the spot, along with a complete point-by-point test report, attested to by the supervisory calibration engineer.

Since the Mobile Microwave Calibration Laboratory provides an essential service at a lower cost than alternatives, in a matter of hours rather than the weeks required for calibration at the factory, we anticipate that it will operate at or near saturation for the first year of its service. It has been designed to maintain a high level of schedule reliability and service under those conditions.

Table 1. Typical Test Programs for Microwave Instruments

Parameter Class	Receivers	RI/FI Meters	Spectrum Analyzer	Signal Gen. and Source
Frequency	Dial Calibration	Dial Calibration	Dial Calibration	Dial Calibration
	Bandwidth (CW/pulse)	Bandwidth (CW/Impulse)	(local osc.) Dispersion	P.R.F. of internal Modulators
	Image Rejection	Image Rejection	Resolution	
	Spurious Responses	Spurious Responses	Spurious Responses	Stability
Power Level and Power Ratio	Sensitivity	Sensitivity		Absolute Output
	Meter Scale Tracking	Meter Scale Tracking	Sensitivity	Attenuator ratio
		Absolute level of internal source (CW or impulse)		
Impedance Mismatch (vs. freq. if req'd)	Input Impedance	Input Impedance	Input Impedance	Output Impedance
Time	Indicator response-time characteristics	Indicator response-time characteristics	Sweep Rate	Modulation pulse widths, rise and fall times, delays sq. wave symmetry
Voltage Level	Ext. Modulation Sensitivity

Circle 121 on Inquiry Card

Table 2. Range Capability

Parameter Class	Range Capability
Frequency	0.1 CPS* to 40 GC
Absolute Power Level	0.1 Watt to 1 Watt, DC-40 GC
Relative Power Level	100 db dynamic range, 10 MC-Xband 80 db dynamic range, Ku band-40 GC
Impedance Mismatch	50 nominal coaxial; } 500MC to 12GC waveguide } 12GC to 40GC
Time	Inverse of Frequency
Voltage Level	10 MV-500V, DC-2MC

* Extendable to 0.0001 CPS by "multiple-period" techniques, but subject to sensitivity, jitter, and accuracy limitations.

Table 3 — Calibration Accuracies


Parameter	Limit-of-Error Uncertainty	
	Reference Standard	Actual Measurement
Frequency	Primary: 1 part in 10 ⁹ at 10 MC Secondary: 1 part in 10 ⁷ up to 18 GC 1 part in 10 ⁶ , 18 GC-40 GC	from secondary reference accuracy to ±0.01%, using poorest transfer device.
Absolute Power Level	3% through X band	6% through X band, 15% above X band to 40 GC
Relative Level	0.01 db/db step	from reference accuracy to ±0.75 db over 1-60 db range beyond 60 db range, + 1.5 db
Impedance Mismatch	1.02 residual VSWR	1.03 residual VSWR
Time	See Frequency	See Frequency
Voltage Level	DC: ±10 ppm std cell AC: ±3%, 30 CPS-2MC	±4%

Table 4 — Equipment Employed in Mobile Laboratory

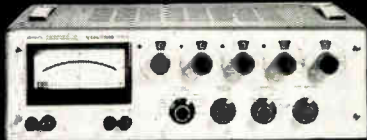
Primary Reference Equipment	Secondary Reference Equipment	Transfer Equipment	Auxiliary Equipment (does not significantly affect calibration accuracy)
Antenna and Special Receiver for VLF Pickup	10 MC digital counter/timer/freq. meter with oven-stabilized crystal "clock"	Transfer Oscillator Wavemeters	Multimeters Cathode-Ray-Oscilloscope*
Broad-band Calorimetric Power Meter	Bolometer-Power Meter Combination	Attenuation Receiver	Lines
Saturated Standard Cell	Potentiometric Voltmeter	Slotted Lines and Guides	Pads
Cutoff Attenuator	Spectrum Analyzers with Crystal Markers	Bolometer-Standing-Wave-Amplifier/Indicator	Directional Couplers
Calibrated Mismatch	Impulse Calibrator	Signal Generators for: Video, VHF, UHF, L, S, C, X, Ku, K, and Ka bands	Terminations
		*Cathode-Ray-Oscilloscope	Detectors
			Transitions
			Recorder

* Used in both categories of test function.

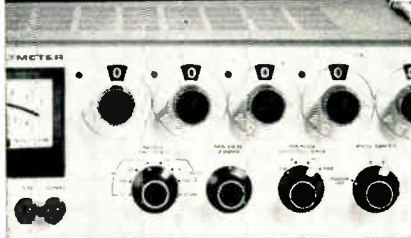
measure dc



100mv to 500v



within 0.02%



**New
Differential
Voltmeter**

Keithley 660 measures dc voltages with the accuracy and stability of a laboratory standard and the ease and low cost of an ordinary VTVM.


Features include:

- 0.02% limit of error
- reference supply stable to 0.005% indefinitely, without periodic re-standardization
- 100µv f.s. null range
- 2µv resolution
- infinite resistance at null, to 500v
- 0.005% repeatability
- 10mv recorder output
- fully guarded input
- positive, negative or floating

Model 660 Differential Voltmeter . \$575
Model 6601 10:1 Divider Probe . \$175

*Send for four page Engineering
Note on the Model 660*

latest catalog available
upon request



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SYSTEMS & CIRCUITS

MICROELECTRONIC DEFINITIONS have been formulated by the Electronic Industries Association. The first listing of terms took about a year to formulate and is now available. EIA will keep the list up to date and will welcome any comments, additions or changes that industry feels are needed.

MAGNETIC TAPE DEVELOPMENT EMPHASIS has centered around the importance of greater pulse density and higher frequency response. This interest stems from the potential for more expedient and more precise data accumulation and processing. But this interest has overshadowed some magnetic tape advancements for present-day recording uses in which high frequency response and optimum density are not so important. Tape manufacturers are now drawing attention to the tape factors of greater dependability, longer use life, and durability.

THE ARTIFICIAL EAR is the subject of a recent handbook issued by B & K Instruments, Inc., 3044 West 106th St., Cleveland 11, Ohio. Two years ago the International Electro-

technical Commission set up a Working Group to establish international standards on this subject. The new handbook is a history of that group's operations. Besides covering the requirements for an artificial ear, the book also treats the design of a standard high-impedance earphone, impedance of the human ear, a survey of existing artificial ears, and the development of a standard artificial ear.

RESULTS OF MARINER VENUS probe show that Venus' mass is 0.81485 times Earth's (13 septillion lbs.). Probable error is 0.015%.

The magnetometer experiment could find no evidence of a magnetic field, at 21,594 miles from the planet. There were no magnetically-trapped particle belts about Venus.

Using the anton 213 counter (which measured a rate of several thousand particle/second 20,000 miles from Earth) Venus' rate was only 1 particle/second. This is because of the absence of the magnetic field, believed due to Venus' slow rate of rotation. NASA's recent radar probe of the planet showed Venus may be rotating


backwards—clockwise, where as Earth rotates CCW—at one complete turn every 250 days.

GERMANIUM PRODUCTION AND USE decreased according to a preliminary report by the U. S. Bureau of Mines. While germanium production was down, the reported production of electronic devices using the material was up. This is attributed to greater manufacturing efficiency and the trend toward smaller devices.

LASER MODULATION can be accomplished using cuprous chloride or cuprous bromide. This material is said to be better than ADP or KDP. Basically, modulation takes place by varying the refractive index of the crystalline material. (See page 90 in our November 1962 issue). Cuprous Chloride (CuCl) can eliminate the problem of crystal destruction by a modulating signal and increases the modulation range. Mechanically, this material is more resistant to shock and vibration than some of the previous materials, according to RCA, Somerville, N. J.

(Continued on Page 192)

NOW POLYPROPYLENE PLASTIC CLAMPS



7 SIZES
1/8" TO 1/2" DIA.
NEW LOW COST
...much less than other types!

STRONG—toughest plastic clamp made . . . high tensile strength. Tougher 'n' ell!

MOLDED to uniform size and shape, smooth edges.

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It stands alone



You can't buy HYDRAZINE-ACTIVATED FLUX® or Core Solder under any other brand name. Fairmount is the sole producer.

Hydrazine-Activated Flux and Core Solder offers an exclusive combination of advantages:

- High wetting properties for good "bite."
- Non-corrosive connections.
- Residues removed by heating or water rinse.
- No change on aging.

These performance characteristics were confirmed in a recent evaluation of leading fluxes used in the fields of printed wiring and etched circuitry.

No one flux is best for all purposes. TEST HYDRAZINE FLUX AND CORE SOLDER FOR YOURSELF. The liquid permits pre-fluxing, is useful for soft-soldering a wide range of copper and copper-based alloys. The core solder flows at an ideal rate, leaves a minimum of soldering residues. Write for samples of either, or technical literature.

*U.S. Patent No. 2,612,459 and others

Available only from Fairmount and its sales agents.

Fairmount
CHEMICAL CO., INC.
136 Liberty St., N. Y. 6, N. Y.

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SAVE CIRCUIT BOARD SPACE!



1

2

“KEMET” P-SERIES

SOLID TANTALUM CAPACITORS

provide maximum capacitance per unit of chassis area—plus these important and exclusive “Kemet” features:

- 1 **Instant Polarity Determination** — Two rounded edges on one face of epoxy case and molded-in polarity symbol indicate polarity instantaneously.
- 2 **Recessed Lead Slots** — Bridge permits easy removal of soldering flux residuals that may accumulate at solder joints.

P-Series • Actual Size

(Smaller Case Sizes in Development and Available Soon)



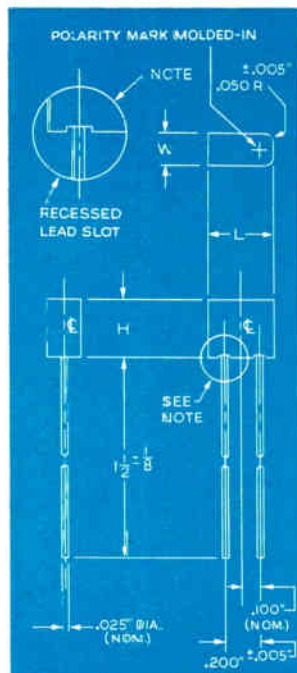
CASE SIZE	H.	L.	W.
X	.225	.290	.170
Y	.325	.360	.170
Z	.375	.600	.195

Catalog Tolerance = $\pm .015$ "

“The High-Density Packages to Shrink Today's Printed Circuits!”

LINDE/KEMET PRODUCTS for Electronics/Aerospace

LINDE Laser/Maser Crystals • Sapphire • Rare Gases/Mixtures • Cryogenic Materials • Single-Crystal Refractory Metals • Semiconductor Silicon • Silicon Monoxide • KEMET Barium Getters and Solid Tantalum Capacitors (Request Technical Data)



Here is capacitor design that *really* takes the squeeze out of printed circuit boards!

New “Kemet” P-Series polar solid tantalum capacitors give you a sintered, dry tantalum anode in a flat, rectangular epoxy package—especially molded for closer tolerances and offering excellent dielectric properties.

The unique “instant polarity determination” feature makes the P-Series suitable for automatic insertion equipment. The solder-coated, high-purity nickel leads can be welded or soldered.

Performance characteristics are typical to the requirements of MIL-C-26655A. Capacitance values range from 1 to 220 microfarads in ± 20 , ± 10 , and ± 5 per cent tolerances. Working voltages are 6, 10, 15, 25, 35 and 50; operation is continuous at 85°C. without derating.

For complete information on the space-saving, time-saving P-Series—or Kemet’s popular, tubular J- and N-Series (up to 75 volts)—write to:

“The Specialist in Solid Tantalum Capacitors”

Kemet Department, Linde Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio. Telephone 216-221-0600.

KEMET DEPARTMENT

LINDE COMPANY



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SYSTEMS & CIRCUITS

SOVIET POWDER METALLUR-GISTS frankly discussed this important industry and technology with their U. S. counterparts during a special conference sponsored by the Metal Powder Industries Federation in cooperation with the National Academy of Sciences and the National Research Council. This highly unusual meeting took place in New York and provided a rare opportunity to obtain facts and technical data on current Soviet powder metallurgy advances in comparison with America's state-of-the-art. Copies of a complete transcript may be obtained from the federation which is located at 60 E. 42nd St., New York, at \$5.00 per copy.

RCA AND PHILCO HAVE AGREED ON THEIR long-standing patent dispute. RCA receives non-exclusive licenses under all present Philco and Ford patents to radio-purpose apparatus (including color TV), transistors, and data processing equipment. Licenses to run full lives of patents. Also, for the next five years, RCA is free to use any domestic color TV

patents issued to Philco. RCA paid \$9 million to Philco.

Ford and Philco received non-exclusive licenses from RCA relating to radio-purpose apparatus (other than color TV), transistors, and data processing equipment, for the full lives of the patents.

Philco has withdrawn its claim for \$150 million damages against RCA, and RCA has withdrawn its claim for \$174 million in damages against Philco.

A "MEMORY DEVICE" is a feature of a new line of accounting equipment recently announced by IBM Electric Typewriter Div. The IBM 6400 magnetic ledger accounting equipment employs a ledger card, which uses a magnetic stripe on its reverse side. The stripe acts as a "memory device" as it stores alphabetic as well as numeric data which appears on the front of the card. Previously available ledger cards stored only numeric information.

The ledger card facility is combined with two printers and a computer to provide an integrated accounting system. Applications such as billing, in-

ventory control and accounts receivable may be simultaneously combined and completed on the 6400.

FCC CHAIRMAN, THE PEOPLE, and Senator Clifford P. Case (R-N. J.) are "in total agreement" about loud commercials on radio and TV. The senator, after many complaints from constituents, first complained to the FCC in Dec. '61. The Commission said that while stations were not permitted to turn up the volume on commercials, there was no bar to the use of loud sounds or even shouting on commercials, so long as they were reproduced at their actual sound level. The FCC staff is now making a detailed study of the problem.

NASA HAS ASKED FOR PROPOSALS from industry for a large-surfaced micrometeoroid satellite. It will be used for further studies of meteoroid and micrometeoroid hazards to space flights. Weighing over 4,000 lbs., its surface area will be more than 2,000 sq. ft. when erected. It will be used on the 8th and 9th Saturn test flights

Brady self-sticking Wire Markers tell which wire goes where, permanently . . . *directly*. The number on the wire list is the number on the wire. No confusing colors and tracers to convert. Brady stocks thousands of standard legends in five different sizes — four job-tested materials. Dispenser card mounted for fast application.

Write for new bulletin and testing samples. **FREE!**

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Circle 126 on Inquiry Card

The number of Howard Unit Bearing Motors in service has now reached a total of over *four million*, with a performance record that enables Howard to guarantee a minimum of 5 years' continuous operation without lubrication maintenance. For the *guarantee* instead of the hope of long, maintenance-free performance, make sure your air movement units are powered by Howard . . . Write for blower-and-fan bulletin.

HOWARD INDUSTRIES, INC.
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Divisions: Electric Motor Corp., Cyclohm Motor Corp., Racine Electric Products, Loyd Scruggs Co., Micro Gear Inc.

POWERED BY
HOWARD

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ELECTRONIC INDUSTRIES • February 1963

Weckesser PLASTIC Fasteners and Holding Devices



Nylon Cable Clamps Etho-Loc Cable Clamps (Ethyl Cellulose) Butyrate Cable Clamps Tab-Loc Cable Clamps

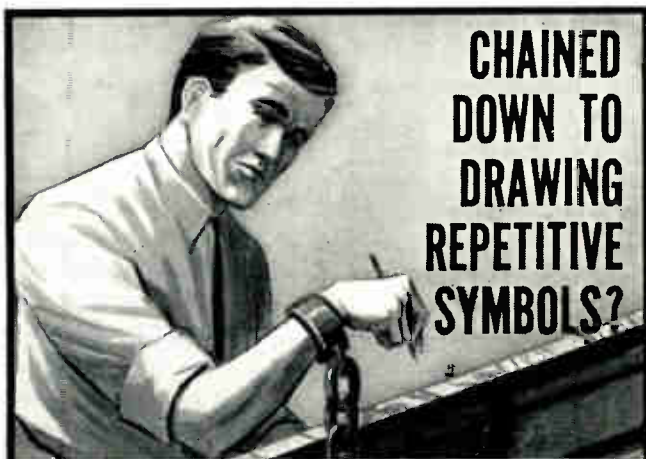
Flat Nylon Clamps Nylon Strap Clamps Nylon Half Clips Wedge Lock Band Clamp

Nylon Snap Clips Teflon Cable Clamps Nylon Washers Nylon Strapping

Nylon Screws Nylon Hexagonal Nuts Nylon Cap Nuts Mounting Tabs and Cradles

Threaded Nylon Rod "D" Washers Send for samples and latest bulletins.

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 Mercury Wetted Contact

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 (NON-BRIDGING)
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**Most complete line of mercury relays in the industry.*

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 mercury relays

THE
 ADAMS
 AND
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 ELKHART,
 INDIANA

Circle 130 on Inquiry Card

VARIABLE MULTIVIBRATOR (Concluded)

(Continued from page 103)

charge on C_1 and C_2 is controlled electronically. R_{11} and R_{12} of Fig. 2 have now been replaced by R_{11} through R_x . The effect of each resistor is controlled by whether its corresponding switching transistor is on. By this means, the oscillator's frequency can be controlled electronically. This is principally applicable in an airborne computer.

Further Modifications

Maximum size of the timing capacitor would be needed for the lower frequencies. It was found that the oscillator could be operated as low as 6 CPS. with satisfactory output waveshape. However, difficulty was encountered when the frequency was increased. Highest frequency that could be achieved was about 60 CPS. Required frequency was at least 100 CPS. It can be seen that the timing capacitors charge through the collector resistors of the transis-

tors. As explained before, for stable oscillator operation (self starting, etc.), these resistors were fixed.

The time constant of the large timing capacitors and large collector resistors therefore limited the speed at which the timing capacitor could be charged.

Since the capacitors were $1.0 \mu\text{f}$ and the collector resistors were 10 K ohms, the time constant to reach 90% charge level (3 time constants) is:

$$T = 10 \times 10^3 \times 1 \times 10^{-6} \times 3 \\ = 0.03 \text{ sec.}$$

For 100 CPS., half the period (which is the time that each capacitor would have to charge) is:

$$\text{Period} = \frac{1}{100} \times \frac{1}{2} \\ = 0.005 \text{ sec.}$$

Needless to say, the charging time is too long for the higher frequencies.

The solution to this problem is shown in Fig. 4. Here, the capacitors are being charged through two emitter followers. In this way, the resistance of the charging path is close to zero rather than the collector resistance. With this method, the frequency could be increased to the required 100 CPS.

Conclusion

The full circuit is shown in Fig. 5. Further testing showed that the frequency could be increased to as

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by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.



many new applications

Newest of the rapidly increasing CAMBION® miniature plugs and jacks is Part No. 3103, a solid front plug-jack combination, .045", that is insulated, and permits multiple contacts by "piggy-backing." Its supplied insulation can be quickly and permanently shrunk into place.

Other newcomers are the .025" No. 3231 plug and No. 3230 jack, ideal for dip soldering or encapsulation. The jack after 68,000 cycles showed no change in contact resistance, thanks to its unique beryllium copper caged spring. Like all CAMBION components, CAMBION plugs and jacks are quality guaranteed. For prints, and Plug and Jack Catalog No. 70, write to Cambridge Thermionic Corporation, 330 Concord Avenue, Cambridge 38, Massachusetts.

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Vinyl-coated Fiberglass Sleeving

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Why specify two when one will do?

• Available in 10 colors; in coils, spools, 36" lengths or short pieces; all of precise uniformity, end to end. Sizes .010" to 6" ID.

Send for **FREE** Folder containing Varflo test sample and results of laboratory performance ratings.

Varflex CORPORATION

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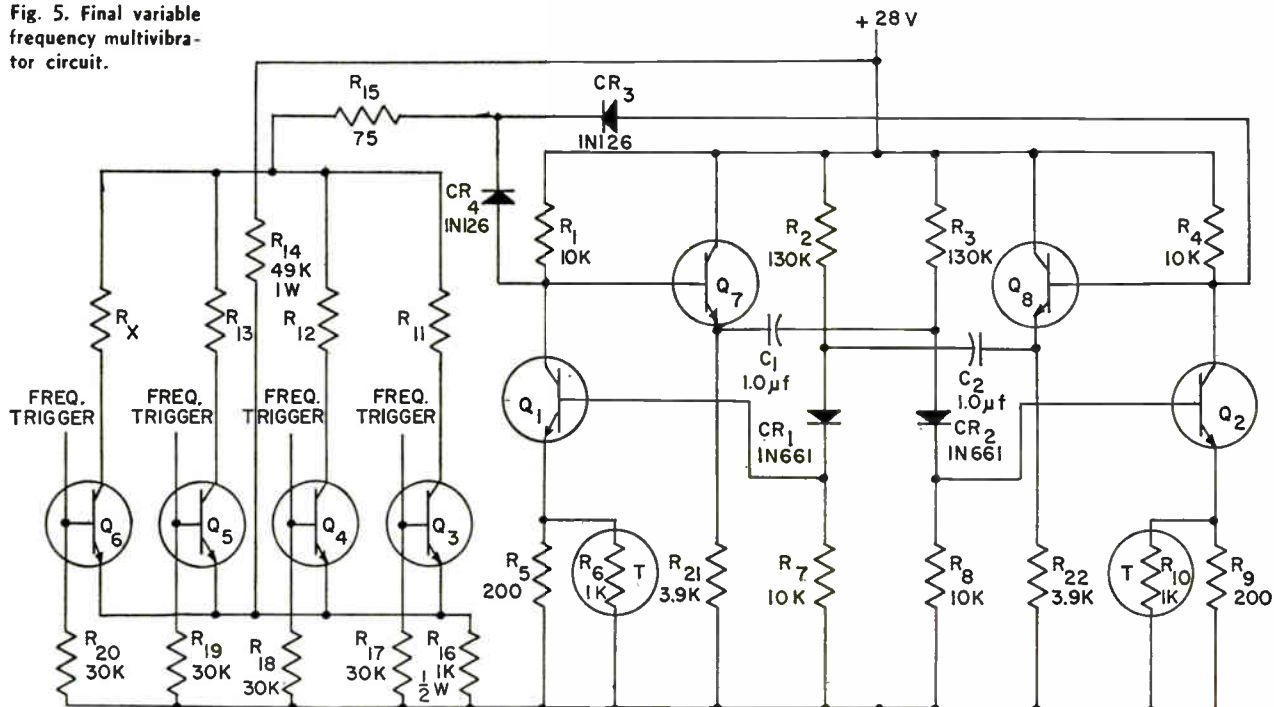


Flame Resistant —
will not support
combustion.



More Stable — re-
tains dielectric
value during sol-
dering.

Fig. 5. Final variable frequency multivibrator circuit.



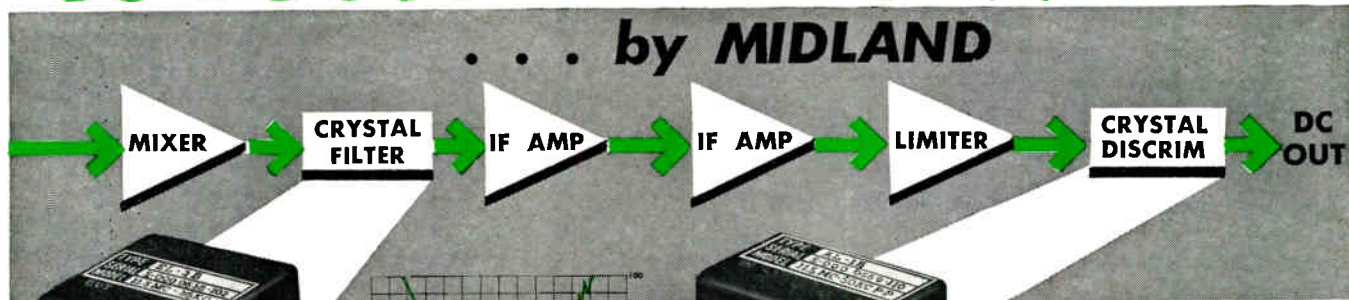
TRANSISTORS ARE 2N167: RESISTANCE VALUES IN OHMS $\pm 5\%$, 1/4 w
 $R_{11} - R_X$ 250 TO 250K DEPENDING ON REQUIRED FREQUENCY

high as 140 CPS if the output wave shape could be slightly degraded. This was done by changing the oscillator's emitter resistors. Since Q_3 through Q_X were being switched from saturation to cutoff, there

was no temperature variation effect due to these transistors; the variable resistors, however, were 1%. For additional stability, thermistors were also used in the emitter circuits.

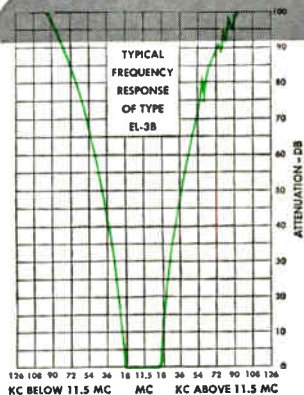
What a Team!

... by MIDLAND



SPECIFICATIONS EL-3B

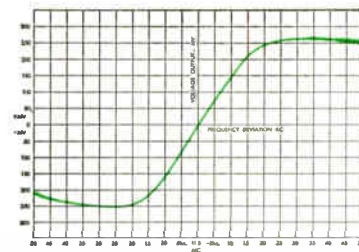
CENTER FREQUENCY: 11.5 MC ± 1 KC
 3DB BANDWIDTH: 36 KC ± 1 KC Min.
 60DB BANDWIDTH: 100 KC Max.
 ULT. REJ.: 90 db — 8 MC to 14 MC
 INSERTION LOSS: Less than 3 db
 INBAND RIPPLE: 0.5 db nom./1.0 db Max.
 OPERATING TEMPERATURE: -55°C to $+90^\circ\text{C}$
 Z_{in}/Z_{out} REQ.: 50 ohms $\pm 5\%$ resistive
 MAX. INPUT LEVEL: $+10$ dbm
 SHOCK: 200 g's
 VIBRATION: 15 g's to 2 KC
 APPROX. SIZE: 1 1/2" L x 1 1/4" W x 1/2" H



WRITE FOR ENGINEERING BULLETIN NBS-106

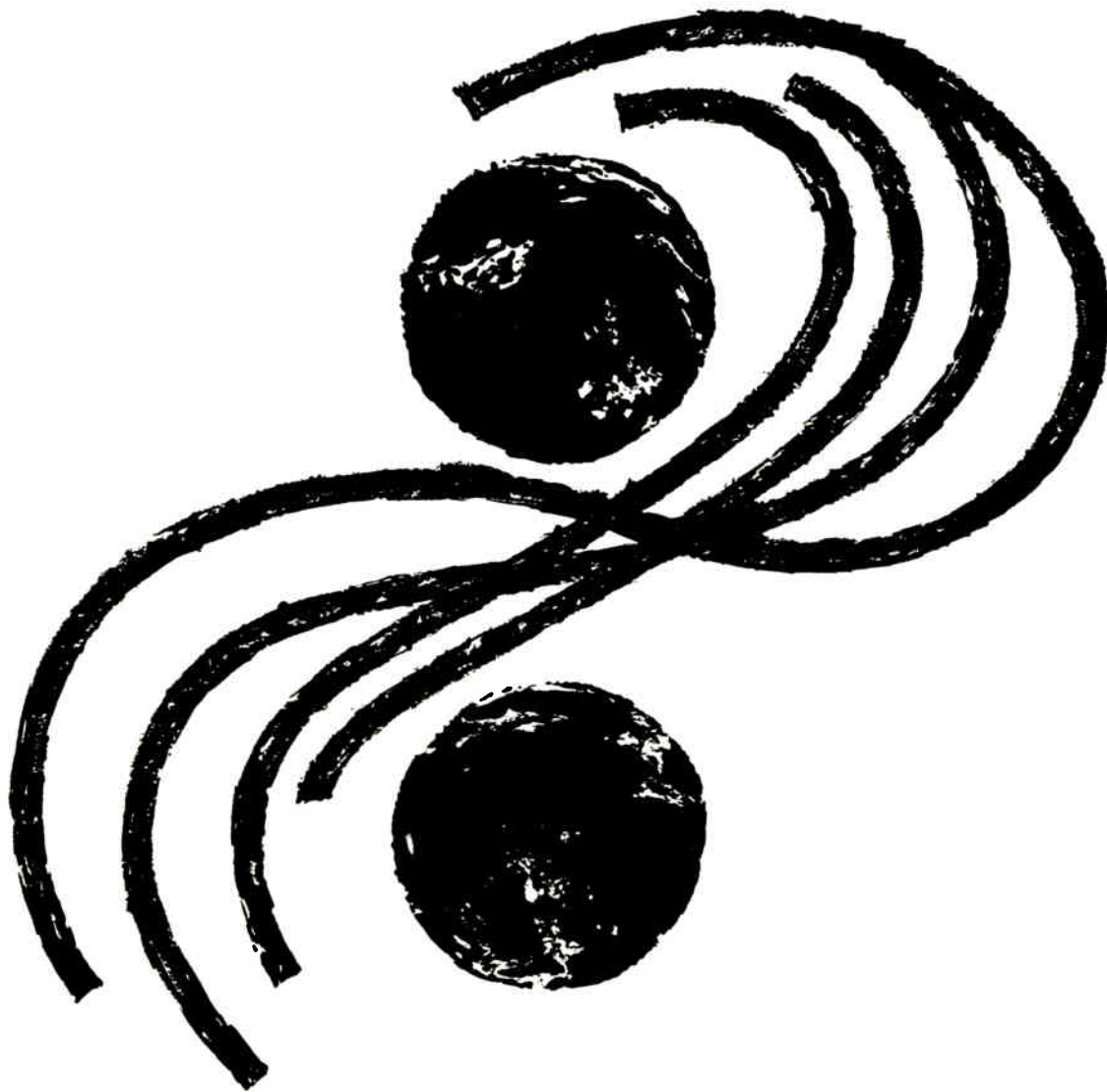
SPECIFICATIONS AL-1B

CENTER FREQUENCY: 11.5 MC ± 2 KC
 BANDWIDTH PEAK/PEAK: ± 25 KC
 Min. ± 6 KC dev.
 HARMONIC DIST.: Less than 2% @ ± 6 KC dev.
 ZERO ADJUST.: ± 1 KC
 INPUT LEVEL: 400 mv to 6 volts RMS
 OPERATING TEMPERATURE: -55°C to $+90^\circ\text{C}$
 Z INPUT: 300 ohms $\pm 5\%$ resistive
 Z OUTPUT: Greater than 100K ohms
 SHOCK: 200 g's
 VIBRATION: 15 g's to 2 KC
 APPROX. SIZE: 1 1/2" L x 1 1/4" W x 1/2" H



WRITE FOR ENGINEERING BULLETIN CDS-107

Midland MANUFACTURING COMPANY • KANSAS CITY 15, KANSAS
 WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS AND CRYSTAL FILTERS • DIVISION PACIFIC INDUSTRIES, INCORPORATED



Said Johann Kepler: *"The planets move in elliptical orbits about the sun, and the square of their periods of revolution are proportional to the cube of their mean distances from the sun."*

With interplanetary voyages fast becoming a reality, complete information regarding the velocity requirements for travel between planets is of vital importance. With these data available, it is possible to analyze propulsion requirements, plan ultimate system configurations, and conduct feasibility studies for any particular mission.

Lockheed Missiles & Space Company scientists have actually evolved a rapid-calculation method, utilizing a high-speed computer. This has produced literally thousands of orbits, velocity requirements, and elapsed time, for design studies of trips to and from both Mars and Venus—every tenth day from now until January, 1970.

More simple to analyze are many factors which make Lockheed Missiles & Space Company a wonderful place to live and work. Located in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, Lockheed is Systems Manager for such programs as the DISCOVERER and MIDAS satellites and the POLARIS FBM. These, together with research and development projects in all disciplines, make possible a wide diversity of positions for creative engineers and scientists in their chosen fields.

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A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS programs. Other current programs include SAINT, ADVENT and such NASA projects as OGO, OAO, ECHO, and NIMBUS.

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PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

GOVT. BOOSTS PAY OFFERS FOR SCIENTISTS, ENGINEERS

Government agencies will offer higher salaries to scientists and engineers needed for hard-to-fill positions.

A new order permits the Government to pay some employees more than the large increases granted in 1962. This will only apply where a person cannot be hired or retained for a certain job.

In the future Federal pay scales will be reviewed annually to make sure they are equal to private industry.

FRESHMAN ENGINEERING ENROLLMENT DOWN IN '62

Freshman engineering enrollments declined 2.3% in 1962 from 1961, reports the Engineering Manpower Commission, Engineers Joint Council.

The survey, taken of 207 engineering schools, also reports engineering degrees declined by 6% at these schools.

Institutions surveyed reported 60,611 freshman engineering enrollments in 1962, or 1,447 less than in 1961. The West South Central states went against the national trend, recording a 3.8% gain.

Based on survey results, EMC reports, engineering graduates will probably decline in numbers for the next four years. It will probably be six years before we again reach present levels.

Seventy-six colleges also reported a 9% increase in degree awards for physical and biological sciences and mathematics combined.

ELECTRONIC PAY HIGH

Census figures for 1960 show the median income for electrical and electronic engineers was \$8,613. This ranked only behind that of dentists, doctors and lawyers, all of which made over \$10,000.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 200.

Keating Charges Defense Dept. Continues To Favor West Coast in Making Contract Awards

Sen. Kenneth B. Keating (R.—N. Y.) has complained that the Dept. of Defense continues to favor California and the West Coast over New York in awarding prime contracts. The New York Congressional delegation has opposed the Dept. of Defense for some time on this score.

Awarding of these contracts greatly affects engineering employment because New York and California together employ one-fourth of the nation's engineers.

California alone employs 125,000, while New York, in second place, employs 87,000. California's total went up 2½ times between 1950 and 1960.

Keating pointed out that New York's dollar share of prime defense contracts, according to latest DOD figures, fell from \$385 to \$377 million for June through August, 1962, compared with the same period in 1961. This, he said, was despite the fact that the overall national value of such contracts rose \$125 million in this period.

The Senator noted California's share of defense contracts for the three-month period of 1962 increased from 23.7 to 26.8%. For the first time, he said, one state, California, now gets three times as much defense money as any other state. (New York's percentage fell from 8.1 to 7.8%.) Washington's share went up from 2.1% to 5.6%, he noted.

The Pacific Coast states, mainly California, received about 19% of all Government contracts during the Korean War. This had advanced to over 33% by 1961, according to one source.

During the last three years, though, the Coast's percentage of the national defense spending total has leveled off. The official DOD Pacific Coast defense spending total was 27.3, 26.9 and 27.8% in 1960, 1961 and 1962. Similarly, California's total was 23.7, 23.9 and 23.9% during the same three years.

In 1962 the Pacific Coast was awarded nearly \$7 billion in prime defense contracts. The Middle Atlantic states were second with \$4.7 billion, 18.8% of the total. New York's percentage total dropped from 12 to 10.7% in fiscal 1962 to account for over a 1% drop in the Mid-Atlantic total.

COMPONENT CLASS VIA TV



At Leach Corp., Los Angeles, Calif., woman employee studies detail of tiny half-sized "crystal can" relay on TV screen. It is exposed on table to camera, magnified ten-fold on screen. Instruction program is to develop reliable components for U.S. space programs.

R & D JOBS ABOUND IN WASHINGTON AREA

More engineers and scientists than ever are being employed in the Washington, D. C., area, states the Board of Trade.

The largest employer is the Federal Government with some 13,112 working in military development, space technology, medicine and agriculture.

The number of private R & D firms in the Washington area has grown from 48 in 1950 to 198 last year. Largest among them are Melpar, Johns Hopkins, Vitro Labs, ACF Electronics, Page Communications Engineers and Atlantic Research. Smaller firms abound also.

SALARIES HIGHER

The National Science Foundation says the median salary for scientific and technical manpower increased to \$10,000 a year in 1962, up \$1,000 since 1960.

Advances in the field of solid-state device applications and circuits are highlighted in this year's conference. Details concerning the meeting are given and the variety of subjects covered are outlined.

PREVIEW OF...

1963 INTERNATIONAL SOLID-STATE CIRCUITS CONFERENCE

THE 1963 INTERNATIONAL SOLID-STATE CIRCUITS CONFERENCE to be held Feb. 20-22 will highlight broad advances in the field of solid-state device applications and circuits. Fifty-two papers by over 90 specialists from here and abroad will cover these advances.

The leadoff session on Wednesday morning will feature digital memories. It will be followed by sessions on logic, low-frequency circuits, microwave circuits, digital design techniques, linear circuits, integrated circuits, and optoelectronics. High-frequency generation and amplification, transistor switching circuits and solid-state sensing will be covered by invited and tutorial speakers in other sessions. There will be twelve daytime sessions in all. These will be held at Irvine Auditorium and University Museum, both of which are located on the University of Pennsylvania campus.

Informal Sessions

In addition to the daytime program eleven informal discussion sessions are scheduled for Wednesday and Thursday evenings in the Sheraton Hotel in central Phila. Topics for discussion include nanoswitching circuits, integrated linear circuits, statistical and computer techniques in circuit design, magnetic thin-film memories, packaging and the measurements problem, and special circuit design considerations for the nuclear environment. Coherent optical techniques and applications, integrated digital logic, broadband amplifiers, combined analog-digital circuit techniques, and partial switching of ferrites are other subjects on the discussion program.

Formal Opening

A special paper-award presentation ceremony will be held at the formal opening Wednesday to cite speakers for outstanding 1962 conference efforts. Also featured at the formal opening will be a keynote address by James H. Mulligan, Jr., Chairman of the Electrical Engineering Department of New York University. Mr. Mulligan served as Chairman of the

1958 Transistor and Solid-State Circuits Conference. He will talk on "The Role of Network Theory in Solid-State Electronics — Present Accomplishments and Future Challenges."

Conference Digest

A 120-page letterpress conference report book featuring digests of every paper, including the tutorial and invited discussion, will be given to all registrants at no extra charge. The book contains over 300 diagrams and photographs to supplement the digests.

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 IRE Professional Group on Circuit Theory, the IRE Phila. Section, the AIEE Electronic Circuits and Systems Committee, the AIEE Phila. Section, and the University of Pennsylvania.

Technical Program

As evidenced by session titles, the conference technical program covers a variety of topics. Let us dwell on a few of these.

The high level of current interest in computers, logic, and digital techniques is emphasized by the number of papers covering these and related subjects.

A visitor from abroad—H. J. Harloff of Siemens and Halske AG, Munich-Berlin, Germany—will open the conference with his paper entitled "Operating Speed of Thin-Film Memories." In it he will evaluate a model for velocity, attenuation and distortion of pulses in both normal and superconducting lines.

A paper which should be of interest is "The Waffle Iron Memory" by A. H. Bobeck and T. R. Finch of Bell Telephone Laboratories, Inc., Murray Hill, N.J. The Waffle Iron Store uses a new magnetic memory employing soft, microgrooved ferrite combined with a plated layer of isotropic square-loop material. Paper will describe a random access, variable store, designed to operate at 400 nsec read-write cycle.

Another visitor from abroad will deliver a paper on "Microwave Logic Circuits Using Esaki Diodes" in the first of two sessions concerned with logic. Y. Komamiya of Electromechanical Lab., Japanese Government, Tokyo, Japan, will describe a Dynamic Asynchronous Logic Circuit (DALC), in which the oscillatory and non-oscillatory states of an Esaki diode represent the binary levels of a microwave logic system.

Computer Design

A new approach to computer design is discussed in the second logic session. "The Diamond Circuit Computer Element" by R. H. Baker of MIT Lincoln Laboratory, Lexington, Mass., discusses the new approach which combines the better features of digital and analog methods and reduces the system complexity. The approach reduces the power by two to three orders of magnitude over digital methods alone. For those engaged in the design of digital circuits, the Thursday afternoon session is a must. The five papers to be presented in this session on "Digital Design Techniques" are all noteworthy. For example, the paper "Method of Using Parameter Confidence Limits in Circuit Design" by L. J. Ragonese of Electronics Laboratory, General Electric Co., Syracuse, N. Y. describes a design procedure, especially applicable to digital circuits. The method combines the design of realizable circuits and the effect of the system thermal characteristics for least probability of drift failure.

In addition to the papers on memories, logic and digital design techniques, there are several discussion sessions which will cover these and other techniques.

Microwave circuits are well represented with five papers scheduled for presentation on Thursday. Design problems will be discussed and techniques described. Theoretical and experimental results will be given. The paper on "Low Noise Nonreciprocal Parametric Amplifier with Power Matching at the Input and Output" by R. Maurer and K. H. Löcherer, Telefunken G.m.b.H., Ulm (Donau), Germany should prove worthwhile. How nonreciprocity can be achieved by pumping two parametric diodes in phase quadrature and by shunting the combination with a passive feedback admittance will be disclosed.

Semiconductors

Two tutorial sessions are concerned with frequency and power limitations of solid-state devices, and transistor switching circuits. Two papers will be presented in each session.

Possible future advances are a feature of both papers in the Wednesday morning session. M. E. Hines, Microwave Associates, Inc., Burlington,

Mass., will review present high-frequency generating and amplifying devices. He will then talk about improvements in semiconductor and circuit technology which will lead to further advances. His paper is entitled "High-Frequency Limitations of Solid-State Devices and Circuits."

The other paper scheduled for this session will discuss the physical properties which determine the frequency response, switching speed, power capability, gain and bandwidth of transistors and switching diodes. The extent of possible further progress will be estimated. Paper is "Are Transistors Approaching Their Maximum Capabilities?" by J. M. Goldey and R. M. Ryder of Bell Telephone Laboratories, Inc., Murray Hill, N.J.

Solid-State Sensing

Papers for the session on Solid-State Sensing have been invited and should be of interest. The three papers deal with "Solid-State Sensors for Process Control," "Considerations Underlying the Study of

(Continued on page 202)

University of Pennsylvania's Irvine Auditorium where some of the daytime sessions of the Solid - State Circuits Conference will be held, is located at 34th and Spruce Sts.



See Professional Profile on page 200

ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

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 Professional Memberships _____

College or University	Major	Degree	Dates

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Company	Div. or Dept.	Title	Dates

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A Message to the Engineer/Scientist Community At Large — and a Question: there's a dynamic technological race going on at the Atlantic Missile Range, a race between the fast-increasing capabilities of new missiles and space vehicles and the capacity of range instrumentation to test their performance. □ We wonder how much you have heard about this. ...and about the challenge it offers engineers and scientists with PAN AM at Cape Canaveral? □ You may know a small segment of the work...many do. But only a handful are aware of its scope. In fact, we of PAN AM'S Guided Missiles Range Division sometimes think that only the ubiquitous sea-gulls know the full story of the new range instrumentation technology we've created in the 9 years we've been charged with development and management responsibilities for AMR by the U.S. Air Force. □ The measure of the distance we've come is the measure of the technological jump between MATADOR and MARINER. □ In the simplest terms, this has meant acquiring ever greater funds of data, of ever higher accuracy, at ever greater distances — and converting and transmitting it at ever increasing speeds. □ FIRST, the existing range instrumentation and communications techniques were pushed to the utmost bounds of their capacities — THEN they were replaced with new range systems built to new concepts, as specified by PAN AM engineers and scientists

backed by research groups. □ *Today — a new phase of range technology development is under way — staff build-up is proceeding on schedule.* □ To meet the demanding requirements of both today and tomorrow, much of the work of the Range is divided into three time projections:

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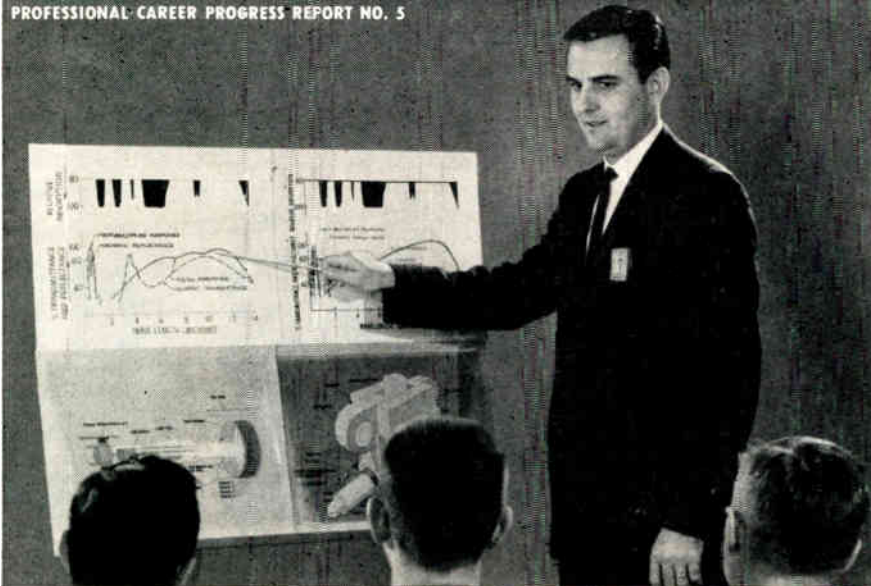


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PH 5

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INDUSTRY NEWS

Dr. James C. Fletcher—elected Vice President—Advanced Systems, Aerojet-General Corp., Azusa, Calif., a subsidiary of the General Tire & Rubber Co.

Stuart E. Arnett—appointed Marketing Director, ITT Industrial Laboratories, Ft. Wayne, Ind.

Robert B. Brown—appointed Manager of Market Research, Beckman Instruments, Inc., Fullerton, Calif.

Fred Lorge — elected President of Kings Electronics Co., Inc., Tuckahoe, N. Y.

William E. Keene—appointed Standards and Specifications Manager, Aladdin Electronics, Nashville, Tenn. Also, **J. Scott Grigsby, Jr.**—named Field Engineer and Marketing Assistant.

Edward F. Moskal—appointed Marketing Manager, Navy simulation equipment, Riverside, Md., Plant, ACF Electronics Div., ACF Industries, Inc.

Walter A. Rudolphsen—elected Executive Vice President, Belden Mfg. Co., Chicago, Ill.; **Warren Stuart**—elected Assistant Vice President — Sales; **Robert W. Hawkinson** — appointed Assistant to the President.

William R. Dixon—appointed Advertising Manager, Electronic Components Group, Sylvania Electric Products, Inc., New York, N. Y.

Richard A. Wilson — appointed Vice President and General Manager, General Dynamics/Electronics, Rochester, N. Y.

Stephen E. Einig—appointed Director of Marketing, Defense Products Div., Fairchild Camera and Instrument Corp., Syosset, L. I., N. Y.

David R. Busch—appointed Atlantic Regional Sales Manager, Bendix Industrial Controls Section, The Bendix Corp., Detroit, Mich.

Edmund J. Goehring—named General Sales Manager, Hart Manufacturing Co., Hartford, Conn., subsidiary of Oak Manufacturing Co., Crystal Lake, Ill.

F. G. Rodgers—named Vice President and Western Regional Marketing Manager, International Business Machines Corp., New York, N. Y.; **Wesley R. Liebttag** — named Assistant General Manager, IBM Supplies Div.

Vinton K. Ulrich — named Product Sales Manager, Receiving Tube Operation, Industrial Components Div., Raytheon Co., Newton, Mass.

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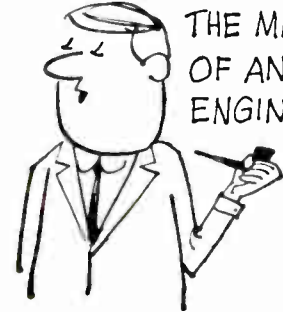
SO HERSHEIMER
COMES IN AND
I TELL HIM
I'M QUITTING!



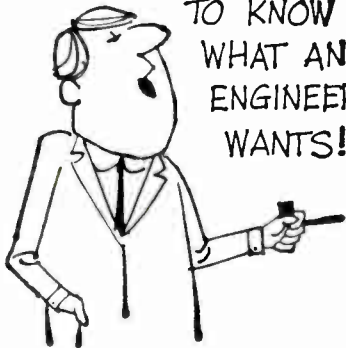
AND HE SAYS
WHY? YOU'RE
GETTING AS MUCH
AS SIEFRIED
AND LUCAS!



SO I SAID: MONEY!
WHAT'S MONEY? YOU
BUSINESSMEN JUST
DON'T UNDERSTAND
THE MIND
OF AN
ENGINEER!



I'M AN ENGINEER
AND I OUGHT
TO KNOW
WHAT AN
ENGINEER
WANTS!



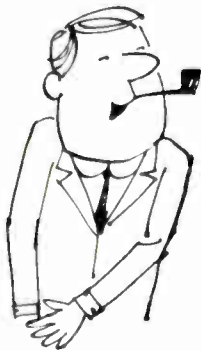
I WANT FULFILLMENT
I WANT TO WORK ON
THE **SURVEYOR**
AT HUGHES!



JUST THINK!
SOMEDAY THERE'LL
BE A LITTLE
PIECE OF ME
ON THE
MOON!



NO MORE ELECTRONIC
EGG-TIMERS! I'LL
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INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification, air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

SYSTEMS ANALYSTS. To consider such basic problems as: requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.



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PERSONALS

William F. Eicher—named Manager of the newly formed Mobile Medium-Range Ballistic Missile Div., Hughes Aircraft Co., Culver City, Calif.

John E. Woodward—named Corporate Director of Material, Texas Instruments Incorporated, Dallas, Tex.

Dr. Edgar A. Sack—appointed Engineering Manager, Molecular Electronics Div., Westinghouse Electric Corp., Pittsburgh, Pa.

Earl Gregory—named Minuteman Program Manager, Semiconductor Div., Raytheon Co., Mountain View, Calif.

Clinton W. Hartman—named Resident Manager, CTS of Berne, Inc., Berne, Ind.; **Howard F. Christner, Jr.**—named Assistant Resident Manager, CTS of Paducah, Inc., Paducah, Ky.

Geoffrey C. Winkler—named Manufacturing Manager, Tube Div., Huggins Laboratories, Inc., Sunnyvale, Calif.



G. C. Winkler



W. Hedge

William Hedge—named New Products Manager, Engineered Electronics Co., Santa Ana, Calif.

John A. Kennedy—named Chief Industrial Engineer, Cincinnati, Ohio, Div., The Bendix Corp.; also **Donald A. Plett**—named Factory Manager; **Charles P. Boegli**—named Assistant Director of Engineering of the division.

Earl C. Whitney—named Plant Manager, Howard Industries, Inc., Racine, Wis.

John E. Maychrowitz—named Chief Engineer, Kelvin Corp., Fajardo, Puerto Rico.

A. F. Gaetano—named Microwave Applications Manager, Electronics Div., Lockheed Missiles & Space Co., Palo Alto, Calif.; **Norbert J. Gamara**—named Electromagnetics Research Manager; **Lester L. Libby**—named Manager of Design Techniques Dept.

Dr. David A. Kahn—named Chief Engineer, Melpar, Inc., Falls Church, Va.

(Continued on page 208)

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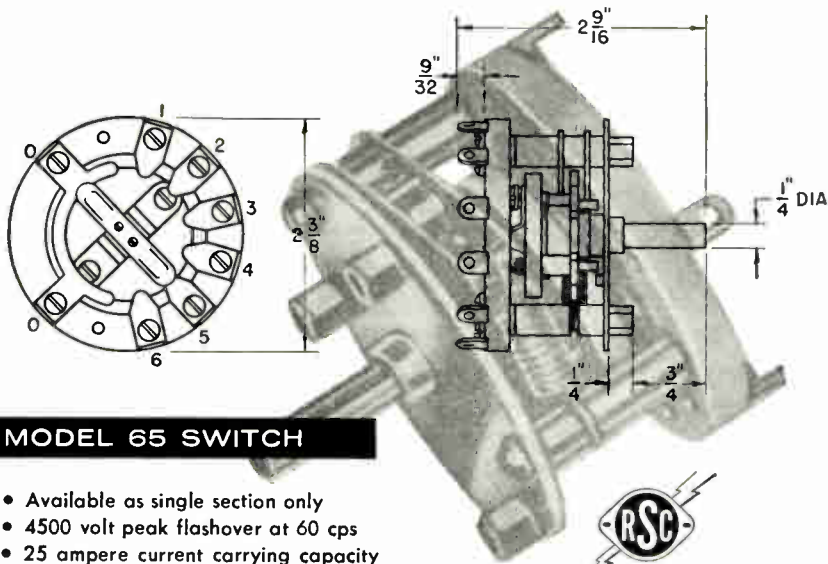
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Claude C. Kirk—appointed Assistant Manager, AiResearch Manufacturing Div., The Garrett Corp., Phoenix, Ariz.

William C. Giegold—appointed Manufacturing Manager, Silicone Products Dept., General Electric Co., Waterford, N. Y.; **Harold W. LeBoeuf**—named Manufacturing Practices Consultant for the department; **Dr. Archie Broodo**—appointed Engineering Manager for solid tantalum capacitors, GE Electronic Specialty Capacitor Operations, Irmo, S. C.

A. M. Okun—appointed Corporate Director of Reliability, General Instrument Corp., New York, N. Y.

John Vergeichik—appointed Engineering Director, Clifton, N. J., facility, Defense Products Div., Fairchild Camera & Instrument Corp.



J. Vergeichik



A. F. Perkins

Arthur F. Perkins—named Chief, Transmission Engineering, Engineering Dept. General Dynamics/Telecommunication, Rochester, N. Y.

David M. Pixley—appointed Manager, Product Development, Havelex, Taunton, Mass., Div., Haveg Industries, Inc.

Dr. C. H. Sutcliffe—appointed Director of Engineering, Lansdale Div., Philco Corp.

J. A. Scarlett—appointed Operations Manager, Palm Beach Gardens, Fla., plant, RCA Electronic Data Processing.

Henry K. Kindig—named General Manufacturing Manager, Black and White TV Picture Tubes, Electronic Tube Div., Sylvania Electric Products, Inc., Seneca Falls, N. Y.; **Clarence S. Jones**—named Manager, Equipment Engineering Laboratory, Sylvania Electronic Defense Laboratories, Mountain View, Calif.; **James L. Clark**—named Manager, Sylvania's AN-MPQ-32 Weapons-Locating Radar Program, Waltham, Mass.

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news about solders, fluxes, preforms, special alloys, lead and tin products

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new bar solder cuts printed circuit joint rejects



Use of a recently developed Vaculoy® bar solder cuts printed circuit joint rejects from 1 in 500 to 1 in 5,000. The primary reason for this amazing performance is the fact that the new bar solder is significantly freer from oxide forming elements.

Here are some of the other advantages offered by Alpha Vaculoy solder:

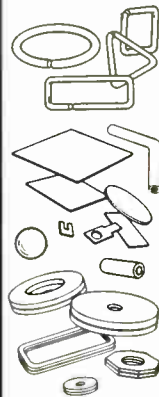
1. Substantially less dross.
2. Increased bath life.
3. Less inherent inclusions.
4. Improved wetting.
5. Brighter joints.
6. More finished units per pound.

Alpha's new Vaculoy solder was developed specifically for electronic and computer printed circuit applications. It conforms to latest revisions of Federal Specification QQS-571 and ASTM.

Its initial cost is pennies per pound more than ordinary solders, but in terms of effective joints and man-hours, Vaculoy costs appreciably less. Full information on request.

Circle 152 on Inquiry Card

automatic soldering with solder preforms

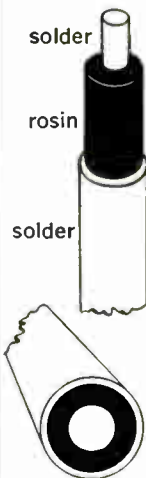


Automatic soldering requires solder preforms of controlled alloy content, size and shape. The right preforms can increase production, guarantee product precision, cut labor costs and provide stronger, smoother joints.

Alpha's experience can help you secure the correct solder preforms for every job and achieve the maximum effectiveness and economy from automatic soldering. Alpha solder preforms are available in discs, rings, spheres, washers, pellets and an almost limitless variety of forms. Both solid and flux filled forms can be supplied. The Alpha "Guide to Automatic Soldering with Solder Preforms" is yours for the asking.

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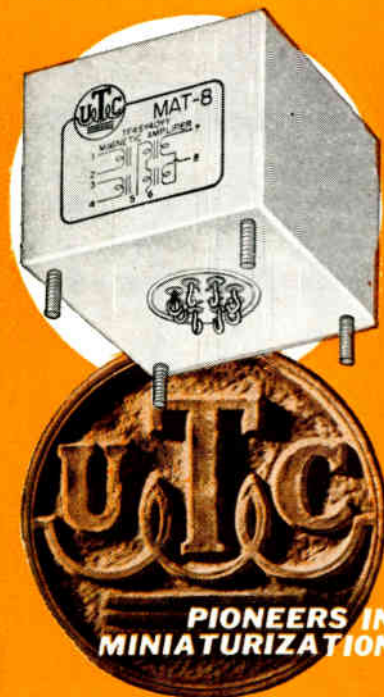
soldering, automatic wave fluxing and installations requiring foam fluxing.

Alpha's fluxes meet all government specifications. Full information on this new series of activated liquid rosin fluxes for critical soldering applications is yours on request.

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Circle 140 on Inquiry Card

NEWS OF MFRS. REPRESENTATIVES

REPRESENTATIVES WANTED

Well known manufacturer of large electronic and microwave test equipment wants technically experienced representative organizations in the following areas: the Midwest, Texas, Florida and Seattle, Wash. Box Z-1, Editor, ELECTRONIC INDUSTRIES.

Lorber Instrument Div., Sheridan Sales Co., Cincinnati, Ohio—appointed representative in Ohio, Pennsylvania and West Virginia by American Electronic Laboratories, Inc., Colmar, Pa. AEL manufactures microwave antennas, diodes, and instruments, communication systems and equipment.

Luscombe Engineering Co., Pasadena, Calif.—appointed California, Nevada and Arizona representative by Chatham Electronics Div., Tung-Sol Electric, Inc., Livingston, N. J., power supply manufacturer.

Harvey Teplitz & Co., Cleveland, Ohio—appointed accelerometer representative for Ohio, Michigan, Western Pennsylvania and Eastern Indiana by Clevite Electronic Components, division of The Clevite Corp., Cleveland, Ohio; **Fowler Beach Corp., Rochester, N. Y.**—appointed Clevite Electronic Components representative for accelerometers, filters and piezoelectric ceramics in New York State north of and including Rockland County, but excluding Westchester County, except for IBM facilities.

Budd Cato Associates, Brielle, N. J.—appointed representative to cover Long Island, New York City, New Jersey and Eastern Pennsylvania by Consolidated Ceramics & Metalizing Corp., Flemington, N. J.

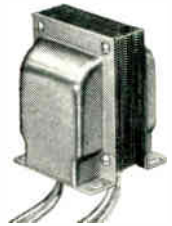
Engineering Services Co., St. Louis, Mo.—appointed Midwest representative by Frequency Engineering Laboratories, Asbury Park, N. J., microwave component manufacturers. F.E.L. also announces these appointments: **El-Com Sales Co., Hollywood, Calif.**—named Southern California representative; **Rocke International Corp., New York, N. Y.**—appointed representative for foreign sales in the Free World.

Vector Sales, Belmont, Mass.—named New England representative by Micro-Radionics, Inc., Van Nuys, Calif. M.R.I. manufactures precision microwave components, antennas and ground support test equipment.

(Continued on page 212)

for solid state applications

silicon
rectifier



power
transformers



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ELECTRONIC INDUSTRIES Advertisers - February 1963

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J. L. Feinberg Assoc., New London, Conn.—appointed New England representative for Panelgraphic Corp., Caldwell, N. J., manufacturer of military and industrial instrument and control panels, dials, scales, tapes and specialty finishing and marking.

Instruments for Measurements, Hollywood, Calif. — appointed California, Arizona and Nevada representative for the Data Systems Div., Harman-Kardon, Inc., Plainview, N. Y. The division manufactures digital logic modules and digital systems.

Edgar A. Moore Assoc., Atlanta, Ga. —appointed representative in Alabama, Georgia and South Carolina by Spectrol Electronics Corp., San Gabriel, Calif., manufacturer of trimmers, precision potentiometers and turns-counting dials.

Ray Johnston Co., Inc., Seattle, Wash. —named Northwest and Alaskan representative by Sperry Semiconductor Div., Sperry Rand Corp., Norwalk, Conn.

Northport Engineering, Inc., St. Paul, Minn. — appointed representative in Minnesota, Wisconsin, and the Dakotas by Wayne-George Corp., Newton, Mass.; **L. H. Schwartz & Assoc., Inc.**, Dayton, Ohio — named representative in Ohio, Indiana, Michigan, Kentucky and Western Pennsylvania. Wayne-George manufactures optical shaft position encoders, pulse tachometers, gyro test tables, gas and oil bearings and inertial test systems.

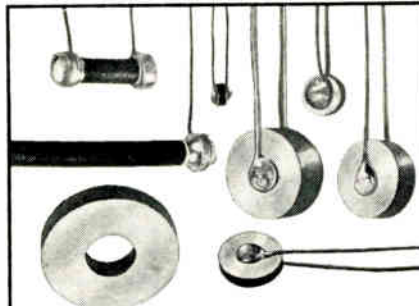
Carruth Laboratories, Inc., Dallas, Tex. — appointed representative by ERCO Radio Laboratories, Inc., Garden City, N. Y., for Texas, Oklahoma, Arkansas and Louisiana; **Dickerson Engineering Sales Co.**, Jacksonville, Fla.—appointed to cover Georgia, Florida, Alabama, Tennessee, Virginia, North and South Carolina; **Garrett Manufacturing, Ltd.**, Rexdale, Ont., Canada—appointed Canadian representative; and **Wallace & Wallace**, Los Angeles, Calif.—appointed to cover Southern California, Nevada and Arizona. ERCO specializes in the design/manufacture of ground-based communications receivers and transmitters for airports and other communication centers.

Jadd Associates, Detroit, Mich. — appointed national stamp trade representative by Snyder Mfg. Co., Philadelphia, Pa., manufacturer of auto radio

and TV antennas, pole lamps, hi-fi tables and other household products; **Chester C. Willard Co.**, Ft. Worth, Tex. — named Texas and Oklahoma representative for Snyder.

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10 mv rms full scale to 10 v rms full scale in seven ranges; full scale readings of 0.01, 0.03, 0.1, 0.3, 1, 3 and 10 v rms

Frequency Range:

500 kc to 1 gc with accessory probe tips; usable indications to 4 gc

Accuracy:

500 kc to 50 mc, $\pm 3\%$ of full scale; 50 mc to 150 mc, $\pm 6\%$ of full scale; 150 mc to 1 gc, ± 1 db using appropriate probe tips

Meter Scales:

Two linear voltage scales, 0 to 1 and 0 to 3, calibrated in the rms value of a sine wave; db scale, calibrated from +3 to -12 db; 0 db = 1 mw in 50 ohms

Probe Tip Furnished:

411A-21E BNC open circuit tip, 500 kc to 500 mc; shunt capacity less than 5 pf; max. input 200 v dc; input resistance at 10 mc typically 80K ohms

Galvanometer

Recorder Output:

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Price:

Ⓢ 411A, (cabinet) \$450
Ⓢ 411AR (rack mount) \$455

*Data subject to change without notice.
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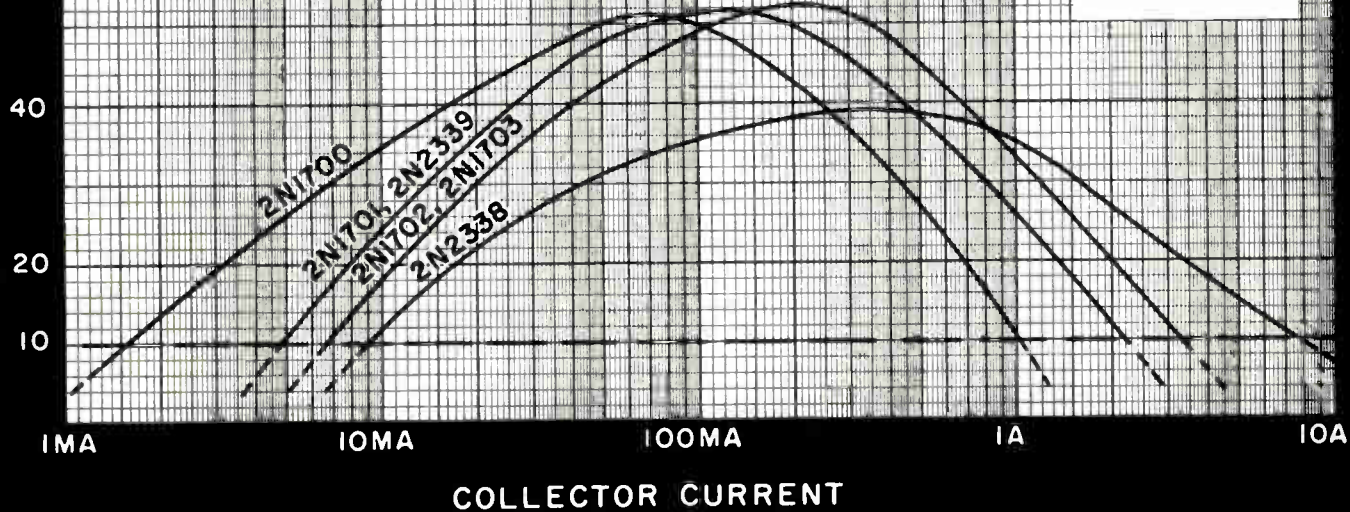
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2N1701	25 Watts
2N1702	75 Watts
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2N2338	150 Watts
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