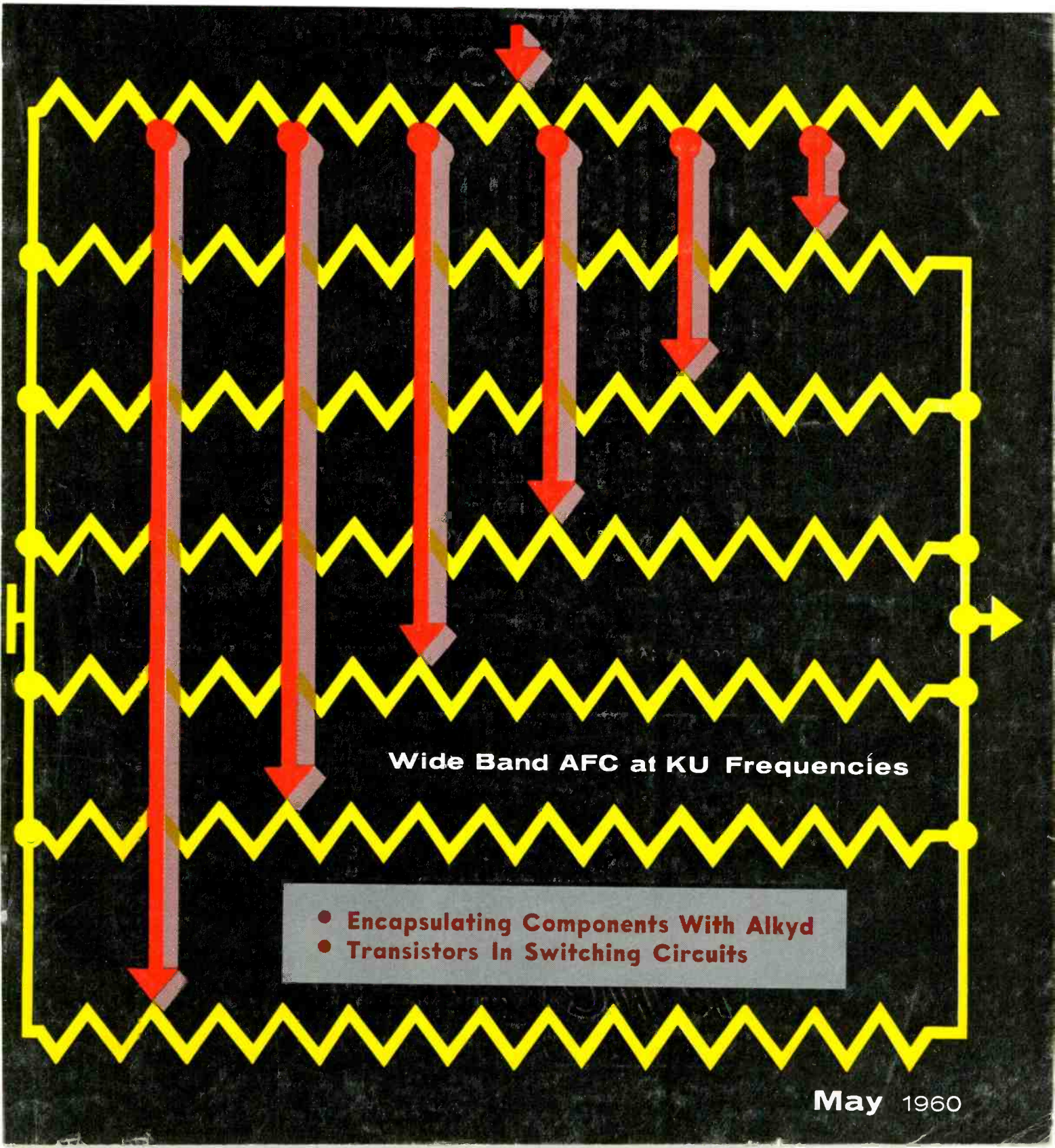
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



Wide Band AFC at KU Frequencies

- Encapsulating Components With Alkyd
- Transistors In Switching Circuits

May 1960

RMC

SUBMINIATURE

DISCAPS

DESIGNED FOR COMPACT PRODUCTS

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

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TEST VOLTAGE (FLASH): 1000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic (⅛" max. on leads)—vacuum waxed

STAMPING: RMC—Capacity—Z5U

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

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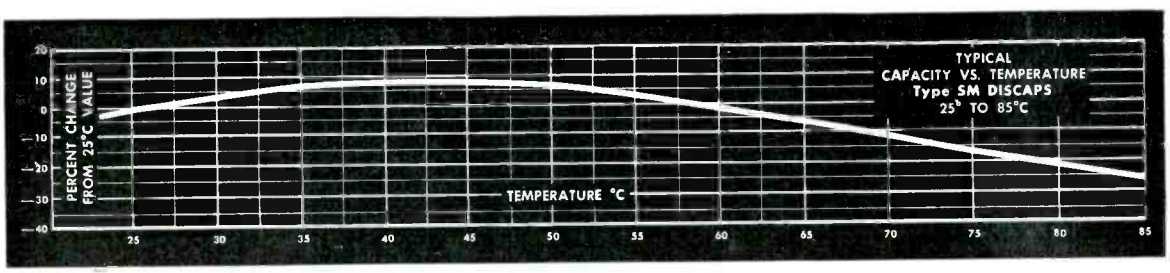
RMC Type SM DISCAPS are designed for applications in compact radios, testing products, communication equipment and other products where space is of prime importance. These DISCAPS are rated at a working voltage of 500 volts and exhibit a minimum capacity change between +10° and +85° C. Type SM DISCAPS can be specified with the complete assurance of quality and reliability that is inherent in all RMC DISCAPS.



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ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

SUPPORT FOR EDUCATION

GENERAL JAMES H. DOOLITTLE, in accepting the 1959 Silver Quill Award at the recent National Business Publications "State of the Nation Dinner," listed five national priorities to win the world struggle between communism and freedom. Second on his list was "Support for Education."

This month we received four very interesting bulletins on this subject. They compare the extent of science and engineering education in the USSR with that of the United States, and show the tremendous deficiencies we will have in scientific manpower and educational facilities in the 1960's unless something is done about it. Three of these bulletins are addresses made by Hilliard W. Paige of the Missile and Space Vehicle Department, General Electric Co., 3198 Chestnut Street, Philadelphia, Pa., while the fourth is from the Hertz Engineering Scholarship Foundation, 1314 Westwood Boulevard, Los Angeles, California. Copies are available from these sources for interested readers.

The box score for scientific and engineering graduates in the two countries over the last decade looks something like this:

	U.S.A.	U.S.S.R.
1950	50,000	30,000
1955	30,000	50,000
1956	32,000	70,000
1959	37,000	100,000
1960	40,000	110,000

And there is another interesting point. . . . It is reported that in Russia 70% of the cabinet (the equivalents of our Secretaries of State, Defense, etc.) possess backgrounds in technology or science. In the U. S. it is nearly impossible to find an American in high government circles who has a good technical background.

In recent years there has been a decided trend toward the establishment of more and more scientific and engineering college scholarships. But the sum total of all such scholarships today will provide a minuscule number toward a competitive engineering manpower figure. Scholarships also do not guarantee that the most talented or gifted will receive the education. Most of them involve a "need" clause and if the head of the household earns more than $12,000 per annum it becomes nearly impossible to obtain outside support. At present only about 9% of the U. S. families are in this income bracket but estimates indicate that by 1975 there will be 20%. With rising costs and inflation, the breadwinners of families having more than one child will be very hard pressed. Consider, too, how can existing plant facilities for higher education handle three times the present annual output.

Worst of all, perhaps, is our failure to interest enough youngsters to follow a scientific career. Of 23,000 high schools in the United States only 12,000 offer a course in physics. Many of them are limited courses.

High schools are really the area where lasting scientific impressions and interests can be created. But oddly enough, while we frequently hear of a new college scholarship award there is seldom any announcement of organized plans to scientifically strengthen the "critical" high school area. Schools such as Stuyvesant High School in New York City and Brooklyn Technical High School have done excellent work in arming interested students for scientific careers. There are undoubtedly others in other parts of the country, but here too, the number is now totally inadequate to meet the challenge.

Available space restricts us in a fuller discussion of this subject. All of us, however, should be aware of this unhappy situation. We hope in the months to come that there will be some real activity at the junior levels. Industry can contribute much in their local areas in the way of men, money (tax-free) and materials. Girls as well as boys should be actively encouraged toward scientific pursuits. Arrangements might be made for experienced scientists nearing retirement age to retire earlier to accept teaching positions. And let's let them keep social security benefits added to their teaching salaries. Individual cities might single out at least one high school as a scientific preparatory center and concentrate their best teaching and student talent there. In this way the gifted could be brought forward rapidly and not be chained to the pace of the slowest learner.

These are but a few ideas that come to mind. We hope readers will suggest many others and we'll be glad to publish them in our columns.

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ELECTRONIC INDUSTRIES

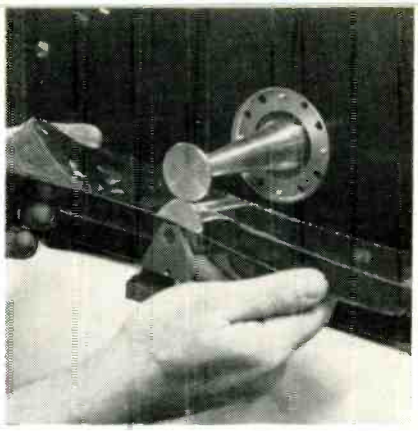
Vol. 19, No. 5 May, 1960

MONTHLY NEWS ROUND-UP

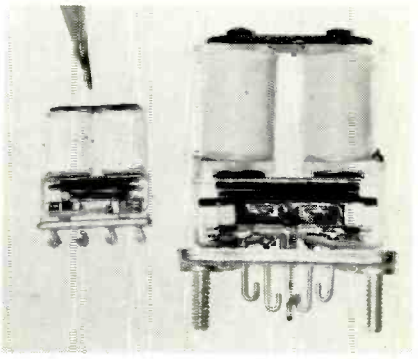
NEW PRODUCTS & TECH DATA

DEPARTMENTS

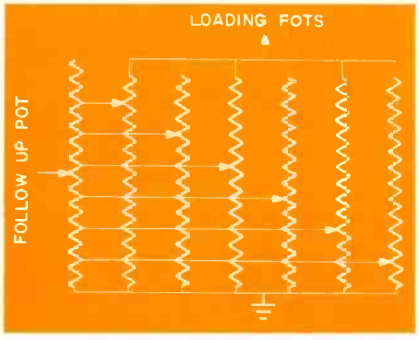
Highlights of this issue



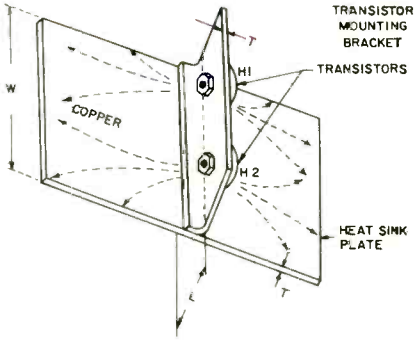
Ultrasonic Welder



Double Coil Relay

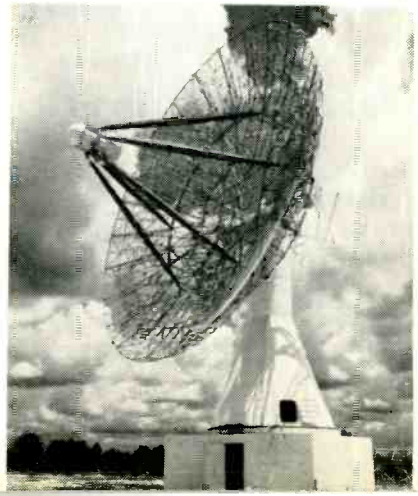


Wide Band AFC

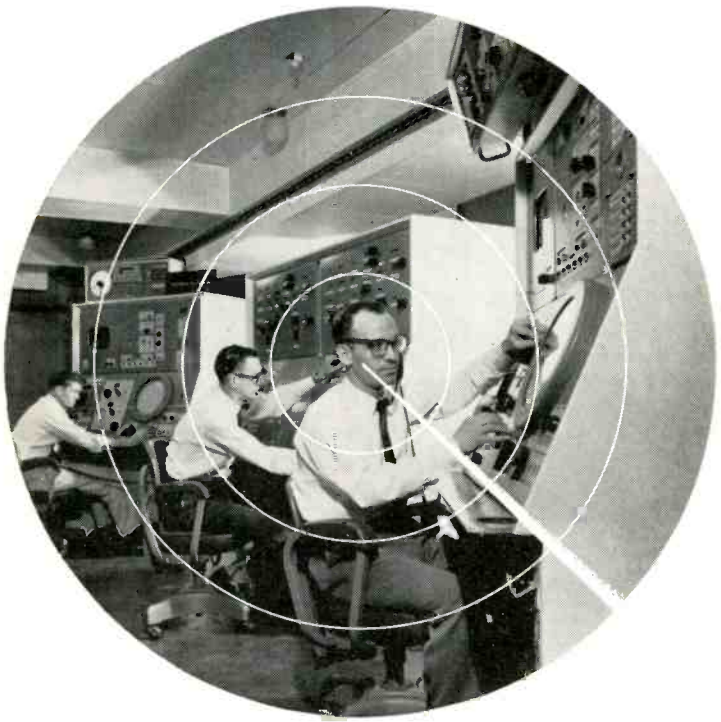


Heat Sinks

Antenna's Role in RFI



RADARSCOPE



ABOARD MISSILE-TRACKING SHIP

Technicians operate the control panels in the main control room of the missile measurement ship, the S.S. American Mariner. The ship, a floating laboratory, was fitted out by RCA to handle complex tracking and recording functions for the Dept. of Defense.

LOOK FOR the National Aeronautics & Space Agency (NASA) to receive more authority concerning the disposition of property rights in inventions made under NASA contracts. A bill submitted to the house last month will grant NASA authority in several areas of activity similar to the authority already possessed by military departments. At present NASA can enter into the leasing of Government property only for monetary considerations. There are times when other considerations are involved, such as the convenience of the Government. NASA also wants authority to indemnify contractors against unusually hazardous risks. In the development and testing of operational space vehicles this is a prime consideration.

IT IS NOT GENERALLY REALIZED but the bulk of inflation has occurred in services, not in goods. In services there is a chronic labor shortage and an inability to raise productivity. The fact that the prices of goods have not risen as much as other prices is evidence that American know-how applies to price as well as to production. Goods have been held down in price because of the sizeable capital investments made by American industry.

EMPHASIS ON R & D, expected to increase over the next few years, is likely to inspire more and more engineers to start their own companies. Small electronic R & D firms have certain inherent advantages in their flexibility, the high level of enthusiasm that can be generated in small groups and the increased personal attention that can be given each project.

THE SIGNAL CORPS has reportedly built an airborne radar that can produce maps with almost the quality of a photograph. The prototype of the "aerial surveillance platforms" will be demonstrated this month in Washington.

AUTOMATIC MACHINE TRANSLATION of Russian has been brought one step closer with the development of predictive analysis. Predictive analysis is a series of educated guesses in which each word in the sentence predicts most the likely grammatical form of following words. Experiments in automatic translation at Harvard have shown that the structure of the Russian language—its grammar and syntax — is much simpler than previously thought.

FLIGHT DATA DISPLAY

"Visual Integrated Presentation," (VIP) is a new method of providing flight and command data for crew members of supersonic aircraft, space vehicles and submarines. As shown in this cockpit mock-up the system presents a direct optical view of the terrain and horizon with unusual clarity and 3-dimensional effect. Chicago Aerial Industries of Melrose Park, Ill., is the developer.

NEW TRANSDUCER ELEMENTS, reportedly 50 times more sensitive than present metallic strain wires, have been developed by Electro-Optical Systems, Inc. and the Army Ordnance Corps. Approximately .001-inch in diameter and .25-inches long, the transducer is produced by two methods. In one the sliver is grown thru vapor deposition and in the other the slivers are cut from silicon bars and lapped and etched to microscopic diameter. The transducers will measure pressure, acceleration and vibration.

MEDICAL ENGINEERING may become a new kind of academic degree. Authorities in the field of medical electronics feel that if any real progress is to be made in bridging the gap between medicine and biology on one hand and physical science on the other a new creative scientist would have to be trained who is competent in both fields. One suggested curriculum would comprise a 4-year undergraduate program leading to a B.S. degree, a 2-year postgraduate program for the M.S., and a 4-year postgraduate schedule for the Ph.D. degree.

NEW TECHNIQUE for sealing wave guide components for use in high altitude aircraft has been developed for the Air Force by Armour Research Foundation. Wave guide windows have been developed with a reflection coefficient of less than 2½% over a band width of 40% for C, X, Ku band wave guides. The windows are made of glass re-enforced Teflon laminates and are bonded to the wave guide flanges with temperature stable epoxy resin.

THE MAIN BREAKTHROUGH enabling man to send messages via the moon at the rate of 1,000 words per minute has been achieved, according to R. L. Hensell, Project Manager of the Moon Relay System, developed by Developmental Engineering Corp. for the Navy. The present Moon Relay System uses the band of 435 to 445 megacycles, and a bandwidth of 16 kilocycles. The relay network links Washington and Hawaii, with both stations having separate transmitter receiver facilities, 100 KW transmitters and 84 ft. steerable high gain (40 DB) parabolic antennas. Effective radiated power is more than half a billion watts.

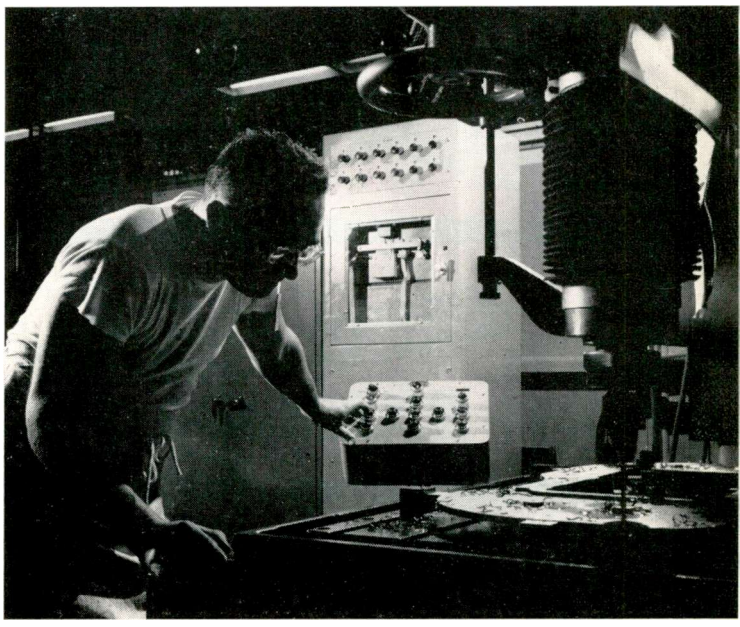
CERTAIN DIAMONDS are semi-conductors, with electrical resistances very sensitive to slight changes in temperature. Changes as small as 1/500th of a degree Centigrade can be measured by checking the electrical characteristics of the diamond. Some thought is being given to the application of diamonds as an extremely sensitive thermometer The field of medicine, for instance, would like to record minute temperature changes in the skin and other parts of the body.

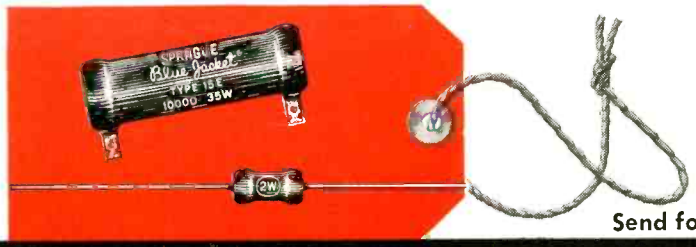
NEW LIAISON GROUP, which will pass along component requirements from computer system manufacturers to component manufacturers has been organized within the Electronic Industries Association. The group, called the Microminiature Electronics Components Sub-Committee, is to both recommend physical and mechanical requirements for individual small, reliable, active and passive components as used in digital computing systems. The Sub-Committee is part of the Computer Component Requirements Committee of EIA's Industrial Electronics Panel. The Sub-Committee Chairman is Edward Keonjian of ARMA, Division of American Bosch Arma Corp.

THE FCC is being pressured to dispose of the appeal keeping motor carriers from owning and operating their own microwave radio communication systems. On July 30, 1959 the FCC handed down a ruling which allowed private development on microwave radio for point-to-point communications. But the FCC ruling was appealed by A. T. & T. and the Western Union Company on the grounds that licensing of private communications systems would adversely affect their ability to provide service to the general public. The granting of operating rights were held up pending a ruling on the appeal.

PUSH-BUTTON PRODUCTION

At Sperry Gyroscope Co., Div. of Sperry Rand Corp., numerical machine tool control equipment controls boring operation with a spacer table. The equipment can control positioning, drilling, reaming, boring and tapping operations, from pre-punched tape.





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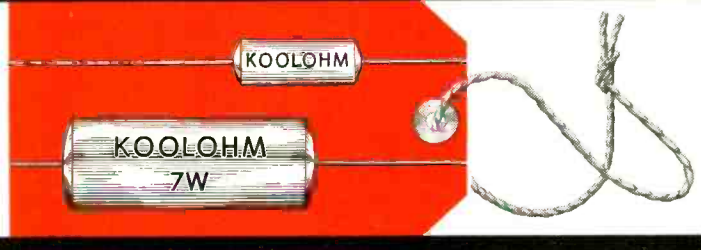

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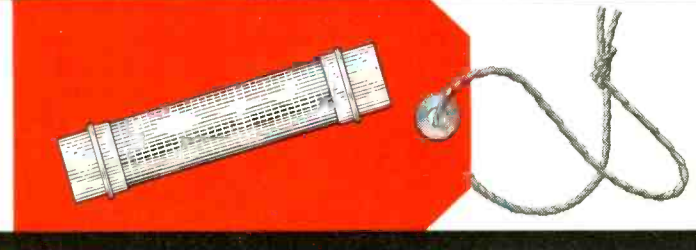

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As We Go To Press...

"Ruby" Maser Increases Radar Range 10 Times

An X-band solid-state maser, using a synthetic ruby, has been developed and fabricated for the U. S. Army Signal Corps by Hughes Aircraft Company. The maser improves the sensitivity of radars by a factor of 10.

The gain-bandwidth product of the amplifier is 105 MC when operating at a temperature of liquid helium (4.2°K). This is the highest value yet reported for a cavity type maser.

The paramagnetic crystal employed in the amplifier is synthetic ruby, having about 0.1% chromium concentration.

The maser cavity is formed from a solid 2-carat block of ruby cut to the correct dimensions and coated with silver. Since the dielectric constant of ruby is large (En10), the cavity dimensions are quite small (approximately 0.28 by 0.28 by 0.14 in.).

With these small dimensions, instead of an external magnet weighing several hundred pounds, a small magnet weighing only 12 oz. was used, attached to the helium dewar. This represents a saving, on the magnet, of some $4,000.

Where conventional masers weigh several hundred pounds, the "ruby" maser has an overall weight of 25 lbs., and a size of ⅓ cu. ft. With its companion receiver the maser makes up the first complete package of its kind designed for military field use.

The device is now under test at the U. S. Army Signal Research & Development Lab., Ft. Monmouth, N. J.

Light Amplifier Makes Single Electron Visible

Small electronic tube developed by Westinghouse Research Labs, Pittsburgh, Pa., can make visible a single electron released at the tube's input by an individual photon.

The tube, the Astracon, focuses the image of an object by lenses onto a light-sensitive screen called a photosurface at the end of the tube. Photons eject electrons from the surface. 2000 v. accelerate the ejected electrons which strike a thin two-layer film releasing four or five more electrons.

Five such steps multiply a single electron by about 3000.

New Data System

Bendix Aviation Corp., Washington, D. C., has introduced a new data-processing system for high-speed scientific, business, and industrial use. The transistorized 45,000 floating point operations per sec. (the machine keeps track of computer, the G-20, is capable of decimal points for the operator).

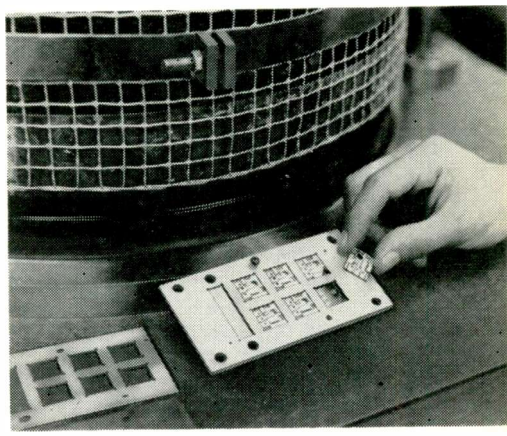
EIA Medal of Honor

David R. Hull, President of Electronic Industries Assoc. and a Vice President of Raytheon Co., has been named to receive the 1960 EIA Medal of Honor for "distinguished service contributing to the advancement of the electronics industry."

POLARIS MISSILES

Preliminary assembly area of test vehicles in the Navy-Lockheed Polaris fleet ballistic missile development program. Lockheed (Sunnyvale, Calif.) technicians are working on the instrument sections for the test birds.

MINIATURE CIRCUITS



The deposition of exceedingly thin films of component material (resistors, capacitors, inductors) on glass makes possible these postage-stamp-sized electronic circuits. Units were developed by International Resistance Co., Phila., Pa. for American Bosch—Arma Corp. Co. will use units in missile-borne computers.

New Etching Process Jacks Power of MADT's

Philco has developed a unique method of etching semiconductor material that greatly extends the high power capabilities of the Micro-Alloy Diffused-base Transistor (MADT).

The ETL (Etching by Transmitted Light) process uses a new approach to the problem of illumination during etching. High intensity light is focused on one side of a wafer of semiconductor material, and a jet of electrochemical solution is directed on the opposite side.

Light diffuses through the material, and makes hole-electron pairs available at the surface being etched, greatly increasing the speed and accuracy of the etching process.

In the standard precision etch process, the surface being etched is illuminated directly, rather than by light transmitted through the material. This technique is used to etch pits up to approximately 12 mils in diameter. The new ETL technique makes possible extremely flat surfaces 120 mils in diameter, and larger.

New MADT transistors available can switch currents as high as 400 ma. at a clock rate of 10 MC. On the drawing boards is an MADT capable of dissipating 15 watts and switching 1 ampere at a clock rate of 5 MC.

ELECTRONIC SHORTS

▸ An extensive new program in the field of electronic medicine is being pushed by Minneapolis-Honeywell Regulator Company. The company has assigned specialists to a newly formed medical instrumentation group that will institute "entirely new development programs" in cooperation with medical authorities. The new group's headquarters are at the Heiland Plant in Denver, Colorado.

▸ Battle area reports are displayed on the face of a TV-type tube at rear line command posts on a new tactical communication system developed by Stromberg-Carlson—San Diego in cooperation with U. S. Marine Corps. The high-speed field intelligence gathering and display is known as BASIC, for Battle Area Surveillance and Integrated Communications. BASIC equipment consists of small hand-held pushbutton message generators, a portable data processing unit containing logic and data storing circuits, an electric typewriter read out and a direct viewing display unit.

▸ Last month, for the first time, a U. S. Air Force Intercontinental Ballistic Missile made a flight with a self-contained inertial guidance system. The inertial system used in the flight ran on "open loop," a pre-programmed auto pilot performed the guidance function.

▸ An Air-Rescue Radio Beacon delivering an immediate. automatic, alerting and locating signal from a downed aircraft has been developed by Granger Assoc. in association with United Air Lines.

▸ An experimental automatic terrain avoidance system has been developed by Cornell Aeronautical Laboratory. The low altitude automatic flight control system is now being installed in an Air Force B-57B for flight evaluation. The Terrain Avoidance Program is called Project Auto Flite.

▸ Several billion dollars are invested in air commerce and additional billions are lost by the country each year in storm damage, but less than $10,000,000 a year is spent on meteorological research for aviation, and only $250,000 on weather control. Considerably accelerated activity can be expected in this area.

▸ Page Communication Engineers, Inc. and Aeronutronic Division, Ford Motor Company have teamed to produce a system design plan for a national space surveillance system (496L) for the U. S. Air Force. The ultimate objective of "space surveillance" is to gather and process the necessary information to maintain a complete current catalog of space satellites, regardless of origin and including both active and passive types.

▸ Radio Corp. of America has entered the tape manufacturing field. They are producing tape for commercial and home recording use at their Indianapolis Plant. Initial plans call for the manufacture of audio tape, but eventually the plant will turn out magnetic tape for use in electronic data processing systems and television tape recorders.

▸ A new magnetic technique for shaft position-to-digital incoders developed by Librascope Division, General Precision, Inc., is claimed to make possible higher rotation speeds, increased reliability and longer life. The new non-contact technique generates digital signals representing input shaft positions by altering the magnetic state of readout in accordance with the coded pattern cut into the surface of the ferrite disc driven by the input shaft.

▸ New type of altimeter, designed for increased accuracy at high cruise altitudes, has been developed at Boeing for use in high performance missiles and jet aircraft. Called radio isotope density altimeter, the device measures radio-active back scatter, proportional to atmospheric density. Accuracies are to within an estimated 500 feet or less at altitudes above 25,000 feet.

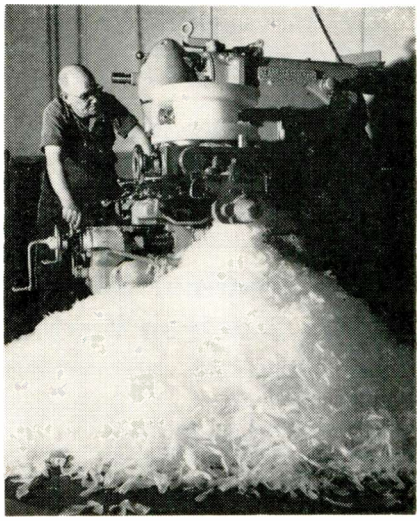
▸ Variation of the TACAN SYSTEM has been developed by Naval Air Development which allows two aircraft having TACAN equipment to take continual bearings on each other. The cost of altering the equipment to handle this function is quite minimum.

Long-Range Data Transmission

A fully automatic data transmission system, CODIT (COmputer DIrect to Telegraph) can transmit reduced missile test information to any point in the world.

Now in operation on the Atlantic Missile Range, it was developed by RCA engineers. It is completely automated and used existing range and commercial communication systems.

SPECIAL INSULATORS



Boeing Airplane Co., Aero-Space Div., Seattle, built this 18½ in. dia. insulator. It is for an electrical switch used in the discharge of heavy current loads from large condenser banks. Each insulator can stand 100 kv.

2-year Program in RFI

The Army Signal Corps has awarded a $18.8 million contract to Pan-American World Airways, Inc. (prime contractor) to set up an electronic environmental test facility and a drone test range near Fort Huachuca, Ariz. Bell Aircraft's Avionics Div., principal subcontractor to Pan-Am, has been awarded a $7.6 million contract for its part.

Bell will operate a test facility to evaluate existing and potential radio interference which handicap all kinds of Army communications under combat conditions. Bell will supply telemetry ground stations and drone flight control equipment, and track down the source of interference, submit recommendations for corrective action, and initiate procedures to eliminate these conditions in the future.

new system for flight safety

Uses Hughes TONOTRON tube to combine radar screen with pilot's field of view

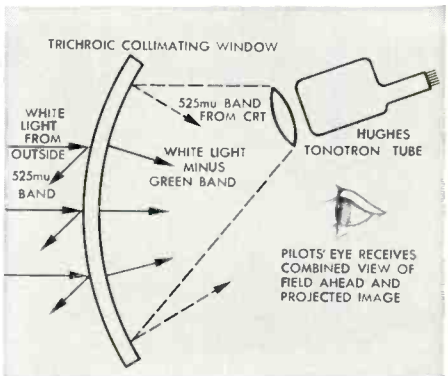
Aptly called the "Magic Window," this new pilot display system developed by Autonetics Division of North American Aviation, presents any luminous pattern produced by a Hughes TONOTRON* tube as an image painted in front of the pilot's normal view. Day or night, in any weather, the pilot can avoid obstacles, maintain attitude, safely accomplish difficult landings.

The grid shown is just one typical application. Any radar mode—terrain, fire control, weather, etc.—can be projected on the "Magic Window." In the ground mapping mode, the TONOTRON tube provides high fidelity reproduction of any desired information with high picture brightness and controllable persistence.

Hughes TONOTRON tubes are ideal for a wide range of applications including: Sector Scanning, "B" Scan Radar, Weather Radar Readout, Armament Control Radar, Plan Position Indicator information and Slow Scan TV.

TONOTRON tube models are available for your use in sizes of 3, 4, 5, 7, 10 and 21 inches—with electrostatic or electromagnetic deflection.

For detailed information and application data on TONOTRON tubes, write or wire: HUGHES, Vacuum Tube Products Division, 2020 Short Street, Oceanside, Calif. For export information, write: Hughes International, Culver City, Calif.



A narrow band of light in the green spectrum is prevented from coming through the "Magic Window." The TONOTRON tube projects a green pattern back onto the screen to form the image.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIVISION
*TRADEMARK OF HUGHES AIRCRAFT COMPANY

Circle 3 on Inquiry Card

When precise temperature control is mandatory

STEMCO TYPE MX THERMOSTATS

are a must

In missiles, avionics, astrionics, or any electronic application requiring the closest temperature control, check into Stemco Type MX Thermostats first. They're compact for minimum cubage . . . light in weight . . . withstand high G loads . . . are absolutely reliable under wide ambient temperature swings.

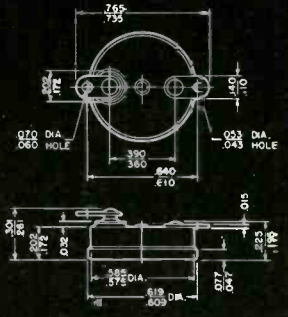
Basic design flexibility of Stemco Type MX Thermostats means they can be supplied from regular production runs in a wide variety of models. Semi-enclosed types with metal bases; hermetically sealed types in round enclosures or crystal cans. Wide selection of terminal arrangements, mounting provisions, brackets, etc., available. Units individually packaged in polyethylene with inspectors' readings of disc opening and closing temperatures.

Stemco Type MX Thermostats give you precision performance . . . small cubage . . . rugged reliability . . . *at a realistic cost.*

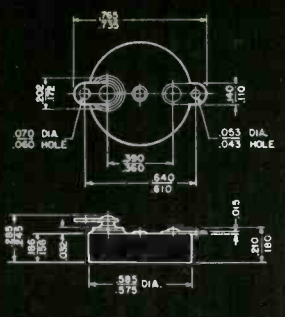
A-1641A

2° to 6°F differentials available

1° to 4°F differentials on special order



TYPE MX HERMETICALLY SEALED—Electrically independent bimetal disc. Rated 3 amperes, basis 250,000 operations.



TYPE MX SEMI-ENCLOSED—Electrically identical to Type MX Hermetically Sealed. Both Types available with one terminal grounded or both terminals insulated.

STEVENS *manufacturing company, inc.*
P. O. Box 1007, Mansfield, Ohio

STEMCO THERMOSTATS

Circle 4 on Inquiry Card

Coming Events in the electronic industry

May 1-4: 52nd Annual Convention, National Assoc. of Electrical Distributors; Dallas Memorial Auditorium, Dallas, Tex.

May 1-5: Conference on Electric Insulation, Electronics, Electrothermics and Metallurgy, The Electrochemical Soc.; LaSalle Hotel, Chicago, Ill.

May 1-7: 87th Semi-Annual Convention & Equip. Exhibit, Soc. of Motion Picture & TV Engineers; Ambassador Hotel, Los Angeles, Calif.

May 2-3: Electrical Safety Instrumentation Symposium, ISA; Wilmington, Del.

May 2-3: Company Member Conference, American Standards Assoc.; Sheraton Hotel, Phila., Pa.

May 2-4: 12th Annual Nat'l Aeronautical Electronics Conf. & Exhibit (NAECON), IRE-Dayton Section, IAS; Biltmore and Miami-Pick Hotels, Dayton, Ohio

May 2-4: North Eastern District Meeting, AIEE; Providence, R. I.

May 2-5: 6th Nat'l Flight Test Symposium, ISA; San Diego, Calif.

May 2-5: URSI-IRE Spring Meeting, URSI, IRE; Sheraton Park Hotel and Nat'l Bureau of Standards, Washington, D. C.

May 3-5: Western Joint Computer Conf., IRE, AIEE, ACM; Jack Tar Hotel, San Francisco, Calif.

May 3-5: 8th Nat'l Conference on Electromagnetic Relays, Nat'l Assoc. of Relay Manufacturers and Oklahoma State University; Oklahoma State University, Stillwater, Okla.

May 5: Flight Collision Avoidance Panel, IRE; John Hancock Hall, Boston, Mass.

May 5-6: Symposium on Graduate Program in Bio-Medical Engineering, IRE, AIEE, University of Vermont, University of Vermont, Burlington, Vt.

May 5-8: AWRT Nat'l Convention, American Women in Radio & TV; Pick-Carter Hotel, Cleveland, Ohio

May 6: 7th Annual Conf. for Engineers & Architects; Ohio State Univ.; Columbus, Ohio

May 6-7: 2nd Annual Bay Area Reliability Seminar, IRE (PGRQC); Naval Post Graduate School, Monterey, Calif.

May 8-11: 27th Nat'l Convention, Nat'l Industrial Service Assoc.; Fontainbleau Hotel, Miami Beach, Fla.

May 8-13: Annual Meeting of All Sections, Scientific Apparatus Makers Assoc., Broadmoor Hotel, Colorado Springs, Colo.

May 9-11: PGMTT Nat'l Symposium, IRE (PGMTT); Hotel del Coronado, Coronado (San Diego), Calif.

May 9-12: 3rd Nat'l Power Instrumentation Symposium, ISA; Civic Auditorium, San Francisco, Calif.

May 9-12: Instrument Automation Conf. and Exhibit, ISA; Civic Auditorium & Brooks Hall, San Francisco, Calif.

May 9-13: Annual Technical Conf., Soc. of Photographic Scientists & Engineers; Miramar Hotel, Santa Monica, Calif.

May 10-12: Electronic Components Conf., IRE, AIEE, EIA, WEMA; Hotel Washington, Washington, D. C.

May 11-14: Annual Meeting, Fluid Controls Institute, Inc.; The Greenbrier, White Sulphur Springs, W. Va.

May 12: Meeting — Exec. Comm. & Board of Governors, ERA; Hilton Hotel, Chicago, Ill.

May 12-13: Seminar—What We Know Today About Metal Cutting, ASTE; Chicago, Ill.

May 16-18: Electronic Parts Distributors Show, Electronic Industry Show Corp., EIA; Conrad Hilton Hotel, Chicago, Ill.

May 16-18: 7th Regional Tech. Conf. & Trade Show, IRE; Olympic Hotel, Seattle, Wash.

May 16-19: Power Sources Symposium, U. S. Army Signal Research & Development Lab.; Shelburne Hotel, Atlantic City, N. J.

May 17: Meeting—ERA Distributor Div., Hilton Hotel, Chicago, Ill.

May 17: Vacuum Ultraviolet Spectroscopy Symp., Soc. for Applied Spectroscopy; Johnson & Johnson Lab., New Brunswick, N. J.

May 17-19: Production Engineering Conf., ASME; Milwaukee, Wisc.

May 18: Meeting—ERA Audio Div.; Hilton Hotel, Chicago, Ill.

May 18-21: 4th Annual Industrial Mutual Aid & Disaster Control Conf., Nat'l Institute for Disaster Mobilization; Netherlands-Hilton Hotel, Cincinnati, Ohio

May 19: Conf. on Parallel Programming, Assoc. for Computing Machinery; Lewis Research Center, Nat'l Aeronautics and Space Administration, Cleveland, Ohio

May 22-26: 41st Int'l Conf. & Office Exposition, Nat'l Office Management Assoc.; Montreal, Canada.

May 23-25: Meeting, Nat'l Paperboard Assoc.; Greenbrier Hotel, White Sulphur Springs, W. Va.

May 23-25: Nat'l Telemetering Conf., IAS, ISA, AIEE, ARS, IRE; Hotel Miramar, Santa Monica, Calif.

May 23-26: Design Eng'g Conf. & Show, ASME; Coliseum & Statler-Hilton Hotel, New York, N. Y.

May 23-28: Int'l Instruments, Electronics & Automation Exhibition, Industrial Exhibitions Ltd. (Brit); Olympia, London, England.

May 24-26: IRE 7th Region Conf. & Trade Show, IRE, ISA; Nat'l Guard Armory, Olympic Hotel, Seattle, Wash.

May 24-26: Convention, Armed Forces Communications & Electronics Assoc.; Sheraton-Park Hotel, Washington, D. C.

May 24-26: National Convention, American Society for Quality Control; Sheraton-Palace Hotel, San Francisco, Calif.

(*Continued on Page 257*)

"CALL FOR PAPERS"

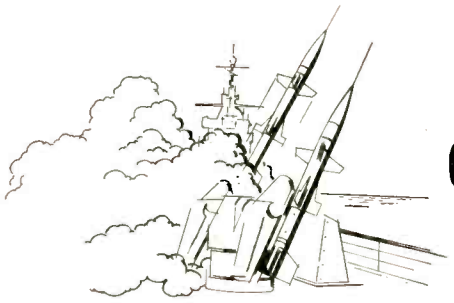
Sept. 14-16: 5th National Conf. on Tube Techniques. Papers deadline is May 15, 1960. Abstract should not exceed one single-spaced typewritten 8½ x 11 page. Presentation time max. is 15 min. Contact: Mr. David Slater New York Univ., College of Engineering Research Div., Electron Tube Group, 346 Broadway — 8th Floor, New York 13, N. Y.

Oct. 24-26: 7th East Coast Conf. on Aeronautical and Navigational Electronics. Abstracts deadline is June 6, 1960. Abstract should be about 500-words long. Contact: S. Hershfield, Mail No. G-3143, The Martin Co., Baltimore 3, Md.

Oct. 3-5: 6th National Communications Symposium. Abstracts deadline is June 1, 1960. Authors should prepare 100-word abstracts and 500-word summaries (both in triplicate). Contact: Bernard H. Baldridge, Technical Program Comm., 6th Natn'l Comm. Symp., General Electric Co., Light Military Electronics Dept., Utica, N. Y.

Nov. 15-16: Northeast Research & Eng. Meeting (NEREM). Papers deadline is July 15. Contact: J. H. Mulligan, Dept. of Electrical Engineer, New York Univ., New York 53, N. Y.

Oct. 31-Nov. 2: 13th Annual Conf. on Electronic Techniques in Medicine and Biology. Papers deadline is July 1. Contact: George N. Webb, Rm. 547 CSB, Johns Hopkins Univ., Baltimore 5, Md.



HANDY & HARMAN SILVER FLAKE

Coats Lighter, More Effective Plastic Lens For Long Range Missile Control System

An exciting new application in the missile control field is the development by the Surface Armament Division at Sperry Gyroscope Company of a silver-coated plastic lens for use with the Navy's Talos missile. As compared to earlier metal versions, the new lens weighs substantially less and provides twice the signal gain at the same production cost! The Talos delivers, with extreme accuracy, a high explosive or nuclear warhead to any altitude at which airplanes now fly, as well as far beyond the range of human visibility.

The silver coat imparts RF reflectivity and electrical conductivity to the lens and is applied in paint form. As the silver base for this paint, Sperry uses Handy & Harman's Silver Flake. An important quality of this flake is that its waferlike particles are asymmetrical and overlap on the surface of the lens, affording up to 35% of the conductivity of an equivalent weight and shape of fine silver.

Handy & Harman Silver Flake finds use throughout the electronic and electrical industries...it is ideal for pigments to make conductive coatings on such non-conductors as ceramics, glass, mica, plastic and paper, as in the manufacture of capacitors, thermistors, carbon resistors, printed circuity and electrostatic shields.

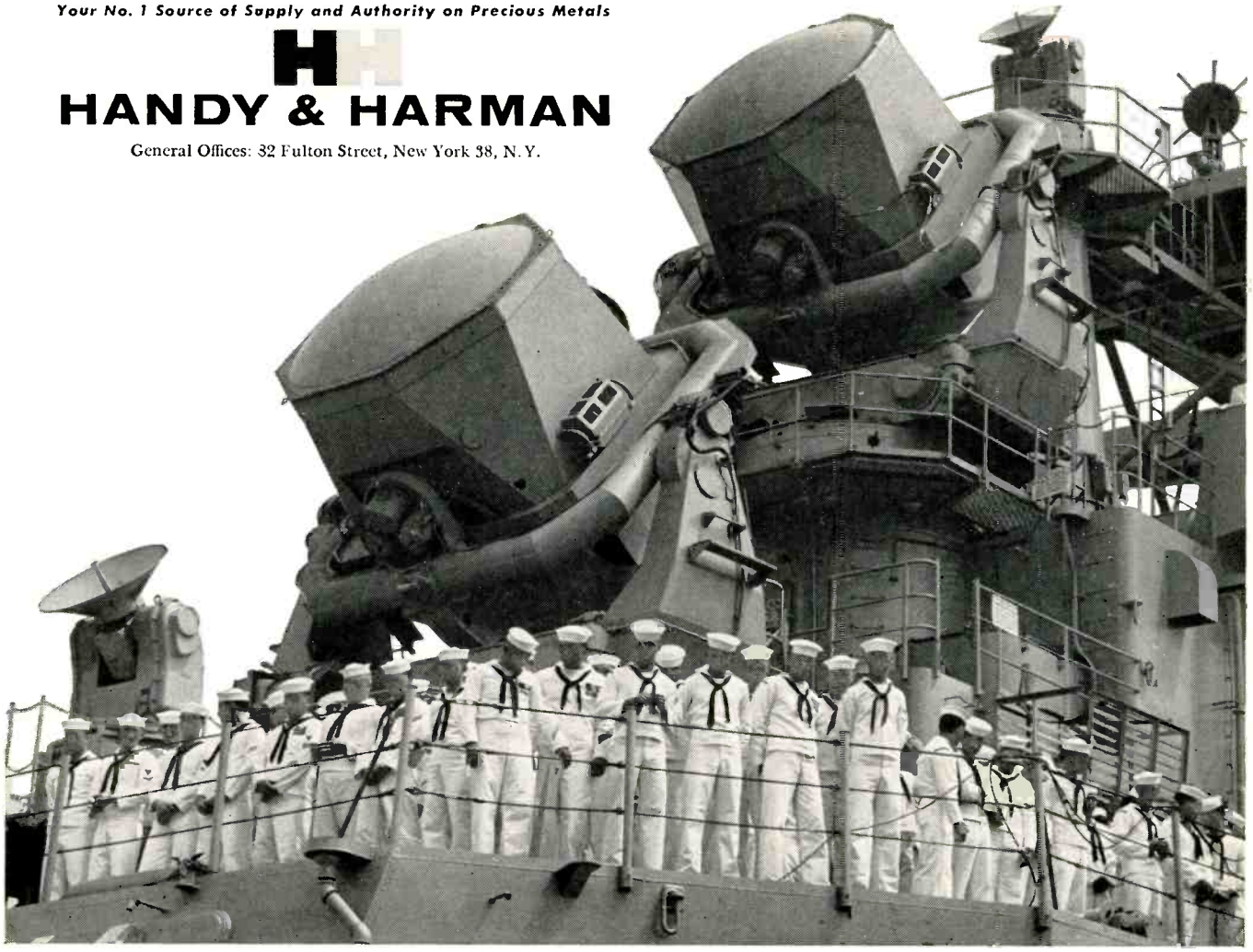
Handy & Harman has available every form of silver useful to manufacturers and fabricators—flake, powder, paint, paste, sheet, strip, wire bimetals, silver oxide, divalent oxide, etc. Our Research and Engineering Department is always available to assist you in the selection or use of any silver form for any application from brazing to conduction coating. **Below are listed six of our Technical Bulletins. Please indicate their numbers for prompt attention.**

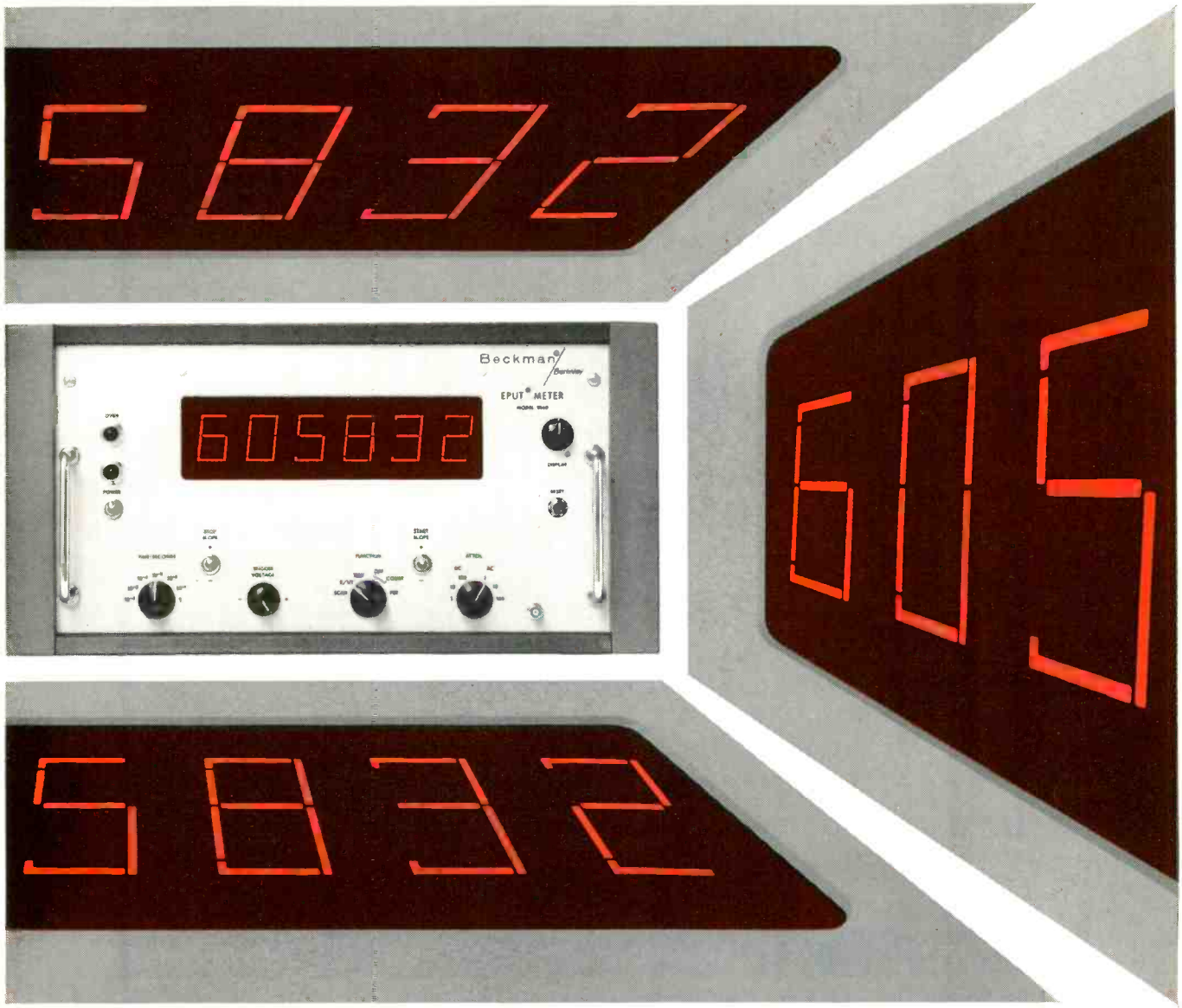
Fine Silver	Bulletin A-1
Silver-Copper Alloys	Bulletin A-2
Silver-Magnesium-Nickel	Bulletin A-3
Silver Conductive Coatings	Bulletin A-4
Silver Powder and Flake	Bulletin A-5
Vacuum Tube Grade Brazing Alloys	Bulletin 25

Your No. 1 Source of Supply and Authority on Precious Metals

HANDY & HARMAN

General Offices: 32 Fulton Street, New York 38, N.Y.





You can read it from any angle

New Beckman counter display is right out front, visible from any angle and unobscured by interposed elements. *Most EPUT® meters, timers and other Beckman counters are now available with this bright red in-line display 1-1/2" high. The display is carefully designed to minimize reader fatigue and prevent reading errors. Because the digits are formed by illuminated segments on the face of the panel, the indication can be read from almost any position in front of the instrument—from above or from either side at angles as close as 30° to the panel. Deep red color makes the display stand out boldly in brightly lit rooms—even in sunlight. The price per digit is only $30 to $45 more than the price of counters with the standard vertical column display.*

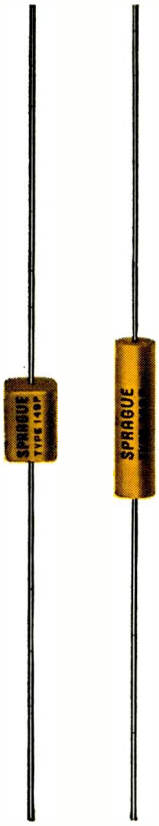
Sophisticated packaging characterizes this most recent advance in in-line displays. Counting unit, decoding circuitry and decimal display form one compact plug-in module. Modules may be purchased separately for use as digital building blocks.

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

Beckman®

Berkeley Division
Richmond, California

T26

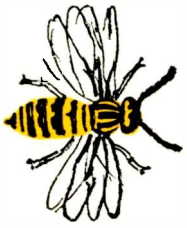


Type 148P and Type 149P

YELLOW-JACKETS

smallest

of Sprague's film capacitors for entertainment and commercial electronics



YELLOW-JACKET® WRAPPER-PROTECTED FILMITE 'E' CAPACITORS

are the smallest of Sprague's family of film capacitors. Type 148P and 149P Yellow-Jackets are designed for compact radio receivers, test equipment, communications equipment, and similar applications. They are especially suited for transistorized and low-voltage tube circuits, as well as all other applicable circuits in which size, weight, and cost are important considerations.

Yellow-Jacket capacitor sections are of extended foil design...wound from ultra-thin, especially selected polyester film and thin gage foil under carefully controlled atmospheric conditions. They are protected against moisture by an outer wrap of polyester film. End seals are of a plastic resin which bonds securely with the film wrap in order to assure long service life.

This construction results in a light-weight capacitor of minimum size, having a distinct space advantage over metal-encased, molded, or wax-coated cardboard-case tubulars of comparable ratings.

Yellow-Jacket Type 148P (cylindrical) and 149P (semi-oval) capacitors are recommended for use in applications requiring reliable operation within the temperature range of −55 C to +85 C at rated working voltages of 100, 200, 400, and 600 volts d-c.

For complete technical data on these Yellow-Jackets, write for Bulletin 2063A to Technical Literature Section, Sprague Electric Company, 233 Marshall St., North Adams, Mass.

SPRAGUE®

THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

As We Go To Press . . .

(Continued)

Department of State Appoints Scientists

The Department of State has appointed seven additional scientists for its Science Program.

The men selected are: Earnest Watson, Dean of the Faculty, California Institute of Technology, as Science Officer for New Delhi; Neal Weber, Professor of Zoology, Swarthmore College, as Science Officer for Buenos Aires; Harry W. Wells, Chairman, Upper Atmospheric Section, Carnegie Institution of Washington, as Science Officer for Rio de Janeiro; John B. Bateman, Biophysicist, United States Army Chemical Corps, as Deputy Science Officer for London; William Littlewood, Zoologist and Oceanographer, United States Navy Hydrographic Office, as Deputy Science Officer for Stockholm; David C. Rife, International Cooperation Administration Adviser to the Government of Thailand, and formerly Professor of Zoology, Ohio State University, as Deputy Science Officer for New Delhi; and Marshall Crouch, Professor of Physics, Case Institute of Technology, as Deputy Science Officer for Tokyo.

The Deputy Science Officer assists the Science Officer whose duties are: advise the Ambassador and his staff on science matters, keep abreast of changes in the organizational structure of science in the Government of the assigned country, evaluate the interaction of science with foreign policy, assess current scientific programs abroad, and enhance liaison between the U. S. and foreign scientists and engineers.

900 LINES PER MIN.

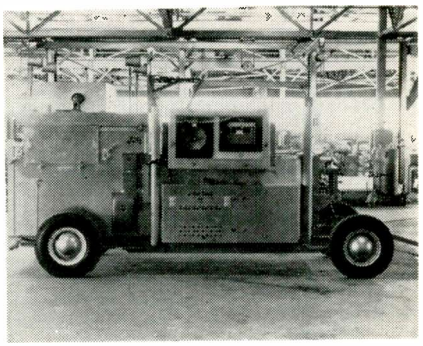
Electronic data processing system, the Honeywell 400, introduced by Minneapolis-Honeywell, Datamatic Div., can print at 900 lines per min. Each line may have up to 120 characters. It also prints carbon copies.

Space Power Engine By 1970—Westinghouse

J. W. Simpson, VP, Atomic Power Div., Westinghouse Electric Corp., predicts that by 1970 the U. S. will be able to orbit a nuclear powered electric generating system with a capacity of 60,000 kw.

Astronauts will have a large scale satellite auxiliary power system that uses a reactor as its source of energy. Power, he said, is the limiting factor of human survival.

PRECONDITION COMPONENTS



Mobile environmental conditioning units from Nucledyne Div., Cook Electric Co., Chicago, preconditions missile components prior to firing. Carts can produce temps of —100°F to 200°F controllable to ± 2°F. It has a 2,000 lb CO_2 dry ice capacity and produces 30kw heat.

WESCON Committee Heads Named

WESCON's Board of Directors has named the 14 Electronic Industry execs who will head the working committees. Over 300 volunteer committeemen plus a permanent management staff are working for the August 23-26 event which is expected to attract over 35,000 engineers and scientists.

Committee chairmen and vice chairmen, and their areas of responsibility are:

All-Industry Luncheon: Edward C. Bertolet (Behlman Engineering) and E. H. Lockhart (Radiatronics).

Cocktail Party: William J. Miller (Burton Manufacturing) and Robert L. Boniface (Neely Enterprises).

Distributor Conference: W. Bert Knight (W. Bert Knight Co.) and R. V. Weatherford (R. V. Weatherford Co.).

Exhibits: Ernest Clover (Triad Transformer) and Herb Becker (Herb Becker Co.).

Facilities: Donald N. Montgomery (Aeronutronic) and Duane Wood (Lockheed Aircraft Service).

Field Trips: A. N. Curtiss (RCA) and Eugene M. Knight (Space Technology Labs.).

Future Engineers: Joel H. Axe (Ramo-Wooldridge) and Col. Frank J. Shannon, Sr., USAF (Ret.) (Packard Bell).

Hospitality: Burgess Dempster (Electronic Engineering) and John J. Guarrera (Burton Manufacturing).

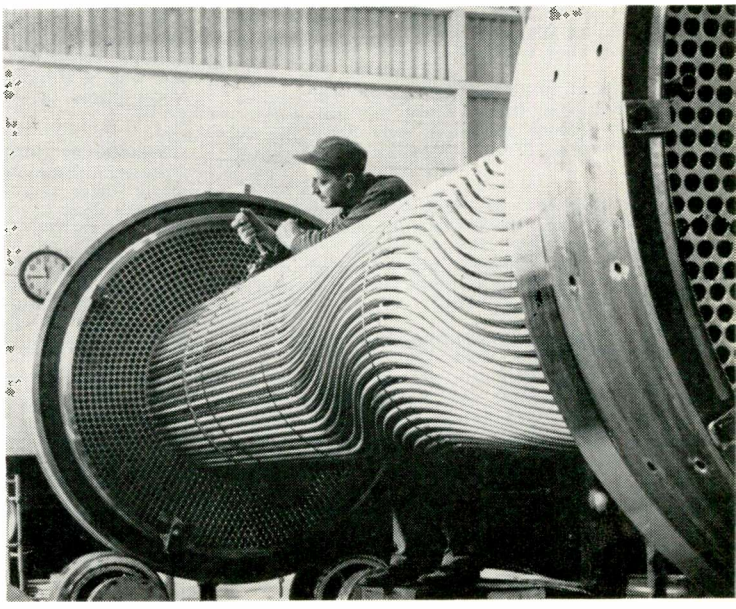
Industrial Design: Kenneth J. Slee (Librascope) and Robert C. Saunders, Jr. (Benson-Lehner).

Public Relations: Willard B. Gregory Beckman Instruments) and Richard L. Paullus (Electron-

(*Continued on page* 252)

TUBES FOR ATOMIC POWER

More than 19-mi. of stainless steel tubing snakes through three intermediate sodium heat exchangers being built for the Enrico Fermi Atomic Power Plant, Detroit. Allegheny Ludlum Steel Corp. is supplying tube — Alco Products Inc., Dunkirk, N. Y., the heat exchangers.



Electronic Industries' News Briefs

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

EAST

HERMETIC SEAL CORP. has moved to new quarters at 43 River Rd., No. Arlington, N. J. The new 15,000 sq. ft. building will be used for design, development and manufacture of their complete line of glass-to-metal and ceramic-to-metal seals.

EMBREE ELECTRONICS CORP. is a new firm established in West Hartford, Conn., to manufacture computer components for electronic control of machinery and processes. The firm is headed by John M. Embree, formerly Director for Sales and Application Engineering for Philbrick Researches, Inc.

FEDERAL PACIFIC ELECTRIC CO. has purchased over 80% of the outstanding common stock of Cornell-Dubilier Electric Corp. Federal Pacific plans to operate C-D, for the present, as a consolidated subsidiary.

ELECTRO-MECH CORP. of Norwood, N. J., manufacturers of control systems and associated control apparatus, has been purchased by the American Chain & Cable Co., Inc., of New York.

NATIONAL RESEARCH CORP. has established a Space Vacuum Laboratory to provide ultra-high vacuum testing services for the nation's missile and space vehicle programs. The new laboratory is located in the company's Cambridge facilities.

IONICS INC. has purchased all assets of Electron Arc., Inc., of Lynn, Mass. Manufacture and sale of Electron Arc's line of specialized electrical power supplies, transformers, rectifiers and control panels will continue under the new name Electron Arc Div., Ionics, Inc. Ionics is building a new plant on Route 128 in Waltham, Mass.

AMERICAN ELECTRONIC LABORATORIES, INC., of Philadelphia, has signed an agreement with Nuclear Research Corp., Southampton, Pa., that grants AEL a one year option to purchase a majority interest in the firm.

SPERRY SEMICONDUCTOR DIV. broke ground last month for their new headquarters to be located on a 28-acre site at the intersection of the Merritt Parkway and Main Ave. in Norwalk, Conn. The Sperry Semiconductor line now includes more than 90 types of subminiature silicon diodes and over 30 types of silicon alloy transistors.

LORAL ELECTRONICS CORP. has acquired Alpha Wire Corp. Alpha will be operated as a division of Loral with Peter Bercoe, president of Alpha, continuing in that capacity.

EPSCO INC. has formed a new Advanced Concepts and Engineering Research & Development Group. The new activity will be managed by company president Bernard M. Gordon, and will maintain Epsco's inventive and conceptual abilities.

THERMAL CONTROLS, INC., and **O.K. ELECTRONICS CORP.**, both of Nutley, N. J., will unite under one name and operate as Thermal Controls Inc. Lyle R. Backer will be in charge of the entire operation of the newly formed company.

WESTINGHOUSE ELECTRIC CORP. has plans to expand its semiconductor facilities at Youngwood, Pa., by 30% during the next few months. The new plant will be primarily devoted to the development and processing of semiconductor materials, including new forms of silicon and germanium.

CGS LABORATORIES, INC., Wilton, Conn., will change its name to Trak Electronics Co. Corporate name remains unchanged for the present time and the business will be conducted under the name of Trak Electronics Co., Div. of CGS Laboratories, Inc.

AVIEN, INC., of Woodside, N. Y., has completed arrangements to acquire Colvin Laboratories, Inc., and Pressure Elements, Inc., of East Orange, N. J. Both companies will continue under their present management.

DIGITRONICS CORP., Albertson, N. Y., manufacturers of electronic data processing equipment and components is nearing completion of its new 30,000 sq. ft. plant on Albertson Ave., Albertson, N. Y.

NATIONAL AERONAUTICAL CORP., Ft. Washington, Pa., manufacturer of airborne communications and direction finding equipment, has acquired Air-Shields, Inc., of Hatboro, Pa. Air-Shields is a manufacturer of high-quality medical and hospital equipment.

ATLEE CORP. has acquired and merged with Industrial Electronic Co., Inc., and Applied Dynamics Corp. The new company will continue under the Atlee name, with headquarters at 330 Bear Hill Rd., Waltham, Mass.

AUERBACH ELECTRONICS CORP. has moved into new quarters at 17th and Arch Sts. in Philadelphia.

GENERAL ELECTRIC CO. has set up a new Special Program Section facility in Radnor, Pa. The initial employment is over 75 which will increase substantially through 1960 with the addition of engineering, scientific, and clerical personnel. The Special Program Section has been established by GE to focus the company's design and development capabilities on the system requirements of the U. S. Army. The section comes under the Company's Defense Systems Dept., headquartered in Syracuse, N. Y.

MID-WEST

GENERAL MILLS is negotiating an agreement to acquire the Daven Co. and Laible Mfg. Co. Daven manufactures precision wirewound resistors, switches, networks, and filters.

BURROUGHS CORP.'s "Ticketeer 202" airline ticket processer has been installed at the Chicago offices of United Air Lines. Eighty-four will be installed at United's major ticket offices across the country during the next 3 years.

FRANK R. COOK has resigned from the Presidency of Frank R. Cook Co., manufacturers of silver zinc batteries. Since November 1958 the Cook Co. has been a partially owned subsidiary of Telecomputing Corp.

ALLEGHENY LUDLUM STEEL CORP. will build the world's largest vacuum melting furnace at its Watervliet Works in New York. The furnace will be of the consumable electrode vacuum melting type.

WESTERN UNION received from the U. S. Weather Bureau a letter of intent to order a national facsimile network of approximately 19,000 miles for the transmission of weather maps to more than 600 stations in 330 cities. The speed of the system will be double the speed of the present network—from 60 to 120 scan lines/min.

IRONRITE INC., Mt. Clemens, Mich., manufacturer of home automatic ironing equipment, has acquired the Warren Mfg. Co., Inc., of Littleton, Mass., producers of telephone, teletype and telemetering equipment.

BOWMAR INSTRUMENTS CORP. purchased Applied Dynamics Inc. of Ann Arbor, Mich., manufacturers of computer components.

FIDELITONE INC. and The First Electronics Fund, have acquired an interest in Electro-Mechanical Specialties Co. in California. EMS is a manufacturer of aircraft components, balanced armature and rotary relays, stepping switches and rotary solenoids.

G. H. LELAND INC., became LEDEX Inc. on April 1st.

THE INSTITUTE OF PRINTED CIRCUITS, national trade association of manufacturers of printed circuits, and key suppliers to the industry, has added 7 new companies since the first of the year, making a total of 14 who will join the IPC during the current fiscal year. The division headquarters are at 27 E. Monroe, Chicago, Ill.

RADIO MATERIALS CO., div. of P. R. Mallory & Co., Inc., has broken ground for a new 45,000 sq. ft. production and research facility track bounded by Bryn Mawr and Tripp Aves. in Chicago's new Brynwood Industrial District.

WEST

JFD ELECTRONIC CORP., manufacturers of precision electronic components, has set up a new Western Div., located at 3711 Van Nuys Blvd., Van Nuys, Calif.

THE ELECTRONIC ENGINEERING CO. OF CALIFORNIA and its production subsidiary, Engineered Electronics Co., both of Santa Ana, have formed an alliance with The Sippican Corp. and Francis Assoc., both of Marion, Mass. Francis Assoc. has been producing prototype products, including the Polaris Guidance System, through their own patented "MiniWeld" technique of high density electronic construction. EECO becomes the first West Coast manufacturer to make use of the process.

THOMPSON RAMO WOOLDRIDGE INC. has concluded an agreement to acquire a controlling interest in Good-All Electric Mfg. Co. of Ogallala, Nebr., manufacturers of a variety of electronic components. Good-All has been a leader in the introduction of Mylar and film-type capacitors.

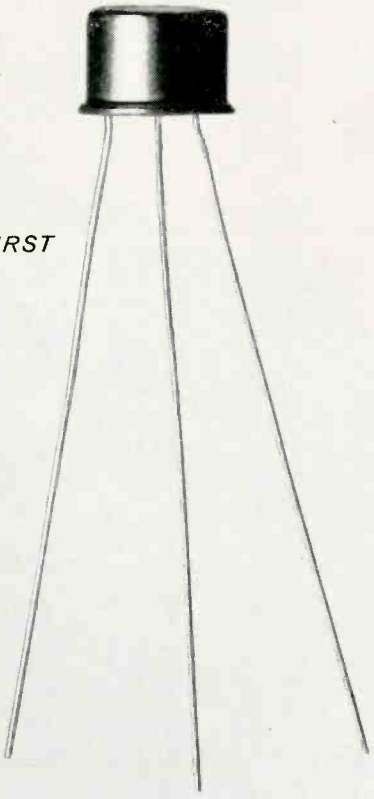
MISSILE SYSTEMS CORP. of Los Angeles, manufacturers of electronic systems for the missile and aircraft industry, has organized a new cabling division to operate at the company's North Hollywood plant.

TRANSVAL ELECTRONICS CORP. has consolidated its manufacturing research and administrative facilities in an 80,000 sq. ft. plant at 2030 Maple Ave., El Segundo, Calif.

LITTON INDUSTRIES has signed an agreement for the exchange of 100% of the outstanding stock of Western Geophysical Co. of America for common stock of Litton. Western Geophysical sales totaled $15 million last year. They have been an outstanding pioneer in offshore exploration.

TELEMETER MAGNETICS has merged two of its subsidiaries, Invar Electronics Corp. and Digital Instrument Laboratories. Both firms are engaged in the development and manufacture of instruments used in the computer and automatic control industries. Consolidated organization will be known as Invar Electronics Corp.

ANOTHER FAIRCHILD FIRST



THE UNIVERSAL TRANSISTOR

FAIRCHILD'S 2N1613

DIFFUSED SILICON PLANAR TRANSISTOR

GUARANTEED USEFUL BETAS FROM 100μA to 0.5A:
15 @ .1mA 20 @ 1mA 30 @ 150mA 15 @ 500mA
Guaranteed minimum Beta over a 5,000 to 1 range of collector current makes the 2N1613 the most versatile transistor presently on the market.

WIDE RANGE OF APPLICATIONS: in Fast Switching (logic and high current): Amplifiers (low level, low noise, wideband, VHF power).

RELIABILITY IN A NEW DIMENSION: The Planar Transistor is the most thoroughly proven transistor ever introduced commercially, with over 5,000,000 transistor hours plus 300°C. stabilization on all units.

SOME IMPORTANT PARAMETERS: 7 db — Noise Figure: 100 megacycles—Gain-bandwidth product; 0.0005μA I_{CBO} typical at 60V, 25°C.

IMMEDIATE AVAILABILITY: Quantities from 1-999 from franchised Fairchild distributors at factory prices.

TENTATIVE SPECIFICATIONS— FAIRCHILD 2N1613

f_t typical	100 mc
P_C @ 25°C. Case Temperature	3W
h_{FE} (see Beta paragraph above)	Min 30
V_{CER}	40V
V_{CBO}	75V
V_{BE}SAT. (Max.)	1.3V
V_{CE}SAT. (Max.)	1.5V
I_{CBO} @ 25°C. (Max.) measured at 60V	25mμA

FAIRCHILD SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD / MOUNTAIN VIEW, CALIF. / YOrkshire 8-8161

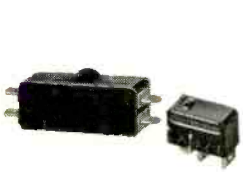
For full specifications, write Dept. J.

A WHOLLY OWNED SUBSIDIARY OF
FAIRCHILD CAMERA AND INSTRUMENT COMPANY

MAJOR MERGER IN SWITCH INDUSTRY

Controls Company of America Merges Hetherington Div. With Electrosnap Corp. to form New Control Switch Division.

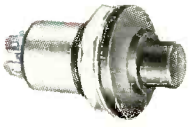
One of the precision switch industry's most complete product lines has come into existence with the announcement by Louis Putze, President of Controls Company of America, Schiller Park, Ill., that its subsidiary Hetherington, Inc., has been merged with Electrosnap Corporation, Chicago. The Electrosnap organization was recently merged with Controls Company of America. "This merger is important to switch users", Mr. Putze stated, "because it combines two major manufact[illegible] switch panel



Basic Snap-Action Switches

Limit Switches

Toggle Switches



Push-Button Switches

Indicator Lights

what's in it for you?

New expanded line from a single convenient source.

Increased R & D and technical assistance.

More localized distribution and service.

Now, you may select from the industry's most versatile and complete line of precision snap-action switches, indicator lights, push-button switches, Switchlites, and environment-free limit switches. You can now make broader product groupings for greater quantity discounts. With this new single source, you will now deal with just one sales engineer for all your switch needs.

Three plant locations—Folcroft, Pa., Chicago, Ill., and El Segundo, Calif.—will provide regional engineering and manufacturing facilities to speed delivery and service.

You will benefit from the combination of military and commercial experience in our new, expanded R & D facilities. Many revolutionary new products are under development in such areas as human factors, sub-sub-miniaturization, image displays, and controls for special environments.

Local sales offices with factory-trained personnel have been set up to provide on-the-spot application engineering. An expanded nation-wide distributor organization will assure you of immediate delivery from local sources.

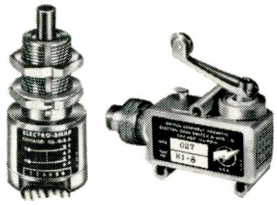
Now, how can we serve *you* today?

ELECTROSNAP
HETHERINGTON

CONTROL SWITCH C C
DIVISION

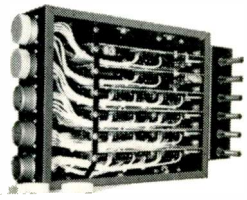
CONTROLS COMPANY OF AMERICA
4218 W. Lake Street • Chicago 24, Illinois
Telephone: VAn Buren 6-3100 • TWX No. CG-1400

Lighted Push-Button Switches



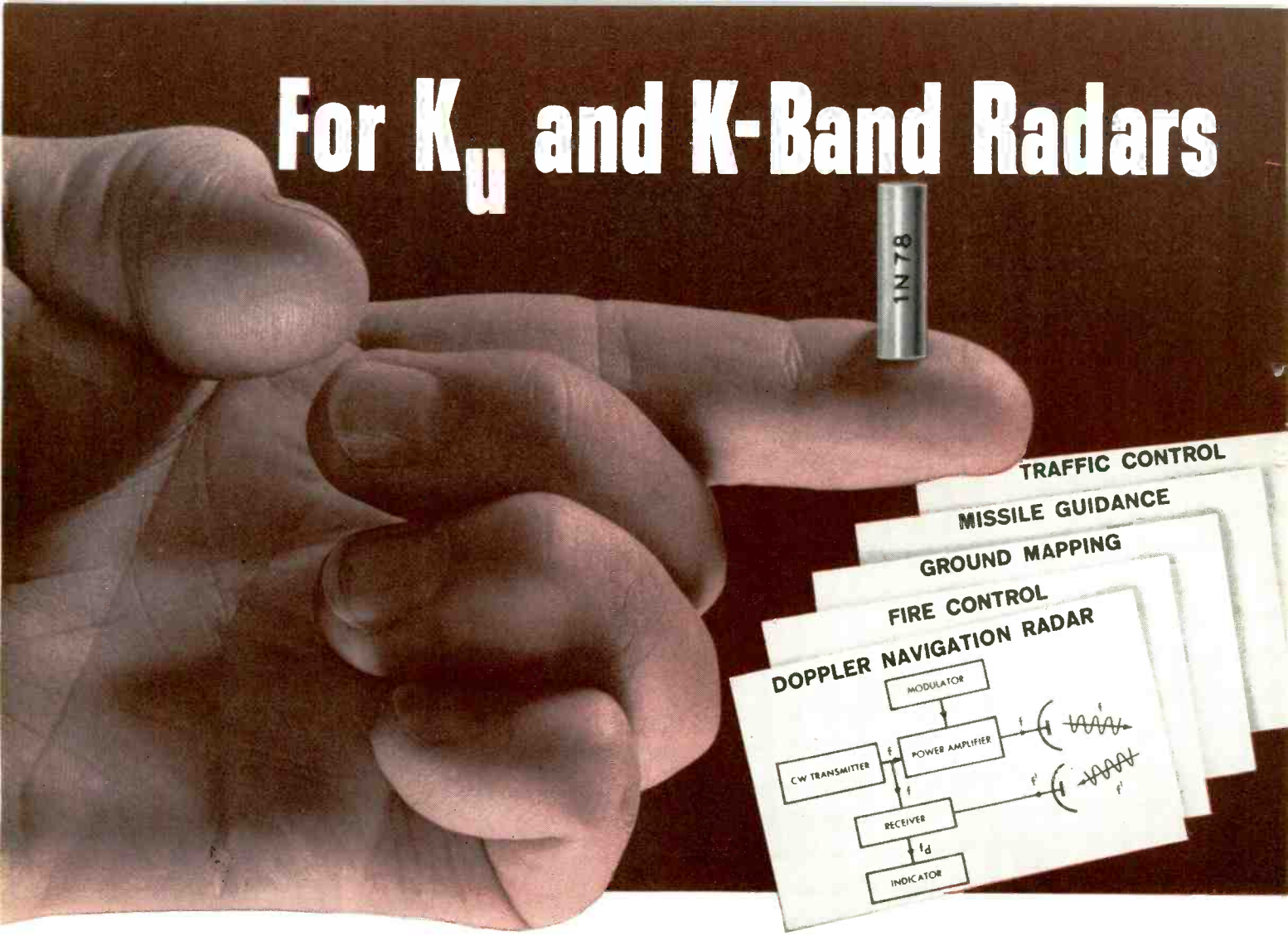
Environment-Free and Hermetically-Sealed Switches

Miniaturized Switches



Special Switches and Panel Components

For K_u and K-Band Radars



PHILCO Silicon Mixer Diodes offer PREMIUM FEATURES ... without PREMIUM PRICES

	1N26	1N26A	1N26B	
Conversion Loss	8.5	7.5	7.5	(db)
Noise Ratio	2.5	2.0	1.5	(times)
RF Impedance	—	1.6	1.5	(VSWR)
Over-all Receiver Noise	13.1	11.3	10.0	(db)

	1N78	1N78A	1N78B	1N78C	1N78D	
Conversion Loss	7.5	7.0	6.5	6.0	5.7	(db)
Noise Ratio	2.5	1.5	1.3	1.3	1.3	(times)
RF Impedance	—	1.6	1.6	1.5	1.5	(VSWR)
Over-all Receiver Noise	11.8	9.8	8.8	8.3	7.5	(db)
Burn-Out	0.3	0.3	0.3	0.6	0.6	(ergs)

Philco offers the only complete line of silicon mixer diodes in the 1N26 and 1N78 families that provides *hermetically sealed cases* and *operating temperature ratings up to 150° C* in the entire line. Every Philco diode, from top to bottom of the line, has these important premium features . . . at no additional cost!

Philco Silicon Diodes give highest performance and sensitivity in both the 16,000 mc and 24,000 mc regions. The newest members, 1N26B and 1N78D, offer the lowest over-all noise figures available. If you are designing for maximum performance and reliability, to meet rigid specifications . . . why be satisfied with ordinary diodes, when these premium feature diodes are available at the same prices . . . from Philco. All diodes in these series are available in matched pairs.

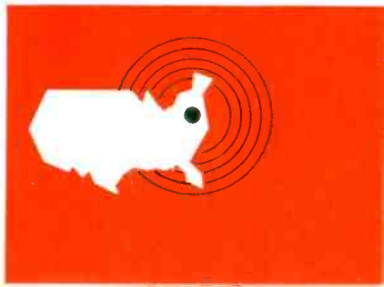
For data sheets, write: SPECIAL COMPONENTS DEPARTMENT EI-560

Immediately Available From Your Philco Industrial Semiconductor Distributor

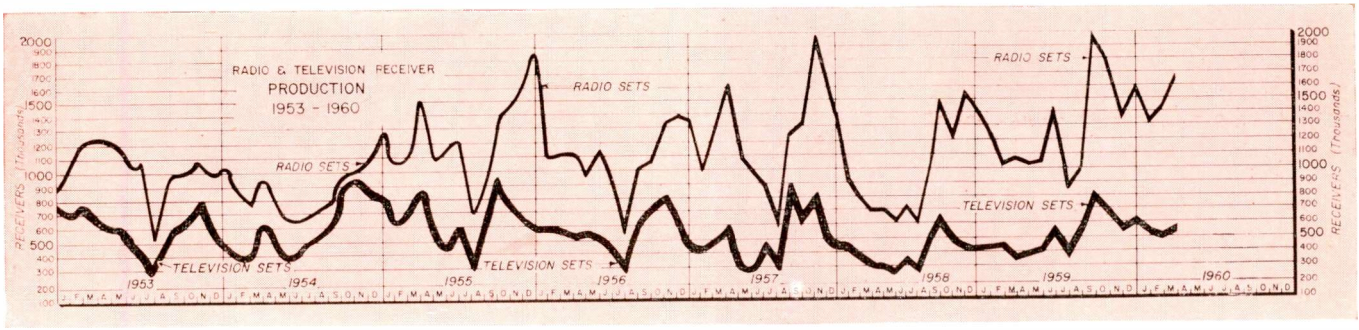
PHILCO®

Famous for Quality the World Over

LANSDALE DIVISION • LANSDALE, PENNSYLVANIA



Circle 9 on Inquiry Card



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in March, 1960.

Amplifiers	1,166,834
Amplifiers, control	59,000
Amplifiers, parrallax	25,410
Amplifiers, synchro signal	99,079
Antennas, loran	26,669
Batteries, dry	483,582
Cable, r-f	281,293
Cable, special purpose	80,032
Cable, telephone	231,236
Calibrator, radar range	683,912
Charger, battery	62,707
Coder—decoders	181,056
Coils	80,691
Coils, focus	62,000
Computers	89,500
Computers, air data	86,532
Computers, ballistic	889,580
Connectors	220,384
Controls, radio set	48,755
Crystal units	30,077
Dosimeters, radiac	29,472
Dummy loads	26,004
Filters, r-f	30,469
Generators, signal	43,433
Generators, timing code	99,300
Gyroscopes	401,000
Handsets	49,139
Indicators, standing wave	129,556
Inverters	63,050
Loudspeakers, dynamic	27,291
Measuring sets, waveguide	26,531
Monitors, FM	25,200
Multi-couplers, antenna	663,850
Multiplexing system, voice	53,356
Networks, pulse forming	58,983
Oscillators, multiplier	196,330
Oscilloscopes	179,752
Power supplies	28,128
Radar sets	23,343,001
Radar sets, telemetry tie-in	254,550
Radiac sets	997,322
Radio sets	1,311,797
Receivers, radio	158,449
Receiver/transmitters	560,382
Recorders, photographic	53,041
Recorders, potentiometer	32,898
Recorder/reproducers, magnetic tape	599,879
Recorders, video tape, TV monochrome	12,075
Relays	47,266
Relay, armature	28,091
Resistors	170,016
Resistors, variable	29,997
Resolvers, servo	28,870
Semiconductor devices	60,550
Solenoids	57,533
Spectrographs	48,005
Switches	287,433
Switches, pressure	39,000
Synchros	137,188
Tape, magnetic	107,820
Tape, recording, plastic	75,000
Teletypewriters	738,590
Terminal sets, data	3,173,820
Test sets, radar	358,286
Test sets, RFI	250,509
Test sets, signal data recorder	49,331
Test sets, transponder	100,000
Tracking equipment, I.R.	46,998
Transceivers	30,800
Transducers	62,032
Transformers	434,590
Transformers, pulse	68,384
Transistors	147,238
Transmitters	221,688
Transponder sets	657,054
Tubes, electron	2,941,193
TV sets	29,600

SALES OF TV, RADIO SETS, PHONOS AND TUBES

Sales and production of TV and radio sets and sales of phonographs took a post-Christmas dip in January, according to figures compiled by the Electronic Industries Association. Factory sales of TV picture tubes and receiving tubes also fell under totals for December.

The charts below show totals for January and the previous month, and for January a year ago. The table for phonograph sales is new and will be published monthly hereafter.

TV and Radio Production (Units)

	Television	Auto Radio	Total Radio
January	526,494	632,461	1,355,788
December 1959	593,170	581,378	1,553,308
January 1959	437,026	420,052	1,124,737

TV and Radio Retail Sales (Units)

	Television	Radio (excluding auto)
January	590,867	803,388
December 1959	701,705	1,755,027
January 1959	501,704	700,490

Phonograph Sales (Units)

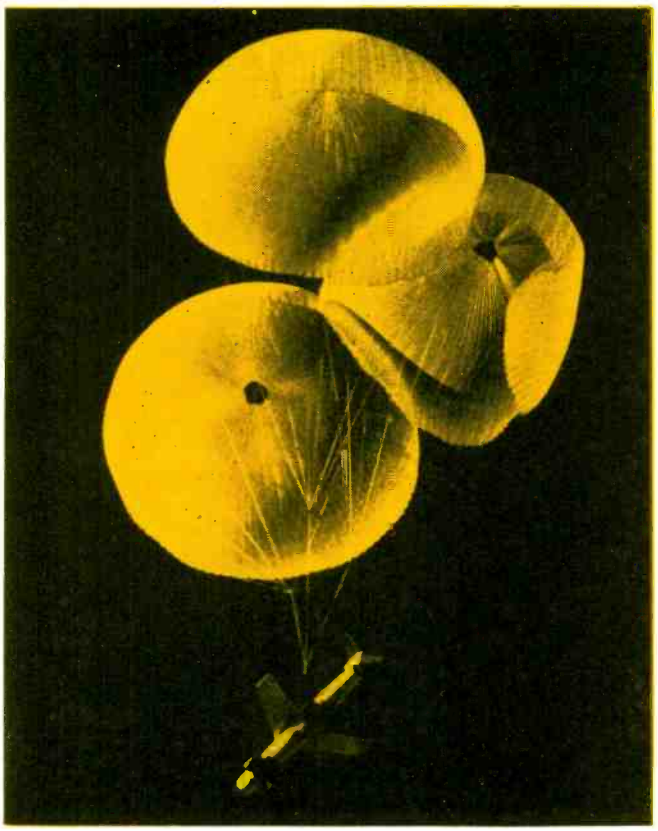
	Factory Sales		Retail Sales	
	Monaural	Stereo	Monaural	Stereo
January	118,400	341,329	150,688	368,964
December 1959	154,574	407,744	229,989	592,772
January 1959	184,147	177,336	231,429	159,214

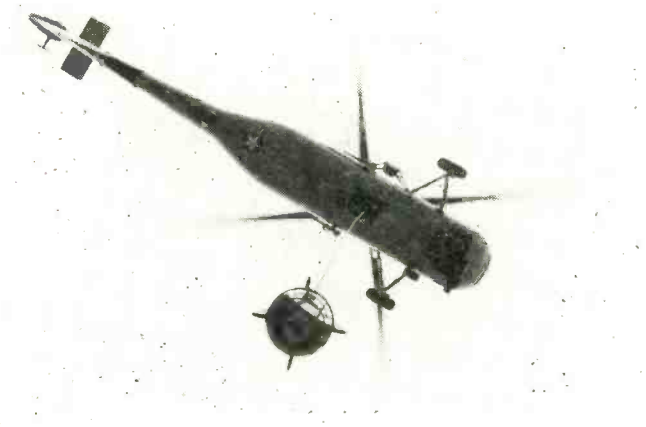
TV Picture Tube, Receiving Tube Factory Sales

	Picture Tubes		Receiving Tubes	
	Units	Dollars	Units	Dollars
January	795,250	$15,834,785	31,367,000	$26,872,000
December 1959	816,787	15,941,040	37,248,000	32,401,000
January 1959	784,906	15,209,896	31,150,000	26,808,000

FACTORY SALES OF TRANSISTORS—1958-1959

	1959		1958	
	Units	Dollars	Units	Dollars
January	5,195,317	13,243,224	2,955,247	6,704,383
February	5,393,377	14,550,056	3,106,708	6,806,562
March	6,310,286	18,117,560	2,976,843	6,795,427
April	5,906,736	16,864,049	2,856,234	7,025,547
May	6,358,097	19,007,293	2,999,198	7,250,824
June	6,934,213	18,031,593	3,558,094	8,262,343
July	6,030,265	15,618,315	2,631,894	6,598,762
August	7,129,696	18,054,138	4,226,616	9,975,935
September	8,652,526	20,851,290	5,076,443	10,810,412
October	8,710,913	22,109,748	5,594,856	13,461,857
November	7,846,500	22,742,525	5,440,981	12,441,759
December	7,826,194	22,819,931	5,627,700	16,595,616
TOTALS	82,294,120	$222,009,722	47,050,814	$112,729,427





SONAR BALL

Ryan AN/APN-97 ground velocity indicator allows Navy anti-submarine helicopter to hover inches above the sea to conduct sonar dunking operations. Sikorsky helicopter is shown lowering sonar ball.

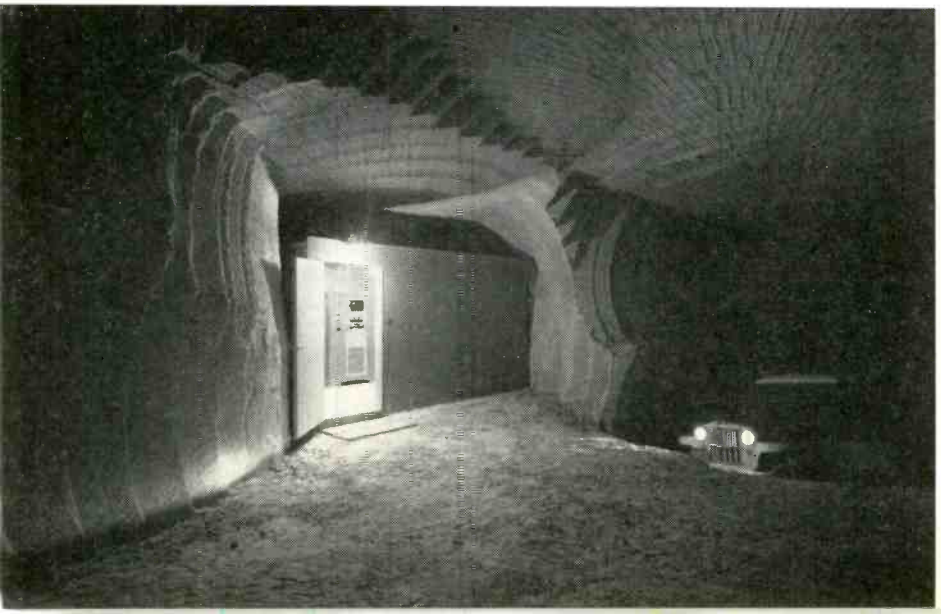
RECOVERY

Air Force TM-76A MACE tactical missile floats earthward after successful flight at the Missile Development Center, Holloman A. F. B. New Mexico. A similar Martin Co.-built "bird" recently completed fourth successful flight. Parachute is carried in place of warhead.

Snapshots . . . of the Electronic Industries

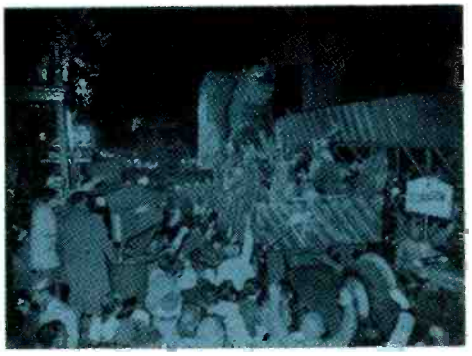
UNDERGROUND TRANSMITTER

Experimental transmitting station is buried in a mine shaft in the Mojave Desert. Space Electronics Corporation, Glendale, California, is using the transmitter to conduct research into techniques of communication beneath the surface using electromagnetic waves.



LEARNING HOW

Engineers at Sylvania Electric Products, Inc., New York, train for installation of data processing phase of Air Forces Ballistic Missile Early Warning System. Engineers below are working with simulator portion of the overall BMEWS data processing system.



OUTDOOR NIGHT COLOR TV

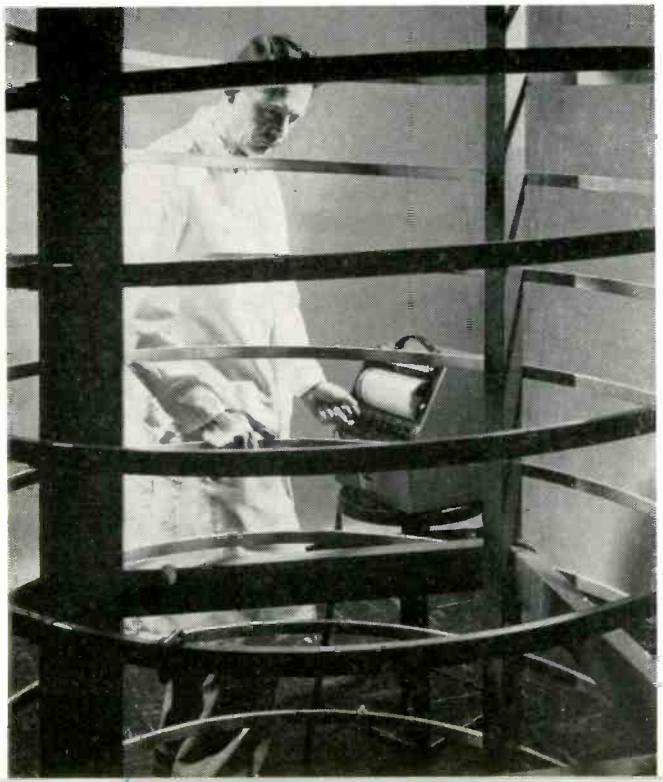
GE's new "see-in-the-dark" super-sensitive camera tube was used for this first night color TV broadcast of the 1960 Mardi Gras in New Orleans. The Tube, GL-7629 requires about 1/10 the light needed for other tubes.

JAPANESE LANTERN

Geodesic radome being tested at GE's Heavy Military Electronics Dept. antenna development facility near Cazenovia, N. Y. Test determines how much a radar receiver is "fooled" by the radome in which it is housed. Silhouetted in translucent radome is reflector for the company's AN/FPS-7 high power radar.

TESTING FUZE SENSITIVITY

Steel marble, rolling down inside this sloping spiral channel at ITE Laboratories, Nutley, N. J., helps engineers analyze the sensitivity of fuzes used in guidance and detonation of missiles. Rolling ball acts as a moving short circuit and its progress simulates a missile "riding down" on a target. Fuze reactions are recorded for analysis.



BROKERS' COMPUTER

M. W. McCarthy (l) Pres., Merrill Lynch, Pierce, Fenner & Smith, Inc., and Albert Williams, IBM Executive VP examine model of 7080 computer ordered by brokerage firm. Trades will be computed at the rate of more than 1,000 a minute by the new system.

ANTENNA RESEARCH

Antenna pattern range at Wichita Div., Boeing Airplane Co. can rotate 350-pound models. For low to super-high frequency testing, range allows full freedom of pattern measurement in any attitude. Purpose of research is study of antennas for high altitude, high Mach number aircraft.

EI's International News

FAR EAST

Taiwan to Get New Microwave System—Loan Approved

New York — Vance Brand, Managing Director of the Development Loan Fund has announced basic approval of a $2,000,000 loan to the Taiwan Telecommunications Administration (Taiwan is more popularly known as Formosa). The loan is to assist the installation of a backbone microwave radio system around which the remainder of the communications system can be integrated.

The system will extend 218 air-line miles and will link all the large cities along the route for long-distance telephone, telegraph, and leased-circuit services. The project includes the installation of microwave equipment, carrier equipment, toll switchboard and switching equipment, power-supply equipment, air-conditioning equipment, and contracting services.

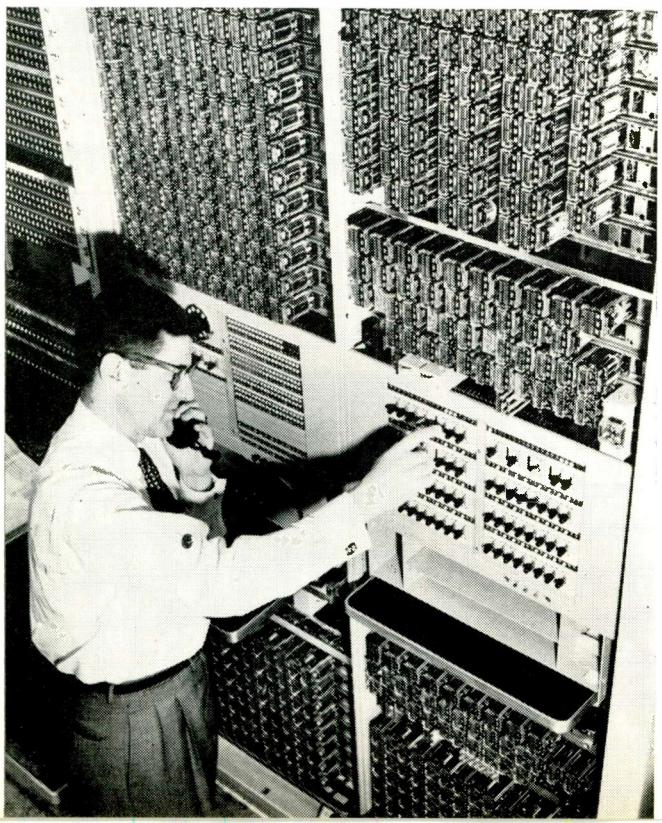
Terminals will be at Taipei and Kaohsiung, with drop repeater stations at Tainan and Taichung. Through repeater stations will be located at Taping, Huo Yen Shan, Kao Chung Shan, and Ching Tsao Hu Shan.

Selection of routes, station sites, traffic studies, and cost estimates were reviewed by the J. G. White Engineering Corp., New York. Taiwan Telecommunications Administration engineers will complete engineering details which will be reviewed by a U. S. consulting engineer. The radio equipment supplier will be asked to send a rep to Taiwan for about 18 months to supervise installation.

Ike Announces Program To Promote Export Business

Washington—A national program to promote an increase in the volume of U. S. exports has been announced by the President. The program is the result of several months of survey and study by the Executive Branch of current trade problems and foreign trade opportunities.

The following are fundamentals of the program. 1: The Executive Branch will give priority to the promotion of U. S. exports as being in the national interest. 2: An integrated export promotion drive, at home and abroad, would be initiated immediately and developed as rapidly as possible. 3: The Dept. of Commerce would undertake to stimulate the interest of U. S. business in export trade—firms new to the trade, for example, would be made aware of the value of export markets. 4: The Dept. of Commerce would improve and expand its export trade services, e.g.: preparing market surveys on a specific product and country basis; dissemination of trade opportunity leads, analysis of U. S. export weaknesses, info on foreign trade and economic conditions, etc. 5: The Dept. of State would establish a vigorous re-emphasis upon trade promotional activity on the part of the Foreign Service, and expand the number of Commercial Officers and Staff assigned to export promotion work. 6: The Export-Import Bank would provide export guarantees of non-commercial risks for short term transactions (details to be announced by the Bank).



TASI

Technician prepares to switch into service a new mechanism that will double capacity of voice cables between London and U. S. Installation, TASI (for Time Assignment Speech Interpolation) takes advantages of lulls in conversation to switch voices from channel to channel. Bell Labs designed system which is being installed by AT&T's Long Lines Dept.

TOUR SOUTH AMERICA

Rodney D. Chipp, Director of Engineering, Communications Systems, Inc., and his wife, Dr. Beatrice A. Hicks, President of Newark Controls Co., Bloomfield, N. J., board plane for South American Tour. Representing the National Society of Professional Engineers, they will work to improve the professional relations of U. S. engineers working in South America.

U. S. Semiconductors, Tubes Rated High Overseas

Electron tubes and semiconductors of United States manufacture have a good reputation abroad and the brisk market that has been established for products of specialized types and technically advanced design holds further promise.

A nine-country survey, "Electron Tubes and Semiconductors; Selected European Countries," Superintendent of Documents, U. S. Printing Office, Wash. 25, D. C. (25 cents) prepared in BDSA's Electronics Division, shows that American producers are supplementing their U. S.-based marketing operations in some cases by establishing European outlets either through licensing arrangements or by direct investment.

Some highlights of the report:

Austria: The electronic industries are still in early stages of development, but represent a potential market for foreign producers of new and technically advanced items. Electron tubes and semiconductors made in the United States are of recognized quality, but U. S. suppliers must compete with low prices and easy credit offered by competitors. Austria's electronics trade is largely oriented towards the Netherlands.

Belgium: The U. S. is expected to continue exporting to Belgium-Luxembourg substantial quantities of transmitting and special-purpose

(*Continued on Page* 32)

BENDIX IGNITION, CONNECTORS, CABLING PERFORM TO PERFECTION IN B-52G "HALF MILLION" TEST

Bendix® Ignition Systems, Pygmy® "Crimp Type" Electrical Connectors, and Fuel Cell Cabling passed the acid test with flying colors aboard a Boeing B-52G missile bomber as it was put through a special, rigorous test program.

This Stratofort flew half a million miles during the 1000-hour test. Included were a 9,000-mile non-stop flight without refueling and a 13,000-mile non-stop refueled mission. At the conclusion of the test—conducted jointly by ARDC, SAC, and Boeing flight test personnel—the aircraft was "fine-tooth-combed" in inspection. According to Boeing, it was "sound as a thoroughbred."

Products of the Scintilla Division, the Bendix ignition systems, connectors, and cabling proved once more that there is no substitute for experience when it comes to delivering reliable, high-key performance such as required on the mighty B-52G.

Scintilla Division
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

When it comes to SEMICONDUCTORS

For the most **complete** line of solid state devices...

● Westinghouse has perfected the widest selection of rectifiers, transistors, and special semiconductor devices available in the industry. In Silicon power rectifiers, Westinghouse is the acknowledged leader in the field.

For the most **dependable** semiconductor devices...

● Every Westinghouse semiconductor device has been carefully designed, manufactured, and thoroughly tested to assure long life, high reliability, and excellent stability.

For **true voltage ratings** in silicon power transistors...

● Only Westinghouse 2N1015 and 2N1016 silicon power transistors offer *true* voltage ratings, guaranteed by 100% power testing—means they may be operated continuously at the V_{CE} listed provided the power dissipation of the transistor is not exceeded. Other conventional power transistors derate the V_{CE} voltage under comparable conditions.

For **new and unusual ideas** in semiconductors...

● Westinghouse is constantly pioneering in exciting new semiconductor devices. Among the latest: a new 50 ampere "TRINISTOR"* controlled rectifier; new thermoelectric cooling devices; an extremely rapid and sensitive infrared detector.

For quality, reliability, performance, and availability...

● Come to *Westinghouse!* For more information call your Westinghouse representative, or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pa.

YOU CAN BE SURE...IF IT'S Westinghouse

*Westinghouse Trademark

Westinghouse Semiconductor Department, Youngwood, Pa.

COME TO WESTINGHOUSE!

SILICON RECTIFIERS

		P.R.V.	Max. DC Current at T°C Resistive Load	Max. One Cycle 60 C.P.S. Surge Full Load	Max. Rev. Peak Current @ Max. Temp. & P.I.V.
LOW POWER RECT.	1N1217 SERIES	50-1000 V.	500 MA @ 110°C. AMB.	15 AMPS.	1.5 MA @ 150°C. JUNCTION
	1N1227 SERIES	50-1000 V.	1.6 A @ 140°C. CASE	15 AMPS.	
MEDIUM POWER RECT.	1N1341 SERIES	50-600 V.	6 A @ 150°C. CASE	160 AMPS.	10 MA @ 190°C. JUNCTION
	1N1199 SERIES	50-600 V.	12 A @ 150°C. CASE	200 AMPS.	
	1N1191 SERIES	50-600 V.	18 A @ 140°C. CASE	220 AMPS.	
	1N1183 SERIES	50-600 V.	35 A @ 140°C. CASE	220 AMPS.	
HIGH POWER RECT.	1N1396 SERIES	50-500 V.	70 A @ 150°C. CASE	1200 AMPS.	30 MA @ 190°C. JUNCTION
	1N1660 SERIES	50-500 V.	160 A @ 125°C. CASE	2000 AMPS.	40 MA @ 190°C. JUNCTION
	1N1670 SERIES	50-500 V.	240 A @ 125°C. CASE	3000 AMPS.	50 MA @ 190°C. JUNCTION
	439 SERIES	50-600 V.	240 A @ 125°C. CASE	3000 AMPS.	

GERMANIUM TRANSISTORS

	Class	Typical Operation			Maximum Ratings			
		I_{CBO} μa	h_{FE}	f mc/s	V_{CE} V	I_C ma	P_C mw	T_J °C
2N59	AUDIO-PNP	10	100	1.2	20	200	180	85
2N60	AUDIO-PNP	10	70	1.1	20	200	180	85
2N403	AUDIO-PNP	10	33	0.85	20	200	180	85
2N614	IF -PNP	3	5	3	20	150	125	85
2N616	IF -PNP	3	20	9	20	150	125	85
2N617	IF -PNP	3	14	7	20	150	125	85

SILICON POWER TRANSISTORS

	Type	h_{fe} or h_{FE}	$f_{\alpha mc}$	V_{CEX} Volts	I_C Amps	T_J °C
2N1015 SERIES—2 AMP.	NPN	10 (V_{CE}=4 V I_C=2 A)	ALPHA CUTOFF .300	30-200	7.5a	150
2N1016 SERIES—5 AMP.	NPN	10 (V_{CE}=4 V I_C=5 A)	ALPHA CUTOFF .300	30-200	7.5a	150

50 AMPERE SILICON "TRINISTOR"* CONTROLLED RECTIFIER

Breakover Voltage @ 125°C T_J	Reverse Blocking Voltage @ 125°C T_J	Turn-on Time	Turn-off Time
TYPICAL			
50-200 VOLTS	50-200 VOLTS	1.0 μ SEC.	15-20 μ SEC.

RECTIFIER ASSEMBLIES

Standard rectifier assemblies are available in all types of circuit configurations, and are designed for either forced air or natural convection cooling with a wide range of ratings. Nickel-plated copper plates and other materials used in these assemblies have been chosen to insure satisfactory performance in corrosive atmospheres and high ambient temperatures.

THERMOELECTRIC COOLING DEVICES

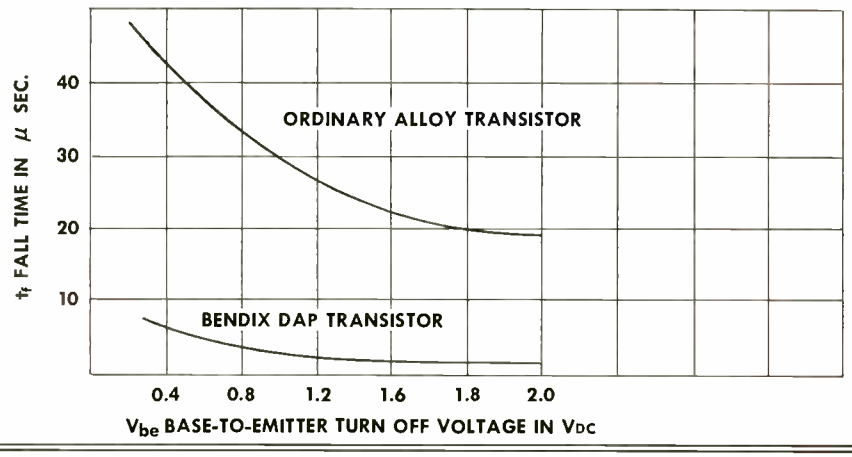
Two types are available in commercial quantities: WX814 (2.5 oz.) and WX816 (3.0 oz.). Both types measure about an inch and a half square and will find immediate application in cooling germanium transistors, infrared detectors, optical systems, mechanical and electric instruments, laboratory and portable medical equipment, and related fields where spot cooling below ambient is necessary.

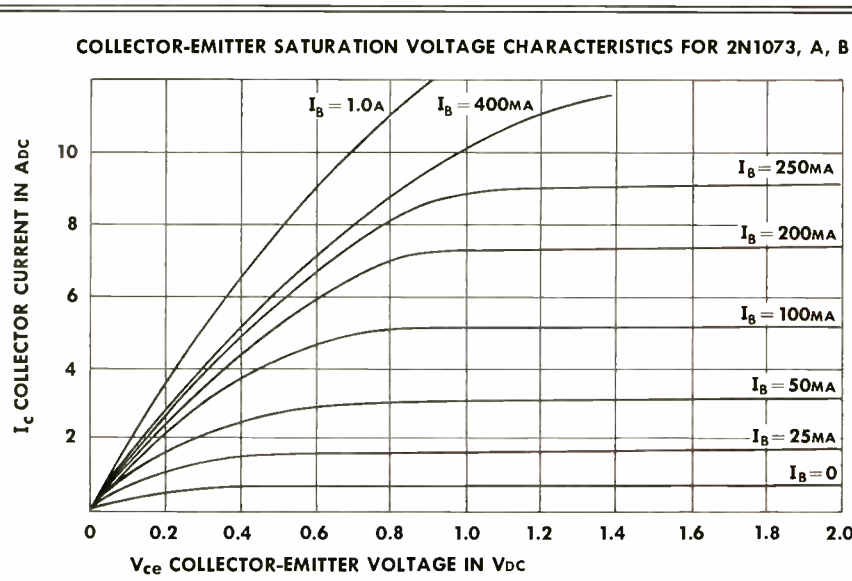
INFRARED DETECTORS

Type	Noise Equivalent Power (NEP) Watts	Wave-length Response. Microns	Time Constant, μ SEC.
	TYPICAL LIMIT		TYPICAL LIMIT
812	$5x10^{-11}$ 10^{-10} MAX.	1-12	0.1 0.2 MAX.

The types listed are just a small sampling of the complete line which can be supplied in volume quantities for prompt deliveries.

NEW DAP TRANSISTORS SWITCH 5 TIMES FASTER





ABSOLUTE MAXIMUM RATINGS

TYPE NUMBERS	Vce Vdc	Vcb Vdc	Veb Vdc	Ic Adc	Pc W	T Storage °C	Tj °C
2N1073	— 40	— 40	10	10	35	−60 to +100	100
2N1073A	— 80	— 80					
2N1073B	−120	−120					

Ideal for such applications as: **ULTRASONICS • HORIZONTAL OUTPUT AMPLIFIERS FOR TV OR CATHODE RAY TUBES • POWER CONVERTERS • HIGH CURRENT AC SWITCHING • CORE DRIVERS • HI-FI**

Higher breakdown than ordinary transistors also a DAP feature.

Now design engineers are freed from many of the limitations imposed by ordinary germanium alloy transistors. Bendix* germanium PNP Diffused-Alloy-Power DAP* transistors can switch up to 10 amperes with typical speeds of a microsecond.

While maintaining high collector-to-emitter breakdown voltage—up to 120 volts—the new transistors provide lower input resistance, controlled current gain, and higher cut-off frequency. Particularly suited to high current, high frequency switching, the DAP transistor's exclusive features will suggest to the design engineer many new applications which, until now, have not been feasible.

NEW BENDIX SEMICONDUCTOR CATALOG on our complete line of power transistors, power rectifiers and driver transistors available on request.

Bendix offers many challenging opportunities in semiconductor engineering and sales. Write Personnel Manager for full details.

*TRADEMARK

SEMICONDUCTOR PRODUCTS

Red Bank Division

LONG BRANCH, N. J.

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New England Sales Office:
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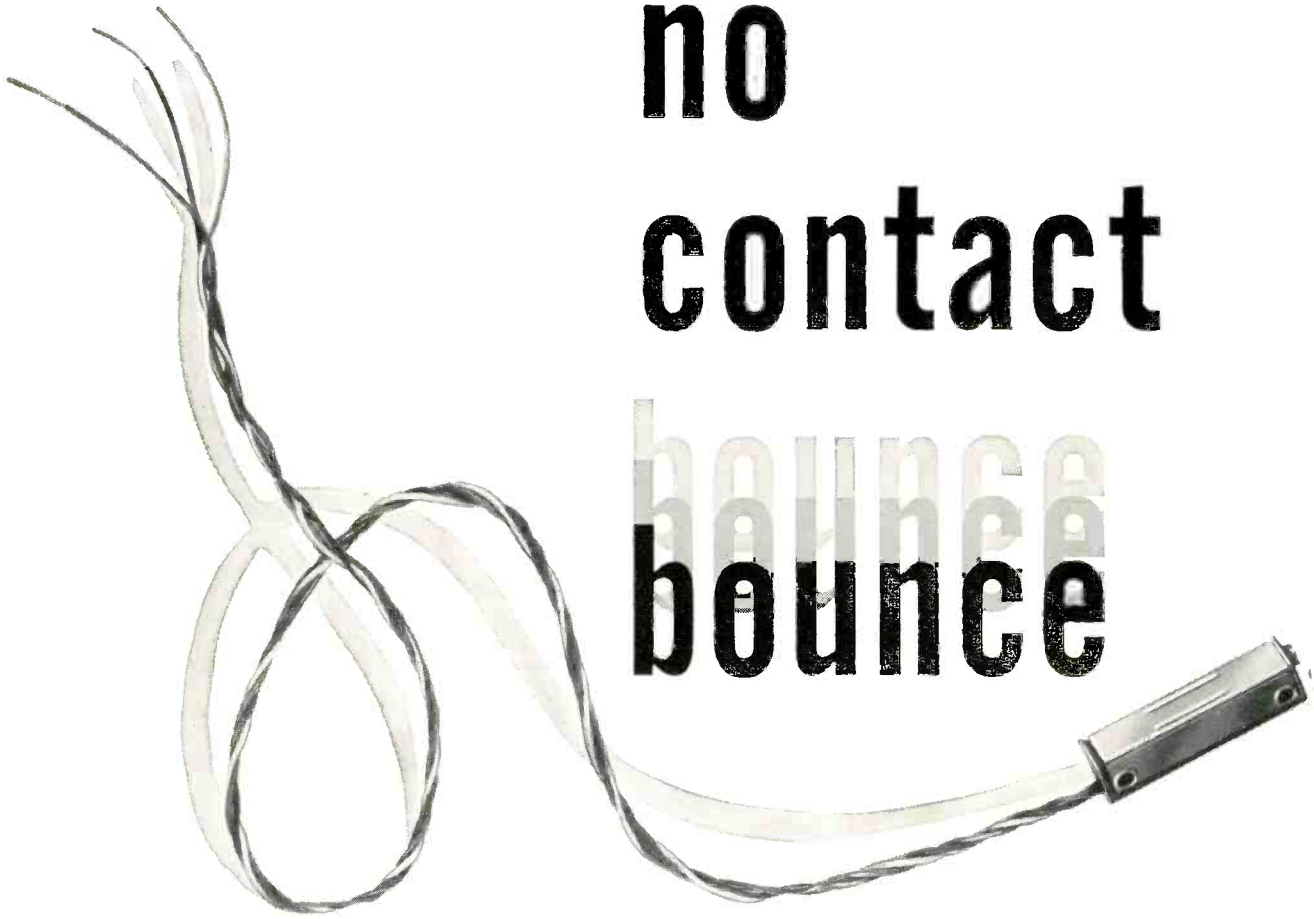
Export Sales Office: Bendix International Division, 205 E. 42nd Street, New York 17, New York

Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario, Canada



no contact bounce

with Centralab's Model 7

linear motion variable resistor

Each CENTRALAB linear motion variable resistor is individually measured for microscopic variations in shaft-case clearance, and individually adjusted to compensate for these variations and to eliminate axial movement of the contact spring. The result is a stable reliable unit with *no contact bounce* when subjected to vibration tests of 20-2000 cps at 30g's for 10 minutes in each of 3 planes.

The performance dependability of CENTRALAB's Model 7 has been continuously demonstrated since 1956, when it was first made available to a limited group of missile manufacturers. Now greatly increased production facilities make it possible to offer the Model 7 to other users.

Model 7 variable resistors are available with composition or wirewound elements, cased or hermetically sealed, with wire or printed circuit leads. The complete electrical, physical, and environmental characteristics of the Model 7 are described in CENTRALAB EP-906, available free on request.

SPECIFICATIONS:	Wirewound	Composition
Resistance Range	100-20K ohms	10K-2.5 meg.
Minimum End Resistance	< 1% of total	< 1% of total
Power rating at 40°C	0.25 watt	0.2 watt
derated at 100°C	0.05 watt	0.02 watt
Rotational Torque	.5 to 3.0 in. oz.	
Component Density	9/cu. in.	
Adjustment	12½ or 25 turns	
Shock —5 shocks in 3 planes at 100g, on JAN-S-44 equipment	less than 1% change in resistance	

Centralab
B-6022

The Electronics Division of Globe-Union Inc.
938 East Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: P. O. Box 400, Ajax, Ontario

Circle 15 on Inquiry Card

IMMEDIATE SHIPMENT! from *PSI*...

Fast Recovery Diodes Featuring Mil Approved Types... Low Capacitance Types... High Conductance Types... Low Leakage Types... High Voltage Types

All types immediately available in production quantities...the broadest line in the industry!

There are PSI silicon diodes for every application in advanced computer design. Listed below are but a few of hundreds of special and standard cataloged types.

Highlights of the extensive PSI line are the now widely used Military Types IN643, IN662 and IN663... the new extremely fast recovery/low capacitance series IN925 thru IN928...and IN789 thru IN804 high conductance diodes which replace older types.

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NEW YORK—870 Broadway, Newark 4, N. J. • HUmboldt 4-5616 TWX: NK 1010

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Phone, wire or write for complete specifications, prices and delivery schedules.

PSI Authorized Distributors from coast-to-coast can supply up to 999 units of any type at factory prices.

PSI®

PSI

SILICON DIFFUSION COMPUTER DIODES

Military Types
IN643-662-663

TYPE NO.	VOLTAGE* @ 100 μa (volts)	MIN. FWD. CUR. @ +1.0 volt (mA)	MAX. REVERSE CURRENT (μa)		REVERSE RECOVERY CHARACTERISTICS	
			25°C	100°C	REVERSE RESIST. (Ohms)	MAX. RECOV. TIME (μs)
1N643†	200	10	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N662‡	100	10	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N663*	100	100	5 (75v)	50 (75v)	200K	0.5

†Mil-E-1/1171 (SigC) ‡Mil-E-1/1139 (SigC) *Mil-E-1/1140 (SigC)

Extremely Fast Low Capacitance Types
IN925 thru IN928

TYPE NO.	MIN. SAT. VOLTAGE @ 100 μa (volts)	MIN. FWD. CUR. 1.0 volt (mA)	MAX. REVERSE CURRENT (μa)		REVERSE RECOVERY CHARACTERISTICS			MAX. CAP. @ ZERO VOLTS (μμf)
			25°C	100°C	REVERSE RESIST. (Ohms)	MAX. RECOV. TIME* (μs)	TYPICAL RECOV. TIME** (Mμs)	
1N925	40	5	1.0 (10v)	20 (10v)	20K	0.15	5.0	4.0
1N926	40	5	0.1 (10v)	10 (10v)	20K	0.15	5.0	4.0
1N927	65	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0
1N928	120	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0

*Switching from 5mA to — 10 volts (R_L = 1K, C_L — 10μμf)
**Switching from 5mA to — 10 volts
(R_{loop} = 100 ohms, C_L = 8μμf including diode capacitance)
*Maximum DC working inverse voltage is 85% of minimum saturation voltage
OTHER SPECIFICATIONS:
Peak Pulse Current, 1 μsec, 1% duty cycle: 3.0 Amps
Storage and Operating Temperature Range —65°C to 200°C

New High Conductance Types
IN789 thru IN804

TYPE NO.	MIN. SAT. VOLTAGE* @ 100 μa (volts)	MIN. FWD. CUR. @ +1.0 Vol (mA)	MAX. REVERSE CURRENT (μa)		REVERSE RECOVERY CHARACTERISTICS	
					REVERSE RESIST. (Ohms)	MAX. RECOV. TIME (μs)
1N789	30	10	1 (20v)	30 (20v)	200K	0.5
1N790	30	10	5 (20v)	30 (20v)	200K	0.25
1N791	30	50	5 (20v)	30 (20v)	200K	0.5
1N792	30	100	5 (20v)	30 (20v)	100K	0.5
1N793	60	10	1 (50v)	30 (50v)	200K	0.5
1N794	60	10	5 (50v)	30 (50v)	200K	0.25
1N795	60	50	5 (50v)	30 (50v)	200K	0.5
1N796	60	100	5 (50v)	30 (50v)	100K	0.5
1N797	120	10	1 (100v)	30 (100v)	200K	0.5
1N798	120	10	5 (100v)	30 (100v)	200K	0.25
1N799	120	50	5 (100v)	30 (100v)	200K	0.5
1N800	120	100	5 (100v)	30 (100v)	100K	0.5
1N801	150	10	1 (125v)	30 (125v)	200K	0.5
1N802	150	50	5 (125v)	50 (125v)	200K	0.5
1N803	200	10	5 (175v)	50 (175v)	200K	0.5
1N804	200	50	10 (175v)	50 (175v)	200K	0.5

Study these specifications! You'll find a decided dollar advantage because you can select exactly the specifications you require... and have the added assurance of reliability standards unsurpassed in the industry!

Pacific Semiconductors, Inc.

12955 CHADRON AVENUE, HAWTHORNE, CALIFORNIA
(A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.)

International News

tubes, particularly those of advanced design. Strong price competition is a drawback to increased shipments of receiving and television picture tubes from the United States.

Denmark: Prices and lack of interchangeability of many U. S. and European tubes tend to limit the Danish market for U. S. products.

France: United States producers are expected to retain their strong position in this market, although the Netherlands' share of the market is increasing. The U. S. was France's principal market for transmitting tubes in the first half of 1959, and took a substantial quantity also of receiving tubes.

Italy: The Italian electronic industries are expanding rapidly and prospects are good for imports of new and advanced types of tubes and transistors. The U. S. is expected to be a leading supplier. United States firms are expanding their direct investment and licensing operations in Italy.

Norway: There is no production in Norway. The United States, the United Kingdom, and Sweden are furnishing a relatively high proportion of the Norwegian market for power, special purpose and transmitting tubes, while the Netherlands and West Germany are the principal suppliers of receiving tubes.

Sweden: Electronic products of United States manufacture are generally priced about 20 percent higher than those produced in Sweden and other foreign countries. There is competition in this market from tubes of U. S. design manufactured under license in Western Europe and marketed in Sweden.

United Kingdom: Tube imports from the United States will probably continue to be of relatively specialized types. Great Britain expects to continue shipping large quantities of receiving and special-purpose tubes to the United States. Investment possibilities for United States firms in Great Britain are favorable.

Terminate Agreement

Tokyo—Sony Corp. of Tokyo, Japan and Delmonico International Div., Thompson-Starrett Co., Inc., have mutually agreed to terminate their arrangement for marketing Sony transistor radios and related products in the U. S.

Distribution in the U. S. of these products will be taken over by the newly-established Sony Corporation of America with offices at 514 Broadway, New York, N. Y. The new company is headed by Akio Morita, executive vice president of the parent organization.

Form European Subsidiary

Kelkheim, West Germany — Camloc Fastener Corp., Paramus, N. J. has established a European subsidiary "Camloc Fastener GmbH." A plant has been leased at Kelkheim between Frankfurt and Wiesbaden. William E. Bracey has been named "Direktor Fur Europe" and will be in charge of the operation.

Microwave for Italy

The U. S. Air Force has awarded Westinghouse Electric Corp., Pittsburgh, Pa., a $1,000,000 contract for a microwave communications system to be installed in Italy. It will operate in the 2000 MC band.

Equipment for the system will be built by the Westinghouse power control and communications department, East Pittsburgh, Pa.

New Electronic Program

Brig. Gen. D. Sarnoff, Chrmn. of the Board, RCA, holds transistor type to be made at Aquila, southern Italy. Looking on (L to R): Dr. M. Brosio, Italian Ambassador; J. L. Burns, Pres., RCA; and Dr. A. Fascetti, Chrmn. of the Board, Instituto per la Ricostruzione Industriale, Italy.

New Tracking Stations

Canberra—The Dept. of State, NASA and Australia have agreed to extend the cooperative efforts of the two nations in space research. New tracking facilities for Project Mercury and deep space probes will be established, and tracking stations established during IGY will continue operation.

Tracking stations will be established at Perth and Woomera for Project Mercury, and one at Woomera for deep space probes. The U. S. will provide electronic equipment. Australia will provide sites and assist in their operation and maintenance. Australian scientists will be able to use each station for independent scientific activities when the stations are not being used for a U. S. program.

(*Continued on Page 72*)

Tele-Tips

A FELLOW IS A FELLOW IS A . . . At a local meeting of the PG on Medical Electronics, where engineers attending are asked to indicate on their identification cards the degree of IRE membership, registrations people were puzzled when a number of obviously foreign visitors—doctors — after a moment's hesitation, checked off "Fellow." When a number of them, who could hardly speak English, did the same those at the desk were completely mystified. And then the answer came—the doctors were checking off "Fellow" — as opposed to "Girl."

AIRLINE BOMB CHECK proposed by Peter H. Stanton, board chairman of American Avionics Inc. would have a simple, production-line lie detector test at all airline check-in counters. With only two lie detector electrodes attached to their hands, all passengers would answer two brief, standard questions as to suicide intentions and explosives in their luggage.

"HAM" LICENSES have jumped 285% in the twelve years since the resumption of amateur radio operation after World War II. The number of individuals in the U. S. now holding amateur radio operator licenses exceeds 200,000 and the number of amateur station licenses outstanding is approaching 204,500. The "extra" number of licenses are held by amateur radio clubs and by operators who have licensed stations at more than one fixed address.

THE JAPANESE are hitting the U. S. hearing aid market with a low-cost unit priced as low as $29.95. In planning the market potential for hearing aids the Japanese came up with estimates that some 15,000,000 Americans have some hearing difficulty. Yet, only 300,000 hearing aids are purchased annually.

TRADE MAGAZINES have become the chief means of commu-

(*Continued on Page* 42)

Tele-Tips

(Continued from Page 41)

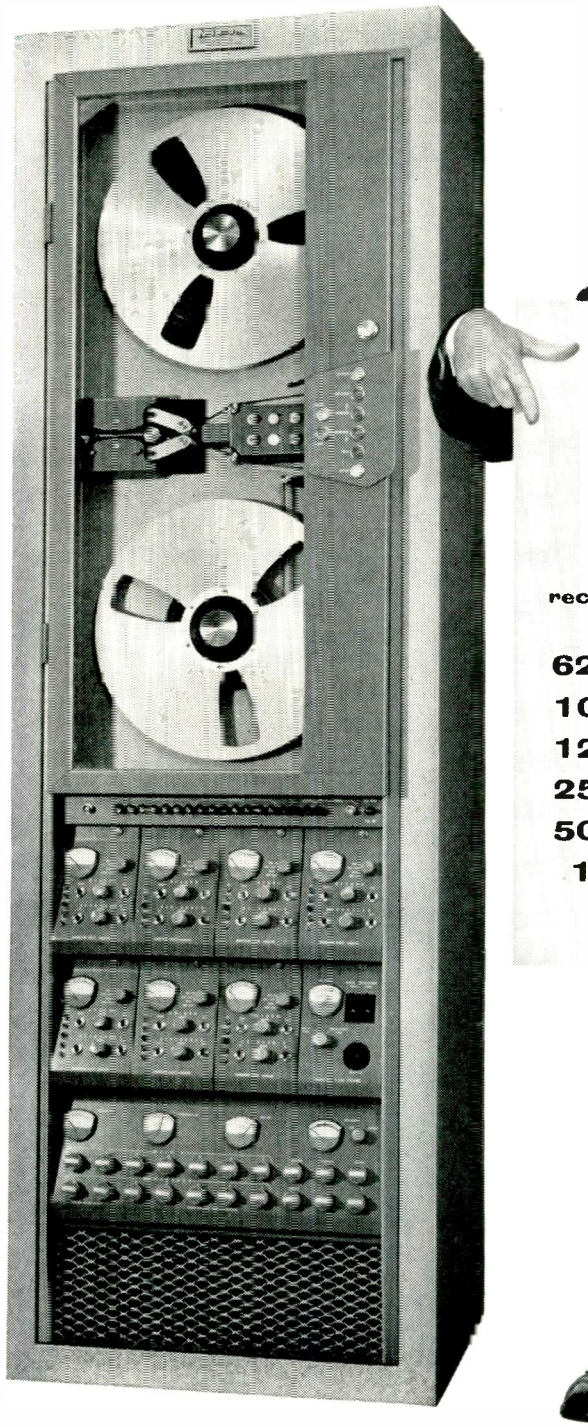
nication between engineers and scientists in different companies. An example is Japan, where some 70% to 80% of all foreign magazines subscribed to consist of trade journals.

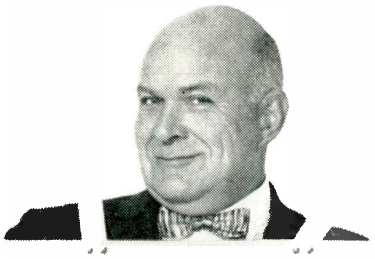
FCC KILOCYCLES KOPS, with mobile equipment, traced on the Florida Keys an illicit transmitter which was sending messages to Cuba that were antagonistic to the Castro government. As a result, other Federal officials were enabled to arrest two refugees from that country who were operating the clandestine station.

Four youths, using a makeshift "station" composed of parts of a cast-off theater sound system and the power supply of an old TV receiver, not only broadcast recorded music and commercials (free) but were conducting "man-on-the-street" interviews. However, one of the persons interviewed on the sidewalk was an FCC field engineer who, in response to the opening questions, announced that he was there to close down the station. There was a sudden sign-off announcement by the "ex-manager." A visit to the "studio" revealed a posted schedule of staff penalties for violating the station's rules. They ranged from "Goofing names on the news—3¢" to "Messing up commercials—5¢."

A one-man, 100-watt unlicensed station was found in Detroit broadcasting over a 15-mile radius. The 18-year-old operator, owner, manager and disk jockey was warned of the law violation and, with the help of his father, dismantled the equipment.

Licensee of a citizens radio station who had been cited for violating Commission rules by trying to get distance on his equipment returned his license with the explanation that "the temptation of having it around is just too great and I have decided to remove the temptation."





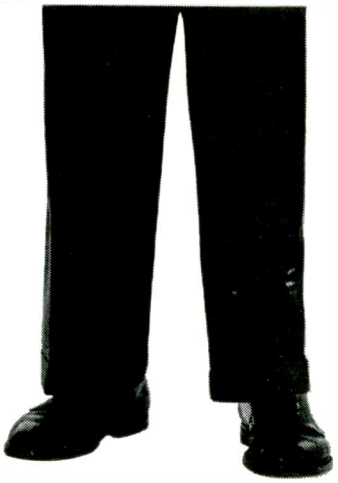
The Newest from

MINCOM

the CM-100

records & reproduces **6 SPEEDS**

62.5 kc – 7½ ips – 192 min.
100 kc – 12 ips – 120 min.
125 kc – 15 ips – 96 min.
250 kc – 30 ips – 48 min.
500 kc – 60 ips – 24 min.
1 mc – 120 ips – 12 min.



Greater bandwidth at a given speed—in six words that's the story of Mincom's newest system, the **Mincom Model CM-100 Magnetic Tape Instrumentation Recorder/Reproducer.** There's more, too: one-rack compactness, no belt changes, dynamic braking, complete compatibility, modular construction. For versatile and reliable performance in any instrumentation application, the CM-100 stands alone. Interested? Write today for brochure.

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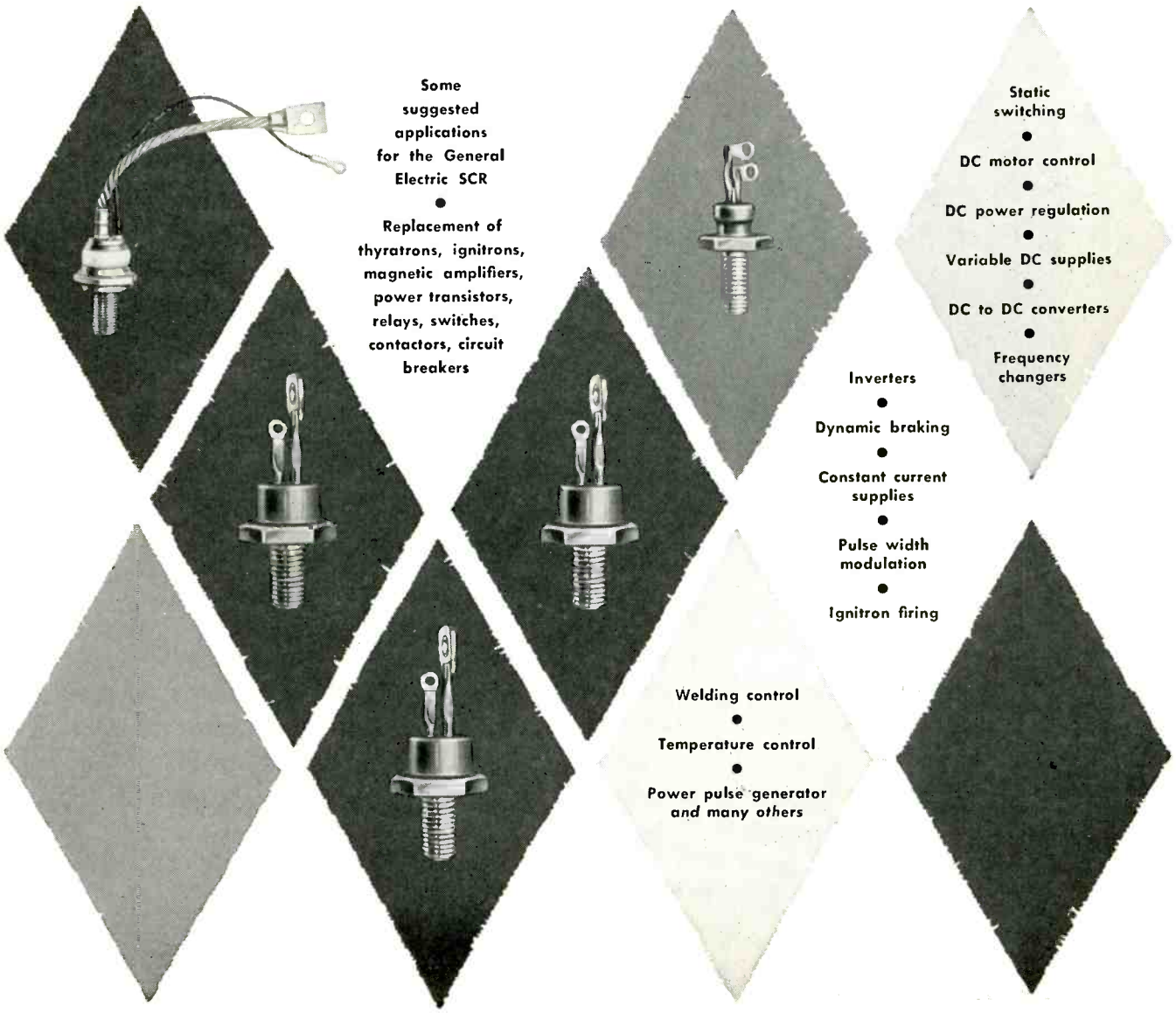
ONLY GENERAL ELECTRIC CONTROLLED RECTIFIER FOR PURPOSE – A COMPLETE 1 TO 50 AMPS, 25 TO 400



Some suggested applications for the General Electric SCR

- Replacement of thyratrons, ignitrons, magnetic amplifiers, power transistors, relays, switches, contactors, circuit breakers

Static switching

- DC motor control
- DC power regulation
- Variable DC supplies
- DC to DC converters
- Frequency changers

Inverters

- Dynamic braking
- Constant current supplies
- Pulse width modulation
- Ignitron firing

Welding control

- Temperature control
- Power pulse generator and many others

HAS THE RIGHT SILICON EVERY POWER-HANDLING CHOICE TO FIT YOUR NEEDS VOLTS

Since its introduction in 1957 by General Electric, hundreds of firms have successfully incorporated G-E Silicon Controlled Rectifiers into their products. The impact of this revolutionary device that not only rectifies but controls current is growing every day. Volume production of a wide range of SCR types is now a reality at General Electric.

G.E.'s medium-current C35 Series provides blocking voltages to 400 volts and load currents to 16 amperes. The high-current C60 Series goes to 300 volts and 50 amperes; low-current C10 Series 400 volts and 4 amperes. The C40 Series has ratings identical to C35, but is specially selected to furnish guaranteed fast turn-off time for inverter circuits. The C36 Series has ratings lower than C35. with currents up to 10 amperes. The C60 features an all hard-solder design for a high degree of freedom from thermal fatigue.

New SCR Application Manual presents all significant design information developed to date and many new circuits. Your G-E Semiconductor Sales Representative also has complete application data. Many authorized G-E Distributors now stock Silicon Controlled Rectifiers for fast delivery at factory prices in quantities up to 100.

●

General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y. In Canada: Canadian General Electric Co., 189 Dufferin St., Toronto, Ont., Export: International General Electric Co., 150 East 42nd St., N. Y. 17, N. Y.

Maximum Allowable Ratings*	C10 Series (8 types)	C35 Series (8 types)	C40 Series (5 types)	C36 Series (8 types)	C60 Series (7 types)	
Continuous Peak Inverse Voltage (PIV) and Minimum Forward Breakover Voltage (V_{BO})	25-400	25-400	100-300	25-400	25-300	Volts
Transient Peak Inverse Voltage (non-recurrent <5 millisecond)	35-500	35-500	35-500	35-500	35-400	Volts
Average Forward Current, Single Phase (up to)	4.7 @ 60°C Stud	16 @ 65°C Stud	16 @ 65°C Stud	10 @ 43°C Stud	50 @ 87°C Stud	Amperes
Peak One Cycle Surge Current	60	150	150	125	1000	Amperes
Operating Temperature	−65°C to +150°C	−65°C to +125°C	−65°C to +125°C	−40°C to +100°C	−65°C to +150°C	
Characteristics At Maximum Ratings						
Maximum Forward Voltage (full cycle Avg.) at Maximum Forward Current	0.75	0.86	0.86	1.25	0.75	Volts
Maximum Gate Current to Fire (I_{GF})	6	25	25	50	50	ma
Maximum Gate Voltage to Fire (V_{GF})	2	3	3	3.5	3.5	Volts
Maximum Thermal Resistance (R_T)	3.1°	2°	2°	2.5°	0.7°	°C/watt Junction to Stud

*Ratings shown are from the lowest to the highest rated types within the series.

GENERAL ELECTRIC

Books

Electronic Circuits, Signals, and Systems

By Samuel J. Mason and Henry J. Zimmermann. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 612 pages. Price $12.50.

Matrix, topological and signal-flow-graph methods of circuit and system analyses are presented. In each case the formulation and solution of electronic circuit problems is stressed, but the methods are applicable to many other fields.

The unified treatment of signals is based on the correlation function, the Fourier integral, and the Fourier series. Pulse, periodic, almost-periodic and random signals are analyzed and synthesized.

The foregoing methods of circuit analysis and signal analysis are applied to the transmission of signals through linear systems. Nonlinear and time-varying-linear systems are described from the system viewpoint, the signal viewpoint and the circuit viewpoint. The negative-feedback concept is introduced and its implications are illustrated by a number of examples.

The book is one of several resulting from a recent revision of the EE course at M.I.T. It is a companion volume to the authors' "Electronic Circuit Theory" (Wiley 1959). The books have the general format of texts.

Electronic Computers Principles and Applications 2nd Rev. Ed.

By T. E. Ivall. Published 1960 by Philosophical Library, Inc., 15 East 40th St., New York 16. 259 pages. Price $15.00.

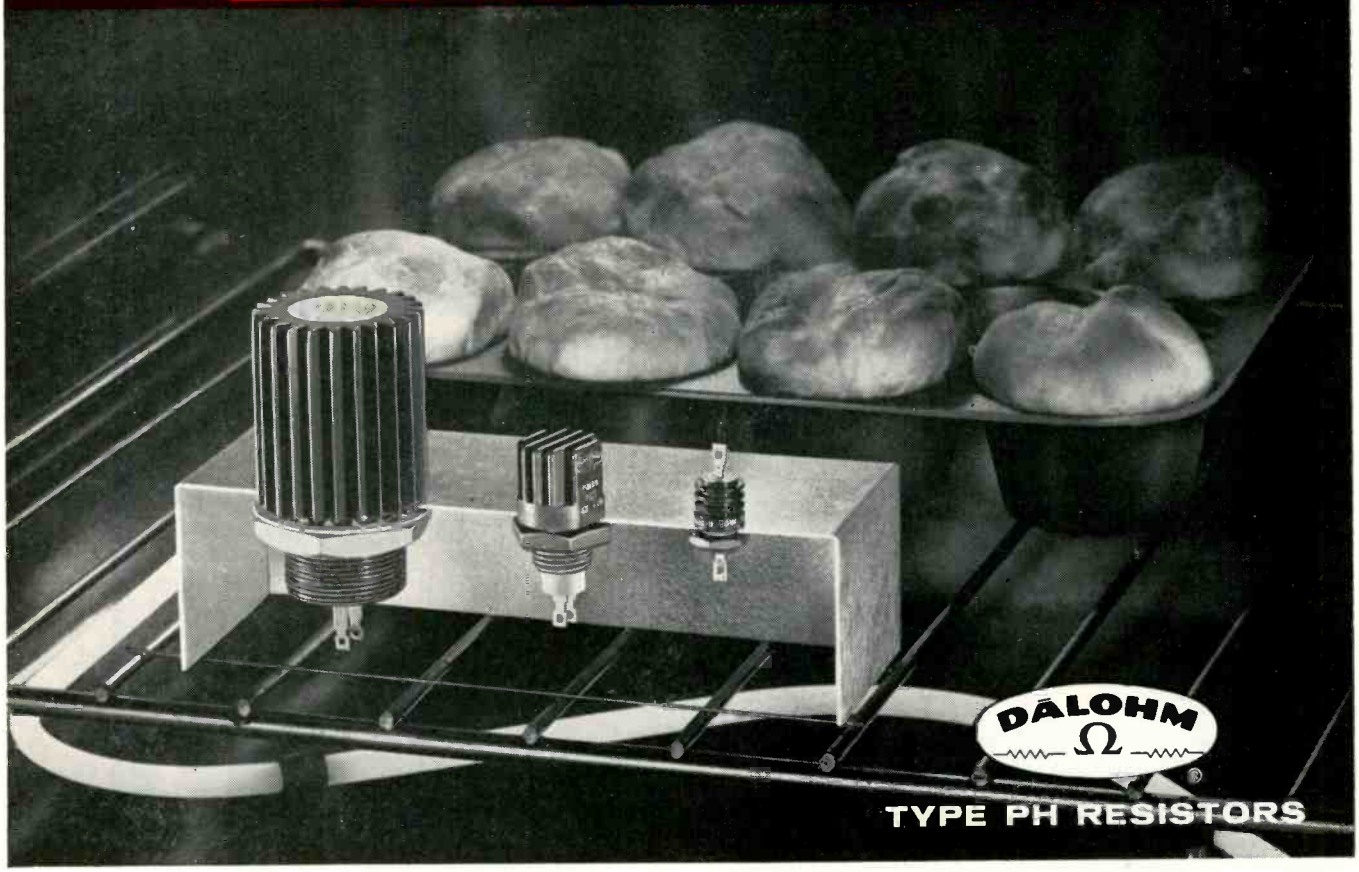
A non-mathematical introduction to the principles and applications of computers using tubes, transistors, and other electronic devices. It is designed to appeal to those with a knowledge of electronic or electrical engineering; but some chapters are also suitable for the interested layman. The treatment is very general and gives a broad background picture of the whole field of computing.

The bulk of the book is devoted to describing the circuitry and construction of both digital and analog computers. Their rapidly developing applications in industry, commerce, and science are also outlined. Considerable emphasis is placed on the application to "automation," or "control," techniques in industry and also on the computing techniques which are playing such an important part in R & D work.

Three new chapters have been added to this revised edition. They deal with analog computer circuits, the programming of digital computers, and the evolution of the more "intelligent" machines of the future.

(*Continued on page* 50)

BAKE IT!



INHERENT STABILITY
Assured in a DALOHM PH Resistor

Neither bake-oven heat nor bone-chilling cold causes a deviation from the inherent stability that is standard in Dalohm resistors.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

HIGH POWER • WIRE WOUND • MINIATURE
DALOHM TYPE PH RESISTORS

Designed for primary application of high power requirements, coupled with precision tolerance. Mount through hole in chassis for maximum heat dissipation.

DERATING DATA		
All resistors dissipate rated wattage at 25° C. and derate to 0 at 275° C.		
	Mounted on Heat Sink	Free Air
PH-10-1	10 watts	6 watts
PH-25	25 watts	12.5 watts
PH-100	10 watts	50 watts

- **Rated at** 10, 25, and 100 watts
- **Resistance range** from 0.1 ohm to 60K ohms, depending on type
- **Tolerance** ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%
- **Temperature coefficient** 20 P.P.M.
- **Operating temperature range** from —55° C. to 275° C.
- **Smallest in size,** ranging from ½" x ¾" to 1¾" x 2-31/32"
- **Ruggedly housed;** sealed in silicone and inserted in rodiotor finned oluminum housing.
- **Complete welded construction** from terminol to terminal
- Made in accordance with MIL-R-26C and MIL-R-18546B (Ships).

Write for Bulletin R-36, with handy cross-reference file card.

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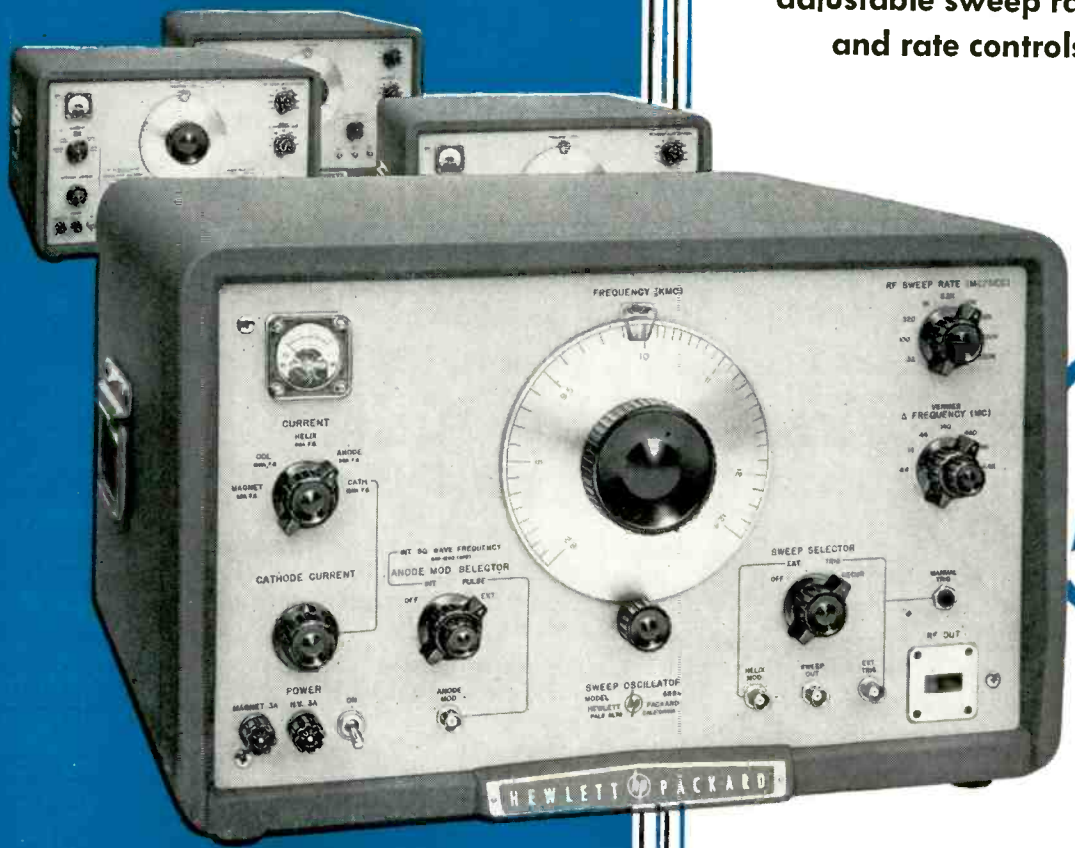
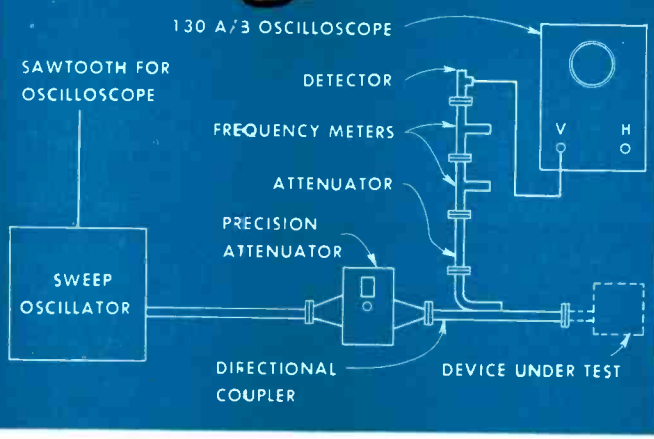
NOW!
4 new microwave sweep oscillators

speed, simplify measurements 2.0 to 18.0 KMC

Covers full band, or any part
Use with 'scope or recorder
All electronic; no mechanical sweep
Direct reading, independently adjustable sweep range and rate controls





◀ Figure 1. Arrangement for high speed microwave measurement to provide rapid visual display with hp 130A/B oscilloscope.

hp Dependable, quality

Hewlett-Packard Electronic Sweep Oscillators are new measuring tools deliberately designed to give you simpler, faster microwave measurements. Four models are provided, covering frequencies 2.0 to 18.0 KMC as follows: Model 683A, 2.0 to 4.0 KMC; Model 684B, 4.0 to 8.1 KMC; Model 686A, 8.2 to 12.4 KMC and Model 687A, 12.4 to 18.0 KMC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. These oscillators provide a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the new oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the hp sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the new oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as hp 130A/B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your hp field engineer. Detailed discussions of these methods are also contained in the hp Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

TYPICAL SPECIFICATIONS

Below are specifications for -hp- 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for -hp- 683A, 684B, and 687A (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decode steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level ± 1 db.

External Amplitude: Direct caupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: +10 volts or more, 5 millisecond maximum duration.

External FM: Approx. 350 v peak to modulate full frequency range.

General

Input Connectors, Impedances: BNC; above 100,000 ohms.

Output Connector: Waveguide cover flange (686A, 687A); Type N, female (683A, 684B).

Power Requirements: 115/230 volts ±10%, 50/60 cps; approximately 540 watts.

Price: hp 683A (2.0 to 4.0 KMC) $3,000.00.
hp 684B (4.0 to 8.1 KMC) $2,900.00.
hp 686A (8.20 to 12.40 KMC) $2,900.00.
hp 687A (12.40 to 18.00 KMC) $3,400.00.

(Prices above are f.o.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

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instruments that speed and simplify your work

Books

(*Continued from page* 46)

Mathematics for Engineers (2 Volumes)

By W. N. Rose, B.Sc. Eng. Published 1958 by John F. Rider Publisher, Inc., 116 West 14th Street., New York, N. Y. Volume 1, (9th, Ed.) 528 pages. Price $6.60. Vol. 2 (5th Ed.) 403 pages. Price $6.60.

Volume 1 treats fully the fundamental rules and processes of algebra, plane trigonometry, mensuration and graphs, the work being graded from an elementary to an advanced stage. There are 259 figures and almost 1400 worked out numerical examples.

It opens with an introduction to equations, their significance and application. Of significant value to the engineer are chapters on the application of difficult curve equations, the determination of laws, and the construction of practical charts.

Volume 2 is devoted to the calculus and its applications. Graphic proofs or constructions are used to amplify or explain the subject. Of particular importance are complete chapters devoted to the applications of differentiation and applications of the calculus. Volume 2 also has practical engineering problems and examples throughout the text.

Physics For Students of Science and Engineering. Part 1

By Robert Resnick and David Halliday. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 594 pages. Price $6.00.

The unifying ideas of physics, such as conversation principles and field concepts, are stressed throughout the book and the relation of classical to modern theories is emphasized.

The book presents principles rather than specific procedures and selects areas of contemporary interest rather than past interest. Much contemporary material has been woven into the body of the text. For example: gravitation, kinetic theory, electromagnetic waves, and physical optics are treated in greater depth. Atomic standards, collision cross section, inter-molecular forces, mass-energy conversion, isotope separation, the Hall effect, the free-electron model of conductivity, nuclear stability, nuclear resonance, and neutron diffraction are discussed.

Most electronic engineers will have a mathematical background adequate for understanding the material. The derivative is introduced in Chapter 3 and the integral in Chapter 7. Calculus is used freely in the latter half of the book. Vector notation and vector algebra, including scalar and vector products, are used throughout. Displacement is taken as the prototype vector, and the idea of invariance of vector relations is developed.

There are approx. 25 pages of tabular data in the appendices. These

(*Continued on page* 54)

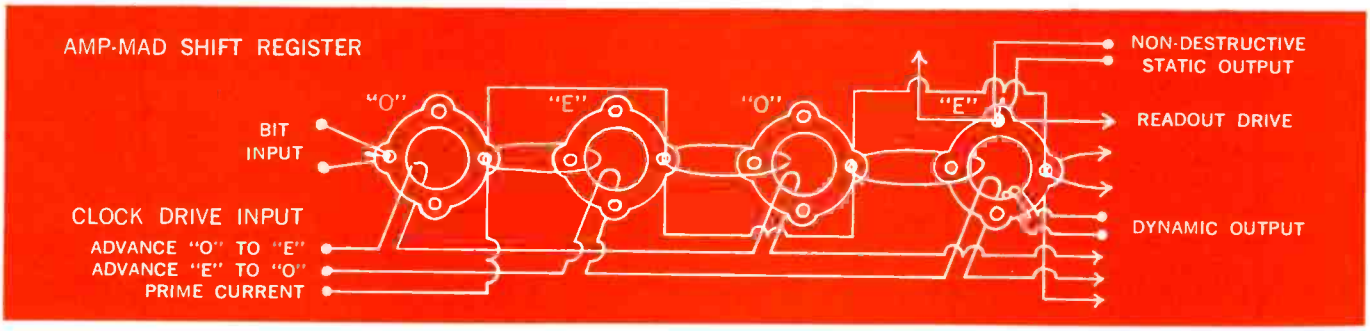
10 BIT REGISTER
ACTUAL SIZE

AMP INTRODUCES

A COMPLETELY NEW KIND OF SHIFT REGISTER USING MAGNETIC ELEMENTS ONLY...

Here is the first commercially available line of all-magnetic shift registers. Now you can have both non-destructive dynamic and static output in the same register. Now you can have the minimum number of components, the minimum number bit to bit interconnections and any serial/parallel input and output combination. Made with AMP multiaperture ferrite cores and copper wire only (see schematic below), the AMP Shift Register line has a number of other useful features:

- —40°C to +75°C temperature operating range
- minor aperture output level up to 100 mw at several volts
- immune to nuclear radiation
- small size—ideal for miniaturization requirements
- ultimate in reliability and simplification



For complete information, including operating data, send for our AMP-MAD Shift Register brochure.*

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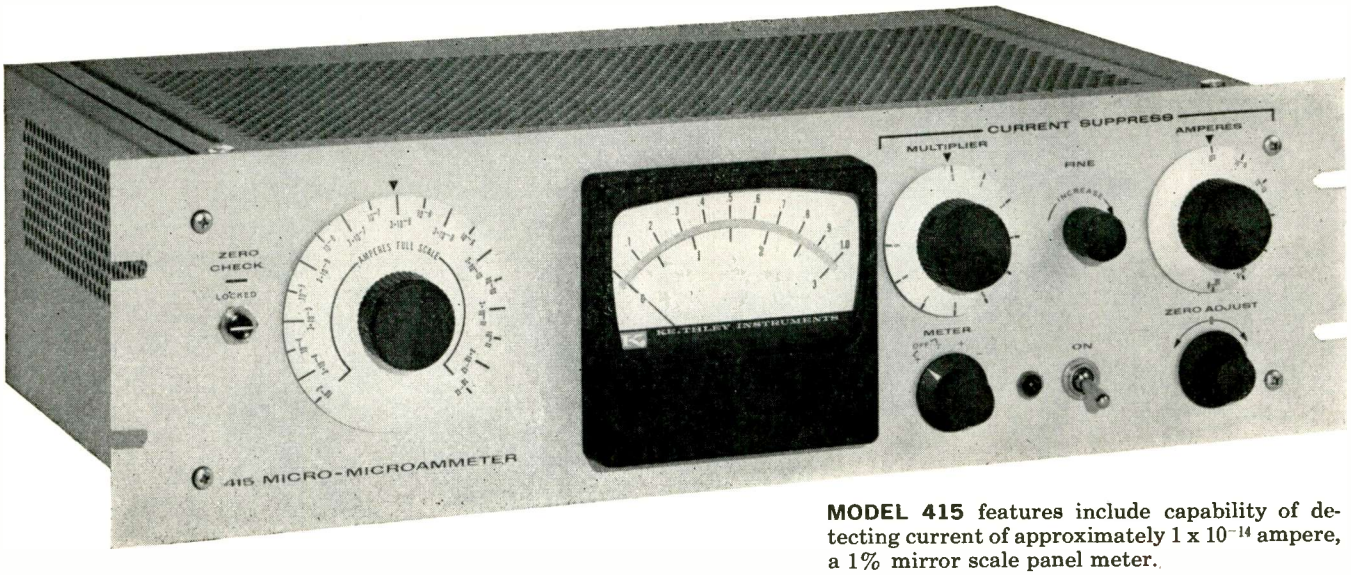


MODEL 415 features include capability of detecting current of approximately 1 x 10^{-14} ampere, a 1% mirror scale panel meter.

new high-speed research micro-microammeter

Model 415 offers high speed of response, accuracy, and zero suppression.

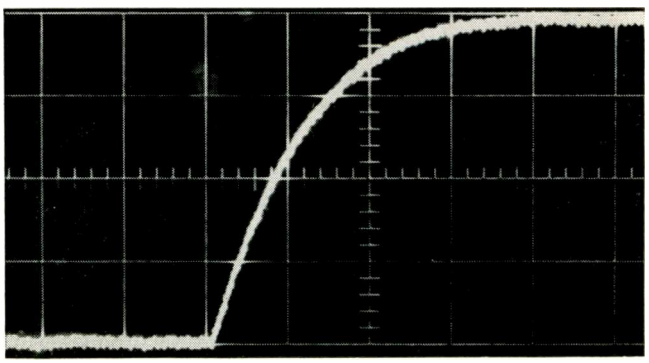
The new Model 415 incorporates advanced high-speed circuitry developed by Keithley Instruments for rocket and satellite experimentation — where measurements of Lyman-Alpha night glow and upper air density require fast response.

A speed response of less than 600 milliseconds to 90% of final value at 10^{-12} ampere is possible where external circuit capacity is 50 picofarads ($\mu\mu$f). Critical damping of the circuit, with any input capacity, is maintained on all ranges through one infrequent adjustment. There is no possibility of oscillation or poor response, on any range.

Accuracy is ±2% of full scale on 10^{-3} through 10^{-8} ampere ranges, and ±3% of full scale on 3 x 10^{-9} through 10^{-12} ampere ranges.

The 415 also provides zero suppression up to 100 full scales, permitting full scale display of one per cent variations of a signal. Once suppressed to zero, such variations may be observed on any of the next four more sensitive ranges without resetting the suppression.

Excelling other Keithley 400 Series Micro-micro-ammeters in speed of response, the 415 is ideal for current measurements in ion chambers, photomultipliers, gas chromatography, mass spectrometry.



AN OSCILLOGRAM demonstrating response to a current step of 10^{-12} ampere. Input capacity is 35 picofarads ($\mu\mu$f). One major horizontal division equals 200 milliseconds.

BRIEF SPECIFICATIONS

RANGES: 10^{-12}, 3 x 10^{-12}, 10^{-11}, 3 x 10^{-11}, etc. to 10^{-3} ampere f.s.

ACCURACY: ±2% f.s. 10^{-3} thru 10^{-8} ampere ranges; ±3% f.s. 3 x 10^{-9} thru 10^{-12} ampere ranges.

ZERO DRIFT: Less than 2% of f.s. per day after warmup.

INPUT: Grid current less than 5 x 10^{-14} ampere.

OUTPUT: 1 v f.s. at up to 5 ma. Noise less than 20 mv.

RISE TIME: Typical values given in sec. to 90% of final values.

Range amps f.s.	C_{in} = 50 $\mu\mu$f seconds	C_{in} = 150 $\mu\mu$f seconds	C_{in} = 1500 $\mu\mu$f seconds
10^{-12}	.600	.800	2.5
3 x 10^{-12}	.200	.300	1.0
10^{-11}	.060	.080	.250
3 x 10^{-11}	.020	.030	.100
10^{-10}	.006	.010	.030
3 x 10^{-10}	.002	.003	.010
10^{-9}	.001	.001	.003
3 x 10^{-9} and above	.001	.001	.001

PRICE: Model 415, $750.00

For complete details, write:

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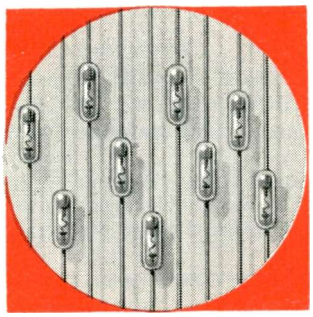
12415 EUCLID AVENUE CLEVELAND 6, OHIO

announcing reliable diffused silicon diodes

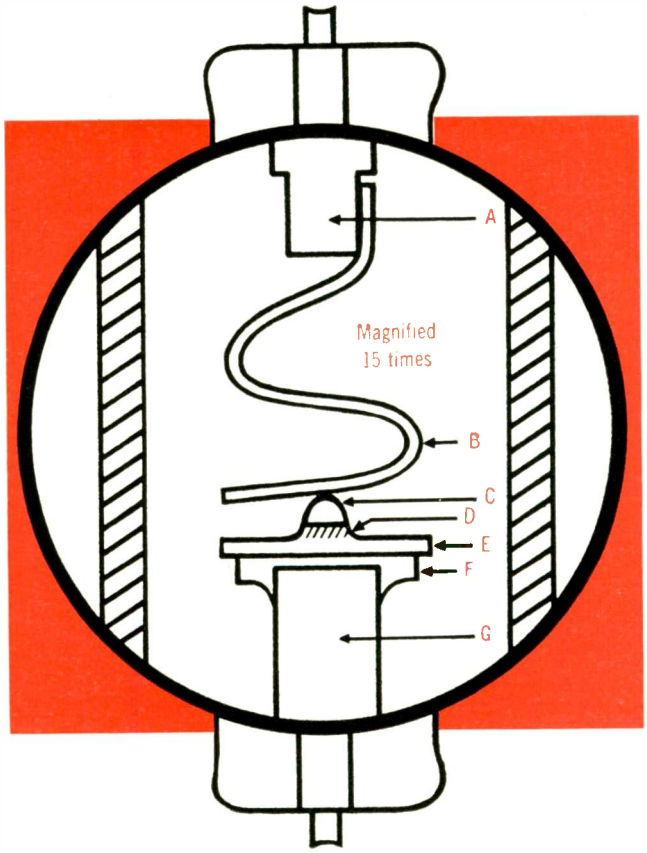
Advance-engineered diffusion techniques are now applied to CBS silicon diodes. Fast switching . . . high conductance . . . high temperatures . . . high voltage . . . low capacitance . . . and low reverse current are achieved.

The diffusion technique offers many other advantages over the alloying method: Close process control of all parameters, great uniformity, and high reverse voltage for a given resistivity through the graded junction. Hermetic sealing of miniature glass package also contributes to the exceptional life.

Now you can have proven CBS reliability in diffused silicon diodes. Watch for further announcements on this growing CBS silicon line.



a comprehensive line for computers



A – dumet, B – platinum, C – gold, D – diffused region, E – N-type silicon, F – gold, G – dumet.

Active portion and consequently the capacitance of these diodes are minimized by etching away all but a small diffused section. Rugged construction provides resistance to shock and vibration exceeding MIL-STD. 202A.

Note the two major classifications particularly designed for computers in missiles, rockets, airborne and industrial equipment. Typical applications include switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating and detector circuits. Write for complete technical Bulletins E-373 and E-374.

FAST RECOVERY TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Min. Forward Current		Maximum Reverse Current @ 25°C		Maximum Reverse Current @ 100°C		Reverse Recovery Characteristics*	
		I_F (mA)	E_F (volts)	I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)	Zrec (Kohms)	t (μsec)
1N625	−35	4	1.5	1	−20	30	−20	400	1.0
1N626	−50	4	1.5	1	−35	30	−35	400	1.0
1N627	−100	4	1.5	1	−75	30	−75	400	1.0
1N628	−150	4	1.5	1	−125	30	−125	400	1.0
1N629	−200	4	1.5	1	−175	30	−175	400	1.0

*JEDEC 14.5-1 (Modified IBM-Y reverse recovery circuit with: I_F = 30mA, E_R = −35V, R_L = 2K ohms.)

HIGH CONDUCTANCE TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Max. Fwd. Voltage @ 100 mA (volts)	Maximum Reverse Current @ 25°C		Maximum Reverse Current @ 150°C		Max. Avg. Fwd. Current	
			I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)	@ 25°C (mA)	@ 150°C (mA)
1N482	−40	1.1	0.25	−30	30	−30	100	25
1N483	−80	1.1	0.25	−60	30	−60	100	25
1N484	−150	1.1	0.25	−125	30	−125	100	25
1N485	−200	1.1	0.25	−175	30	−175	100	25

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Books

(*Continued from page* 50)

include: Fundamental and Derived Physical Constants, Terrestrial Data, Solar System, Periodic Table of the Elements, Properties of Elementary Particles, Symbols, Conversion Factors, etc.

Space Flight Vol. 1 Environment and Celestial Mechanics

By Krafft A. Ehricke. Published 1960 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 513 pages. Price $14.50.

Part one of this volume (first of a series of three) covers the concept of space flight and the environment in which it will take place—to the extent that we know it at this time—with emphasis on the gaps in our present knowledge which require space research by means of rocket vehicles. It traces the historical development of the space flight. The solar system is studied from the viewpoint of the astronautical engineer with emphasis on useful comprehensive tables of consistent data.

Part two is devoted to celestial mechanics from the viewpoint of the astronautical scientist rather than the astronomer. Central force field orbit determination, and perturbation analysis are successively covered. Central force field theory is treated in general as well as with respect to its specific conics, and includes a comprehensive collection of formulae for time-saving computational work. In orbit determination, the orbital elements are derived, and coordinate systems and their transformation, units of time, aspects and methods of orbit determination are covered.

Electromagnetic Fields, Energy and Forces

By Robert M. Fano, Lan Jen Chu, and Richard B. Adler. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 520 pages. Price $12.00.

A consistent macroscopic theory of electromagnetism is developed, and the relation between circuit theory and field theory is discussed. The theory is developed in successive steps from the Lorentz force, the integral form of Maxwell's equations in free space, and suitable macroscopic models of polarized and magnetized matter.

Special features include: the electromagnetism of moving bodies and the process of electro-mechanical energy conversion; a power-series technique for analyzing quase-static fields and quase-stationary systems; the synthesis of fields as opposed to the analysis of fields is emphasized; and in the appendix, the four-dimensional relativistic formulation of macroscopic electrodynamics recently developed by L. J. Chu (one of the authors).

(*Continued on page* 56)

ARNOLD: WIDEST SELECTION OF MO-PERMALLOY POWDER CORES FOR YOUR REQUIREMENTS

For greater design flexibility, Arnold leads the way in offering you a full range of Molybdenum Permalloy powder cores . . . 25 different sizes, from the smallest to the largest on the market, from 0.260″ to 5.218″ OD.

In addition to pioneering the development of the cheerio-size cores, Arnold is the exclusive producer of the largest 125 Mu core commercially available. A huge 2000-ton press is required for its manufacture, and insures its uniform physical and magnetic properties. This big core is also available in three other standard permeabilities: 60, 26 and 14 Mu.

A new high-permeability core of 147 Mu is available in most sizes. These cores are specifically designed for low-frequency applications where the use of 125 Mu cores does not result in sufficient Q or inductance per turn. They are primarily intended for applications at frequencies below 2000 cps.

Most sizes of Arnold M-PP cores can be furnished with a controlled temperature coefficient of inductance in the range of 30 to 130° F. Many can be supplied temperature stabilized over the MIL-T-27 wide-range specification of −55 to +85° C . . . another special Arnold feature.

Graded cores are available upon special request. All popular sizes of Arnold M-PP cores are produced to a standard inductance tolerance of + or −8%, and many of these sizes are available for immediate delivery from strategically located warehouses.

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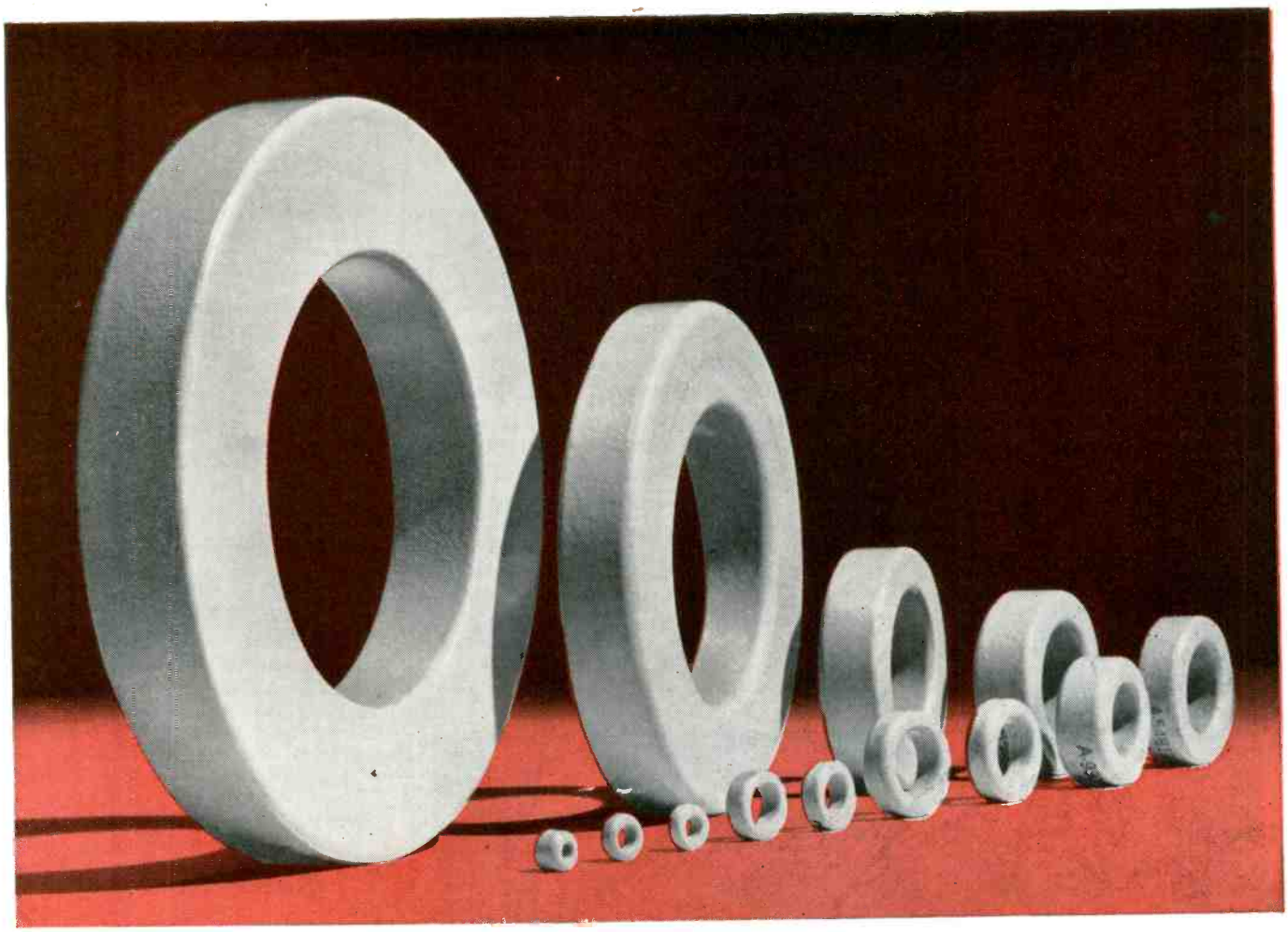

Circle 31 on Inquiry Card

Books

Fluid Power Control

Edited by John F. Blackburn, Gerhard Reethof, and J. Lowen Shearer. Published 1960 by The Technology Press of M.I.T. and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 710 pages. Price.

The fundamentals of the operation of power-control systems in which the working media may be either liquids or gases. Both analytical and experimental approaches to the understanding of the fundamentals are presented.

There are four major parts to the book. There is a review of fluid properties and fluid mechanics, following with the theory and practice of hydraulic control components, with emphasis on control valves. The last two parts describe recent progress in the use of gaseous working fluids, especially high-pressure pneumatics, with concepts of system analysis and design and with actual system designs.

Books Received

How to Use Meters, 2nd Ed.

By J. F. Rider & S. D. Prensky. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 216 pages, paper bound. Price $3.50.

Principles of Frequency Modulation

By B. S. Camies. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 160 pages, paper bound. Price $3.50.

Basics of Fractional Horespower Motors and Repair

By Gerald Schweitzer. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 176 pages, paper bound. Price $3.90.

How to Use Grid-Dip Oscillators

By Rufus P. Turner. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 112 pages, paper bound. Price $2.50.

How to Troubleshoot TV Sync Circuits

By Ira Remer. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 128 pages, paper bound. Price $2.90.

Moon Base, Technical and Psychological Aspects

By T. C. Helvey. Published 1960 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 80 pages, paper bound. Price $1.95.

Radio Club of America's Golden Jubilee Yearbook

December 1959 marked the Golden Anniversary of the Radio Club of America. A few extra copies of their 216 page yearbook are still available. This volume traces the history and growth of radio and communications in the U. S. from 1909, and contains pictures and descriptions of famous personalities and events. The handbook can be obtained from the Radio Club of America headquarters at 11 West 42 Street, New York 17, N. Y. Price per copy $4.50.

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Coldite 70+ Resistors are the latest development of a firm which, since the early days of radio, has been one of the largest, most dependable resistor suppliers. Laid end to end, the resistors Stackpole has produced would extend around the world so many times you'd get dizzy counting them!

Coldite 70+ Resistors look good — and they're every bit as good as they look. They're unmatched for load life and moisture resistance. What's more, performance far exceeds MIL-R-11 requirements. And now, for the first time in resistor procurement history, you can get such resistors in a complete line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (½-watt) styles FROM STOCK from leading distributors!

FOR ECONOMY AND CONVENIENCE on your smaller lot purchases, write, wire or call for name of nearest Coldite 70+ distributor with complete stocks of all 3 sizes, all 269 standard values, and all 3 standard tolerances.

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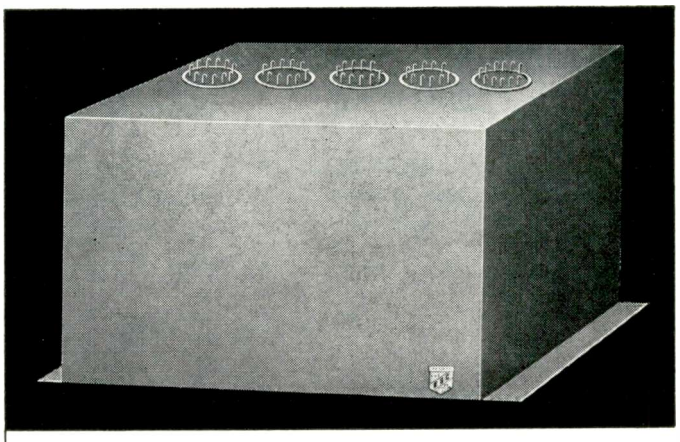
ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/RISE TIME RATIO

Model 61-34 Perfected For Specialized Communications Application

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.



SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1
Delay: 200 usec.
Rise time: 1.16 usec.
Attenuation: less than 2 db
Frequency response: 3 db = 325 KC
50 taps with an accuracy of ±0.2 usec. at each tap.

Complete technical data on the new unit can be obtained by writing to

ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

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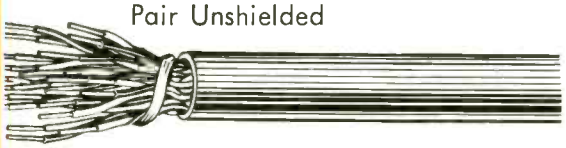
Intercom Cables—Multiple Pair Unshielded



Conductors paired with short lay twist. No crosstalk. Offers high dielectric strength, free stripping, small diameter. Vinyl jacket resists water, sun, oil, grease, and ozone.

Belden . . the most complete Electronic Wire and

Strain Gauge Cables

100% Shielded with conductors under BELDFOIL* aluminum-mylar shield. Low capacitance, small diameter, extremely flexible. Vinyl jacket resists water, sun, oil, grease, and ozone.

*Belden Trademark, Reg. U.S. Pat. Off. Patent Pending

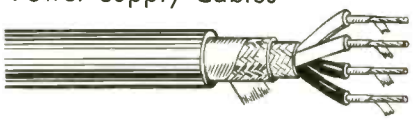
Unshielded Sound, Alarm System, and Speaker Extension Cables

Two-conductor twisted pair. All insulations and sizes. Uniform quality and dimensions for dependable service and installation.

Special Intercom and Sound Cables

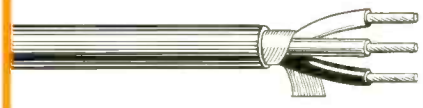
For wiring systems requiring shielded lines cabled with unshielded control lines. Wide variety of types and conductor groupings.

Rubber Microphone and Shielded Power Supply Cables



Maximum abrasion and impact resistance. Limp—lies flat on stage or studio floor. Long flex life, high tensile strength.

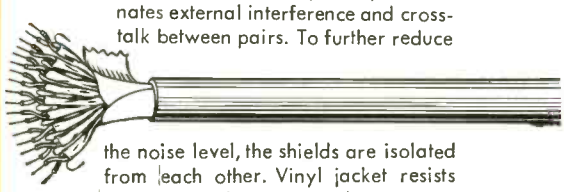
Shielded Sound, PA, and Intercom Cables



Variety of gauges, number of conductors, and shields for every application.

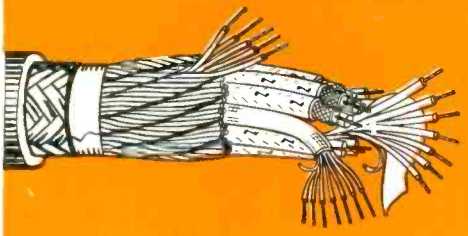
Intercom Cables—Multiple Pair Individually Shielded

BELDFOIL* aluminum-mylar tape eliminates external interference and crosstalk between pairs. To further reduce



the noise level, the shields are isolated from each other. Vinyl jacket resists water, sun, oil, grease, and ozone.

TV Camera Cables



For all color, and black and white TV transmission. Lightweight, small diameters, low friction coefficient, maximum flexibility.

Juke Box Cables

For speaker and control cables in all types of commercial music systems. Variety of shield types for every application.

Broadcast Audio Cables

Drain wire and shield isolation eliminate current loops. Free stripping jackets, fast shield termination, small diameters.

Hi-Fi, Stereo, and Phonograph Cables

Shielded connector cords and pick-up arm cables. Extremely light, flexible—small diameter. Excellent dielectric strength.

Transmission Line Cables

Variety of types and impedances for every application. Resistant to whipping, twisting, and weather; for long-lasting installations.

line of Cable

Antenna Rotor Cables

Vinyl insulated for optimum resistance to sun and weather. Provides longer trouble-free service.

Mil-Spec Hook-Up and Lead Wire

Exceed rigid requirements of all military specifications. Wide variety of sizes, insulations and jackets.

High-Voltage Cathode Ray Tube Lead

High dielectric strength. Small diameter with maximum flexibility.

UL Inspected Hook-Up and Lead Wires

Widest variety of sizes, insulations, and jackets for all electronic and electrical applications.

Portable Cordage and Rubber Multiple Conductor Cables

Two to five conductors for power supply, speaker lines, and unshielded control cable. Abrasion and impact resistant, limp and flexible — always lie flat. Also complete cord sets.

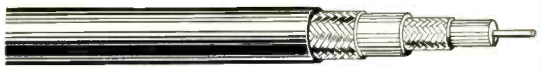
RG/U Transmission Line Cables

Wide variety of RG/U sizes and types. Approved under Mil-C-17B. Cables manufactured with strict adherence to government specifications.

These and many more

AVAILABLE from Stock

Community and Multiple Set TV Antenna Cables



Provide clear picture reception on all multiple TV set hook-ups. Sweep tested.

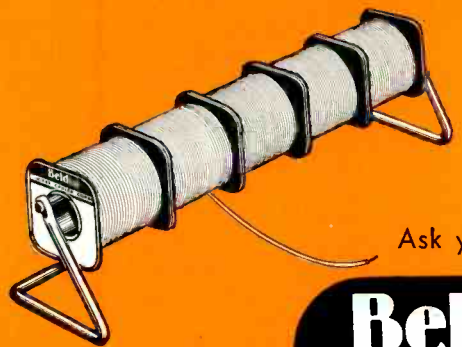
Test Prod Wire

Extremely limp and flexible. High dielectric strength. Long-life rubber jacket.

Unshielded All-purpose Sound and Intercom Cables

Solid & stranded conductors for speaker lines, unshielded control lines, and low voltage circuits of all types.

Belden Electronic Wire and Cable is available in many different packages



This handy Workbench Hook-Up Dispenser Kit is an example of how Belden's packaging program helps minimize waste . . makes stock maintenance easy. Each kit contains an assortment of Hook-Up Wire colors and types. The dispenser is designed for workbench or wall mounting.

Ask your Belden jobber

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

magnet wire • lead wire • power supply cords • cord sets • portable cordage • electronic wire • automotive replacement wire and cable • aircraft wire • electrical household replacement cords

One wire source for everything electronic and electrical.

Belden wires, cords and cables mean the lowest over-all cost from your assembly line to field operation

8-2-9

Letters

to the Editor

"EI's RFI Series"

Editor, ELECTRONIC INDUSTRIES:

The editorials concerning radio interference that appeared in the March 1960 issue of ELECTRONIC INDUSTRIES, were reviewed with considerable interest. I have been engaged in radio interference work for several years, formerly with the U. S. Air Force and presently with the Electronics Division of Temco Aircraft Corporation. Technical publications on radio interference have been very limited in the past. Only in the last five years with the initiation of the Radio Interference Reduction Conference held at the Armour Research Foundation in Chicago, Illinois, the organization of the IRE professional group on radio interference and the organization of the Radio Interference Technical Committee in Los Angeles, has limited amounts of literature become available to industry, emphasizing the serious consequences of neglecting radio interference in the design of complex airborne systems.

I would appreciate several reprints of each article on radio interference appearing in the March 1960 issue and future issues of ELECTRONIC INDUSTRIES. These articles will provide excellent material for training electronic engineers in the proper approach to design of interference free equipment.

Thank you for your interest in the radio interference field.

William C. Grubbs, Jr.
Technical Specialist, RFI
Temco Electronics Division
Temco Aircraft Corporation
Dallas, Tex.

"Outlook Studies"

Editor, ELECTRONIC INDUSTRIES:

We appreciate your interest in our Outlook Studies, as indicated by your article on page 1 of your February issue.

As you may know, all 89 Outlook Studies have now been compiled into one convenient volume, entitled *The U. S. Industrial Outlook for 1960: 89 Selected Industries*, which is now available from the Superintendent of Documents. Furthermore, the studies are indexed and grouped into industry categories such as Metals and Minerals, Forest Products, Consumer Products and Services, etc.

Robert G. Ferris
Publications Officer
U. S. Dept. of Commerce
Business & Defense Services Adm.
Washington 25, D. C.

(*Continued on page* 68)

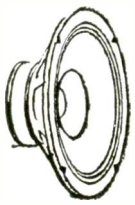
INDIANA GENERAL CORPORATION

a new symbol of magnetic progress

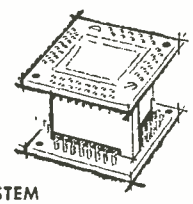
Two established leaders — Indiana Steel Products and General Ceramics — Combine to Serve You Better

This trademark is the calling card of a new leader in science-age materials — Indiana General Corporation. It is born of a union between two established leaders — The Indiana Steel Products Company in permanent magnets . . . the General Ceramics Company in ferrites and memory systems. Together, as Indiana General Corporation, they serve you better by placing at your disposal the brains and resources of two scientifically oriented concerns. Research and development have been the backbone of both of the original companies; both have records of significant achievement in their particular fields.

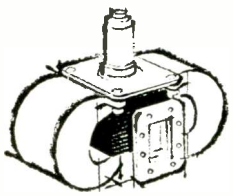
Indiana General can help you "design-engineer" your products with the latest magnetic innovations. If you have a design problem, the Indiana General sales engineer in your area will be most happy to advise you. And, behind him, our experienced scientists and design engineers are available for consultations — at no cost or obligation. Write us outlining your problems.



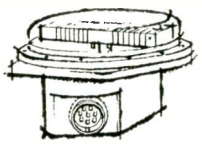
LOUD-SPEAKER
INDOX V ceramic permanent magnet provides high energy level . . . reduces speaker length and weight.



MEMORY SYSTEM
New microstack unit for coincident current memory systems saves 90% of space required by conventional stack, yet is more reliable.



MAGNETRON
Powerful Hyflux ALNICO V magnets improve performance in many types of microwave equipment.



AUTOMATIC DIRECTION FINDER
Ferramic "E" magnetic core material helped engineers create a new concept in aircraft antenna design.

This is Indiana General Corporation

INDIANA STEEL PRODUCTS DIVISION Valparaiso, Indiana • Metallic and Ceramic Permanent Magnets

GENERAL CERAMICS DIVISION Keasbey, New Jersey • Ferrites, Memory Products, Technical Ceramics and Chemical Stoneware

ADVANCED VACUUM PRODUCTS (Subsidiary) Stamford, Connecticut • Alumina Ceramic-to-metal Hermetic Terminals

STEARNS MAGNETIC PRODUCTS DIVISION Milwaukee, Wisconsin • Magnetic Materials Handling and Separation Equipment

THE INDIANA STEEL PRODUCTS COMPANY OF CANADA LIMITED Kitchener, Ontario • Permanent Magnets and Stainless Steel Castings

If your product involves magnets or ferrites, Indiana General can help you make it better.

INDIANA GENERAL
CORPORATION
VALPARAISO, INDIANA

Revolutionary General

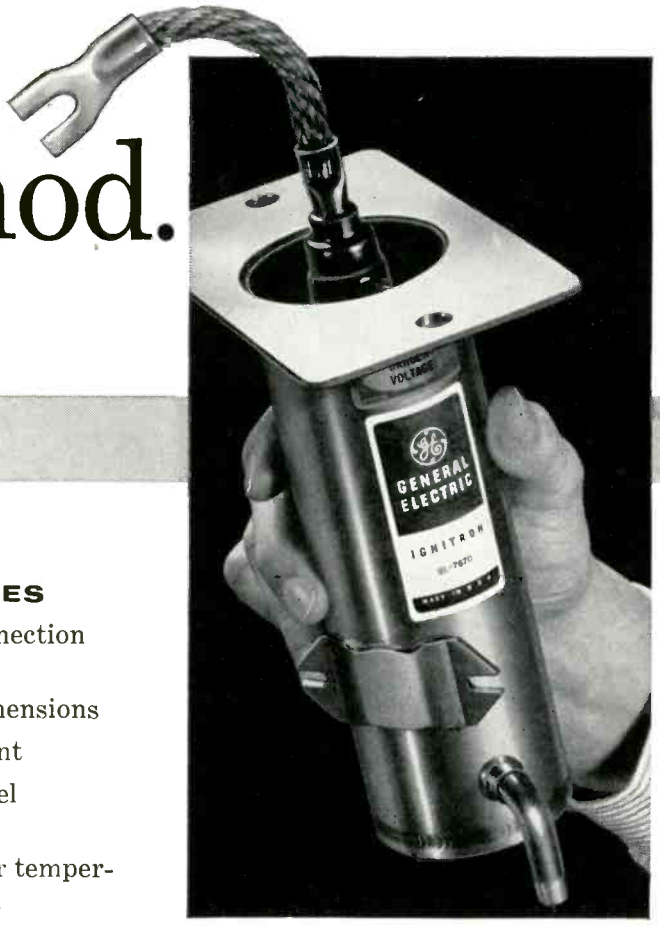
has unique high peak power which resistance welding

A new type of control ignitron with coaxial design, the GL-7670, has been developed by General Electric to control high-current, short-duration power pulses utilized by a new "pulse-power" resistance welding method.

In the new General Electric ignitron, current passes down the inside of the tube from anode to cathode, then back up the wall of the tube to a *coaxial* cathode terminal at the top. This coaxial flow of current provides a magnetic *shield* to prevent the damaging arc deflection which such high peak currents could cause in standard ignitrons.

Available for immediate delivery, the new GL-7670 may be used to advantage in a number of other high peak current applications—such as capacitor discharge circuits. The new tube meets standard size "B" welder ratings, and has the same basic dimensions as the standard "B" welder ignitron. Full information from offices listed at right.

Electric Control Ignitron coaxial design. Handles is vital to radically new method.



GL-7670
Coaxial Ignitron

FEATURES

1. Cathode connection at top
2. Compact dimensions
3. Easy to mount
4. Stainless steel jacket
5. Provision for temperature control

Progress Is Our Most Important Product

GENERAL ELECTRIC

9545-8481-25

Phone your nearest General Electric Power Tube Dept. office for samples and application assistance.

Schenectady, N. Y.
FRanklin 4-2211

•

Chicago, Illinois
SPring 7-1600

•

Clifton, New Jersey
GRegory 3-6387

•

Dayton, Ohio
BAldwin 3-7151

•

Los Angeles, Calif.
BRadshaw 2-8566

•

Newtonville, Mass.
WOodward 9-9422

•

Washington, D. C.
EXecutive 3-3600

Circle 40 on Inquiry Card

NEW

NEW BORG MICRODIALS ADD RICHNESS AND STYLE TO CONTROL PANELS AND INSTRUMENTS

Now from Borg, originator of famous Microdials, comes a fresh, new concept in turn-counting dial appearance . . . Series 1360 Microdials. These new Borg Microdials were specially developed to add style and color to electronic control panels and equipment. Available in five smart models of red, gray and black color variations. Colors are inlays of colored plastic . . . will never wear, scale or rub off. Quality mechanical features such as smoothness of action . . . absence of noise . . . fewer ambiguities in reading and setting assure accurate, reliable performance. Contoured brake arms lock settings in place, but do not interfere with reading and setting. Catalog data sheet BED-A137 gives complete color combinations and specifications. See your Borg technical representative or distributor, or let us put him in touch with you.

BORG®

BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation
Janesville, Wisconsin

Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards

Letters

to the Editor

(*Continued from Page 62*)

MIL Specs & Dummy Loads

Editor, ELECTRONIC INDUSTRIES:

Due to its very brief nature, the lead statement of "Electronic Shorts" (E.I. February 1960) is an implied error.

The statement, "Naval Research lab has developed ferromagnetic waveguide dummy loads for radar bands that can operate at all temperatures up to the present military limits," implies that the NRL group has developed a series of dummy loads that meet approved military standards for radar bands.

Actually, this statement should be qualified to state that although the NRL load series meet some military requirements, to our knowledge they have not been tested per JAN specifications MIL-D-3954A, which currently governs the military qualified products list for dummy loads,—nor were they qualified per the previous military requirements set forth under JAN specification MIL-D-14454.

The question of whether or not a firm is a qualified and approved vendor for a component is an extremely important one in the industry; so important, in fact, that one New Jersey company went so far as to assign model numbers to their line of dummy loads that correspond *exactly* to the JAN nomenclature assignments made by the military to a series of dummy loads that had been officially tested, approved, and qualified. Needless to say,—they received a Government "Cease and Desist" order to discontinue such false advertising.

At this time, the Bogart Manufacturing Corporation 4063 series of dummy loads is the only family of high power loads that has been tested and qualified in accordance with specifications MIL-D-3954A, MIL-D-14454, and MIL-T-945A. *Please note* that Bogart Manufacturing Corporation is the only firm named on the current qualified products list for dummy loads produced in conformance with the above mentioned JAN specifications.

George Zanis, Staff Supervisor
Engineering Sales
Bogart Mfg. Corp.
315 Siegel St.
Brooklyn 6, N. Y.

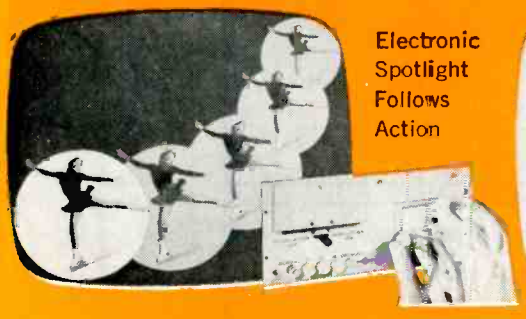
New Headquarters

Tokyo — Lear, Inc., Santa Monica, Calif., has established Far East sales headquarters in Tokyo, Japan. The company had previously maintained a Field Service Dept. in the Far East. E. H. Shrenzel will head the new office.

NEW
"Joy Stick" Positioner

Move Insert To Any Position

Model 491-A1



Electronic Spotlight Follows Action

Electronic Pointer

Create Wipes With Motion

TELECHROME SPECIAL EFFECTS GENERATOR
with Exclusive "JOY STICK" POSITIONER

First, Telechrome provided broadcasters with a vastly improved system for producing a wider variety of dramatic wipes, inserts, keying and other special effects. Now, Telechrome engineering introduces the "Joy Stick" Positioner. This makes it possible to create many hundreds more effects and to move wipes, inserts, keying or other special effects to any place on the TV screen. The effects are startling! A new era in program creativity begins now! Ask to see the "Joy Stick" Positioner demonstrated, today!

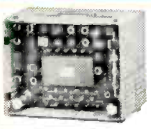
Write, Wire, Phone for Literature

COLOR TV • INDUSTRIAL INSTRUMENTATION • TELEMETRY

TELECHROME MANUFACTURING CORP.

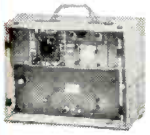
AT THE FRONTIERS OF ELECTRONICS

TELECHROME MANUFACTURING CORP.
28 RANICK DRIVE • AMITYVILLE, N.Y.
Lincoln 1-3600
Cable Address: COLORTV
TWX: AMITYVILLE NY2314



490WA1 Waveform generator. Generates keying signals for the 72 different wipes.

490SA1 Switching Amplifier. Combines two picture signals in accordance with applied keying waveform.



490RA1 Remote Control Unit. Selects and controls desired effect. Designed for console or desk mounting. Easily modified for integration into existing studio facilities. Complete with power supply—512CR1

Available Portable or Rack Mounted

N.A.B. Show
Booth No. 20

WESTERN ENGINEERING DIVISION • 13635 Victory Blvd., Van Nuys, Calif., STate 2-7479
MIDWESTERN ENGINEERING DIVISION • 106 W. St. Charles Rd., Lombard, Ill., MAyfair 7-6026
SOUTHWESTERN ENGINEERING DIVISION • 4207 Gaston Ave., Dallas, Tex., TAylor 3-3291

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

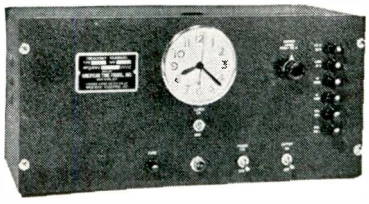
Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type

Size 1½" dia. x 3½" H. Wght. 7 ozs.

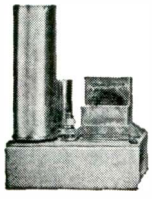
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A



Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

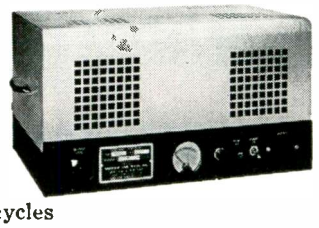


FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

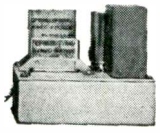
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

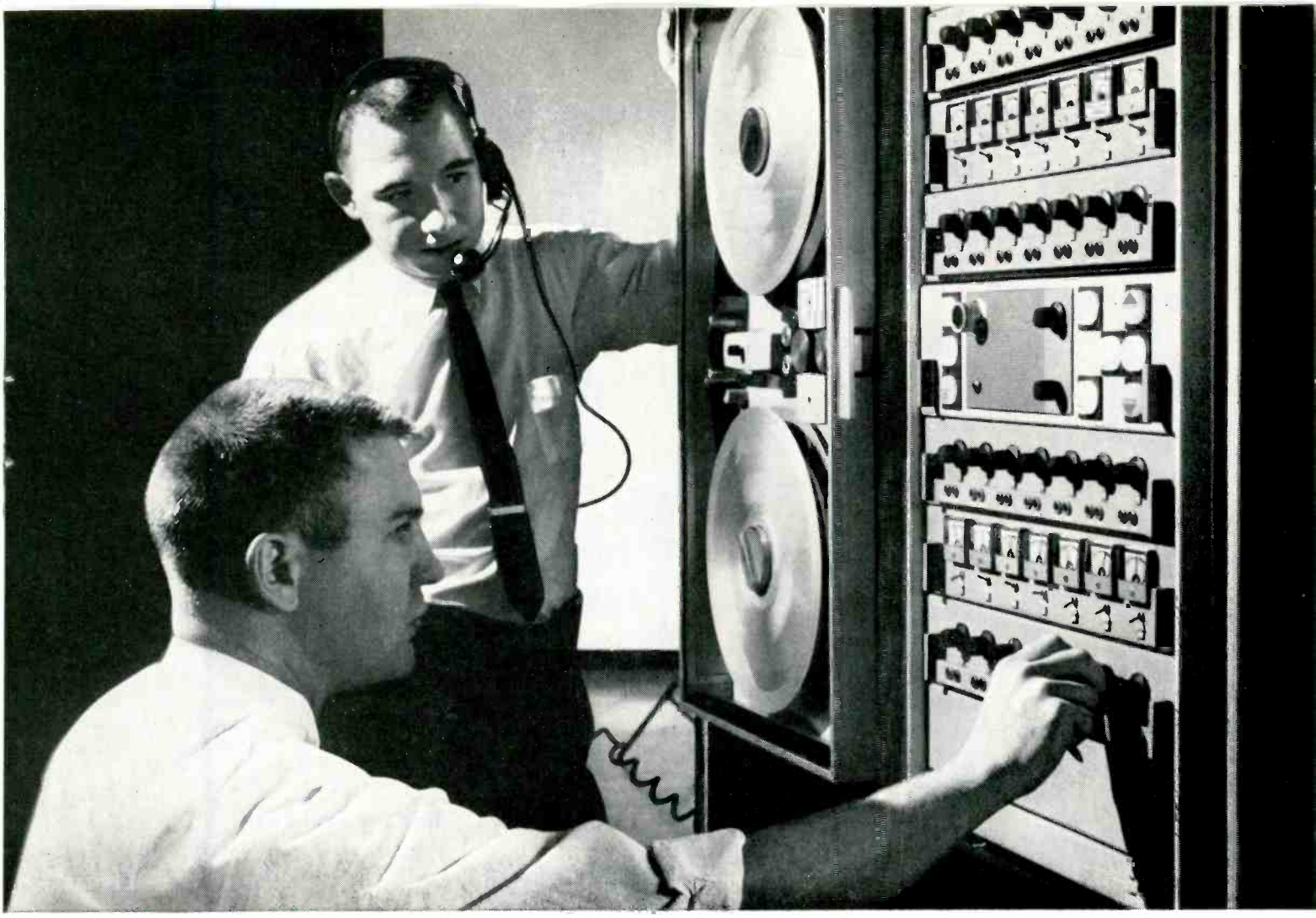
WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.



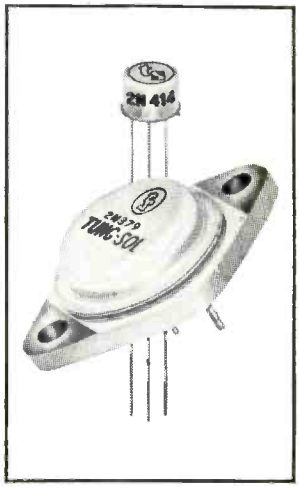
AMPEX specifies Tung-Sol transistors for FR-600 analog tape recorder

The Ampex FR-600 records the same bandwidth at half the tape speed previously required. It's the first Ampex laboratory-type instrumentation recorder to offer all solid-state electronics. Frequencies as high as 250 kc can be handled (at a tape speed of 60 ips). FM, pulse-duration modulation, direct and digital recording modes are available through plug-in amplifier modules. FM response from d-c to 20 kc within ½ db is double that previously available. The FR-600 is already handling data recording in the new Minuteman missile project.

With reliability the keyword, the choice of components for the FR-600 had to be an exacting one. Tung-Sol germanium power and switching transistors were specified for several major assignments. Tung-Sol's high stability 2N379 transistors deliver reliable power to the motor drive amplifier, the FR-600 control unit, and each bay power supply of the recorder. Tung-Sol's precision 2N414 germanium switching transistors handle important switching functions in the direct record amplifier, direct reproduce amplifier, FM record, FM reproduce, pre-amplifier and frequency standard.

More and more are Tung-Sol components assuming critical tasks in modern electronics where long-life reliability is paramount. Whether in industrial, military or commercial applications, there's a Tung-Sol tube or semiconductor for virtually every need. Every component is the product of production processes and quality control that have made Tung-Sol the name synonymous with the finest componentry. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ontario.



TUNG-SOL®

Circle 46 on Inquiry Card

International News

(*Continued from page* 32)

CANADA

Open Canadian Plant

Montreal—Automatic Timing & Controls, Inc., King of Prussia, Pa., has established a manufacturing plant at 5485 Notre Dame St. West, Montreal, Quebec. It will be known as the Automatic Timing & Controls Division of Interprovincial Safety Industries Ltd.

The new Canadian division is under the management of James Cullen, who will also continue as President of Interprovincial Safety Industries Ltd.

Form Canadian Subsidiary

Windsor — Robotron Corp., Detroit, Mich., has formed a new subsidiary, Robotron of Canada, Ltd., at Sandwich West, near Windsor, Ont. The plant will produce controls and electronic equipment. Design and engineering work will be done by the Detroit headquarters staff.

Nuclear Fuel Pact

Port Hope, Ontario — AMF Atomics (Canada) Ltd., has entered into a five-year contract with Atomic Energy of Canada Ltd. for the development and manufacture of nuclear fuel elements for Canada's atomic research and power programs. The Canadian company is an American Machine & Foundry Co. (New York) subsidiary.

EUROPE

Exchange Microwave Know-how

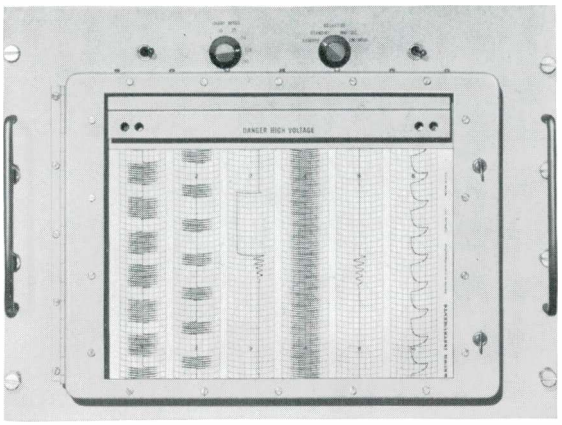
Paris—Raytheon Co., Waltham, Mass. and CSF (Compagnie Generale de TSF) France have agreed to exchange certain technical information in the microwave tube field, especially in the backward wave tubes including Carcinotrons and Amplitrons.

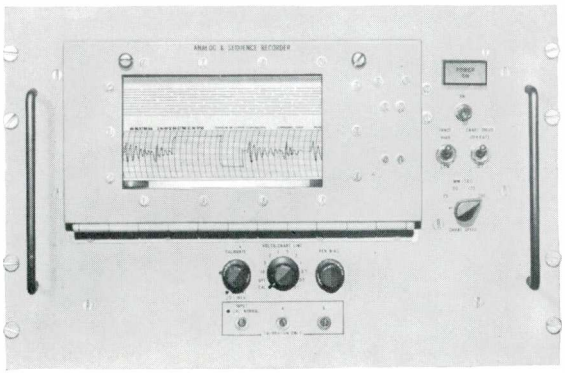
The agreement provides for more cooperation on research programs where the companies' skills are complementary. Both are currently working together on a number of Dept. of Defense R & D contracts.

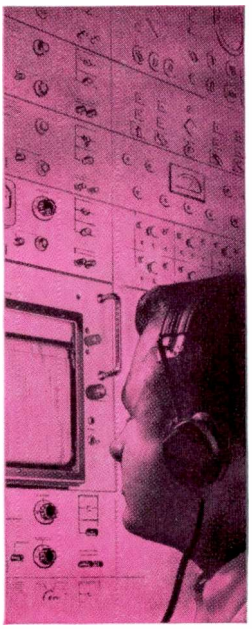
UNITED KINGDOM

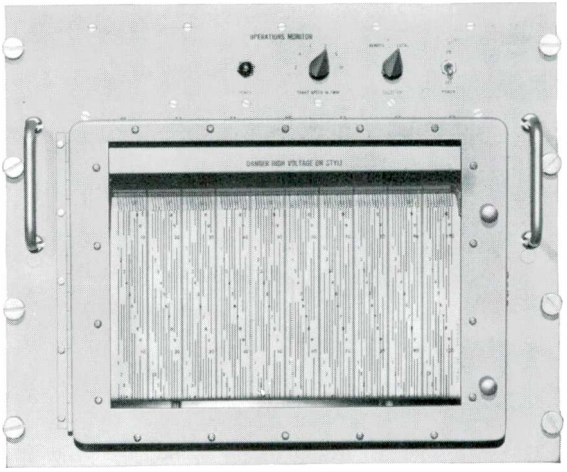
Reach Technical Agreement

Chelmsford, Essex — Marconi's Wireless Telegraph Co., Ltd., and Hermes Electronics Co., U. S., have reached an agreement for general technical collaboration in the field of point-to-point communications. The two companies will collaborate specifically in planning and supplying complete systems. Each will be licensees and agents for the other in their own countries.









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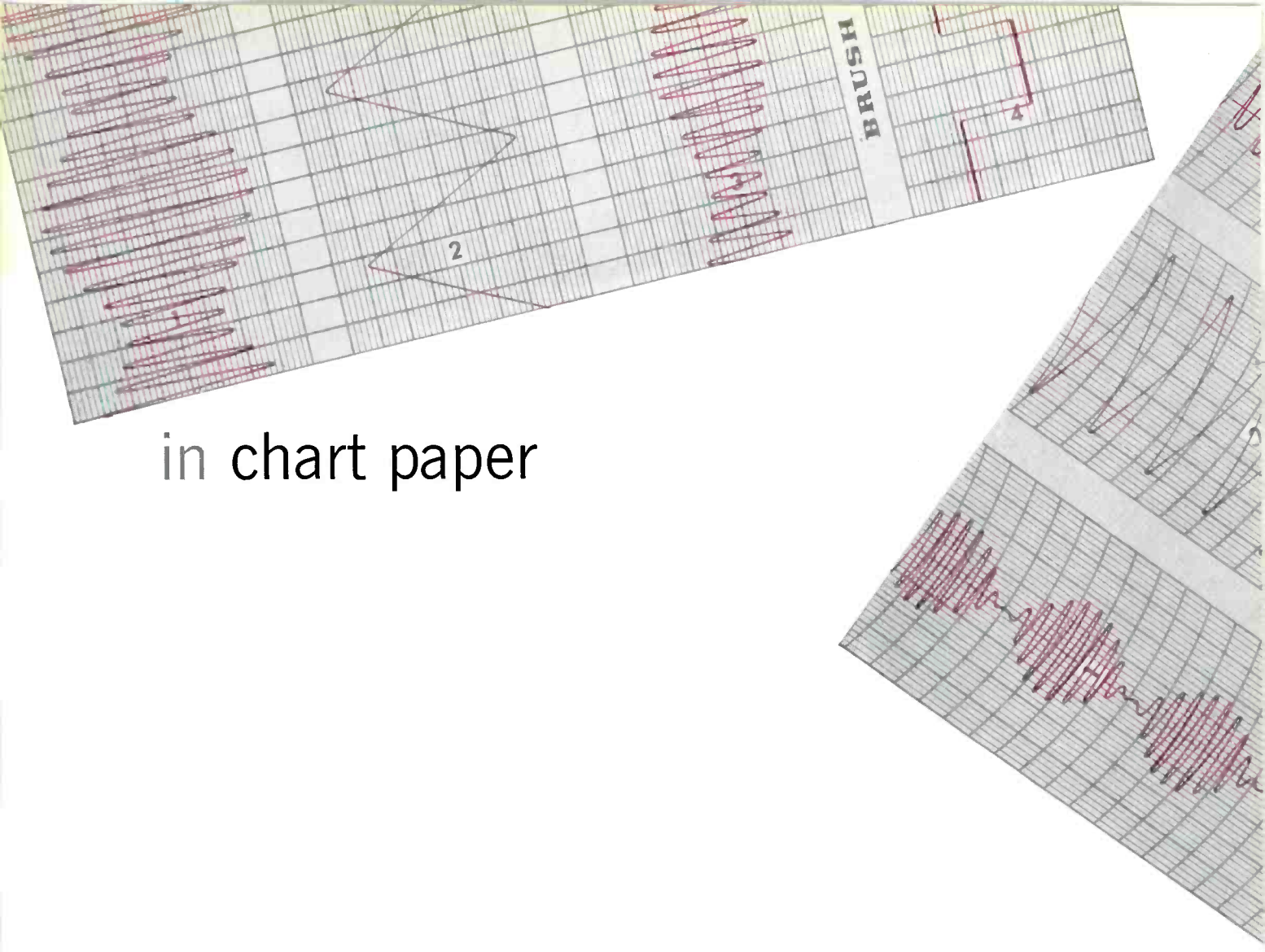

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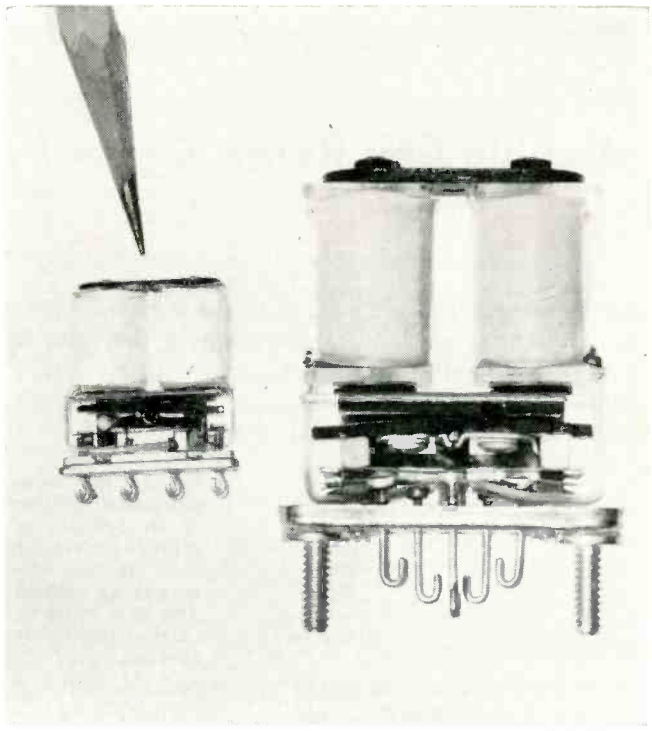


Fig. 1: Cutaway view showing single working gap double coil approach, with the balanced armature design.

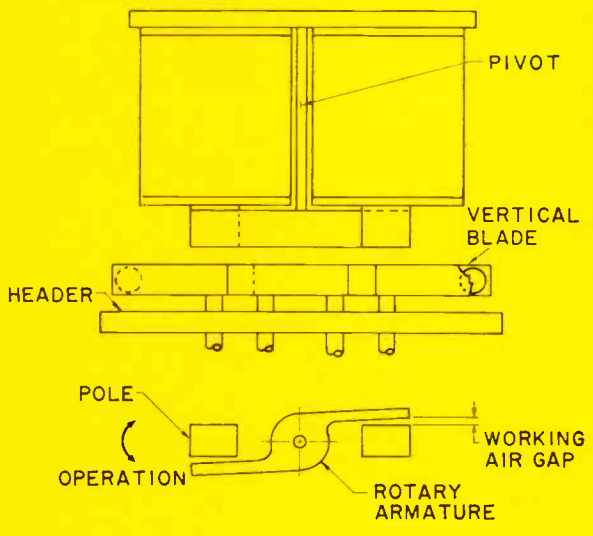
Rectangular shaped, miniature relays dictate a two-coil design if sufficient ampere-turns are to be available. This design gives a two-coil relay with a single working gap and the entire mechanical operation is close to the relay mounting surface for resistance to shock and vibration.

Double Coil Relay with One Working Gap

IN most two-coil designs using a narrow rectangular shape, the armature takes on a rotary-type action operating on a pivot between two pole faces and with two working air gaps. (Fig. 1.) The armature pivots on a line perpendicular to the header face and the contacts mount on edge relative to the header face. This type of operation, a vertical approach, would tend to put moving parts farther away from the header than a horizontal approach, and, considerably alter the mechanical aspects of the relay design and construction.

The balanced armature design, Fig. 2, consists of an armature located as close to the header as possible and with its hinge parallel to the face of the header. Below the armature are the contact blades which operate perpendicularly to the face of the header. With the contact assembly mounted directly on the header

Fig. 2: In most two-coil designs, the armature takes on a rotary-type action with two pole faces and two working air gaps.



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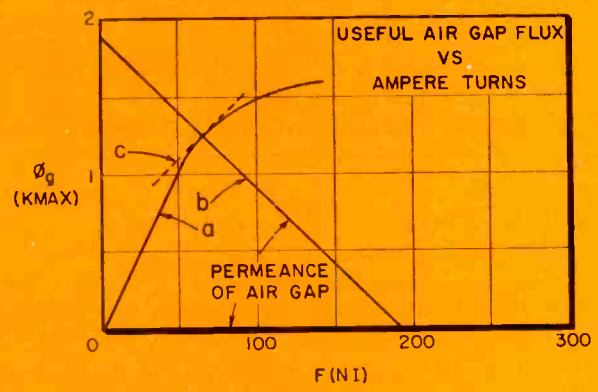

Fig. 9. Useful air gap flux vs ampere turns.

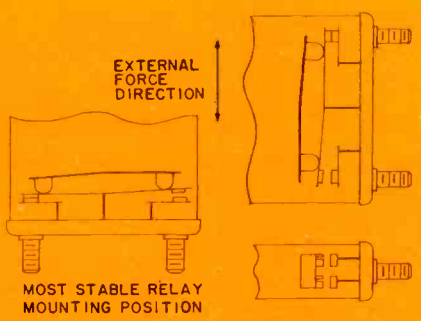

Fig. 10: Dual mounting places the blades in the best plane to resist environmental effects.

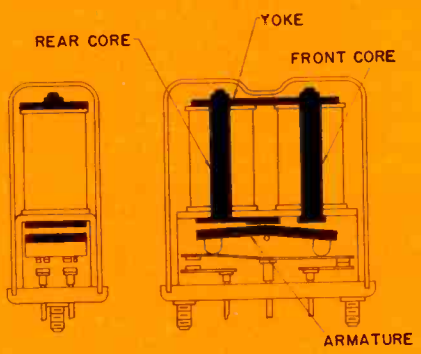

Fig. 11: Relay design lends itself to a simplified production approach.

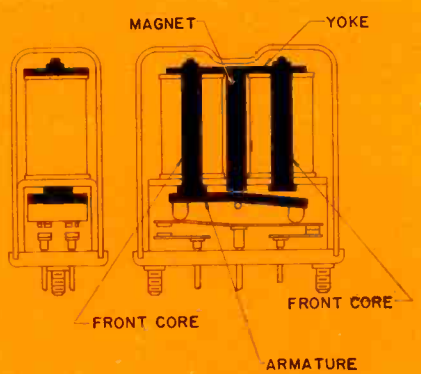

Fig. 12: The magnetic latch version, except for the permanent magnet, looks almost identical to the single working gap relay.

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided so as to permit them to be punched with standard three-hole-punch without obliterating any of the text. They can then be filed in standard three-hole notebooks or folders.

Double Coil Relay *(Concluded)*

Results

Leach Relay Div., Leach Corp., is successfully producing units of this basic design type which give an efficient, powerful, magnetic circuit to satisfactorily meet the most rugged specification requirements.

With the single working gap, double coil approach, the balanced armature relay design using the horizontal position approach is retained. This not only allows us to retain our usual armature position but again gives a blade arrangement that offers the best resistance to shock, vibration and acceleration. With the horizontal position for the blades, the dual mounting used for the relay will place the blades in the best plane to resist environmental effects. See Fig. 9.

When shock, acceleration or vibration is encountered perpendicularly to the header, the blades are in their only vulnerable position, however, in this plane, the relay is in its most rigid mounting position. In the two side planes, which are the worst planes for the relay mounting, the blades are in their best position to resist external forces. Therefore, it can readily be seen that maintaining the armature and blade position of the balanced armature relay line is a distinct advantage for the single working gap approach.

In addition, the relay design lends itself quite nicely to a simplified production approach. As shown in Fig. 10, the whole relay consists of a minimum amount of parts, readily fabricated and easily assembled. The armature is held in the frame by a standard hinge pin and positioned by the return spring. When assembled, it is easily adjusted to the proper gap relative to the staked in cores and the whole assembly attached to the header. The coils are then placed on the cores, the yoke is tightened down and the relay is ready for adjustment and soldering. In a few simple steps, the relay is ready for final processing and inspection.

Finally, an added feature that was readily available with the mechanical approach used in this design, was the simplicity of conversion to a magnetic latch relay. As can be seen by Fig. 11, the magnetic latch version, except for the addition of the permanent magnet between the coils, looks almost identical to the single working gap relay.

Actually, the only major difference between the single working gap relay and the magnetic latch, other than the magnet, is that the rear core now is the same as the front core. So, with the addition of the magnet (the only new part necessary), the single working gap relay is converted to a magnetic latch relay. This conversion makes it possible to have a second design available from the same tooling, screw machine parts and production assembly approaches as used for the first relay.

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For the Designer . . .

Heat Sinks for Power Transistors

Heat transfer problems of semiconductor power devices differ from those encountered in vacuum tube techniques. Presented here is a simple method which enables the busy engineer to quickly determine the best heat transmission path.

ALL semiconductor devices have definite junction temperature limits which cannot be exceeded without possible damage to the unit. In any event, performance will deteriorate to an unacceptable point, if these limits are exceeded.

Semiconductor manufacturers have designed their housings to provide the most efficient transfer of heat from the junction to the mounting base. From there it is the engineers responsibility to provide a path for heat transmission. This path should have the smallest practical temperature gradient and a heat sink of the smallest practical dimensions.

Heat Transfer

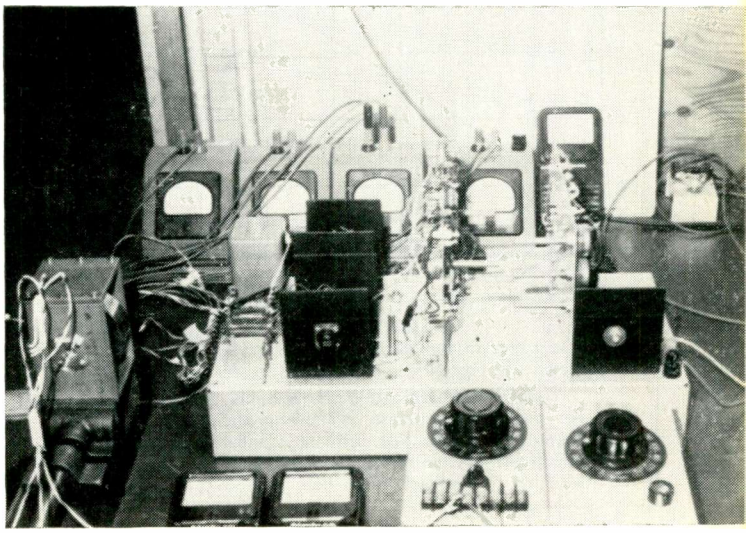
The basic principles and equations for various modes of heat transfer are well understood and covered in detail in many texts on thermodynamics. But, the busy engineer, who needs only a small heat sink for a particular transistor, is often too busy to unearth the information he needs. It is with this need in mind that this article has been written. The equations are derived from the basic laws of heat transmission, modified in some cases by empirical data obtained as a result of measurements. The terms are those commonly used in practical electrical design work.

In addition, a set of curves have been plotted which cover many applications in the laboratory. They may eliminate the need for calculation when a simple heat sink is needed.

MR. ARTHUR F. LOHMAN was associated with M. Ten Bosch Inc., Pleasantville, N. Y., when this article was prepared.

The ultimate heat sink for any source of heat energy is the earth and the atmosphere. Generated power must eventually be transferred to these sinks by conduction, convection, radiation, or a combination of these methods. It is a common mistake to assume that a large chassis or housing is the ultimate sink in itself. It, the chassis, is actually only a medium in transferring heat to another sink.

Four 2N389 silicon power transistors and one 1N1362, 10 watt silicon zener diode, each mounted on a radiator, are used in this experimental model which delivers 30 watts of 3 phase power to a motor load at 100° maximum temp.



Heat Sinks *(Continued)*

Heat to be Dissipated

The first step in designing a heat sink for a power transistor, or other device, is to determine the heat energy to be dissipated. A simple case is the Zener diode voltage regulator, operating at a constant current and voltage. If the duty cycle is 100%, the total power is readily determined. Generally, the solution requires the calculation of power input, the efficiency of the device, and the duty cycle involved. A servo amplifier is a typical example where the duty cycle may vary from 10 to 100%. During portions of this range, full power may not be demanded by the load. A typical calculation is as follows:

Power input	28 v. 0.5 a.
Power output	40 v. RMS across an $R_{EFF.}$ of 260 Ω
Duty cycle	30% approx.

Power input − power output × duty cycle = power dissipated in heat.

Example:

$$\left[28 \times 0.5\right] - \left[\left(\frac{40^2}{260}\right) \times 0.3\right] = 12.155 \text{ watts}$$

Generally, the heat to be dissipated is concentrated in a few locations, primarily power devices. The problem is then localized to conducting the heat away from these devices into the heat sink chassis. The heat generated by signal amplifiers is usually so small that special provisions for conducting the heat into the sink are not necessary.

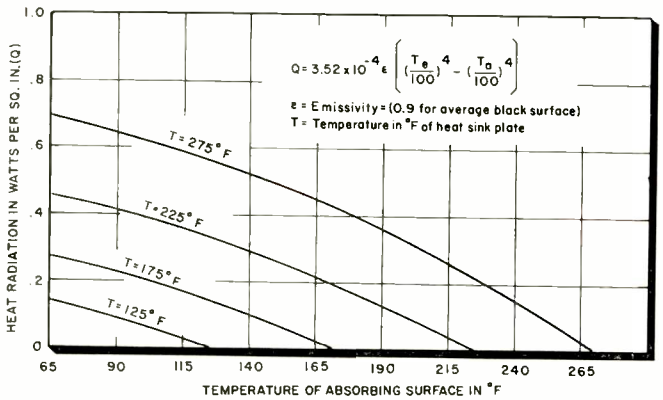


Fig. 1: Radiant heat loss from a copper plate with dull black surface.

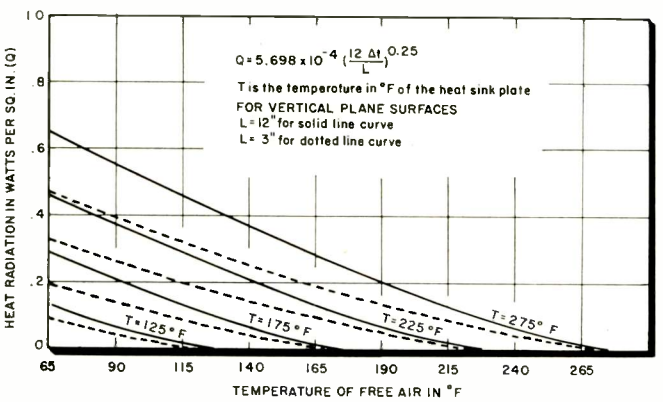
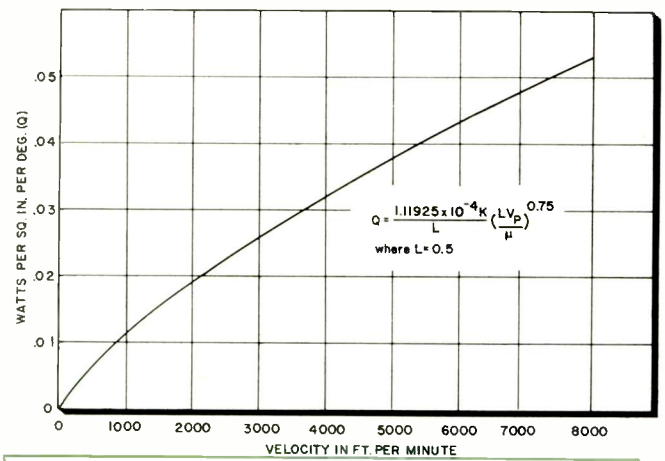


Fig. 2: Free air convection heat loss from vertical plane surfaces.

Fig. 3: Heat dissipation curve when using forced air convection.



Surface Area Required

For the moment, let us assume that the heat has been conducted from the source to a sink which will dissipate the power by the combined means of convection and radiation. To simplify the calculation, further assume, for the first case, that the temperature gradient over the entire surface area of the sink is essentially zero, which will result in uniform radiation and convection. Actually this is never the case, but by using proper materials with sufficient cross sectional area, the temperature gradient may be reduced to a negligible value.

Radiant Heat Energy Loss

Heat loss due to radiation is primarily determined by the temperature difference between the radiating body, the absorbing body, and the emissivity of the two bodies. The configuration factor is also a fundamental term in the equation. For simplification, it will be assumed to be unity, i.e., the absorbing body completely surrounds the radiating body. Fortunately this is usually the case.

$$H_c = 0.173\, A_1\, \epsilon\, F_A \left[\left(\frac{T_e}{100}\right)^4 - \left(\frac{T_a}{100}\right)^4\right] \text{ Btu/hr/sq.ft. (1)}$$

where,

F_A = configuration factor

T_e = temperature of emitting body (° R)

T_a = temperature of absorbing body (° R)

ϵ = emissivity

This equation can be converted into the following expression which uses terms more commonly found in electronic design.

$$Q = 3.52 \times 10^{-4}\, \epsilon \left[\left(\frac{T_e}{100}\right)^4 - \left(\frac{T_a}{100}\right)^4\right] \text{ watts/sq.in. (2)}$$

The emissivity ε, is a function of both the radiating and absorbing body; for elementary cases, it may be considered the same for both. The surrounding air is not the absorbing body for radiant heat energy, since only a very small percentage is actually absorbed

by the air. The surrounding solid objects such as walls, earth, and supporting chassis absorb the greatest portion of radiant heat energy.

The emissivity ϵ, for some typical chassis materials is given in Table 1.

A dull or oxidized surface is far superior to highly polished surfaces. Flat black oil paints and lacquer on a good conductive material result in very efficient radiators. It is recommended that the heat sink and surrounding absorbing surfaces be sprayed with several coats of a durable flat black enamel wherever it is permissible to provide such a surface finish.

Radiant heat loss from a copper plate with a dull black surface is shown in Fig. 1. An emissivity factor of 0.9 has been assumed for both the radiating and absorbing bodies, a figure which is conservative, so that actual radiation may be slightly higher for optimum values of ϵ.

Loss from Free Convection

Heat loss due to free air convection is a function of the surface temperature of the sink, its physical shape, its orientation, and the air density. Since heat sinks for semiconductors can generally be designed as plane surfaces, the following is confined to a horizontal or vertical plane surface at normal atmospheric pressure. The heat loss is usually referred to as the film coefficient and for a vertical plane surface is basically expressed as follows:

$$H_c = 0.28 \left(\frac{\Delta t}{L}\right)^{0.25} \text{Btu/hr/sq.ft./°F} \qquad (3)$$

Δt = temperature difference between free air and heat sink (°F)

L = vertical height (ft.) (where L is less than 2.0)

Converting Eq. (3) into watts per square inch we have

$$Q = 5.698 \times 10^{-4} \left(\frac{12\,\Delta t}{L}\right)^{0.25} \text{watts/sq.in.} \qquad (4)$$

For horizontal plane surfaces with the warm side upward, multiply Q x 1.29 and with the warm side downward, multiply Q x 0.636. Table 2 gives the film coefficient C, for other configurations. When the pressure is less than one atmosphere, Q is proportional to the square root of the pressure in atmospheres. At high altitudes, the film coefficient is reduced to a very small value and heat loss must be achieved primarily by radiation. For example, at an altitude of 70,000 ft., the pressure is approximately equal to 1.32 inches of mercury and Q is 20.8% of its value at one atmosphere.

$$Q = \sqrt{\frac{1.32}{29.92}} = 0.208$$

A set of curves showing heat losses from vertical plane surfaces 3″ and 12″ high are shown in Fig. 2. A uniform temperature is assumed over the surface area.

Loss from Forced Convection

When the combined heat losses from radiation and free air convection indicate the use of a heat sink which is too large for practical purposes, forced air convection is necessary. The surface coefficient for turbulent flow of air parallel to plane surfaces may be expressed by the equation,

$$H_c = 0.055 \frac{K}{L} \left(\frac{L\,V\,P}{\mu}\right)^{0.75} \text{Btu/hr/sq.ft./°F} \qquad (5)$$

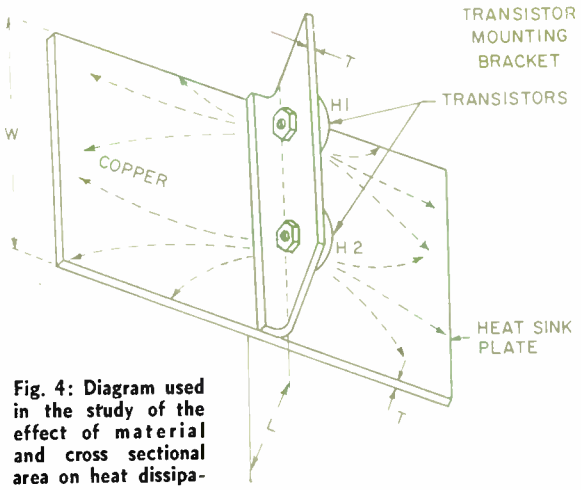


Fig. 4: Diagram used in the study of the effect of material and cross sectional area on heat dissipation.

TABLE 1

Material	ϵ
Polished aluminum plate	0.040
Natural rolled brass	0.06
Commercial polished copper	0.030
Heavily oxidized copper (black surface)	0.78
Smooth polished sheet iron	0.28
Flat black lacquer	0.97
Oil paints, dark colors	0.92 to 0.96
Lampblack, thin layer	0.95
Thin paper, pasted on tinned iron plate	0.924
Water	0.95

TABLE 2

Shape and Position	C
Vertical plates	0.55
Horizontal cylinders	0.45
Long vertical cylinders	0.45 to 0.55
Horizontal plates, warm side downward	0.35
Horizontal plates, warm side upward	0.71
Spheres	0.63

TABLE 3

Table of Thermal Conductivities

Material	Gram calories per second per centimeter of length, per degree centigrade	Btu per hour, per foot of length, per sq. ft. of area, per degree fahrenheit
Silver	0.99	242
Copper	0.91	224
Aluminum	0.49	117
Brass	0.26	64
Steel	0.15	35
Mercury	0.0195	4.8
Mica	0.0012	
Air	0.000054	

where,

K = thermal conductivity of air—(0.0153)

V = velocity (ft./hr.)

μ = viscosity (lb./ft./hour of air)—(0.045)

P = density (lb./ft.^{3} of air)—(0.0734)

L = length (ft.)

Converting Eq. (5) into watts per sq. in. we have,

$$Q = \frac{1.11925 \times 10^{-4} K}{L} \left(\frac{L V P}{\mu}\right)^{0.75} \text{watts/sq. in./°F} \quad (6)$$

By substituting in Eq. 6, the constants for values of K, and P for air, it may be further simplified to the following expression,

$$Q = \frac{1.7125 \times 10^{-6}}{L} (1.812\ L\ V)^{0.75} \text{ watts/sq. in./°F} \quad (7)$$

Heat dissipation for forced air convection is shown in Fig. 3. A uniform temperature over the surface area has again been assumed. It will be noticed that with zero air velocity, the heat dissipation as indicated by the curve is zero. Practically, this is not the case, as some free air convection will usually occur, depending upon the surface configuration and orientation of the heat sink.

Material and Cross Sectional Area

Up to this point, the assumption has been made, that heat energy has been conducted from its source to all points on the surface of the heat sink plate with a negligible temperature gradient. Consider Fig. 4, where the heat source consists of a pair of power

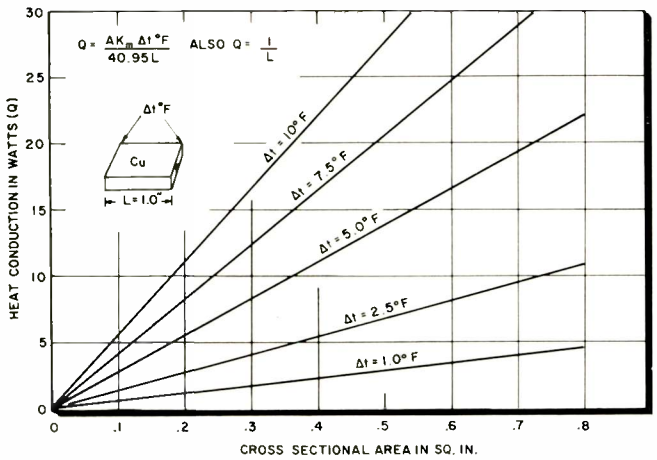


Fig. 5: Steady state heat conduction in the pure copper plate shown.

transistors fastened to a bracket which is fastened to a heat sink chassis. Assuming that H_1 and H_2 have equal power dissipation and are mounted close to each other, heat will flow in all directions as indicated by the arrows with a temperature gradient dependent upon the thermal conductivity of the materials and their cross sectional area.

Table 3 gives the thermal conductivity of various common metals and chassis materials. Inspection shows that the most conductive materials of a practical nature are aluminum and copper while brass and steel should be avoided for use as a heat sink or a conductive path. Mica insulating washers are frequently used as an insulator between a semiconductor and a heat sink, but the thickness should be held to an absolute minimum because of the poor conductivity of mica.

It is also very important to eliminate all air gaps in a conductive path, by precise fitting of the members and then silver soldering. When small air gaps are unavoidable, such as when an assembly is bolted in place to a main chassis, filling the air gaps with a heat conducting silicone grease will greatly reduce the temperature gradient.

The basic equation for steady state heat conduction is

$$Q = \frac{A K_m (t_1 - t_2)}{L} \text{ Btu/hr.} \quad (8)$$

where,

A = area (ft.^{2})

K_m = mean thermal conductivity (Btu/hr./sq.ft./°F/ft.)

$t_1 - t_2$ = temperature difference at opposite faces of the conducting material (°F)

L = length of heat conducting path (ft.)

Converting Eq. (7) to watts and inches, we have

$$Q = \frac{A K_m (t_1 - t_2)}{40.95\ L} \text{ watts} \quad (9)$$

where,

L = length of heat conducting path (in.)

A = area (in.^{2})

Referring again to Fig. 4, it must be determined what the cross sectional area of the vertical bracket should be. A temperature gradient must be assumed, e.g., 1°F, and the length and width are generally determined by other considerations in packaging a unit. Eq. 9 will indicate the cross sectional area required.

Obviously, since all of the parameters may be varied to suit a particular case, a choice will have to be made which results in the most desirable configuration. It is usually best to select copper as a material for a bracket of this type because of its superior heat conduction and the ease with which it may be soldered to the main heat sink.

Since the required surface area of the heat sink has already been determined, the length and width will usually be governed by other considerations in the final design. Eq. (9) will indicate the thickness needed for the selected material for a given temperature gradient along the surface of the heat sink. The smallest gradient possible should be maintained in keeping within practical limits of material thickness.

The curves on Fig. 5 show the thermal conductivity for copper with a path length of 1.0 inches for various temperature gradients. Since the conduction in watts is directly proportional to the length, Q is proportional to $1/L$ for other values of L.

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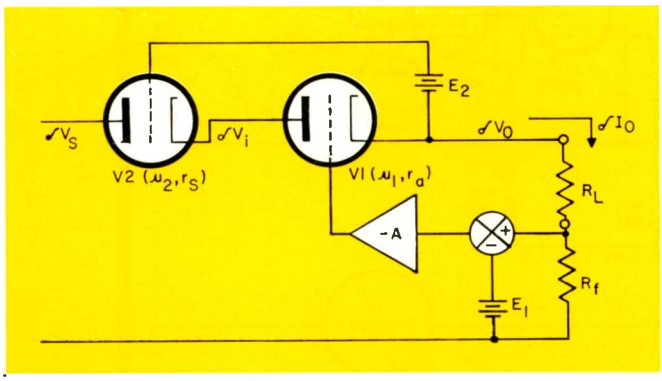
Current Stabilizer Has Wide Dynamic Range

A conventional series—tube current stabilizer often requires each tube to be able to dissipate full load power—a much greater capacity than required under steady-load conditions. How to avoid or reduce this problem is described here. A stabilizer is developed in which the dynamic range is large enough to permit sudden-short-circuiting of the load at maximum current without significant load current change.

THE design of a conventional series-tube current stabilizer is often difficult where the load impedance changes widely and rapidly. If a constant-voltage rectifier forms the basic power supply, the series tube(s) must be able to dissipate nearly full-load power. The final design, therefore, employs a much greater series tube capacity than is required under steady-load conditions. This situation can be avoided, or at least ameliorated, by incorporating a second feed back loop, operating on some form of input voltage control, whose object is to maintain approximately constant voltage across the series tube(s). A stabilizer of this type having a current range of from 10 to 200 ma in a maximum load of 6000 ohms is described here. The dynamic range is large enough to permit sudden-short-circuiting the load, at max. current, without significant load current change.

Fig. 1: General form of the two-loop stabilizer.



Circuit Analysis

Fig. 1 shows the general form of the two-loop stabilizer. The load current is monitored by passing it through a measuring resistor R_f. The voltage across R_f is compared with a reference voltage, (E_1) amplified, and fed degeneratively to the grid of V_1. This part of the system is a conventional stabilizer. The voltage across V_1 is compared with a second reference voltage E_2, and the difference fed degeneratively to whatever mechanism is used to vary the input voltage. For the purposes of analysis, this control is represented by a 2nd series tube V_2, though quite obviously an actual controller of this form would give no advantage over a simple stabilizer, since the power of which V_1 is relieved would have to be dissipated in V_2.

Consider first the main loop. Let there be a voltage change δV_i at V_1 anode, and let this give rise to a change δV_o at V_1 cathode, the load impedance being constant. Then:

$$(\delta V_i - \delta V_0) = (\delta I_0 \cdot r_a - \mu_1 V_{g1})$$

and since:

$$V_{g1} = -A\left(\frac{R_f}{R_f + R_i}\right)\delta V_0,$$

and:

$$\delta V_0 = \delta I_0 (R_f + R_i),$$
$$(\delta V_i - \delta V_0) = \delta I_0 (r_a + \mu_1 \cdot A \cdot R_f) \quad (1)$$

also:

$$(\delta V_i) = \delta I_0 (r_a + R_L + (1 + \mu_1 A) R_f) \quad (2)$$

Eq. 2 is the well-known expression from which the stabilization ratio and output impedance of a series stabilizer can be obtained.

Considering now the auxiliary loop, and assuming that the hypothesized change δV_i was in turn the result of an input change δV_s,

$$(\delta V_s - \delta V_i) = \delta I_0 \cdot r_s - \mu_2 V_{g2}$$

and since

$$V_{g2} = -(\delta V_i - \delta V_0)$$
$$(\delta V_s - \delta V_i) = \delta I_0 \cdot r_s + (\delta V_i - \delta V_0) \mu_2 \cdot \quad (3)$$

whence, from (1) and (2)

$$\delta V_s = \delta I_0 (r_s + (1 + \mu_2) r_a + (\mu_1 \mu_2 A + \mu_1 A + 1) R_f + R_i) \quad (4)$$

This shows that the output impedance of the two-loop stabilizer is

$$R_0 = (r_s + r_a (1 + \mu_2) + [1 + \mu_1 A (1 + \mu_2)] R_f, \quad (5)$$

and on the assumption that $\mu_1 A R_f >> r_s$, r_a, and that μ_2 is not necessarily large, this simplifies to

$$R_0 = (\mu_1 A (1 + \mu_2) R_f) \quad (6)$$

Thus in addition to its economical wide-range property, the two-loop stabilizer gives a significant performance improvement even for very modest values for μ_2. This is in contrast to the simple stabilizer, where additional loop gain almost always has to be bought at the expense of restricted range.

Practical Circuit Considerations

The use of a second series tube as in Fig. 1 does not constitute a solution to the problem, and in practive V_2 is replaced by some form of non-dissipative controller such as a saturable reactor, magnetic-amplifier, controlled rectifier, or servomotor and variac. The circuit described here uses thyratrons as primary power supply rectifiers. The basic circuit is shown in Fig. 2. As in Fig. 1, the V_1 circuit is conventional. The voltage across V_1 is compared directly with E_g, and the difference is applied as dc bias to the control grids of thyratrons V_2, V_3. Full-cycle control is obtained in the normal manner by superimposed quadrature ac line bias. Dc levels are established by putting all series smoothing elements in the negative dc line.

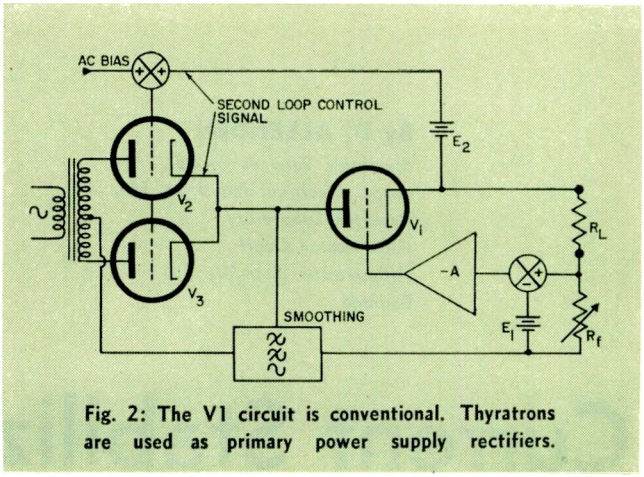
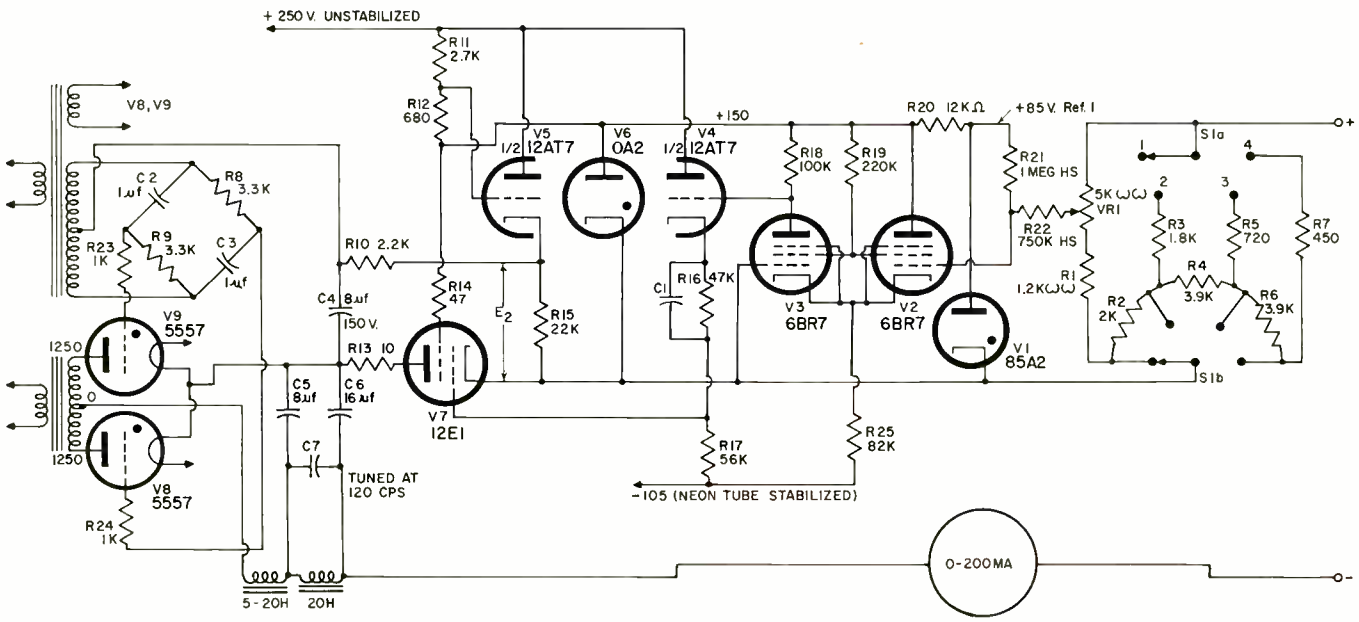


Fig. 2: The V1 circuit is conventional. Thyratrons are used as primary power supply rectifiers.

Detailed Circuit

The stabilizer of Fig. 3 was designed for a space-charge-limited, electron bombardment heating apparatus having a nominal resistance of about 6000 ohms, but in which large reductions, amounting in the worst cases to virtual short-circuit, result from ionization, outgassing, and flashovers. A stabilized working current variable over the range 10-200 ma was required.

Fig. 3: Stabilizer designed for a space-charge-limited, electron bombardment heating apparatus.



Considering the implications inherent in the use of a conventional stabilizer, a peak series tube dissipation of 200 ma × 1200v = 240 w would be necessary. The standard British series control tube (the 12E1) has an anode rating of 35 w, and hence 7 such valves would be necessary. On the other hand, a single 12E1 can easily handle the full 200 ma, at the 175v anode drop necessary to keep dissipation within rating. Referring to Fig. 3, the load current is passed through the 4-range measuring resistor system $R_{1\text{-}7}$, with a potentiometer VR_1 providing overlapping fine control. The nominal range coverage is 10-50 ma, 40-100 ma, 90-150 ma, and 140-200 ma. The voltage at VR_1 slider is compared at V_2 grid with a positive reference voltage obtained from high-stability gas-discharge tube V_1, V_2 and V_3 form a long-tailed pair type of differential amplifier; an amplified error signal of appropriate sign is taken from V_3 anode to V_7 grid via cathode follower V_4 and divider R_{13}-R_{14}. Loop gain at line frequencies is boosted about 6 db. by the capacitor C_1.

The H.T. and negative rail for V_2, V_3, and V_4 and the supply to V_1, are all obtained from an auxiliary power supply giving +250v (unstabilized) and −150v (neon-tube stabilized). A +150v supply is derived from the +250 by neon-stabilizer V_6. A useful increase of loop gain is realized by utilizing the +150v supply as screen grid feed to V_7, so the valve operates as a pentode.

The reference voltage E_2 for the auxiliary control loop does not need to be stabilized, and is obtained by tapping the V_6 feed resistor at an appropriate level. The auxiliary loop is closed merely by returning E_2 to the grids of thyratrons V_8, V_9, though some refinements are necessary. Quadrature bias is added via transformer winding N_3 and phase-shifting bridge R_8 R_9 C_2 C_3. A cathode follower, V_5, buffers the E_2 supply, and a filter R_{10}. C_4 is necessary because there is significant ripple voltage across V_7 which must not be allowed to modulate the error signal.

The use of thyratrons gives rise to power supply ripple greater than would normally be encountered, particularly at small conduction angles, while it is undesirable, for the reason given above to use the series tube for high-level ripple-reduction. Hence adequate pre-stabilizer smoothing must be provided, and two choke-input sections are employed, the second choke being tuned for 120 CPS rejection.

The auxiliary power supplies, and the primary control circuitry, are wholly conventional and have not been shown in Fig. 3. Delayed switching to T_2 primary is provided.

Performance

Performance was measured using a 5000 ohm resistive load which could be short-circuited.

Residual short-term fluctuations are less than 2 parts in 10^4.

Ripple current in the load is less than 1 part in 1000 above 75 ma load, increasing to 5 parts in 1000 at the lowest currents.

The measured value of μ_2 was about 5 between 50 and 150 ma—over the full range its average value was only 2.5.

The output impedance, determined by short-circuiting a 5000 load carrying 200 ma, is 760 k ohms. This is in reasonable agreement with the theoretically-predicted value of 825 k ohms. For small fluctuations the output impedance may be up to three times this value, depending on the exact working point.

Compact Panel Meter

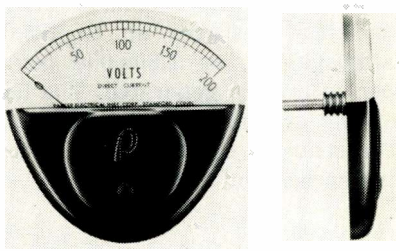
NEW panel meters embody a revolutionary approach to movement design using a printed circuit coil in conjunction with a thin ceramic ring magnet. Manufactured by Parker Electrical Instrument Corp., Stamford, Conn., it is marketed through Interlab Inc., 437 Fifth Ave., New York 16, N. Y.

The most striking advantage of this technique is that the entire meter is contained in the scale housing and nothing projects from the rear except the terminals—which also serve as mounting screws.

Gone is the necessity for drilling large holes in instrument panels. Gone are the tricky mounting problems—and the need to locate small nuts around the meter body. Assembly time is cut to a minimum, and the vacated space is available for other components, facilitating a more compact assembly.

The flat printed-circuit movement is contained between small steel front and back plates which complete the internal magnetic circuit. Thus, complete protection is provided from external magnetic influences. There is therefore no need to specify the panel on which the meter is to be mounted. The close proximity of transformers and choke coils, etc., will not affect its accuracy.

All commonly used metal magnets weaken with age. Those used in panel meters lose sufficient magnetism in a year or two to significantly affect meter accuracy.



On this panel meter, only the combination mounting screws and terminals extend behind the panel. A printed circuit movement is the key to this much needed design.

Ceramic magnets, although free from these losses, have not been used in meters hitherto because of their low residual flux density. In the Parker Meter movement, however, the flat printed circuit coil is exposed to the whole face of the ring magnetic in a manner that ensures full sensitivity while retaining the advantages of exceptional long-term stability.

Standard ranges are 1 milliampere to 1 ampere and 10 volts to 500 volts.

What's New . . .

Growing Diamonds

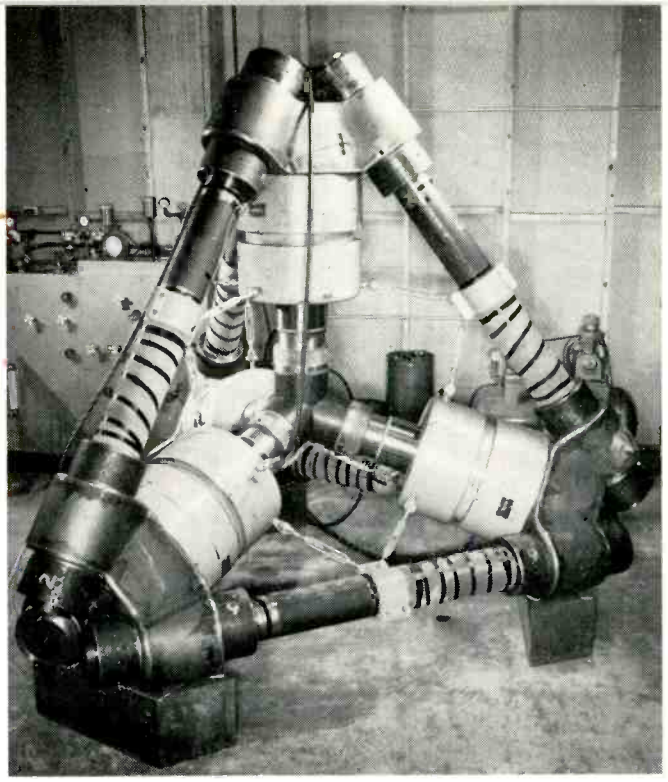


Fig. 1: Tetrahedron anvil press can develop pressures up to 125,000 atmospheres (1,800,000 lbs/in^2). Non-metals can become metals as electrons are forced from their normal orbit and move freely within the substance.

SCIENTISTS at the Electronic Material Sciences Laboratory, Air Force Cambridge Research Center, Hanscom Field, Bedford, Mass., have successfully grown diamond crystals from graphite under conditions of high temperature and ultra high pressure. The experiment was successful on the very first attempt.

Work on the ultra high pressure apparatus began about one year ago. The apparatus, called a tetrahedron anvil press (see fig. 1) will be used in a major research program in the relatively unexplored region of ultra high pressures.

The tetrahedron anvil press consists of four pistons arranged so that their heads meet at a common center. At this common center, working pressures up to 125,000 atmospheres, or 1,800,000 pounds per sq in., are generated. The limit of the pressures possible is set by the strength of the materials used in the head or anvils.

Ultra high pressures can induce profound changes in matter. Under increasing pressure, molecules are squeezed into a succession of differing geometrical patterns — and even the atoms eventually deform. Non-metals become metals as electrons are forced from their normal orbit and move freely within the substance. These reactions are greatly speeded when the material is heated. The new materials which may be formed under varying conditions of temperature and pressure may exhibit unsuspected conducting (and hence electrical) properties.

The diamonds grown by AFCRC were formed from graphite, with nickel serving as an essential catalyst. (The role of the catalyst is not fully understood). They were formed at a combination of temperatures and pressures considerably below the limit of the apparatus—at about 80,000 atmospheres and 1700 degrees C. The application of high temperatures and pressure alone, however, cannot produce a diamond. The combination must be applied in a carefully controlled sequence. First the pressure is raised, then the temperature. With maximum pressure and temperature, the diamond crystals are formed in about two minutes. The temperature, is then lowered, and last the pressure. If the pressure is lowered first, the diamond crystals would revert to graphite. The entire process takes about 12 minutes. The result is a number of beautifully formed crystals (see fig. 2) which, when viewed under a microscope, range in color from dark green to pure white.

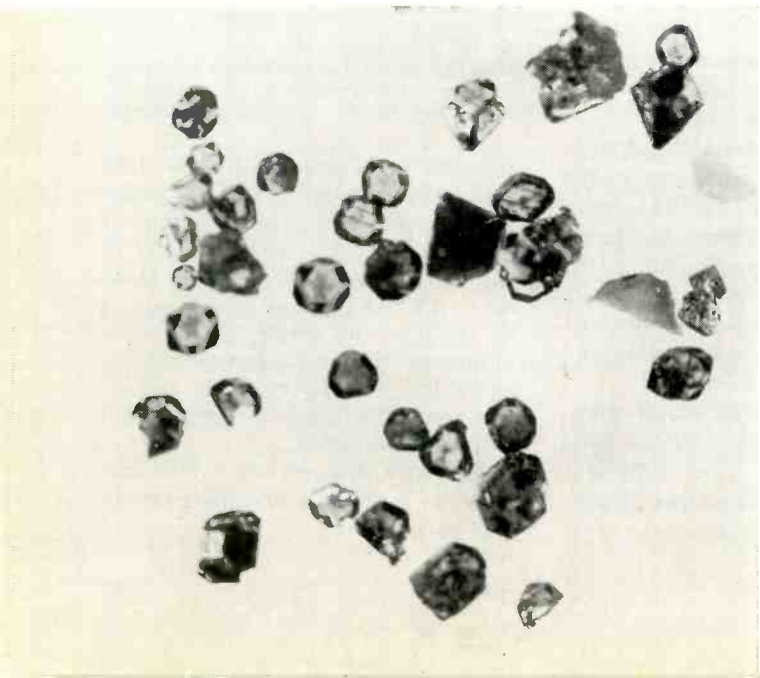


Fig. 2: Beautifully formed diamond crystals when viewed under a microscope range in color from dark green to pure white. Diamonds, excellent semiconductors, were formed at about 80,000 atmospheres and 1700° C.

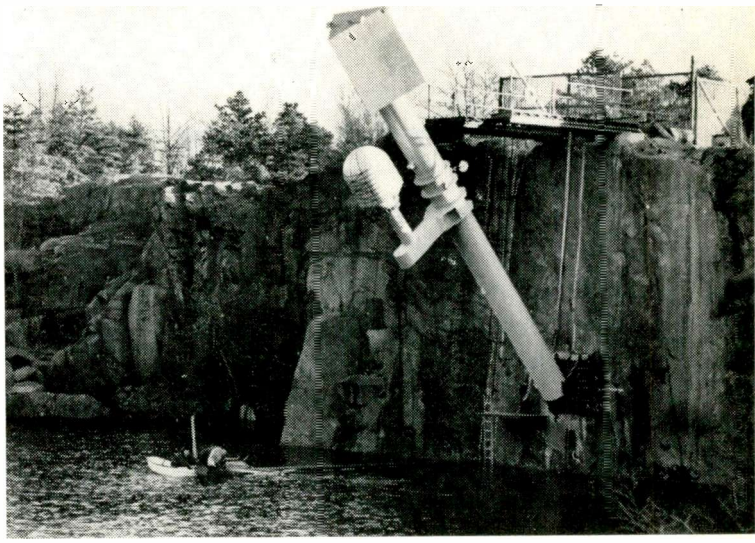
Although diamonds are excellent semiconductors and therefore of considerable interest to the electronic material scientist, AFCRC is also interested in subjecting a variety of materials to ultra high pressures to learn how they are affected. It is not always possible to predict just what the properties of a material formed under ultra high pressure will be.

Water Impact Testing

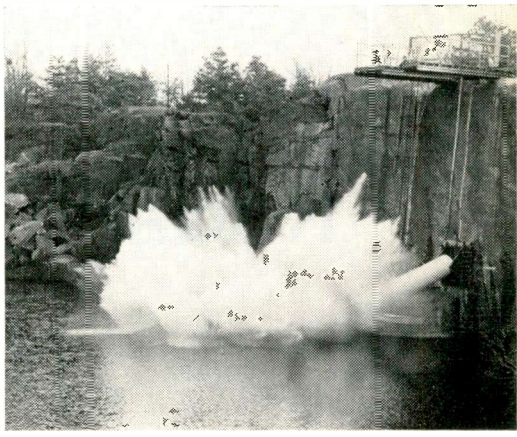
ALLIED Research Assoc., 43 Leon St., Boston, Mass., has built a Water Impact Test Facility in Gloucester, Mass. It will be used for full-scale simulation for testing submarine mounted radomes up to conditions approximating sea state five. Essentially, the test installation is comprised of a large boom affixed near the base of a sheer cliff. A radome is attached near the top of the boom. The boom falls freely as a pendulum from various heights to impact the water at various velocities. An instrumentation system records data for measuring structural dynamics.

The facility consists of seven major elements: a boom, hinge, support beam, "sting" balance, water brake wedge, engine winch, and instrumentation recording equipment.

The installation can be used for other water impact test applications such as capsules, recovery systems, and launching systems. Such testing could possibly contribute to the development of ejection seats, sonar transducers and housings, etc. It has several advantages over the usual drop test. Direct wire instrumentation permits positive recording; it is instantly known if usable data have been obtained; there is precise regulation of drop height; impact velocity of item tested, for practical purposes, is retained during water penetration; the impact angle of the device tested can be accurately established and regulated; and there are no post test recovery problems.



(Above) Boom is in upright position with radome attached. Height of radome above water can be precisely set. Water brake wedge at top arrests motion after impact.



(Right) Submarine radome being tested. Deep quarry water eliminates reflective effects. Data is recorded by direct wire oscillographs supplemented by underwater photography.

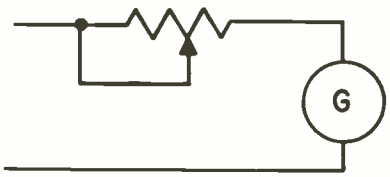


Fig. 1: Typical circuit used in the airborne recorder that is part of the checkout system for the Falcon air-to-air missile.

Trimmers in Missiles

TO achieve precision promptly in complex circuitry, a new approach is being used more frequently in new designs. This is due to a new line of trimmers, available from Dale Products Inc., Columbus, Nebraska.

The trimmer potentiometer is suitable for use in many applications where larger units and/or fixed precision resistors were required in the past.

Trimmers was used successfully in the airborne recorder that is a part of the Falcon air-to-air checkout system by Hathaway Instruments. The trimmers were used to accurately set the final sensitivity of the analog and digital signals.

Fig. 1 represents a typical circuit used in the airborne recorder. The degree of adjustability must be extremely high to achieve a good balance on the galvanometer.

T-Pots were chosen for the application because of size, ease of installation, and accessibility. These features became paramount after consideration was given to performance under operational conditions in anticipated environments.

Properly used trimmers can greatly reduce design time and costs. Two of the most commonly used methods will be covered using examples of a rheostat. The accuracy of adjustment is the same when the T-Pots are used as voltage dividers.

Let's assume we know the desired resistance value is between 20K and 25K. A 25K variable resistor is required to cover the range. The resolution or adjustability of the 25K T-Pot is 0.13%

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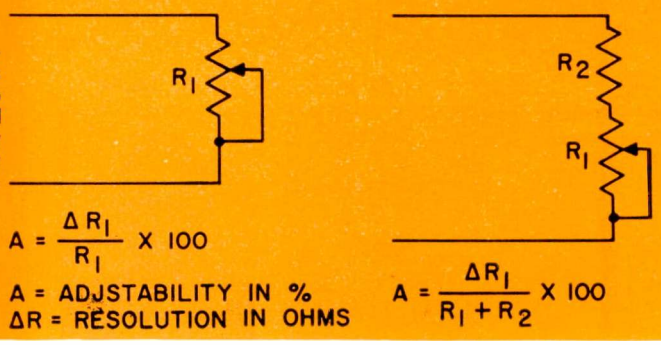
Fig. 2: Two examples of how trimmers can be used to achieve precision and stability equalled only by the most closely controlled fixed components.



The complex systems used in the weaponry of today's aircraft must be checked on the ground, by minimum skill level technicians. Adequate system test sets are available. The design considerations of a wide band AFC used in a radar target simulator are presented.

For Weapons Systems . . .

Radar Tester Needs Wide Band AFC

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THIS article describes the wide band AFC used in a Radar Target Simulator. The simulator was designed for use in automatic tactical ground support equipment for the MD-7 Fire Control System (ELECTRONIC INDUSTRIES, Oct. 1959, p. 109). To keep operator skill at a minimum level, the target simulator must be completely automatic, acquiring the radar pulse frequency once it is in the beam range, locking-on, and sending a return target with the proper conscan modulation. The control of such functions as insertion loss, range delay, and pulse group gating, are programmed-in remotely by the System Test Set.

Description

Several problems are involved in sending back a target pulse to the radar. First, the radar pulse frequency must be located in the 1000 MC band. The return pulse from the simulator must then be sent back within 500 KC of the radar pulse frequency. The output signal, a 0.5 μsec r-f pulse occurring at a high repetition rate, must also be variable in range from 900 ft. to 7500 ft. with linearity of ±10 ft.

Several methods of supplying a target at KU band were studied. In each case, the KU band power source acts as a local oscillator, and superheterodyne techniques are used. Incorporating a microwave delay device was rejected because of the delay time required. The first method discussed, an electronically controlled backward wave oscillator, is expensive and requires an extremely stable 2000 volt supply.

The second method studied uses a high harmonic of a low frequency klystron. Since the sweep width would be multiplied by the harmonic used, the 1000 MC band could probably be covered electronically, but modulation would be difficult and power would be low if the harmonic used was a high one.

The third and fourth methods both employ KU band klystrons. The third uses two, one controlled by the other, which, in turn, is controlled by the input pulse. This involves a great deal of wave guide duplication, while the fourth method uses only one klystron controlled by the input pulse. Both, however, require mechanical strut tuning, along with electronic reflector tuning since the electronic tuning range is only 80 MC wide, for the particular klystron used.

Although the first two methods facilitate tuning, their shortcomings make them undesirable. The fourth method was then chosen over the third because of its simplicity.

Klystron Tuning

The reflex klystron must be tuned both electrically and mechanically. Electrical tuning is accomplished by varying the reflector voltage; mechanical tuning by turning the strut. The electrical range is at least 80 MC wide at the 6 db points. Since this is only a small fraction of the 1000 MC band required, the klystron is tuned to the approximate frequency mechanically and then fine tuning is accomplished by means of reflector control.

The radar antenna is nodding at a one cycle per second rate when it faces the boom before the Radar Target Simulator is locked-on, so the input pulses are only present a fraction of the time, Fig. 1. Approximately 70 pulses are received each time the antenna

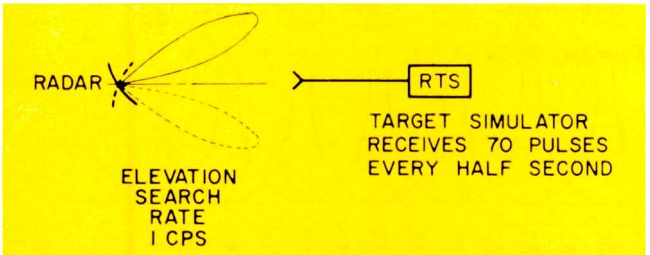


Fig. 1: Before the Target Simulator locks-on, the radar antenna is nodding 1 cps; input pulses are present only a fraction of the time.

passes between 3 db points on the beam. The Target Simulator must, therefore, receive information on input pulse frequency during this short burst of pulses, position the klystron to the proper point after the pulses are gone, and hold position for at least 0.5 second until the pulses return, Fig. 2.

The limited time that pulses are available rules out the possibility of searching the 1000 MC zone during this short interval, since the total mechanical tuning required is 5 turns. After the klystron is in position mechanically, the reflector must be swept electrically during one of the short bursts and target pulses sent back to the radar indicating target position.

Once the radar has seen at least 3 target pulses, it will return to the coordinates from which pulses came, and remain there transmitting for one second. Since the AFC will return to its sweep condition while the antenna is pointed away, it must lock-on again when the antenna returns. The Target Simulator will then supply target pulses and the radar will lock-on in range and angle.

When the klystron is tuned mechanically, it is set to within 34 MC of the desired position. The reflector is then controlled by a closed loop system of the sweep-lock type. The 6 db mode width was chosen because of the minimum power requirements for good mixing.

Filtering

The 1000 MC band is then divided into 15 zones, each zone being 67 MC wide, Fig. 3. This provides a safety factor of 13 MC on each zone, since the electronic mode width of the klystron is 80 MC. The proper position for the local oscillator with respect to the input pulse is decided by a series of staggered filters and a logic circuit.

Several methods of arranging the filters were investigated to extract the maximum amount of information with the minimum number of filters. The optimum arrangement seemed to be 8 filters, 200 MC wide, overlapping each other by 67 MC. The first and last filters would extend beyond the desired band, Fig. 6.

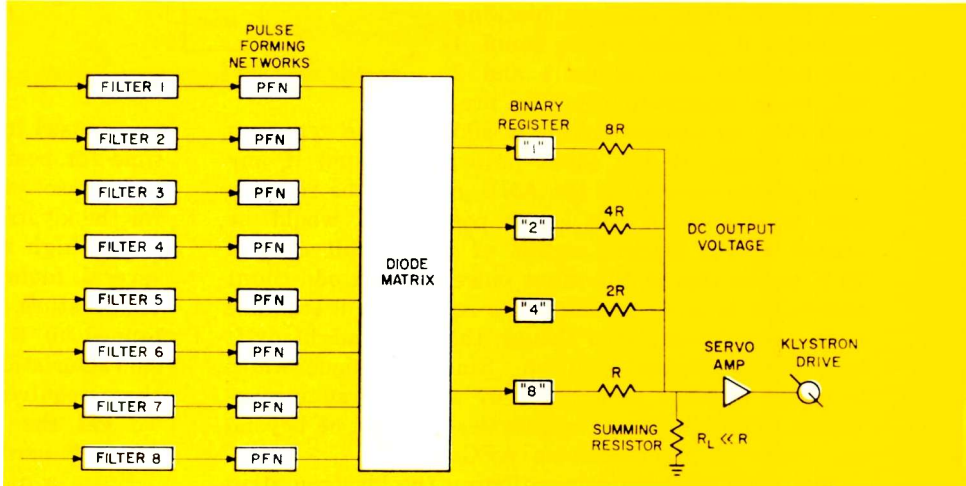
The bursts of r-f energy that are passed by the filters are converted into video pulses by crystal detectors, Fig. 2. These video pulses will be at least 0.12 volts, if the radar pulse frequency is within the filter bandwidth. These video pulses then trigger blocking oscillators providing information for a diode matrix.

The diode matrix accepts the 8 filter inputs and has 7 outputs which trigger 4 binary registers. The registers have the capability of counting from 0 to 15. From the plate of each register is a resistor, each of which is double the previous one, i.e., R, 2R, 4R, 8R.

These 4 resistors are in series with a load resistor R_L, which is much smaller than R. These resistors along with the registers act as current generators for R_L. By energizing the registers in all possible combinations, 15 step voltages can be obtained which represent 15 input frequency zones. These voltages are converted into local oscillator position with a chopper stabilized null type servo.

The servo follow-up pot, a 10 turn pot, is geared to the klystron. The nonlinearity in the klystron frequency vs. turns characteristic requires a similar nonlinearity in the follow-up pot voltage vs. turns characteristics. This is accomplished by bringing a tap off the winding every 600° to a low impedance, high resolution potentiometer. Six of these poteniometers are available for loading and are set after a composite function of logic circuit output voltage vs. desired klystron turn has been obtained. This curve is then approximated with 6 straight lines and the intersection of these lines are the tap settings, Fig. 4.

Fig. 2: Eight filters, 200 MC wide each, divide the 1000 MC band into 15 zones.



Wide Band AFC

(Continued)

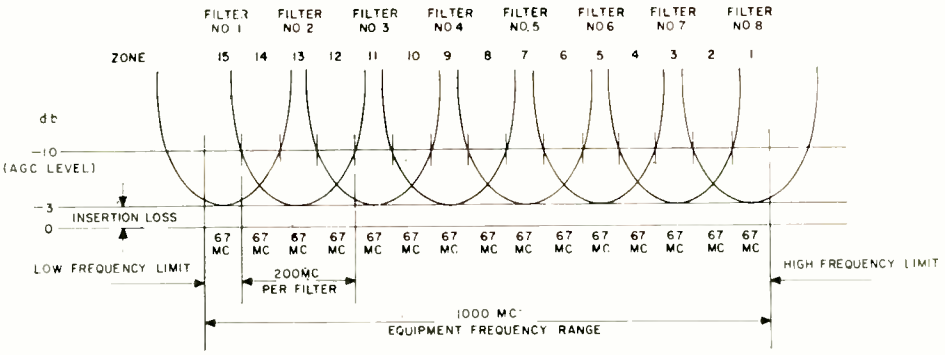


Fig. 3 (above): A safety factor of 13 MC is provided on each of the 15 zones; electronic mode width of klystron is 80 MC. The first and last filters extend beyond the desired band.

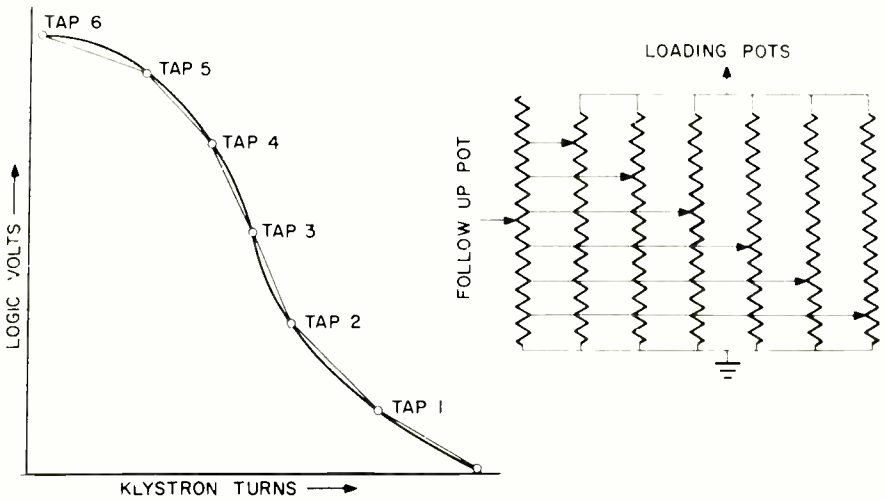
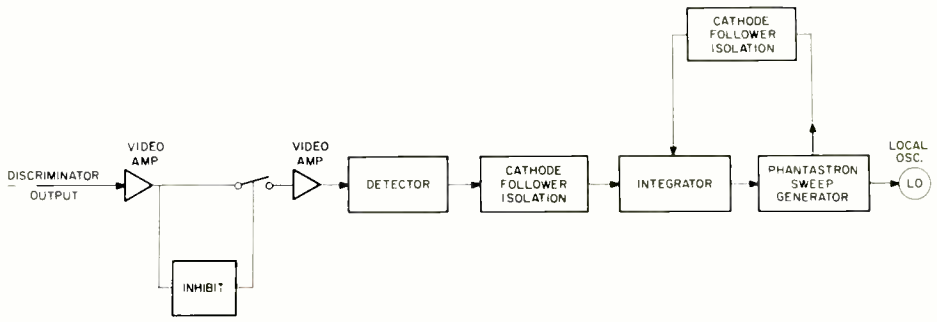


Fig. 4 (above): This approximated curve shows how the non-linearity of the klystron frequency, with respect to its turns characteristic, is compensated for by the loading pots.

Fig. 5 (below): Importance of the relationship between the mechanical and electronic portions of AFC system is pointed out by outlining these circuits with heavy lines.



Coarse Tuning

Several problems were encountered in the coarse tuning mechanism. The first occurred when the input signal was in a zone where 2 filters overlapped. Since the slope of the filter has some finite value, there is a frequency range where intermittent triggering occurs. This is aggravated by the frequency drift of the magnetron over several megacycles.

If the information indicating position were continuous and the frequency of the radar signal seemed to jump from one zone to another and back again, the logic output would be a series of step functions rather than a dc voltage. This would cause the klystron tuning mechanism to be continually moving and make electronic automatic frequency control impossible. It was necessary, therefore, to make the positioning system a one-sample device.

The binary registers are activated by two devices, AND gates and OR gates. The OR gates trigger the registers to the count position and the AND gates keep the registers from counting, or, if the registers have already counted, they erase the count.

If the input frequency is in a zone where an odd count is required, say "count 3," filter 7 is energized. If the magnetron drifted into the zone where filter 6 overlaps filter 7 and triggers blocking oscillator 6 several times, count 4 will register and counts 1 and 2 will erase intermittently. To prevent this, an inhibit circuit is added to the registers which clamps all the count pulses to ground if any erase pulses come from the AND gate. If the register was previously in the count position it would be erased by the flipping action of the inhibit circuit. This means that if the input pulse is in an odd count and drifts to an even count, the register will stabilize in the even count, even though the input might drift back to its original position. Since the mode width is 80 MC and the zone width 67 MC, the radar magnetron drift of several megacycles will not be beyond the range of the electronic AFC.

The other problem in positioning the klystron strut was caused by the time limitations. The total elapsed time for positioning was originally intended to occur in one second. This meant an average speed of 5 rps for the klystron strut and 10 rps for the follow-up pot.

The high speed for the follow-up pot is caused by several factors. A high resolution pot, stable with temperature, is required. This pot also has to be tapped in 6 even increments so that the klystron characteristics can be duplicated by loading. To meet these requirements, a 10-turn wirewound pot is used. To get the required performance, a size 18 servo motor is used.

Since a motor this large has a significant amount

of inertia, acceleration and deceleration time become significant with respect to tuning time. The peak pot velocity reaches 20 to 30 rps. The pots have been used extensively at this speed and a great deal of trouble occurred in the wiper arms. Since delivery time is a critical matter and custom made pots are a long delivery item, a compromise has been obtained on the specification regarding tuning time, and the size 18 motor has been replaced with a size 11 motor and gearhead. This combination develops the same torque, but tuning now takes 5 seconds instead of one. This reduces the pot speed to a more reasonable number of 2 rps, which is the speed at which life tests are run.

Electronic AFC

Once the klystron strut has been positioned, the electronic AFC takes over and tunes the klystron so that the output frequency is within ±500 KC of the input signal frequency. The system used is a modified sweep-lock type system using a phantastron as the sweep generator. Some modifications were necessary due to time constants, and the fact that the input pulses are available for a few miliseconds out of every half second.

As the AFC sweeps through the mode, a minimum of 4 pulses pass through the positive portion of the discriminator. To lock on to 4 pulses requires a wide band detector. If the delay time constant is too long, the response to decreasing amplitude video pulses would be poor. A gated detector was employed, and while its response was good to both increasing and decreasing video pulses, reflector ripple was excessive during lock-up. Two separate networks are necessary, a wide band detector-integrator for quick lock-up, and a narrow band detector-integrator once lock-up is achieved.

The problem is then using a network that can be switched from a short-time constant to a long-time constant. Two choices are available, switching resistors or switching capacitors with a time constant ratio of 50:1.

The most convenient point to switch time constants is in the integrator network that follows the detector. It is composed of the large resistor coupling in the dc to the phantastron grid and the shunt Miller capacity to ground. The only limitation is the minimum value resistor, 1 megohm, that can be used without loading down the phantastron so that it does not sweep. Since a 50 megohm resistor is an impractical value, switching capacitors were tried.

When components which are storage devices are switched, the problem of transients is encountered. Several techniques were tried to prevent a jump in the phantastron plate potential during switching, but in each case variations in voltage at lock-up caused a frequency discontinuity. The problem has been solved by using a cathode follower for isolation between the detector and the integrator and another isolator between the phantastron and the integrator. In this way, the integrator time constant can be changed by switching reasonable value resistors and neither the detector nor the phantastron is loaded down.

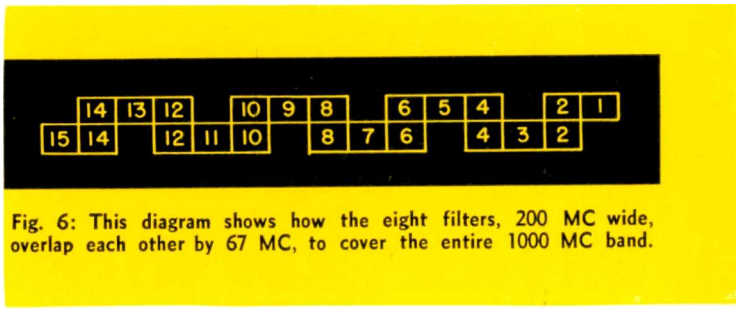


Fig. 6: This diagram shows how the eight filters, 200 MC wide, overlap each other by 67 MC, to cover the entire 1000 MC band.

Since the Target Simulator locks on 40 MC above the radar frequency, the klystron is mechanically tuned through the 1000 MC region. The reflector is also swept from high to low frequency so the first i-f pulse the discriminator sees should be 40 MC above the radar. The klystron, however, sweeps an area on the order of twice the i-f. The possibility still exists that lock-up could occur on the lower sideband.

Since the sweep direction is constant, and the slope of the discriminator as the i-f passes through crossover is positive above the radar frequency and negative below it, a device can be used which recognizes the proper order of pulses, i.e., positive then negative. This device consists of an inhibit gate which is reset after each sweep. It will only pass negative pulses after it has been triggered by positive pulses. If the negative pulses proceed the positive pulses, they will not cause lock-up. The necessity of having such a device when both the electrical and mechanical sweeps go from high to low frequency might at first be questioned. But, when one considers that the radar antenna is nodding in elevation and the train of pulses enter the Target Simulator at a random time, it is immediately obvious that the antenna beam could come by the Simulator while the klystron is sweeping through the wrong side band.

The Radar Target Simulator contains other circuits which obey range functions, and keep insertion loss constant independent of power input, but it is the AFC system which perhaps lends the greatest flexibility to the unit. It enables the Target Simulator, with the operator required only to turn on 400 cycle power, to acquire and lock-on to a radar signal within a 1000 MC region and return a target whose frequency is within 500 KC of the radar frequency.

A block diagram of the test set using the system described in this article is shown in Fig. 5. The relationship between the mechanical and electronic portions of the AFC system can be seen from this diagram and their importance to the system is pointed out by outlining these circuits with heavy lines.

This is the fourth in a planned series of editorial features on Radio Frequency Interference arranged for by the editors of ELECTRONIC INDUSTRIES

Through good antenna design RFI problems can be drastically reduced. However, even in antennas of the same exact type RFI levels will vary. This is caused by minor differences in tolerances during manufacture. Equations given here will aid in the prediction of interference from antennas as well as facilitate calculations of other antenna parameters.

Predicting the Antenna's Role

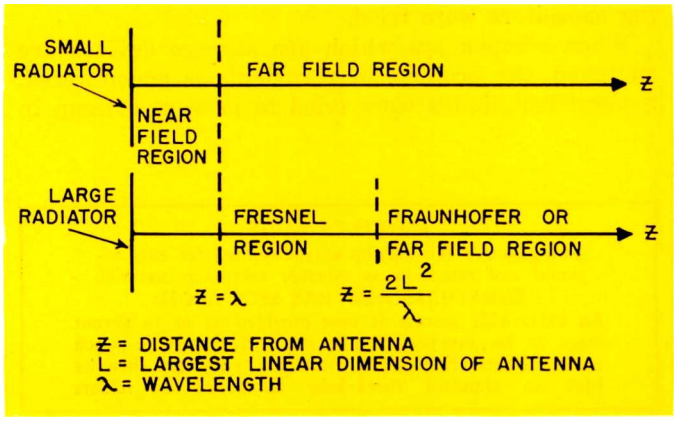
THE purpose of an antenna in a radiating system is to beam energy in a given direction. Depending on the type of system involved, the antenna can be designed to beam energy over a broad or very narrow angle. In designing an antenna, the engineer must accept as a practical matter some radiation in undesired directions in the form of minor lobes. The minor lobe display is a function of many factors, including constructional details. Separate antennas of the same type sometimes have somewhat different minor lobe patterns. This is probably due to small dimensional variations.

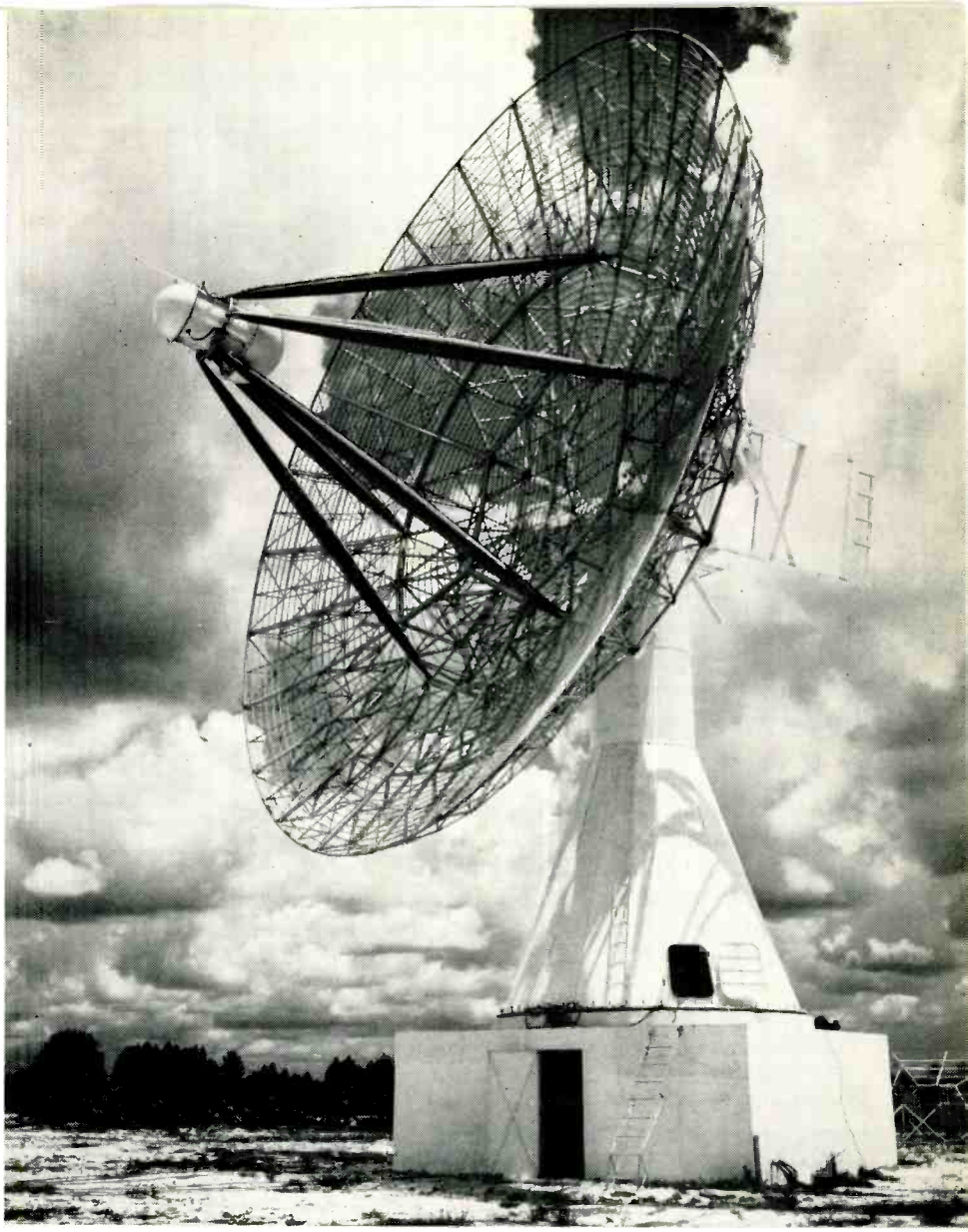
Theoretically, an antenna is designed to radiate only a certain band of frequencies and not too much thought is given to what happens outside the band. Unfortunately, frequencies outside of the operational band are always generated in the oscillator in any practical system. It is true that these spurious frequencies may be generated at power levels considerably lower than at the operational band, nevertheless, they are always present and the levels can still be high enough to cause interference. The antenna radiates this undesirable output with a pattern that is usually different from the one at the designed frequencies. The spurious frequency pattern can be modified by small dimensional variations and thus it is possible for the spurious frequency patterns of two separate antennas of the same type to be different.

The radiation at the operational frequencies in the main beam or beams is the purpose of the antenna design. This is the antenna's function and should not be changed for interference reasons if possible. However, we do not want to minimize the fact that the main beam radiation can cause interference to other systems, because it certainly can. But one looks at this as an operational problem because, when a system that requires scanning by a beam of electromagnetic energy is proposed to obtain certain information, the effect that this radiation will have on existing systems should definitely be considered before its adoption. The main beam radiation level is an essential part of the equipment's operation and cannot be altered without changing its characteristics.

Similarly in a receiving system, it is desired to receive a certain band of frequencies from a particular direction or directions. Energy from other direc-

Fig. 1: Antennas have regions of operation. These regions have no definite boundaries. The regions shown are approximate.





Ballistic missile tracking antenna built by Radiation, Inc., had to be designed and built with RFI problems kept in mind.

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in RFI

tions or outside the frequency band constitute an interference potential. If this energy is delivered to the load, it can give a false indication. It is also possible for the interfering signal to overload the system to the extent that it becomes completely inoperative.

The minor lobe characteristics and the spurious frequency behavior of an antenna are very important from an interference viewpoint for both receiving and transmitting systems. These are the areas of antenna behavior that are not normally of any great interest to the antenna designer and thus there is not much information available. The difficulty is also increased because there may be some behavior variations between separate antennas as discussed previously. This indicates that studies involving spurious frequencies or minor lobes could conveniently be statistical in nature, provided sufficient data is available.

Antenna Regions

Before going into the general principles of antennas, it is advantageous to have a brief discussion on the antenna's regions of operation. Actually, there are no sharp dividing lines between the different regions of antenna behavior because this change is a gradual process. The boundaries that will be presented divide the space surrounding the antenna into areas of the same general behavior.

It is convenient in this discussion to classify antennas into two basic types which are as follows:

a. Small radiators (of order of one wavelength or less).

b. Large radiators (much larger than one wavelength).

In Fig. 1 the boundaries of these regions are shown.

The small radiator has two basic regions while the large radiator has three. The near field region is generally very close to the antenna and normally has very little practical importance. It is an extremely difficult region to analyze theoretically because there is substantial "reactive" energy present. By "reactive" energy is meant energy that oscillates back and forth between the antenna and the surrounding space. The Fresnel region applies only to large radiators. In this region, the antenna pattern and gain are functions of the distance from the antenna. The far field region is the most important region of operation and fortunately the simplest to analyze. In the far field, the antenna's free space pattern and gain are independent of the distance from the antenna. Whenever the pattern or gain of an antenna is given without reference to the region of operation, it is

Antennas' Role *(Continued)*

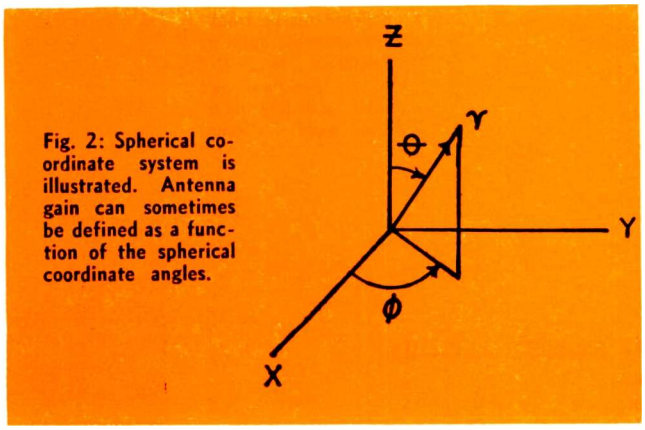


Fig. 2: Spherical coordinate system is illustrated. Antenna gain can sometimes be defined as a function of the spherical coordinate angles.

understood to be far field data. Until recently, far field operation was all that was necessary. However, with the trend toward larger antenna sizes (for higher gain) it has become necessary to consider Fresnel region operation also.

Antenna Characteristics

An antenna is defined as a device which launches a guided electromagnetic wave into free space, or vice versa. It is sometimes also identified as the transition or matching device between equipment and free space. The characteristics of an antenna that are generally used to describe its operation are as follows:

1. Gain
2. Impedance
3. Radiation Pattern

For any antenna, these characteristics are the same regardless of whether it is receiving or transmitting.

The gain of an antenna, G, is defined as follows:

$$G = \frac{W_M}{W_R} \tag{1}$$

where

W_M = Maximum power density of antenna.

W_R = Maximum power density from a reference antenna with same power input.

Any type of antenna may be used as a reference. Occasionally a half wave dipole or a standard gain horn is used. It is convenient in theoretical work to use an isotropic source as a reference. An isotropic source is defined as an antenna that radiates energy uniformly in all directions with 100% efficiency.

In this article, all gains are referenced to an isotrope. For an isotropic source

$$W_R = \frac{P}{4\pi r^2} \tag{2}$$

P = Total power radiated.

r = Distance from the antenna.

It is also possible to define gain as a function of the spherical coordinate angles. (See Fig. 2.)

$$G\,(\Theta, \theta) = \frac{W\,(\Theta, \theta)}{W_R} \tag{3}$$

$G\,(\Theta, \theta)$ = Gain as a function of coordinate angles.

$W\,(\Theta, \theta)$ = Power density of antenna as a function of coordinate angles.

The maximum gain obtained from Eq. 3 is the same as the gain defined by Eq. 1. When reference is made to the gain of an antenna, the maximum gain is implied. However, it is sometimes necessary to obtain information off the axis of the main beam. In this case the gain at the desired angles should be used and not the maximum gain.

It is generally desired that the antenna impedance be matched to the load for several reasons: first, to obtain maximum power transfer between load and antenna and, second, to avoid standing waves on the transmission line between the antenna and the load. High standing waves can be responsible for arcing and causing the signal to have "ghosts." For a receiving system, the antenna is sometimes not matched to the load because the design criterion is to optimize the signal-to-noise ratio and this may not be at the matched condition.

The radiation pattern gives the relationship between the major and minor lobes of the antenna. The antenna is designed for its major lobe or lobes, and the minor lobes (consisting of both side and back lobes) are imperfections in the design that must be accepted as a practical matter. These minor lobes can be a very significant source of interference. If antenna designs could be improved to reduce the magnitude of the minor lobes, the interference potential or susceptibility of equipment would be reduced significantly.

For antennas with a single main lobe beam (teardrop pattern), the gain can be approximated by,

$$G_0 \approx \frac{38000}{\Theta_0\,\theta_0}\,K \tag{4}$$

where Θ_0 and θ_0 are the half power beam widths in degrees

K = Antenna efficiency

A reasonable approximation for efficiency is 0.7 for aperture antennas and 0.9 for small linear antennas.

For an antenna with a doughnut shaped pattern (as is the case for the half wave dipole), the gain can be approximated by

$$G \approx \frac{1}{\text{Sin}\,\frac{\theta_0}{2}}\,K \tag{5}$$

The effective aperture, A, of an antenna is defined as,

$$A = \frac{P_L}{W} \tag{6}$$

where

P_L = Power into the load.

W = Power density of incident wave.

The gain is related to the effective aperture by the following expression:

$$G_0 = \frac{4\pi A}{\lambda^2} \tag{7}$$

Far Field Space Transmission

The power transfer between two antennas in free space, with certain restrictions, is given by Eq. 8.

$$P_R = P_T \frac{G_T G_R \lambda^2}{16 \pi^2 Z^2} \tag{8}$$

where

P_R = Power received at load for free space
P_T = Total power transmitted
G_T = Gain of transmitter
G_R = Gain of receiver
Z = Distance apart

The conditions that restrict the use of Eq. 8 are as follows:

a. The antennas have the same linear polarization. Actually the expression can be used for any two antennas with linear polarization provided that only the field components of common polarization are considered.

b. $Z \geq \frac{2 L_1^2}{\lambda}$, where L_1 is the largest linear dimension of the larger antenna.

c. The receiving antenna is matched to its load.

However, many times in interference studies, the receiving antenna receives at a frequency other than its normal operational one. In this case the antenna and load impedances may be altered so that they are no longer matched. Whenever the antenna is not matched to the load, the right hand side of Eq. 8 must be multiplied by the effectiveness ratio γ.

Fig. 3: Sometimes in antenna calculations it is desirable to consider ground reflections.

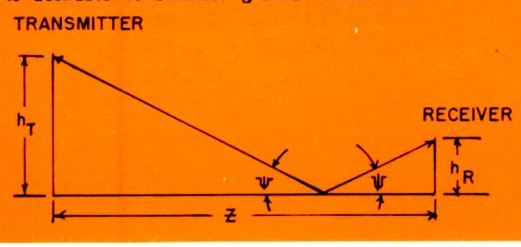
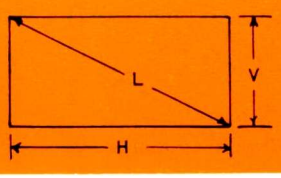


Fig. 4: Rectangular aperture antenna parameters.



$$\gamma = \frac{4 R_r}{(R_r + R_L + R_T)^2 + (X_A + X_T)^2} \tag{9}$$

R_r = Radiation resistance of antenna
R_L = Loss resistance of antenna
R_T = Load resistance at the antenna terminals
X_A = Antenna reactance
X_T = Load reactance at the antenna terminals

Usually R_L is dropped without introducing any appreciable error. However, it should be accounted for if the sum R_r plus R_T becomes low, say ten ohms or less.

If it is desired to consider the effect of ground reflections, the power received, from Eq. 8, must be modified by the following expression:

$$P_R' = 4 P_R \operatorname{Sin}^2 \left[\frac{h_T h_R}{14.67 \lambda Z} \right] \tag{10}$$

Where

P_R' = Power received at load for smooth earth transmission
h_T = Distance of transmitter antenna to ground in feet
h_R = Distance of receiver antenna to ground in feet
λ = Wavelength in feet
Z = Separation in statute miles

Eq. 10 should not be used for distances beyond the radio horizon and frequencies below 30 MC. This is also a limitation on ψ, the grazing angle, for vertical polarization.

$$\text{at } 100 \text{ MC } \psi \leq 1^\circ$$
$$\text{at } 5000 \text{ MC } \psi \leq 5^\circ$$
$$\psi = \operatorname{Tan}^{-1} \frac{h_T + h_R}{Z}$$

As frequency increases, the allowable grazing angle goes up. For horizontal polarization the grazing angle does not restrict the use of Eq. 10.

Fresnel Region

The power transfer between two antennas cannot be determined by the method previously outlined when Z, the antenna separation is subject to the following limit:

$$Z \leq \frac{2 L_1^2}{\lambda} \tag{12}$$

where

L_1 = Largest linear dimension of the larger antenna

This represents Fresnel region operation in which the antenna's gain and pattern are no longer a constant. Generally speaking, the antenna's Fresnel region gain is lower than it is in the far field but there are some exceptions. Also the patterns generally have wider beam widths in the Fresnel region, but again this is not always so because there can be lobe splitting, etc. A method is presented for the computation of Fresnel region maximum power transfer of rectangular antennas under free space conditions. This method requires a knowledge of the aperture illumination of the antennas and normally this information is not available. To use this method, it will be necessary to estimate the aperture illumination from information that is customarily known about the antenna. Since the half-power beam widths of aperture antennas are generally given, a procedure for estimating the aperture illumination from the beam widths will be presented.

Consider a rectangular aperture antenna as shown in Fig. 4.

Let

θ_H = Full beam width at half power points in H direction in degrees

Antennas' Role *(Continued)*

θ_V = Full beam width at half power points in V direction in degrees

Calculate a constant R defined as follows:

$$R = \frac{\pi}{180}\frac{\theta_H H}{\lambda} \text{ or } \frac{\pi}{180}\frac{\theta_V V}{\lambda} \qquad (13)$$

In the following table, limits are given for R to use in estimating the illumination:

Table 1

Limits of R	Estimated Illumination
$0.88 \leq R < 1.2$	Uniform
$1.2 \leq R < 1.45$	Cosine
$1.45 \leq R < 1.66$	Cosine Square
$1.66 \leq R < 1.93$	Cosine Cubed
$1.93 \leq R < 2.03$	Cosine Fourth

This table is based on the assumption that the H and V illuminations are separable.

A check on the validity of the estimated aperture illumination can be made by computing the antenna efficiency from its illuminations constants. This is done by making use of the fact that the far field gain of a rectangular aperture antenna with separable distributions is given by

$$G_0 = \frac{4\pi A F_H F_V}{\lambda^2} K \qquad (14)$$

where

A = Physical area of aperture
λ = Wavelength (same linear units as A)
F_H = Correction factor depending on H direction illumination
F_V = Correction factor depending on V direction illumination
K = Efficiency

The correction factors, F_H and F_V, depending on illumination are as follows:

Table 2

Type of Illumination	Correction Factor F
Uniform	1.000
Cosine	0.810
Cosine Square	0.667
Cosine Cubed	0.575
Cosine Fourth	0.515

Rewriting Eq. 14 we have an expression for the antenna efficiency:

$$K = \frac{G_0 \lambda^2}{4\pi A F_H F_V} \qquad (14a)$$

The efficiency of the antenna can be computed because G_0, the far field gain λ, the wavelength, and A, the physical area are known from the antenna specifications; F_H and F_V can be obtained from Table 2 once the aperture illuminations are estimated.

If the computed antenna efficiency is reasonable, then it is safe to assume that the determined aperture illuminations are satisfactory. Reasonable efficiency can be defined as generally $0.9 \geq K \geq 0.5$. Of course, this criterion can be modified for individual antennas when there is efficiency information specifying otherwise.

Once the aperture illuminations have been estimated and checked to be plausible, the Fresnel region gain corrections can be made. Figs. 5 and 6 are the gain correction factors for antennas having uniform and cosine aperture illumination. The abscissa is the distance from the antenna in wavelengths and the ordinate is the gain reduction db due to Fresnel region operation. Each graph has a family of curves corresponding to different aperture dimensions. The apertude dimension L_λ is in wavelengths.

The gain correction curves for cosine squared, cosine cubed, and cosine fourth aperture illumination are similar to Fig. 6. Gain corrections for these three illuminations can be approximated with sufficient accuracy by taking the reading from Fig. 6 and modified as follows:

Cosine squared: If reading >3db, subtract 2db from reading; otherwise take half of reading

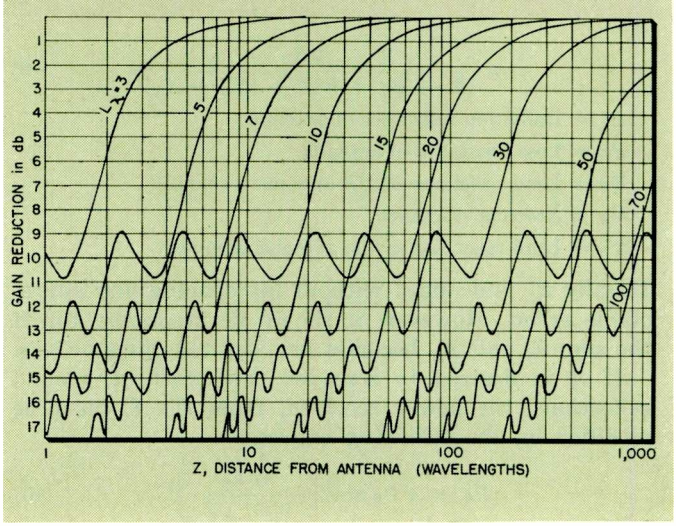
Cosine cubed: If reading >5db, subtract 3.3db from reading; otherwise take half of reading

Cosine fourth: If reading >7db, subtract 4.5db from reading; otherwise take half of reading.

It must be remembered that, in determining the Fresnel region gain of an antenna, correction must be made for both vertical and horizontal illuminations.

By correcting the gain of the larger antenna, the free space power transfer can be computed over a portion of the Fresnel region using Eq. 14.

Fig. 5: Gain correction factors for uniform aperture illumination



$$P_R = P_T \frac{G_L G_S \lambda^2}{16 \pi^2 Z^2} \quad (15)$$

G_L = Gain of larger antenna at distance Z

G_S = Far field gain of smaller antenna

Z = Distance apart

The restriction on Eq. 15 is that

$$Z \geq \frac{L_2^2}{\lambda} \quad (16)$$

where

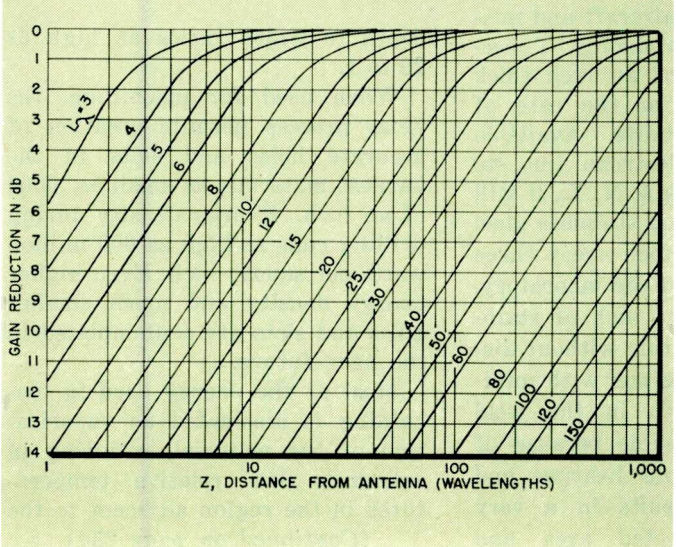
L_2 = Largest linear dimension of the smaller antenna.

G_L can be obtained by subtracting the two gain corrections from the far field gain. Since the gain corrections are only valid for the center of the beam, Eq. 14 can only be used when the antennas are directed toward each other. Generally this is the position for maximum power transfer. Should it be necessary to obtain information for separations less than $\frac{L_2^2}{\lambda}$, Eq. 15 can be used as an approximation to predict the order of magnitude of the power transfer.

Power Density

Until a short time ago, the power output from electronic equipment was low enough that it was not considered a serious hazard. However, with the recent development of high power radars, tropospheric scatter equipment, etc., there has developed some interest in the possibility of biological effects which may result from exposure to r-f radiation. Research is presently being conducted along this line by several organizations. It has been observed from past research that microwave energy causes injury to animals; this experimental injury appears to be thermal in nature. From the information that is presently available, the USAF has set the safe exposure levels for average powers of 0.01 watts/cm^2. This figure is the maximum power density, regardless of frequency, to which personnel can expose themselves without being subject to possible injury.

Fig. 6: Gain correction factors for cosine aperture illumination



The free space power density of a system in the far field is given by:

$$W = \frac{P_T}{4 \pi r^2} G(\theta, \Theta) \quad (17)$$

Over smooth earth the power density is given by the following:

$$W = \frac{P_T G(\theta, \Theta)}{\pi r^2} \sin^2 \left[\frac{h_T h_R}{14.67 \lambda Z} \right] \quad (18)$$

In the Fresnel region, the power density in the center of the main beam under free space conditions is:

$$W = \frac{P_T G}{4 \pi r^2} \quad (19)$$

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided so as to permit them to be punched with a standard three-hole-punch without obliterating any of the tear. They can then be filed in standard three-hole notebooks or folders

G in the above Eq. is the Fresnel region main beam gain at the distance r from the antenna. This gain is obtained by making the two corrections discussed previously.

Spurious Frequency Gain

Spurious frequency can be considered as any frequency that is not the antenna's operational frequency. Spurious frequency considerations are very important in any interference study. The interference potential of a system may be in the form of either:

1. Interference caused to other equipment due to radiation spurious frequencies, or

2. Having its operation impaired due to receiving spurious frequencies from other equipment.

In order to predict the interference potential in either case, it is necessary to know the gain of the antenna at the particular frequencies under consideration. The antenna pattern at these frequencies would be very valuable additional information; however, one is normally satisfied with just the "worst case" of interference.

For the small linear antenna such as the dipole and discone, this is not too much of a problem because the behavior of these antennas as their lengths are varied (this is essentially the effect of varying frequency) is well known. For the large aperture antenna, such as the parabolic reflectors, this problem becomes complex because of the intricate feeds, etc. In spite of this, one would normally expect, for relative small changes in frequency, the ratio of the gain at the spurious frequency to the gain at the operation frequency would equal the ratio of the frequencies squared. However, preliminary model measurements have indicated that this is not true.

It is indicated that the gain of aperture antennas remain approximately constant as the frequency is increased up to about the 3rd harmonic. At the 3rd harmonic there is a sharp drop in gain that continues up to the 4th harmonic. The author has not seen any

Antennas' Role *(Concluded)*

published data for frequencies above the 4th harmonic.

It is felt that, until further research is reported on aperture antenna spurious frequency operation, the trends observed above be used as a guide; the antenna gain is constant with frequency up to about the 3rd harmonic and above there is a sharp drop in gain.

Conclusion

In making interference studies, one often becomes bogged down because certain vital characteristics are a function of manufacturing tolerances. For example, the minor lobe level of a parabolic reflector type of antenna depends a great deal on the tolerance of fabrication. It is very possible for separate antennas of the exact same design to have minor lobe behavior that is somewhat different. Therefore, the best that an engineer can hope for in an interference study is to obtain the worst case information or a statistical presentation.

In making a worst case study, it is important not to offer information that is so fantastically conservative that it becomes of little or no use. For example, the purpose of making such a study would be to find out what is the minimum realistic separation between two systems that is necessary to avoid interference. The use of excessively high factors of safety for computations to be "protected" can defeat the purpose of such a study.

Statistical presentations, which are becoming more popular, are in many aspects the preferable method of offering interference information. In a statistical study the engineer can take into account the uncertainty of the antenna characteristics. In this type of presentation, all answers have a probability attached to them. Borrowing from the above example, one could present some separation distances with the probability of interference for each distance.

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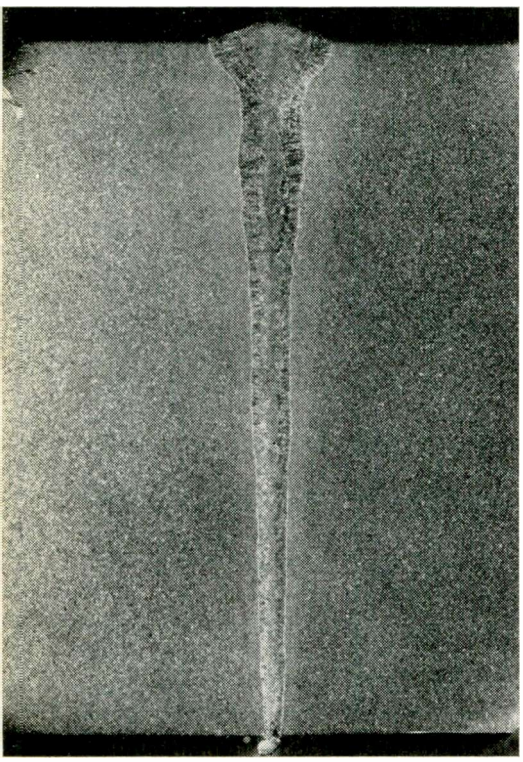
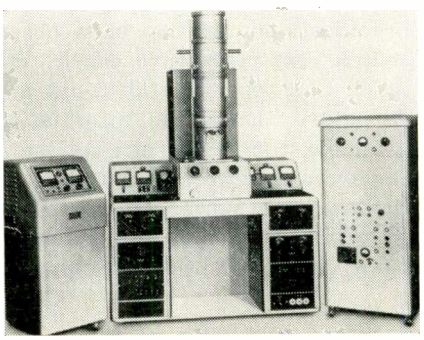
Electron Beam Welding

A typical weld in stainless steel by the Zeiss electron beam process emphasizes the unusual depth to width ratio achieved.



THE Zeiss process, which uses a controlled high density stream of electrons to change matter physically or chemically, is one of the most versatile fabrication tools ever created. Because of its unusual qualities, it may have a profound effect on design methods in many fields of manufacturing.

The Hamilton - Zeiss Electron Beam Welder comfortably handles stainless steel for aircraft and missile structures, producing T sections 60/1000ths of an inch thick from sheet stock at the rate of seven feet per minute. Available from Hamilton Electrona Inc., 40 Wall St., New York 5, N. Y., it will butt-weld 3/8ths inch stainless steel at the rate of an inch every three seconds and has, in the laboratory, welded through one inch of stainless steel. It does this without distortion of the piece and with minimum grain growth in the weld area. This is possible because of the extremely rapid heating and cooling, which results in a very narrow heat affected area and



Equipment used in the Zeiss process of electron beam welding requires little space.

depth to width ratios as high as 20 to 1.

When used for machining, the Zeiss process permits creation of accurate holes and slots in the hardest materials as small as .0008 of an inch. Energy density during drilling runs as high as 600 million watts per square inch. Even higher energy density and much smaller holes and slots are contemplated in the near future.

Most of the energy used in machining is dissipated as vaporization of the material, resulting in extremely low relative temperatures in the region adjacent to the

(*Continued on page* 254)

Page from an Engineer's Notebook #52

Rectification of Narrow-Band Noise

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DURING a discussion on the rectification of narrow-band noise the following questions were asked: As the bandwidth of random noise is reduced and the noise spectrum approaches a single frequency, does the noise wave shape approach sinusoidal form? Is the ratio of rectified dc output to rms input affected? The latter question arises from the fact that the rectification of a sine wave by a linear lossless half-wave circuit with resistive load gives:

$$E_{dc} = (\sqrt{2}/\pi)\, E_{rms} = 0.45\, E_{rms} \qquad (1)$$

while the similar rectification of band-limited random noise gives:

$$E_{dc} = (1/\sqrt{2\pi})\, E_{rms} = 0.40\, E_{rms} \qquad (2)$$

The above questions are answered in a way that may be of interest. When the noise bandwidth is very narrow, the waveform will contain essentially one frequency; but no matter how narrow the bandwidth becomes, the noise voltage probability distribution must remain Gaussian. The resulting waveform that satisfies both of these requirements will appear to be a sine wave which is amplitude modulated by noise. The "carrier" frequency will appear to be the center frequency of the very narrow noise pass-band, and the modulation envelope will have a Rayleigh probability distribution. The highest component of envelope frequency is approximately equal to the noise bandwidth and is, therefore, very much lower than the "carrier" frequency. This allows the signal to be closely approximated by an infinite train of perfect sine cycles, each with an amplitude only slightly different from its neighbors. The Rayleigh probability distribution of these peak amplitudes can be expressed as:

$$P\,(E_p) = (E_p/E^2_{rms}) \exp\,(-E^2_p/2E^2_{rms}) \qquad (3)$$

The average amplitude of the whole train of sine cycles is:

$$\begin{aligned} &= \int_0^\infty E_p P\,(E_p)\, dE_p \\ &= E^{-2}_{rms} \int_0^\infty E^2_p \exp\,(-E^2_p/2E^2_{rms})\, dE_p \\ &= \sqrt{\pi/2}\, E_{rms} \end{aligned} \qquad (4)$$

When a sine wave is rectified in a linear lossless half-wave circuit:

$$E_{dc} = E_p/\pi \qquad (5)$$

By combining Eqs. (4) and (5), the rectified value of the approximate model of very narrow-band noise is found to be:

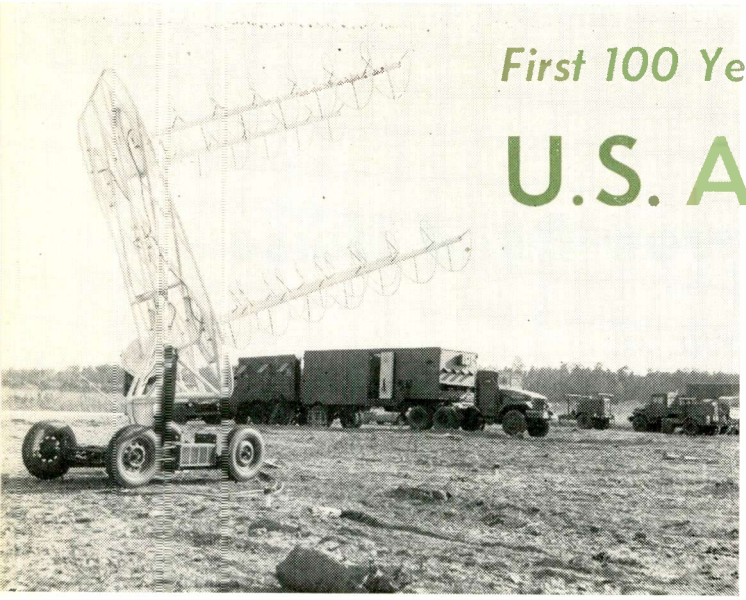
$$E_{dc} = (E_p)_{av}/\pi = (1/\sqrt{2\pi})\, E_{rms} = 0.40\, E_{rms} \qquad (6)$$

This value of E_{dc} can be measured only if the rectifier is followed by a low-pass filter with a cut-off frequency much lower than the input noise bandwidth. Otherwise, a dc meter will follow the low frequency Rayleigh noise. The coefficient in Eq. (6) is the same as that in Eq. (2).

Even though very narrow-band noise approaches a single frequency, this frequency will be amplitude modulated in such a way that when rectified and filtered, its dc output is the same as the output for wide-band noise rather than the output for a sine wave.

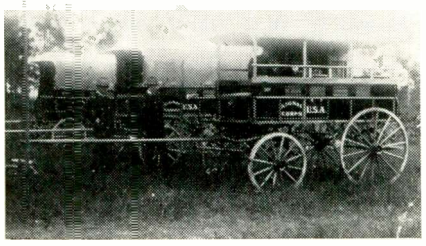
* * *

First 100 Years of the U.S. Army Signal Corps 1860-1960



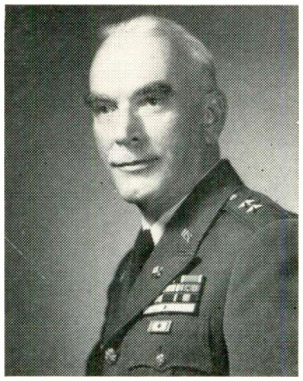
(Above) Tracking Station for Project Score.

Observation balloons were used by both sides in the Civil War. Civilians provided and operated them under temporary contracts.



Field telegraph train for four mules. First used in Peninsular Campaign in the spring of 1862.

Brig. Gen. Albert J. Myer, 1st Army Signal Officer—1860



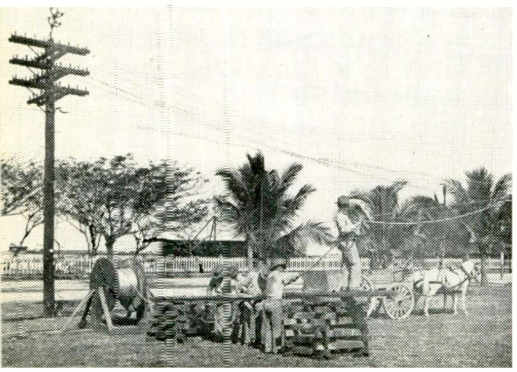
Maj. Gen. R. T. Nelson, Chief Signal Officer—1960

ELECTRONIC INDUSTRIES salutes the U. S. Signal Corps, this year celebrating its 100th birthday.

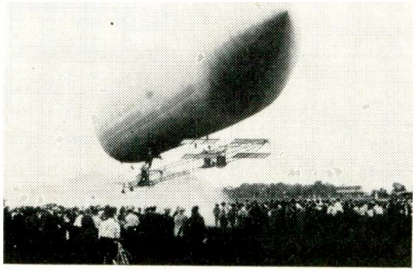
The first signalmen, in 1860, used flag and torch signaling methods. Today, the Corps is a leader in electronic-communications research and development. Its interests range from giant missile tracking radars to tiny microminiature electronic components. The Corps annually sponsors millions of dollars of research by private electronic industry and also has extensive R & D facilities of its own.

The Signal Corps' pioneering achievements include: The first national weather service; the first military airplane, the first American radar; and the first communication satellite.

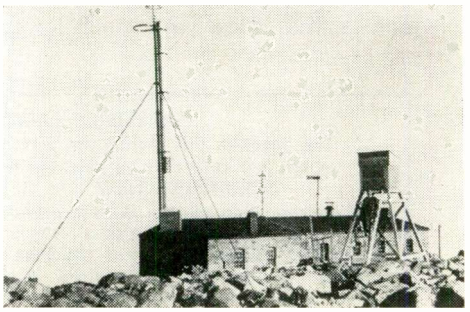
Cable work in Manila, P.I.—1902



U. S. Army Dirigible No. 1—1908



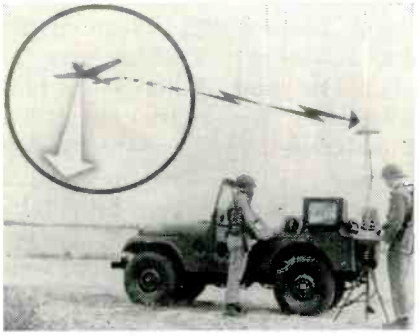
Signal Station, Weather Bureau on Pike's Peak—1880



(Above) 77th Div., Signal Corp photographer at Mareuilen-Dole, France—1918

(Left) Switchboard in Argonne woods, France—1918

(Left) Captured German War pigeons, Victory parade, New York—1919



(Above) Airborne TV station is remote controlled—1956

(Above) Working on lines from Tanyang to Chechon, Korea—1951

(Above) All weather radar "eye" can spot enemy ½ mi. away—1956

(Below) Missile Master, height finder radar-coordinate defenses of industrial complex against attack—1957.

Picture Service Photographer takes pictures of German destruction—1944

(Below) Sig. Corps Engineering Labs' Radar spots satellites—1957.

The use of ultrasonic welders is growing rapidly. This is partly due to the welder's ability to join dissimilar metals and also handle extremely thin pieces. The design information given here is of interest to potential users as well as ultrasonic design engineers.

Ultrasonic Welder Design

ULTRASONIC welding is a mechanical process where solids are joined through the action of high frequency vibrations (see Fig. 1). For the process to be effective, these vibrations must be transverse at the interface between the materials to be joined.

Perpendicular vibrations of the same power level as the transverse ones will not produce the welding effects. The phenomenon is of a threshold type. Below a certain value, no welds are obtained. Above this value, welds are obtained which appear to improve in strength for an increase in the sound energy.

The problem of designing satisfactory ultrasonic welders, therefore, resolves itself into devising units for coupling the maximum transverse motion into the interface between the metals to be joined (see Fig. 2a). This is customarily done by generating compressional waves in a length mode transducer, amplifying these waves in a length mode acoustical horn, and then converting these compressional waves into shear waves in the subjected materials by pressing a coupling tool into this material. Alternately (see Fig. 2b), the appropriate motion can be generated by utilizing a shear wave motion transducer, a shear wave amplifying horn, and direct pressure of the horn onto the material.

Welds can readily be made by the ultrasonic process which have joint efficiencies of 60-80%. Even these limits are not generally due to failure in the weld area but rather breakage around the periphery of the weld area due to weakening and cracking of the parent metal in this area. Both spot and seam welds can be obtained with the ultrasonic method. The seams can be made in several ways:

1. Overlapping spots.
2. Rolling the tool over the work.
3. Dragging the tool over the work.

A very large variety of materials can be welded by this process. These range from aluminum and copper through stainless steels to even mylar. In addition, radically different materials can be joined. For example, aluminum can be easily welded by this process to stainless steel. The different electrical resistances and thermal conductivities make this combination quite difficult to join by standard resistance spot welding techniques. Generally, access from only one side is needed for ultrasonic welding, therefore, difficult configurations can be welded with this technique. Fragile materials, such as thin aluminum foils can also be welded by this process. The amplitude of motion must be kept small enough to prevent tearing.

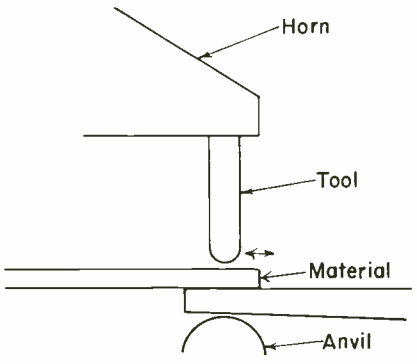


Fig. 1: Diagram shows the welding tip, material and anvil.

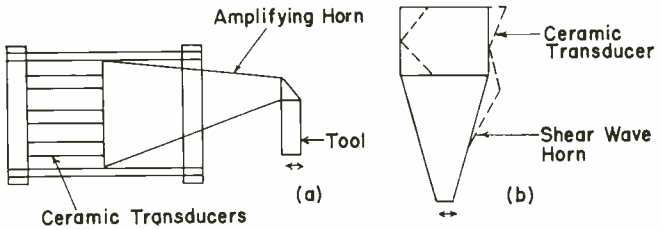


Fig. 2: The transducer in (A) is generating a compression wave. The tool attached transforms energy to shear waves. In (B) the transducer is a shear wave unit.

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Dir. of R & D Labs.
Gulton Industries, Inc.
Metuchen, N. J.

Considerations

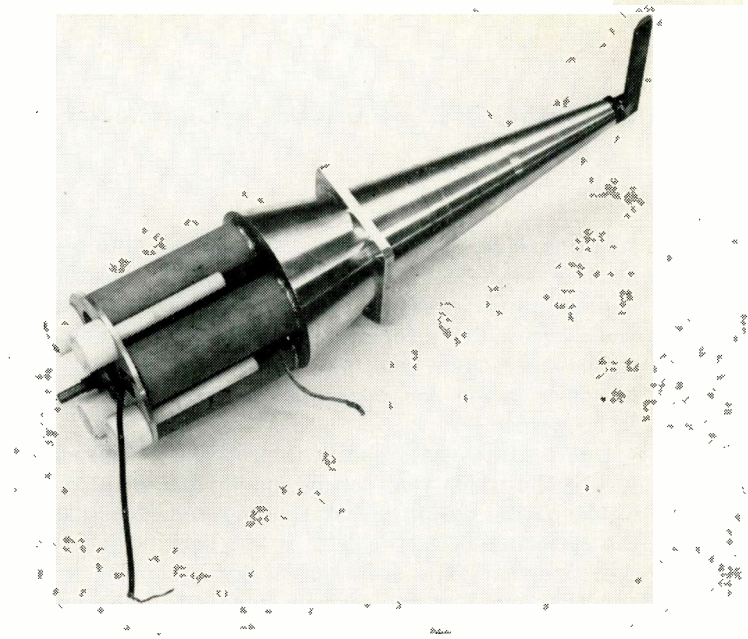


Fig. 3: A compression type transducer is illustrated. Tool at 90° transforms energy from compression waves to shear waves.

Transducer Design

The design of an efficient acoustical transducer system is one of the most important aspects in the overall design of a satisfactory ultrasonic welder (see Fig. 3). The first problem is the choice of transducer material. This can be any of the usual materials utilized in power ultrasonic applications. The material can be magnetostrictive nickel or iron, or it can be piezoelectric ceramic such as barium titanate or lead zirconate titanate. If the ceramic materials are used, it is possible to obtain a material efficiency of 50-60%.

The second step in the design of a welding transducer is the design of a horn amplifying system to provide the large vibration amplitude needed for welding. We utilize a λ length horn in order to get a true horn effect, i.e., wave motion channeled down the horn with a large area ratio between transducer end and tool end (see Fig. 5). If a $\lambda/2$ horn length is used, the taper must be too rapid and poor horn action is obtained. A horn longer than λ is awkward in length for easy use. Since the horn we are using is about $\lambda/2$ in diameter at the large end, the normal horn equations which assume slim horns compared to the wavelength only yield approximate results and experimental modifications must be used. The amplitude of motion at the tool end can readily reach 0.005 in. at 20KC. This precludes the use of horn materials that fatigue easily, such as aluminum. Stainless steel and monel have been found to be satisfactory horn materials. At the tool end, the compressional waves generated in the horn must be converted into shear waves in the tool for proper vibration motion to produce welding. An appropriate reflection angle can be used so that the maximum amount of compressional energy can be converted into shear wave energy in the tool.

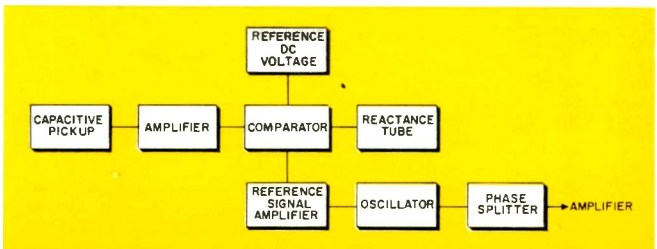
By careful design, a relatively large percentage of the input electrical energy can be delivered as shear wave sound energy in the subject materials. This percentage can be measured by the usual impedance circle method (see Fig. 4). The impedance circle is first obtained for the system mounted and ready to weld but with the tool lifted from the work. Another circle is then obtained with the tool on the work under the required welding pressure. The "efficiency" then obtained by calculating $(D_1\text{-}D_2)/D_1$ is then the percentage of energy delivered to the work. Efficiencies of 25% have been measured by this method on some of the earlier horns designed.

Mechanical Design

The mechanical design of an ultrasonic welder is governed to a large extent by the configuration of the weld required, but is to some extent dependent upon the fact that pressure as well as sound energy is needed for satisfactory acoustic coupling, and hence satisfactory welding.

For example, if the problem is one of seam welding lightweight aluminum foils of less than 0.004 in thickness, then a hand held transducer of a simple design is all that is needed (see Fig. 5.) The pressure can be supplied by hand pressure and the motion can be supplied by hand motion. By guiding the tool with a

Fig. 4: Diagram illustrates automatic amplitude control. System overcomes transducer detuning caused by varying work loads.



Ultrasonic Welder *(Continued)*

straight edge, satisfactory welds can be obtained. If heavier material is to be welded, the design can include an air pressure system for applying pressure and a motor drive for motion (see Fig. 6). For automated operations multiple heads can be used, with provision made for mechanically indexing the work to be welded.

One feature that readily improves the characteristics of the welds that can be made with an ultrasonic welder is the design of satisfactory reflectors backing the materials being welded. If the backing is of such a nature that little acoustic energy is coupled into it, and that most of the energy remains in the subject materials, optimum welds are obtained. Spherical and cylindrical reflectors are quite satisfactory for this application.

Driving Amplifiers

Standard electronic power amplifiers such as those used to drive high power transducer systems can be used for ultrasonic welders. One problem, though, that arises especially with seam welders is that of maintaining the maximum drive from the system under conditions of varying acoustical load and pressure. These tend to detune the transducer.

We utilize an automatic amplitude control system for this optimization (see Fig. 7). A capacitive pick-up at the end of the horn samples the vibration amplitude. This signal is amplified and run into a comparator circuit. In this circuit it is compared in amplitude with a standard signal taken from the electronic oscillator. If, due to varying loads or pressures, the transducer resonant frequency has shifted away from the oscillator frequency, the sampled signal will be smaller than the test signal. The difference signal is then rectified to a dc value and used to control a reactance tube. The tube shifts the oscillator frequency to the desired value. The direction of shift is decided by phase sensing since it is found that the phase of the sampled signal shifts 180° as the transducer passes through resonance. This phase shift is used to determine the sign of the dc control voltage. Since this entire process is automatic, it is possible to weld satisfactory seams on materials with the normally encountered tolerance irregularities. This is a must for satisfactory seam welding.

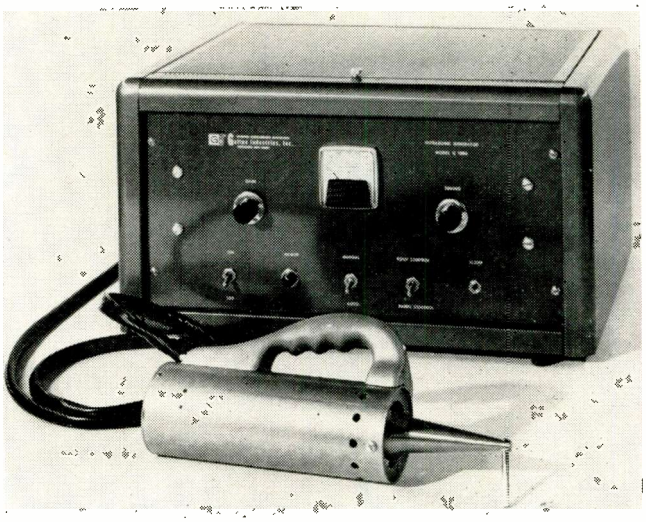
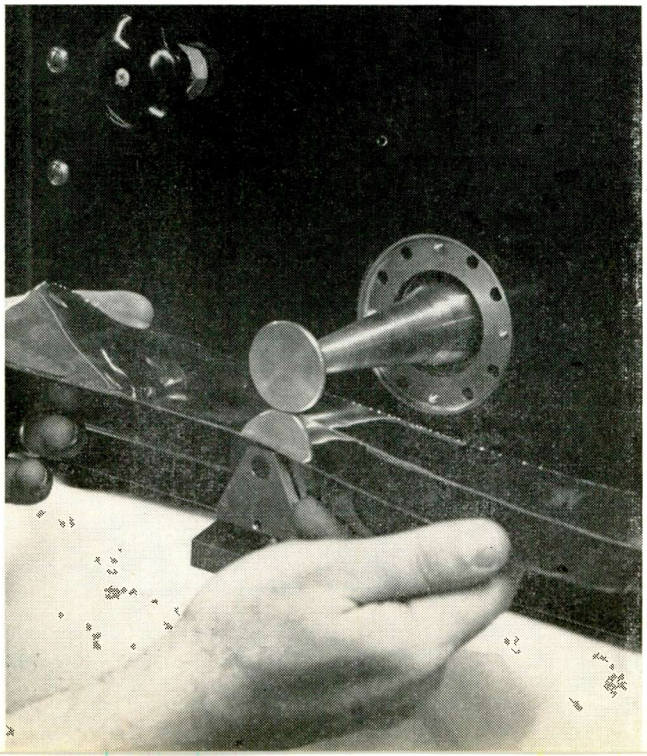


Fig. 5: Ultrasonic welders are available in hand-held models.

Fig. 6: Production seam welder is motor driven for heavier work.



Test Results

As indicated, a wide variety of materials have been welded ultrasonically. We have examined some of these samples quite carefully. Photomicrographs of heat exchanger seam welds made with automated equipment indicate that the welds are true welds where material continuity is obtained. These welds were obtained with a unit wherein the acoustical design of the tool had to be relatively poor in order to fit the required geometry.

The quality of the welds that can be obtained from ultrasonic welding can be observed from the photomicrographs. The material is continuous across the interface region and appears uniform in this region (see Fig. 8). None of the heat effected zones present in arc welding and resistance welding are apparent in ultrasonic welding.

The quality of the foil seam welds in terms of continuity of welds is good. A welded structure (bag shaped) held water without leaks for 8 hour test periods.

Mechanisms

The mechanism by which ultrasonic welding occurs must fit into the general group of mechanisms by which ultrasound produces its effects. This grouping includes secondary phenomena such as heating due to sound absorption and cavitation due to tensions in irradicated media, as well as primary phenomena such as oscillatory particle displacement, velocity, and acceleration plus unidirectional particle motions.

Two mechanisms have generally been suggested to account for the welding phenomenon. One of these

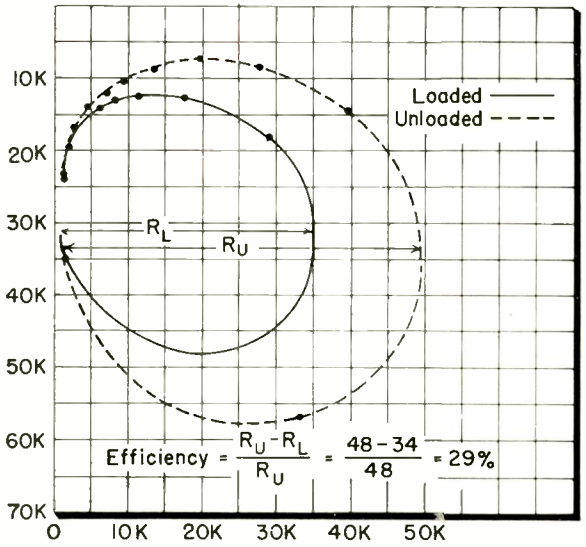


Fig. 7 (left): Drawing shows how to measure efficiency of transducer

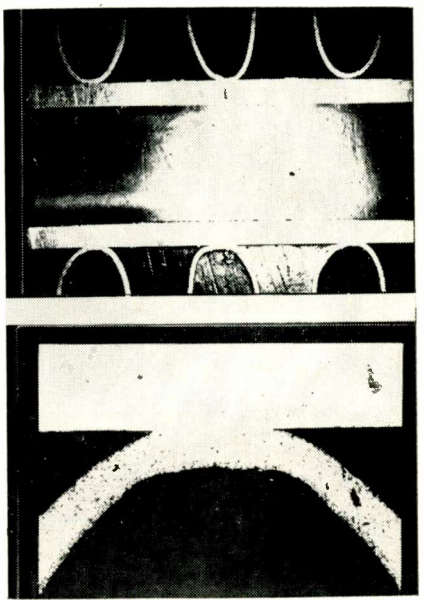


Fig. 8: Photomicrographs are used to observe the weld quality of ultrasonic welders.

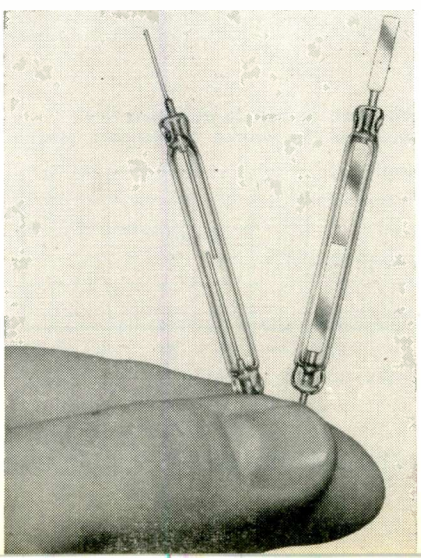
is that the primary properties of the sound field are involved and that molecular motions occur of sufficient energy to cause a molecular interlocking or possibly a granular interlocking of the materials. The other suggested mechanism is that a thin layer of the materials at the interface heat sufficiently from the shear motion at this interface to flow and fuse. The strongest evidence in favor of this second suggestion is that the effect occurs to a great extent only for shear waves in the materials and not for compressional waves. The dissipation of shear waves at the solid to gas interface would generally be greater than for compressional waves and thus lead to this difference in observed effect. In addition, it has been observed that external heating of the subject materials enhances the ultrasonic welding of the materials. This heating would naturally help melt the material.

The evidence in favor of the first suggestion is that thermocouple measurements in the gross material do not indicate temperatures sufficient to melt the gross material. In addition, an examination of the photomicrographs does not indicate the heat effected zones normally associated with fusion welding. If this proposed mechanism be considered seriously, though, a more detailed account of how it occurs will have to be worked out.

* * *

Sealed Contact Reed Relay

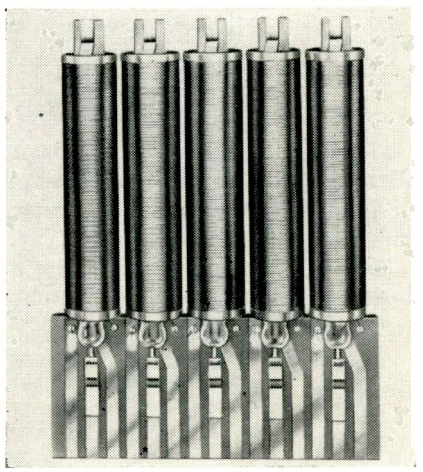
Front and side view of sealed contact relay. The two magnetically operated contacts are hermetically sealed in a glass capsule in an atmosphere of inert gas.



A NEW sealed contact reed relay gives literally hundreds of millions of perfect operations because it is virtually free from contact contamination. Called Clareed, it is manufactured by C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45. Its magnetically operated contacts are enclosed with an inert atmosphere inside a hermetically sealed glass capsule.

The relays are ideally suited for transistor drive applications as well as computers, data processing and automation equipment. Single capsule relays with individual coils or combinations of many capsules surrounded by a common coil are available to meet designers' requirements.

Clareed switch capsules are assembled in an entirely new plant equipped with the most modern air purification machinery ever devised. Electronic filtration equipment removes 99.97% of all particles of more than 0.3 micron diameter from the air in the critical assembly area. (One inch equals 24,500 microns.) The temperature in the Clareed assembly room never varies more than one degree from 72 degrees F.



Ten switches mounted in line, 5 on each side of a printed circuit board, with 5 magnetic coils. This assembly may be mounted directly into a rack.

The Clareed's nickel-iron alloy reeds are gold plated at the contact surfaces. The shaft of each

(*Continued on page* 256)

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P. O. Box 6087, Cleveland 1, Ohio

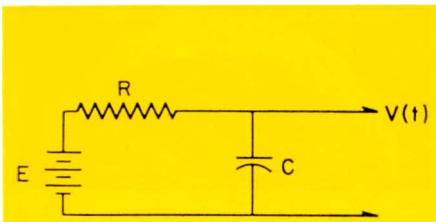


Fig. 1: This typical RC charging circuit is never realized in actual practice.

For Circuit Design . . .

Solid Tantalum

IN a typical RC charging circuit, Fig. 1,

$$v\,(t) = E\left[1-\exp\frac{-t}{RC}\right] \text{ volts} \qquad (1)$$

Starting with Eq. (1), it is easy to show that the time required to reach a specified voltage, V_n, is:

$$t_n = RC \ln\left[\frac{E}{E - V_n}\right] \text{ seconds} \qquad (2)$$

where, R = resistance in megohms, and
C = capacitance in microfarads.

Ideal & Practical Circuits

The ideal circuit of Fig. 1 is not realized in practice, since the leakage resistance of a practical capacitor is often low enough to affect the timing. A practical circuit is shown in Fig. 2(a).

From Thevinin's theorem, it is apparent that the capacitor would view Fig. 2(b) as equivalent to Fig. 2(a) providing

$$E' = \frac{R_p}{R + R_p} E = KE \qquad (3)$$

$$R_{eq} = \frac{R_p}{R + R_p} R = KR \qquad (4)$$

From the similarity of Fig. 2(b) to Fig. 1, it is apparent that to apply Eq. (2) to a practical circuit, we need only substitute KE for E and KR for R. This gives:

$$t_n = KRC \ln\left[\frac{KE}{KE - V_n}\right] \text{ seconds} \qquad (5)$$

For subsequent analysis, it will be helpful to normalize Eq. (5). We thus obtain:

$$t_n = KRC \ln\left[\frac{1}{1 - \frac{1}{K}\frac{V_n}{E}}\right] = RCK \ln\left[\frac{1}{1 - \frac{a_n}{K}}\right] \qquad (6)$$

where

$$a_n = \frac{V_n}{E} \qquad (7)$$

It will also be convenient to express k as a function of the ratio of leakage resistance to series timing resistance. We, therefore, let

$$B = \frac{R_p}{R} \qquad (8)$$

Fig. 2: In (a) we have a more practical charging circuit than that shown in Fig. 1; but the equivalent circuit (b) does resemble it.

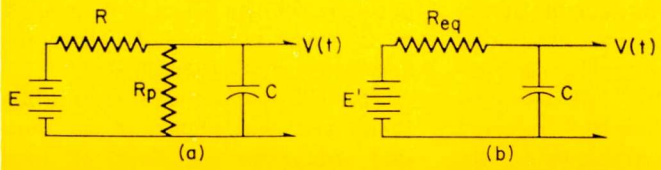
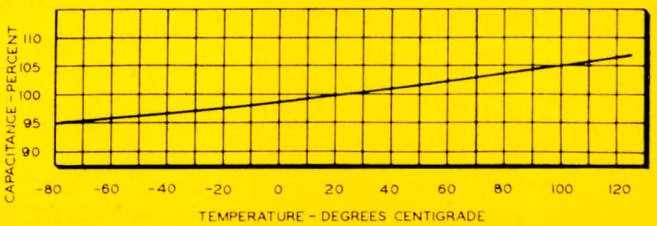


Fig. 3: Manufacturer's curve is used to determine the variation of capacitance for the desired temperature range.



Reliability and reduced size—these characteristics are making the solid tantalum capacitor increasingly attractive. In timing circuits, because temperature and voltage can vary timing, the designer should specify limit holding units—using parameters regularly measured in production.

Capacitors In Timing Circuits

From Eq. (3) it is apparent that

$$K = \frac{R_p}{R + R_p} = \frac{\frac{R_p}{R}}{1 + \frac{R_p}{R}} \qquad (9)$$

so that

$$K = \frac{B}{1 + B} \qquad (10)$$

We may now substitute for K in Eq. (6) to obtain

$$t_n = RC \left[\frac{B}{1 + B}\right] \ln \left[\frac{1}{1 - \frac{a_n}{\left(\frac{B}{1 + B}\right)}}\right]$$

This can be written $t_n = RC\ T_n$

where

$$T_n = \left[\frac{B}{1 + B}\right] \ln \left[\frac{1}{1 - \frac{a_n}{\left(\frac{B}{1 + B}\right)}}\right] \qquad (11)$$

Translating Data

If the T_n function is graphed in terms of the parameters a and B, it should aid in translating manufacturers standard data into their affect upon timing. For example, variations of capacitance and leakage current with temperature may be more easily interpreted as variation in time delay to some critical voltage V_n. Conversely, the specification for a capacitor to produce a time delay with a prescribed temperature stability may be written in terms of the maximum tolerance on capacitance deviation and leakage current.

To illustrate, suppose that a designer must insert a prescribed delay between two actions. Regardless of the specific problem, we assume that it may be translated into one of realizing a voltage V_n in a prescribed time, after closing upon a driving voltage E.

If we are given the following:

$t = 30$ sec. $\pm$ 5 sec.; $E = 28$ volts; $V_n = 11.2$ volts, and,

temperature range $= -55°C$ to $+85°C$

Table 1

Timing Circuits

Timing Values	a_n	0.1	0.2	0.3	0.4	0.5	0.6	0.7
C = K25H15	Secs (Calculated)	2.63	5.6	8.85	13	17.4	23.1	30.3
R = 1 Megohm	(Measured)	2.65	6	9.6	14	19	25.6	34.6
T = 65°C	% error	0.7	6.67	8.3	7.1	8.4	7.8	12
C = K25H15	Secs (Calculated)	2.65	5.63	8.9	13	17.5	23.3	30.8
R = 1 Megohm	(Measured)	2.55	5.4	9	13.5	18.7	25.3	33.7
T = 80°C	% error	3.92	4.26	1.1	3.6	6.4	7.9	8.6
C = K50H30	Secs (Calculated)	4.88	10.4	16.3	23.9	32.2	43.7	59.4
R = 1 Megohm	(Measured)	4.95	10.5	17.1	24.7	34	46	63
T = 30°C	% error	1.41	0.99	4.67	3.24	5.3	5	5.7
C = K50H30	Secs (Calculated)	24.3	51.7	82.8	122	173	255	—
R = 5 Megohms	(Measured)	25.5	55.5	89.2	133	180	291	—
T = 30°C	% error	4.7	6.86	7.2	8.3	3.9	12.4	—

Tantalum Capacitors

(Continued)

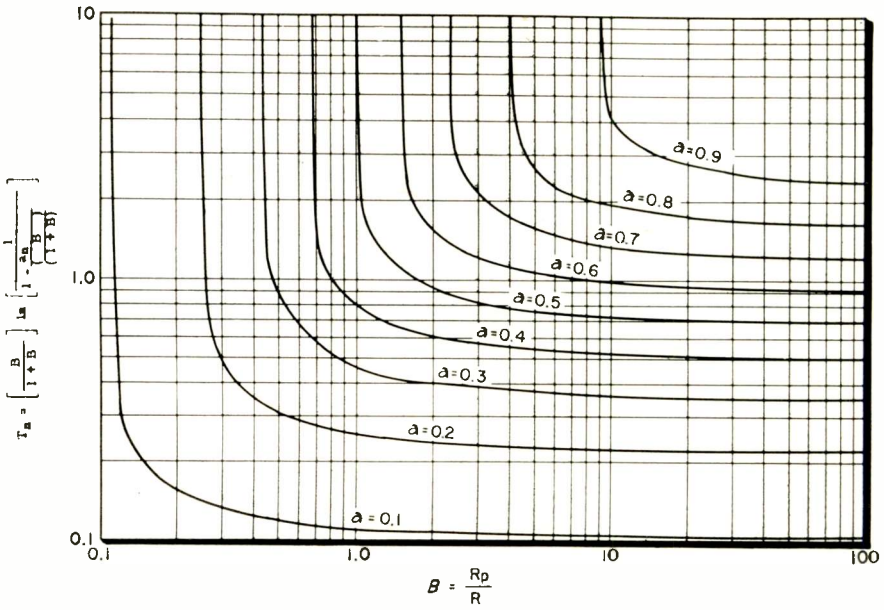


Fig. 4 (right): Graphical presentation of the Tn function in terms of the a and B parameters.

Specify R & C.

First calculate (a_1) from Eq. (7)

$$a_1 = \frac{11.2}{28} = 0.4$$

From the graph of Fig. 4 note that the stable and minimum value of $T_1 = 0.51$ when $a = 0.4$.

Over the temperature range required, from the manufacturer's curve shown in Fig. 3, the capacitance will vary ±4%. If the manimum C is taken as 100%, the maximum C will then be 108.3%.

If the minimum time of 25 seconds is taken as 100%, the maximum time of 35 seconds is 140% or 1.4 t_{min}. Because of capacitance change $t_{max} = 1.083\ t_{min}$; so, to find the maximum permissible value of T_1, from Eq. (11).

$$T_{max} = \frac{1.4}{1.083} = 1.283\ T_{min}$$

$$T_{max} = (1.283)\ (0.51) = 0.654$$

From the graph at $a = 0.4$, $T = 0.654$, $B = 1.55$. Therefore, $R_p \leqq 1.55\ R$ at all temperatures of operation. According to the manufacturer's curves of Fig. 5, this is equivalent to stating that $R_p = 1.55\ R$ at 85°C, since at all temperatures below 85°C, it will exceed its value at 85°C. From Eq. (11):

$$35 \text{ seconds} = RC_{\text{ max}}\ T_{n\ \text{max}}$$

$$RC_{\text{ max}} = \frac{35}{0.654} = 53.5 \text{ Megohm} - \mu\text{f}$$

$$RC_{\text{ nominal}} = \frac{53.5}{1.04} = 51.3 \text{ Megohm} - \mu\text{f}$$

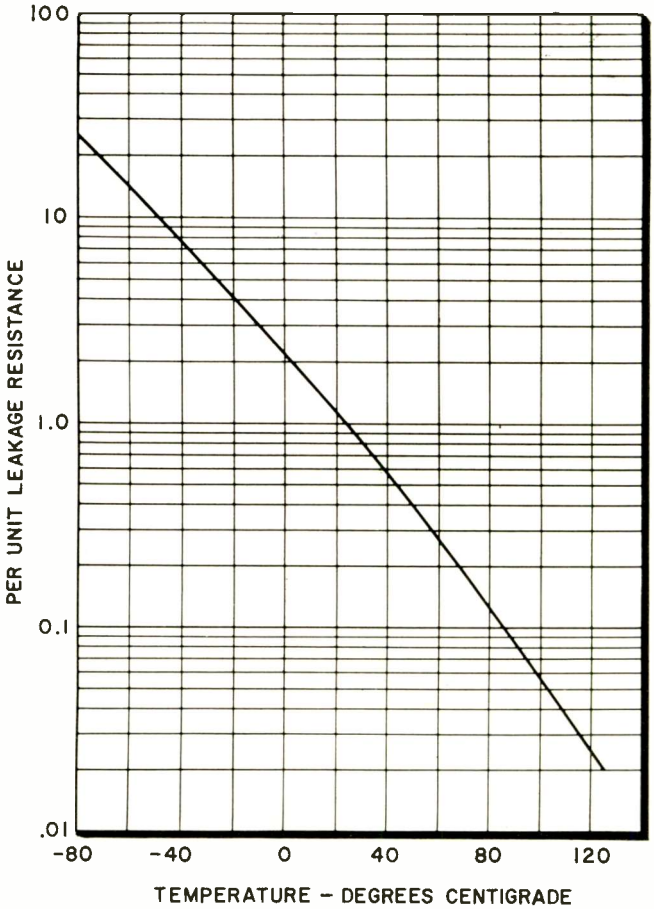
and $R_pC_{\text{ nominal}} = 1.55\ RC_{\text{ nominal}} = 79.8$ Megohm − μf at 85°C 11.2 volts.

Circuit Values

This determines the required circuit values at the temperature and voltage which are critical. They may be converted to equivalent values at the standard conditions of measurement by referring to the manufacturers curves showing variation of leakage current with voltage and temperature.

Depending upon the circuit which is controlled, it may or may not be possible for the capacitor to experience more than 11.2 volts across its terminals. If it is assumed here that 28 volts might eventually be applied, a 30 volt capacitor would be specified. The standard conditions of measurement would then be

Fig. 5: Per unit leakage resistance plotted against temperature.



30 volts and 25°C. A conversion to these conditions can be made using the manufacturer's curves of Figs. 6 and 7.

From Fig. 6, the voltage correction factor, M_v, would be

$$0.05 \times \frac{30}{11.2} = 0.134.$$

From Fig. 7 the temperature correction factor, M_T, would be 10.

The total correction factor $M = M_v M_T = 1.34$. At standard conditions of measurement, therefore, $R_p C_{nominal} = 1.34 \times 79.8$ or 107 Megohm-μf.

From a catalogue, showing leakage current as well as capacitance and voltage rating, a capacitor may now be chosen.

At 25°C, 30 volts, a K100H30 has a maximum i_L of 10μA. This is an R_p of

$$\frac{30}{10} \times 10^6 = 3 \text{ Megohms.}$$

Therefore, $R_p C_{nominal} = 300$ Megohms so the timing will be within the prescribed accuracy over a wider range than that specified. Actually this is well, because some margin is required to allow for change in series timing resistance with temperature, which was not considered in this analysis. It could, of course, be handled just as the variation of capacitance was treated here.

If the 100μf capacitor is chosen, R is found from the RC product already calculated:

$$R = \frac{51.3}{100} = 0.513 \text{ Megohm.}$$

Temperature Range

It is apparent from the graph of Fig. 4 that temperature range may be extended by operating on a curve of lower a_n. This will allow a greater reduction of R_p before timing is affected. It may be accomplished by raising the driving voltage or lowering the critical voltage. Lowering the critical voltage will also take advantage of the natural increase of leakage resistance at lower applied voltages, Fig. 6.

To check the method, recordings of the voltage rise were made from the output of an electrometer. Measured and calculated times are compared in Table 1, showing agreement within 10%. The equipment error is about 2% and dielectric absorption is believed to account for most of the remaining error.

The calculated times shown in Table 1 correspond to capacitance measurements made on a bridge at 120 cps. Capacitance was subsequently measured by integrating current over periods similar to those in Table 1 and dividing by the corresponding voltage. This showed the dc capacitance to be 5 to 8% higher than the 120 cps value, which would correct for most of the error shown in Table 1.

Fig. 6: Multiplier of leakage current plotted as a function of the percentage of the rated voltage that will be applied.

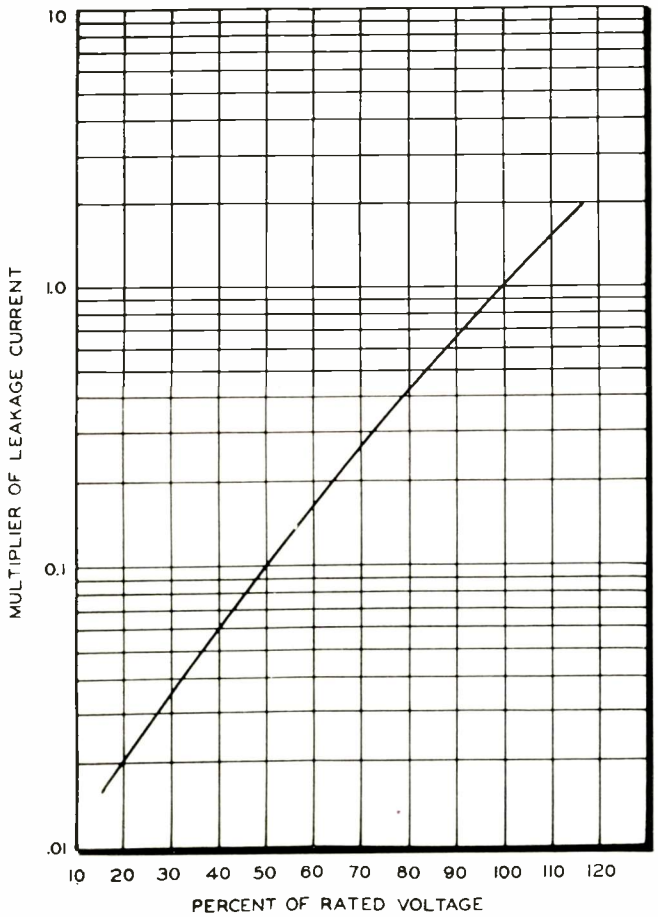
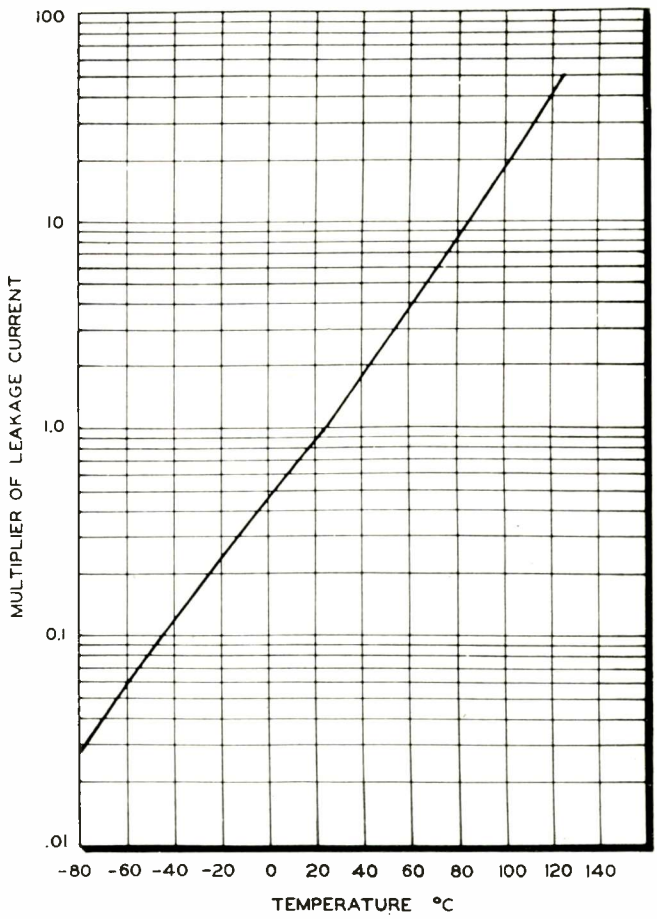


Fig. 7: Multiplier of leakage current plotted against temperature.



Part One of Two Parts

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Switching With Transistors

High reliability, low dissipation, faster switching speeds—these characteristics are making the use of transistors in computer applications grow rapidly. Because of this, design engineers are becoming increasingly interested in the use of transistors as switches. Here's the complete story.

IN Fig. 1a, a pair of mechanical contacts form a switch. $V_R = 0$ when S1 is open and $V_R = E$ when S1 is closed. This assumes that the open-circuit resistance, R_O, is infinity and the closed-circuit resistance, R_S, is zero. That is, there should be complete circuit isolation between A and B when S1 is open and no isolation when S1 is closed.

The ideal switch then has an R_O/R_S ratio of infinity. Mechanical switches provide this ideal ratio, but their slow switching speeds and low reliability restrict their use in a large portion of computer circuitry.

V_R in the circuit of Fig. 1a has two discrete levels, zero and E. The current in the circuit also has two levels, zero and E/R. These levels are used to identify bits of information in digital computer circuitry. The transition time required to switch from one level to the other, Fig. 1b, determines the propagation time of the information through the circuit. Therefore, in discussing transistor switches, there are two areas to be investigated: the steady-state characteristics, which determine the two discrete levels that will be maintained, and the transient characteristics or transition time between the two levels.

Steady-State Characteristics

A transistor is active, capable of amplifying a voltage or current, when the emitter-base junction is forward-biased and the collector-base junction is reverse-biased. When both junctions are reverse-biased, the transistor is inactive; only leakage currents are present.

The following dc equations can be written when the positive direction of current is defined as into each lead of the transistor:

$$I_B + I_C + I_E = 0 \quad (1)$$

$$I_B = -(I_C + I_E) \quad (2)$$

$$I_C = -h^*_{FB} I_E + I_{CO} \quad (3)$$

Assuming I_{CO} is the leakage current across the reverse-biased collector junction, Eq. (3) defines the parameter h^*_{FB} as the static value of the common-

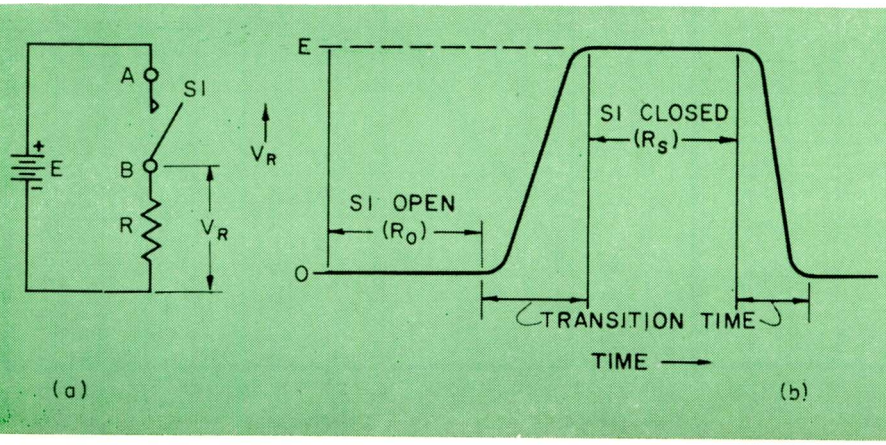


Fig. 1: The voltage across R in (a) has two discrete levels, 0 and E; in digital computer circuitry, these levels identify information bits. The transition time shown in (b) determines propagation time of information through circuit.

base forward current transfer ratio with I_{CO} subtracted from the total collector current.†

$$I_B = -I_E(1 - h^*_{FB}) - I_{CO} \quad (4)$$

$$h_{FE} \equiv \frac{I_C}{I_B} = \frac{-h^*_{FB} I_E + I_{CO}}{-I_E(1 - h^*_{FB}) - I_{CO}} \quad (5)$$

Usually, I_{CO} can be neglected, reducing the foregoing equations to:

$$I_C = -h_{FB} I_E \quad (6)$$

$$I_B = -I_E(1 - h_{FB}) \quad (7)$$

$$h_{FE} = \frac{h_{FB}}{1 - h_{FB}} \quad (8)$$

Since h_{FB} is typically 0.9 to 0.99, from Eq. (6) we see that with a given current for I_E, I_C will be approximately the same in a direction of $-I_E$. From Eq. (7), I_B is a current in the direction of $-I_E$ that will be 0.1 to 0.01 times I_E. From Eq. (8), h_{FE} (the static value of the forward current transfer ratio from base to collector with emitter common) is 9, if $h_{FB} = 0.9$; and, 99, if $h_{FB} = 0.99$. (h_{FE} is frequently referred to as the dc beta). *The common-emitter connection is used for most switching circuits because of the high current gain from the input base lead to the output collector lead.*

Fig. 2 shows a plot of the common-emitter characteristics of an NPN grown-diffused junction transistor with a load line superimposed on the curves. A load resistor, R_L, between the collector and the supply voltage, V_{CC}, will cause the operating points of the transistor to fall on this load line.

When $I_C = 0$, $V_{CE} = V_{CC}$; when $V_{CE} = 0$, $I_C = V_{CC}/R_L$. With $I_B = 0$, the operating point is at A, and the collector current that flows is due to I_{CO}. Thus, V_{CE} is very nearly V_{CC}. At point A, the transistor is inactive because both junctions are reverse-biased.

As I_B is increased, the operating point moves along the load line toward the $V_{CE} = 0$ vertical axis. When I_B is made large enough, the operating point moves to point B and will remain approximately at this point, even though I_B is made very large. When the transistor is at point B, we say the transistor is *saturated.* Since point B is past the knee of the curve, further increases in I_B cause little change in I_C at the given V_{CE}. The collector current has reached a saturated value. To arrive at point B, a given I_B must be fed into the base to generate the I_C. Therefore, $h_{FE} \equiv I_C/I_B$ must have a minimum value. Present-day transistors have h_{FE} values that range from 10 to 150 at currents from 5 ma to 30 amps.

If I_B is limited so the operating point moves only to point C in Fig. 2, the transistor remains in the linear active region and the collector current *is not saturated.*

R_O/R_S Ratio

R_O is measured at the OFF point A, and R_S at the ON point B. At point A, there is high V_{CE} and low I_C, a leakage current. The coordinates V_{CE} and I_C give $R_O = V_{CE}/I_C$, which is a high resistance. At point B, there is low V_{CE} and high I_C. The coordinates $V_{CE(sat)}$ and I_C give $R_S = V_{CE(sat)}/I_C$. This is a low resistance and is called the *common-emitter saturation resistance,* R_{CS} or R_{CES}. In a typical PNP alloy switching transistor,

$R_O = 20\text{v}/5\mu\text{a} = 4\text{M}$ ohms, while $R_S = 0.2\text{v}/10\text{ma} = 20$ ohms.

The ratio

$$\frac{R_O}{R_S} = \frac{4 \times 10^6}{20} = 2 \times 10^5.$$

Because R_O is not infinity and R_S is not zero, transistor switches lack the complete circuit isolation of the mechanical contacts shown in Fig. 1. However, the R_O/R_S ratio is excellent and in many cases extends to 1×10^6. The voltage levels obtained at the output are very close to zero and V_{CC}. Higher R_O and lower R_{CS} are very desirable characteristics; however, since parameters such as frequency cutoff, current capacity, power dissipation, voltage breakdown, and temperature characteristics must be considered in the overall device desired, compromises in the values of R_O and R_{CS} must be made.

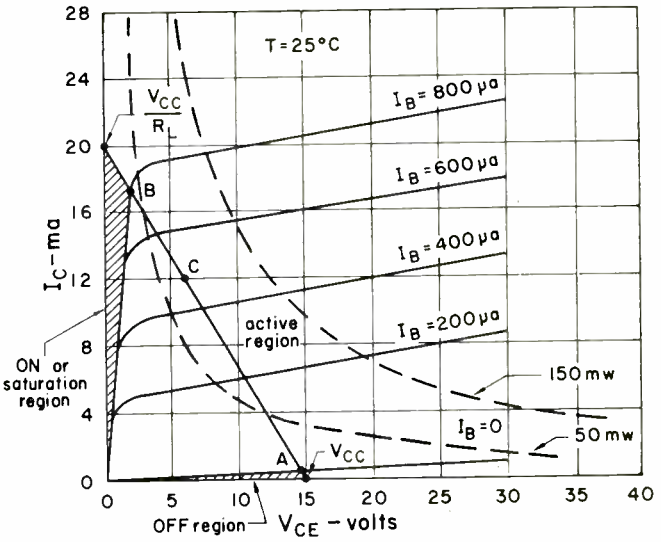


Fig. 2: Common-emitter characteristics of an NPN grown-diffused junction transistor with a load line superimposed on the curves.

Regions of Operation

The steady-state levels, which are used as bits of information, of a saturated transistor are determined by points A and B in Fig. 2, the OFF and ON points respectively. For a non-saturated transistor, the OFF point is A and the ON point is C.

Saturated Operation

Fig. 2 defines the three regions of saturated operation: the ON or saturation region is the vertical crosshatched area; the active region is from point A to B; and the OFF region is the horizontal crosshatched area.

In the ON region, both transistor junctions are forward-biased, the N-type material being negative with respect to the P-type material. Both junctions act as an emitter and collector simultaneously, and I_E, I_C, and I_B are determined approximately by external circuit components and values. Small opposing voltages are supplied by the junctions, which are

† The IRE Standard on Letter Symbols for Semiconductor Devices, 56IRE 28.S1 (reprinted in the *Proc. IRE*, July 1956) states that $h_{FE} \equiv I_C/I_B$ and $h_{FB} \equiv I_C/I_E$, where I_C, I_B, and I_E are total dc currents flowing in the respective leads. h_{FE} is the parameter that is listed on almost every transistor data sheet. The superscript asterisk is used herein to identify the static value of the forward current transfer ratio when I_{CO} is not included in I_C.

Transistor Switches *(Continued)*

added together with the voltage drop in the bulk resistance to determine the $V_{CE(sat)}$ of the transistor.

Alloy-junction transistors have a very low $V_{CE(sat)}$, in most cases less than the V_{BE} required to drive the transistor. Grown-junction transistors have a $V_{CE(sat)}$ 5 to 10 times that of alloy-junction transistors.

Although the R_{CS} of grown-junction transistors is high, it can be tolerated in a great deal of computer circuitry—where the emphasis is on the transfer of information rather than the transfer of power. Because the information is contained in a particular voltage or current level, and because this information must be transferred and manipulated without error, some power is sacrificed to achieve the desired switching speed and the design tolerances necessary to eliminate error. Such a low-power medium-speed circuit is illustrated by the load line on the transistor curves in Fig. 2. The ON and OFF voltages are separated by some 12 volts. This tolerance provides a reliable circuit design by ensuring maximum freedom from effects of power supply variations and noise.

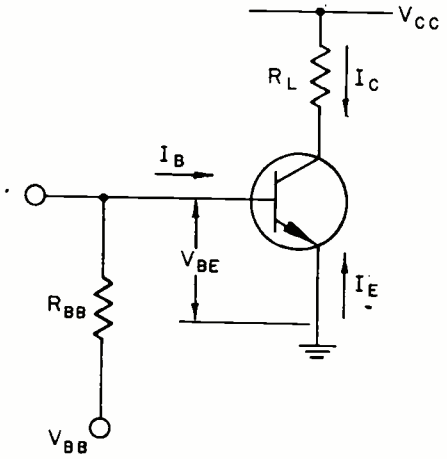
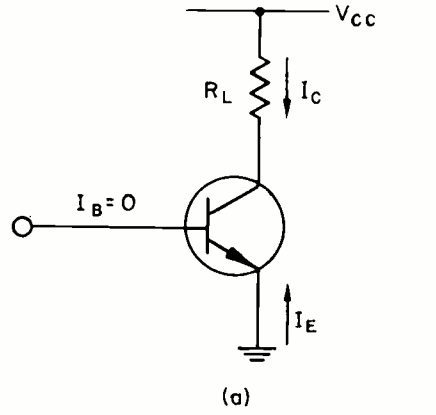
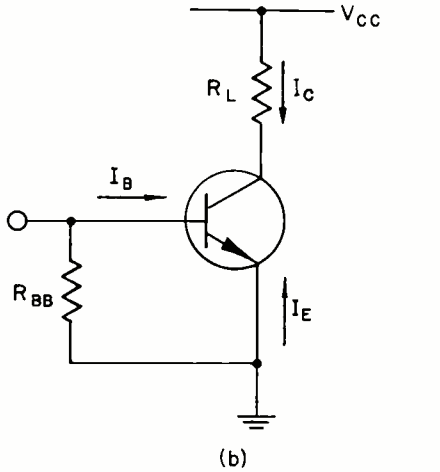


Fig. 3: Emitter junction must be reverse-biased in the OFF region an $I_E = 0$. Circuit shows this condition for an NPN transistor.



(a)

Fig. 4 (a): Reverse-bias error. With the base open, a runway condition of the leakage currents occurs very rapidly.



(b)

Fig. 4 (b): Reverse-bias error. In this tempting circuit, R_{BB} is large. But a small I_{CO} raises V_{BE} above pedestal voltage necessary to cause I_E to flow. Then the same runaway condition exists as in Fig. 4 (a)

High-speed circuits require low-resistance low-capacity components in the external circuit. A low load resistor, by causing the load line to more nearly parallel the vertical axis, produces a much higher current. The supply voltage, V_{CC}, must then be lowered to keep within the maximum current and dissipation of the transistor. Since this brings the OFF point voltage much closer to the ON point voltage, the large tolerance between ON and OFF is lost and the circuit becomes subject to effects of supply voltage variations and noise. To give better tolerance, $V_{CE(sat)}$ should be as low as possible. *Therefore, low R_{CS} is a necessary requirement for high-speed transistor switches.*

In the active region, where normal transistor action occurs, the emitter junction is forward-biased and the collector junction is reverse-biased. A saturating transistor is in the active region only while switching between ON and OFF levels. A non-saturating transistor has its ON level at point C in the active region. The alpha-cutoff frequency and current amplification at a given frequency—used as figures of merit for switching transistors—are both measured at operating bias points in the active region.

In the OFF region, both junctions are reverse-biased, which gives $I_E = 0$. *This must be true at the highest operating temperature for reliable switching circuit design.*

With $I_E = 0$, from Eq. (2) and (3),

$$I_B = -I_C \tag{9}$$

or

$$I_B = -I_{CO} \tag{10}$$

The OFF condition is illustrated in Fig. 3 for an NPN transistor. For I_C to equal I_{CO}, I_E must equal zero; that is, V_{BE} must be negative. V_{BE} will be negative if V_{BB} is more negative than $R_{BB}I_C$. Since $I_B = -I_{CO}$, V_{BB} must be more negative than $-R_{BB}\ I_{CO}$, a small leakage across the emitter junction is neglected.

It is important to understand that the emitter junction must be reverse-biased in the OFF region and that $I_E = 0$. For example, Fig. 4a is the same as Fig. 3 but has the base open.

Using Eq. (2) and (3) with $I_B = 0$,

$$I_C = -I_E \tag{11}$$

and

$$I_C = +h^*_{FB}\,I_C + I_{CO} \tag{12}$$

Therefore,

$$I_C = \frac{1}{1 - h^*_{FB}}\,I_{CO} \tag{13}$$

Eq. (13) states that the OFF leakage current, I_C, with the base open will be greater by the factor $1/(1\text{-}h^*_{FB})$ than I_{CO} leakage current obtained with reverse bias. In this case, h^*_{FB} is the current transfer ratio at emitter currents of the magnitude of I_{CO}. h^*_{FB} increases in these regions of small current. Therefore, as temperature increases, I_{CO} increases, which increases I_C and I_E, which increases the factor $1/(1\text{-}h^*_{FB})$, which increases I_{CO} and I_E, etc. A runaway condition occurs very rapidly.

In some transistors current multiplication also determines the effective value of h^*_{FB}. A factor, M,

multiplies the normal h_{FB} to make it greater than 1. In like manner, h^*_{FB} is increased. Eq. (13) shows that I_C approaches infinity as h^*_{FB} approaches 1. Current multiplication occurs at BV_{CE} voltages that are much less than the normal BV_{CBO} values. Because h_{FB} increases and peaks as I_E is increased from zero, the reduction in BV_{CE} is apparent as I_E, or I_C, increases. Extending the common-emitter collector characteristics into the breakdown region on a curve tracer will reveal the mentioned characteristics at the higher I_C.

That is why BV_{CEX} should be listed on transistor data sheets. The X indicates that a reverse bias is applied when the breakdown voltage is measured. BV_{CEX} is listed as some minimum voltage when measured at some I_C level. BV_{CEX} is also called the avalanche breakdown voltage between collector and emitter. Many transistors have been destroyed by neglecting this quantity in switching circuit design. It is especially important if the collector load is inductive rather than resistive. For micro-alloy or alloy-junction transistors, BV_{CEX} may be limited by the punch-through voltage, V_{pt}, rather than the avalanche breakdown.

The condition of $I_B = 0$ is seldom encountered in practice. However, the design in Fig. 4b is one that many new designers of transistor circuits may be tempted to use. R_{BB} is a large resistor. A small value of I_{CO} raises the V_{BE} above the pedestal voltage necessary to cause I_E to flow, and the same runaway problem exists as for $I_B = 0$. *Therefore, it is necessary design practice to reverse bias an OFF transistor that is to operate over a wide temperature range.* This refers specifically to the +65°C range for germanium and the +150°C range for silicon.

Some further comment is necessary for silicon. At 25°C the V_{BE} pedestal voltage necessary to produce I_E in a germanium transistor is about 0.3 volt, while in silicon it is about 0.7 volt. V_{BE} in each of these transistors will *reduce* about 1.5-2.5 mv/°C *rise* in temperature. I_{CO} for silicon transistors is normally in the 0.1 μa range at 25°C rather than in the 1-5 μa range as for germanium. Also, the current amplification in most germanium units is higher at low emitter currents than it is for equivalent silicon units. These two facts indicate that a circuit condition such as Fig. 4b would be satisfactory for silicon units. That is, no reverse bias would be necessary because both I_{CO} and h^*_{FB} in Eq. (13) would be much smaller for a silicon unit than for a germanium unit. Such is the case if the silicon units are restricted to the same maximum temperature limit as the germanium units, +65°C, and *if the surface leakage is low.* This means that in many industrial applications silicon units can be operated without reverse bias in the OFF condition. However, in all cases, reverse bias would be better.

Non-Saturated Operation

In non-saturated operation the OFF region is the same as for the saturated transistor, that is, I_E must be made equal to zero. The ON region is in the *active* region and, therefore, there is no saturated region.

To be concluded in an early issue

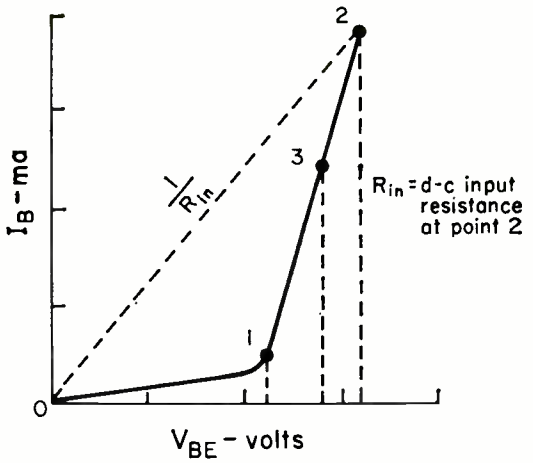


Fig. 5 (above): While recording the data for this curve, the operating point of the transistor was moved along the load line in Fig. 2.

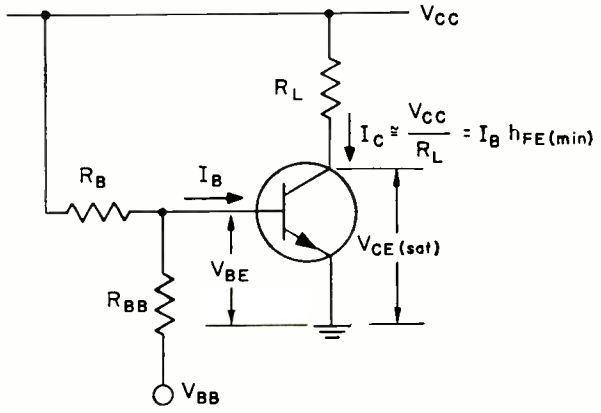
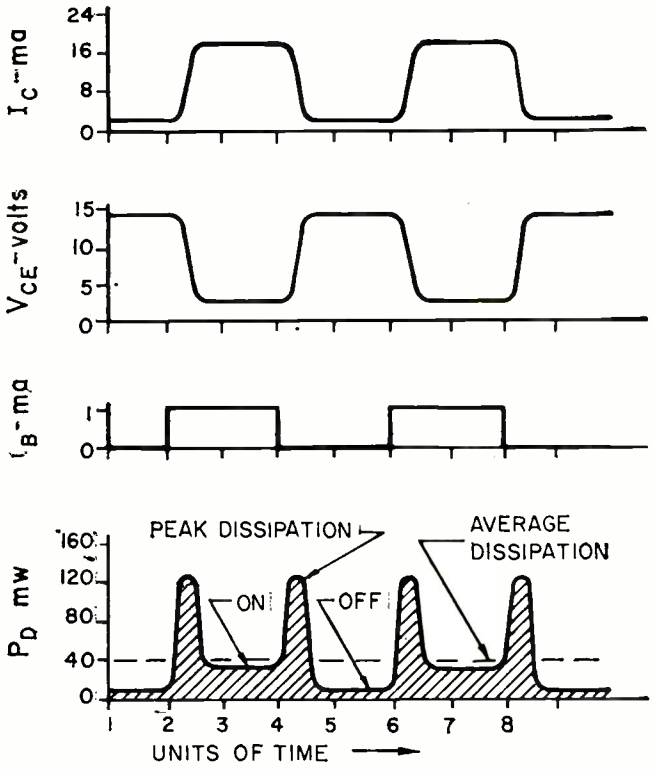


Fig. 6 (above): A high voltage source in series with a large resistor is used to set the base current in a saturating switching circuit.

Fig. 7 (below): Power dissipation as unit in Fig. 2 is shifted from point A to B and back. Average is much less than peak dissipation.



More on

Thermistors . . . . 10 to 600°K

The article "Thermistors . . . 10 to 600°K" by Dr. H. B. Sachse, published in the October 1959 issue, evoked comments from H. L. Armstrong of Queens University. We contacted Dr. Sachse for his reaction to these comments. In the interest of completeness, we present both sides of the story.

Editor, ELECTRONICS INDUSTRIES:

In connection with Dr. Sachse's recent article on thermistors, ("Thermistors - - - 10 to 600°K," *Electronic Industries*, Oct. 1959, p. 81) and the dependence on temperature of their resistance, I would like to raise a question or two.

Sachse related the resistance R of a thermistor to the absolute temperature T, by the relation

$$R = A \exp B/T \qquad (1)$$

and took A as being strictly a constant B, then, was found, in general to be a function of temperature. Now, from the theory of semiconductors, one would expect that $B = U_a/k$, U_a being an activation energy, a constant, and k Boltzmann's constant. Thus one might expect B to be constant.[1]

On the other hand, one might expect that A would be a function of temperature. Roughly speaking, the exponential dependence on temperature in Eq. (1) arises from variations of the number of carriers (electrons, "holes," or both) free in the material to conduct. However, it is not enough that the carriers just be free, they must move around; and in this the carrier mobility is involved. This brings in a function which may be represented fairly well by a power of T; also, a power of T may occur along with the exponential in the factor having to do with the number of carriers free. Thus one expects that Eq. (1) might better be written

$$\begin{aligned} R &= A_0 T^n \exp B/T \\ &= A_0 \exp [(B + nT \ln T)/T] \end{aligned} \qquad (2)$$

Thus, this takes on a form similar to that of Eq. (1), and A is replaced by A_0, which is now truly constant; but B is replaced by $B + nT \ln T$. For n positive, as one expects, the term $B + nT \ln T$ will increase with increasing T, which seems to agree with what is usually observed.

A second matter is this. Suppose that there are two sources of carriers, having activation energies U_{a1} and U_{a2}. Since R goes inversely as the total number of carriers, one expects that

$$\begin{aligned} R &= \frac{T^n}{A_1^{-1} \exp (-U_{a1}/kT) + A_2^{-1} \exp (-U_{a2}/kT)} \\ &= \frac{T^n}{A_1^{-1} \exp (-B_1/T) + A_2^{-1} \exp (-B_2/T)} \end{aligned} \qquad (3)$$

Suppose that the first term in the denominator is much greater than the second; then one may write

$$\begin{aligned} R &= T^n A_1 (\exp B_1/T) \left[1 + \frac{A_1}{A_2} \exp (B_1 - B_2)/T\right]^{-1} \\ &= A_1 T^n \exp \left[\left\{B_1 - T \ln \left[1 + \frac{A_1}{A_2} \exp (B_1 - B_2)/T\right]\right\} \Big/ T\right] \\ &\approx A_1 T^n \exp \left\{\left[B_1 - T \frac{A_1}{A_2} \exp (B_1 - B_2)/T\right] \Big/ T\right\} \\ &= A_1 \exp \left\{\left[B_1 + nT \ln T - T \frac{A_1}{A_2} \exp (B_1 - B_2)/T\right] \Big/ T\right\} \end{aligned} \qquad (4)$$

Thus the factor before the exponential is strictly constant, but B is replaced by

$$B_1 + nT \ln T - (TA_1/A_2) \exp [(B_1 - B_2)/T].$$

Again, this means that the denominator of the exponent appears as a function of temperature. Of course, if there should be more than two sources of carriers, all having different activation energies, an obvious extension of the above argument would apply.

This discussion is written in the hope that it may help in interpreting rationally the empirically observed behavior of thermistors, and also that it may perhaps suggest some thoughts of help in predicting or understanding the behavior of different materials.

H. L. ARMSTRONG,
Dept. of Physics,
Queens University,
Kingston, Ontario.

(*Continued on page* 222)

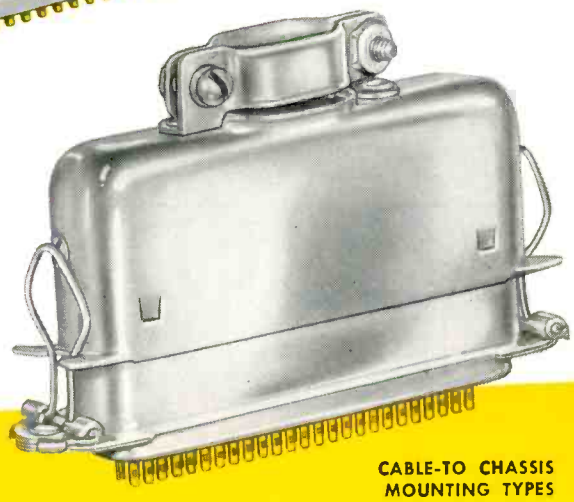
1. Spenke, E., *Electronic Semiconductors*, McGraw-Hill, 1958, p. 305.

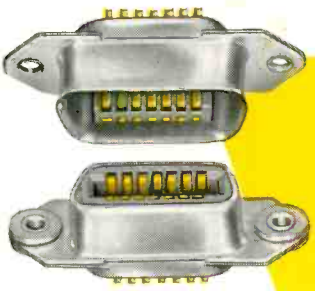
The smooth, easy insertion and extraction action, the self-wiping, self cleaning features and the double-sided, flexing action of both mating contact members make Micro-Ribbons the first miniature connectors to provide reduction in size with added reliability.

☆ CINCH

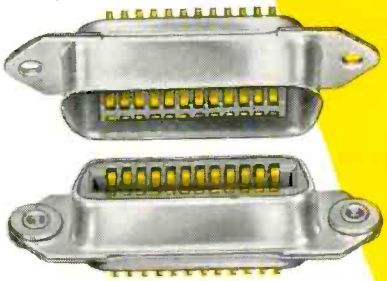
MINIATURE BLUE RIBBON CONNECTORS

Bodies are molded of an improved diallyl phthalate with extremely high impact strength and excellent dielectric features. Contacts are gold-plated over silver. Shells are cadmium-plated brass with clear chromate treatment. Receptacle shells have floating bushings allowing a float of .020 in each direction.

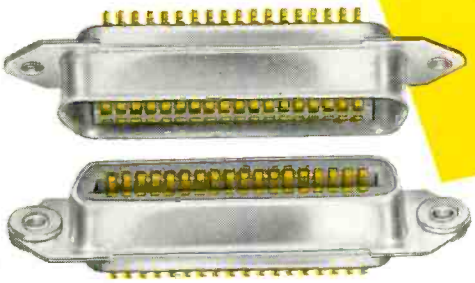




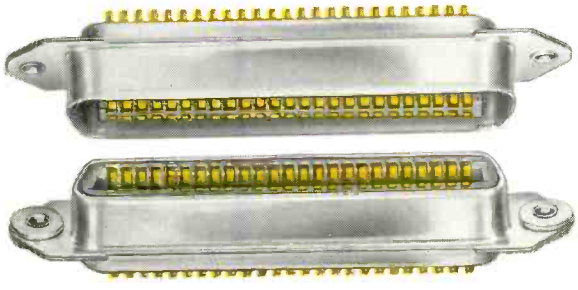
14 CONTACTS



24 CONTACTS

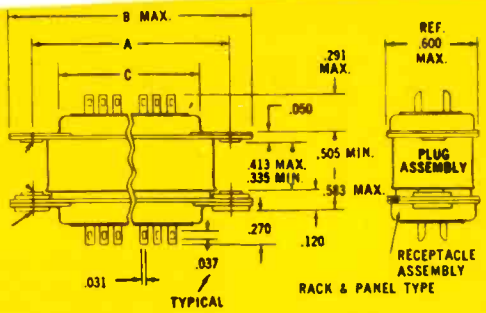


36 CONTACTS



50 CONTACTS

RACK AND PANEL TYPES



RACK & PANEL TYPE

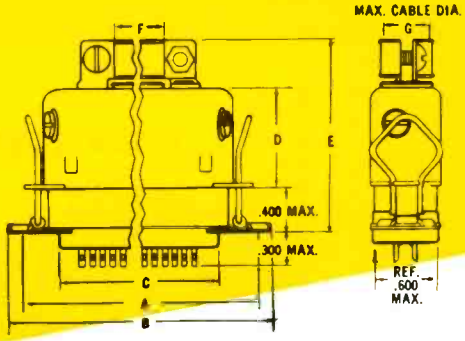
CABLE-TO CHASSIS MOUNTING TYPES

The compact housings are equipped with sturdy spring type latches on the receptacles which are guided and held by cut-outs in the plug flanges.

The shells are cadmium plated brass with clear chromate treatment. Receptacle shells have floating bushings allowing a float of .020 in each direction.

DIMENSIONS

		14 Contacts	24 Contacts	36 Contacts	50 Contacts
BOTH TYPES	A	1.417	1.842	2.352	2.947
	B	1.750	2.175	2.685	3.270
	C	.908	1.335	1.845	2.440
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668	1.668	1.730	1.825
	F	.306	.473	.640	.766
	G	.422	.473	.473	.473



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ELECTRONIC DOT ASSEMBLIES

RACK AND PANEL . . . CODE NOS.

CONTACTS	PLUGS	SOCKETS
14	36-27114	36-27214
24	36-27124	36-27224
36	36-27136	36-27236
50	36-27150	36-27250

PLUG WITH CAP . . . SOCKET WITH LOCK

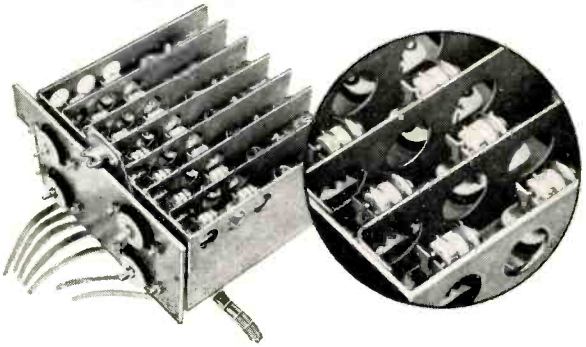
14	36-27314	36-27414
24	36-27324	36-27424
36	36-27336	36-27436
50	36-27350	36-27450

☆ Manufactured by agreement with Amphenol-Borg Electronics Corporation

Circle 50 on Inquiry Card

Good electronic design you limit compromise by PROOF:  G-E 7077 over a wide spectrum of

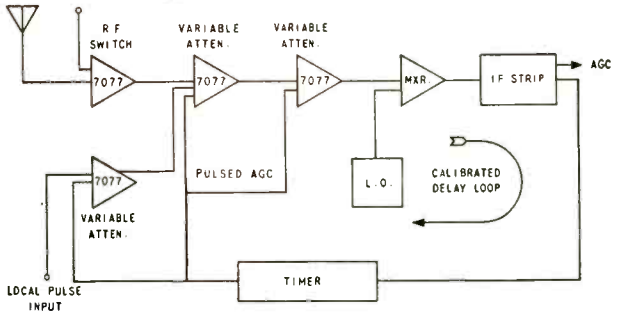
LOCKHEED



WIDE-BAND TAPE RECORDER.

For Lockheed, California Division, 28 General Electric 7077's serve as pre-amplifiers in a 14-channel 500-kc 60″-per-second tape recorder that stores wide-band information from an air defense exercise five times as rapidly as before. Extreme requirements of frequency, timing accuracy, and reproducibility are met by the 7077's low noise, high impedance, and high G_m. Also, the tube's small size matches the miniaturization needs of the Lockheed tape-recorder equipment.

MOTOROLA

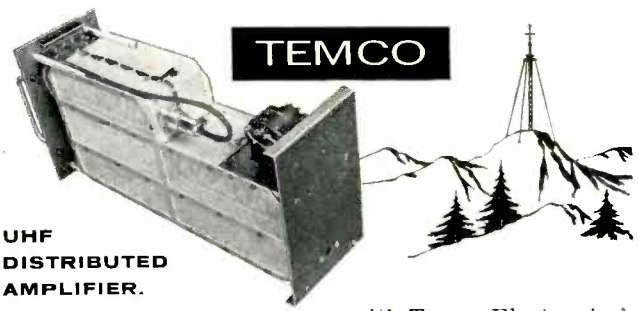


GROUND-SURVEYING RADAR.

Motorola's Western Military Electronics Center in Phoenix uses four General Electric ceramic 7077's for high-speed RF switching and pulse attenuation in a 440-mc distance measuring circuit where timing to *one billionth of a second* is needed for pulse delay measurement. Minimum plate-to-cathode capacitance, high gain, low noise, and a configuration that makes the tube ideal for grounded-grid service, were reasons back of Motorola's choice of the G-E 7077.

involves trade-offs...but using ceramic tubes. meets designers' targets frequency and function.

MISS-DISTANCE INDICATOR.
Ralph M. Parsons Company uses seven General Electric ceramic 7077's in tuned stages as high-gain, low-noise RF amplifiers in its PARAMI system for determining air-intercept missile accuracy. A 324-mc circuit, the Parsons PARAMI system has a gain-bandwidth product approaching the limit of the state of the art.



UHF DISTRIBUTED AMPLIFIER.
Many receivers—one antenna, with Temco Electronics' broadband distributed amplifier. Arranged in six five-stage units, 30 G-E 7077's are used as RF amplifiers, operating over a 750 mc bandwidth, between 250 and 1000-mc. Fills the frequency gap between TWT's and existing distributed amplifiers.

Phone your nearest General Electric Receiving Tube Department Office:
New York: Wisconsin 7-4065, 6, 7, 8 Chicago: SPring 7-1600 Los Angeles: GRanite 9-7765

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431-202

ircle 115 on Inquiry Card

New Tech Data for Engineers

Microwave Data

Special charts and graphs for the microwave engineer are featured in a 26-page catalog of company products from Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif. Products include: microwave switches, coaxial and waveguide; power dividers; direction couplers; and other microwave components. Included are specs, applications, options, dimensional data, schematics and designations chart.

Circle 162 on Inquiry Card

Insulation Testing

Thirty-two page manual contains step-by-step procedures for testing insulation resistance. Measurements are diagrammed for motors, generators, transformers, and many other electrical devices. Methods are outlined for establishing minimum acceptable limits of insulation resistance for a wide range of equipment. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Circle 163 on Inquiry Card

Circuit Breaker

Bulletin B-07 describes the Series 500 electro-magnetic circuit breaker. Discussed are: available ratings, time delays, trip level, rated current, frequency ratings, possible combinations and release coil resistances. Outline dimensions for the series circuit, shunt and relay types are provided and a typical time delay curve is shown. Airpax Electronics Inc., Cambridge Div., Cambridge, Md.

Circle 164 on Inquiry Card

Transformers

A 36-page catalog of electronic transformers, catalog TR-61, offers specs and prices on the complete industrial transformer line, plus over 80 new items in the audio, pulse and transistor applications. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Circle 165 on Inquiry Card

Data Processing System

A 12-page, 3-color brochure describes GE's GE 210 electronic data-processing computer system. Unit uses magnetic character recognition, building-block design, and features transistorization. Brochure CPB-81 (GE 210) Computer Dept., General Electric Co., Phoenix, Ariz.

Circle 166 on Inquiry Card

Aircraft Instruments

Manual 05-100-B, 48 pages, from Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N. J., describes a complete line of aviation instruments and components. It has dimensional drawings and wiring diagrams. Also specs., mounting information, and installation information for ammeters, voltmeters, volt-ammeters, shunts, current transformers, resistance and thermocouple thermometers, resistance bulbs, ILS cross-pointer, trim-tab, frequency and course indicators, plus luminescent materials for dials and pointers.

Circle 167 on Inquiry Card

Solder R & D Kit

Four-page, 2-color, bulletin from Alpha Metals, Inc., 56 Waters St., Jersey City 4, N. J., describes a kit which contains all materials needed for doing experimental work that cannot be done using standard lead-tin solders. A Flux Finder Guide and Solder Selector Chart are built into the kit. The kit has 16 soldering chemicals and 11 solders (special alloys for temperature differential soldering).

Circle 168 on Inquiry Card

Power Supplies

Series of transistorized power supplies for transistor circuit applications feature excellent transient response with controlled under and overshoot, high stability and low weight are described in bulletin PS1059. Series delivers variable and fixed outputs, ranging from 1.5 to 50 vdc and 2 to 5 a with high line and load regulation. Bulletin has information on transient response, ripple, stability, regulation, output impedance, controls, etc. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Circle 169 on Inquiry Card

High Temp Magnet Wire

Technical Paper No. 60-1, High Temperature Magnet Wire (originally presented at the Natn'l Conf. on Application of Electrical Insulation) is offered by Sprague Electric Co., North Adams, Mass. It discusses, among other topics, the improvement of performance of polytetrafluoroethylene insulated magnet wire by using an underlying base of ceramic. Also: oxidation of the copper wire may be substantially reduced by very thin electroplated protection of nickel or nickel-cobalt alloy.

Circle 170 on Inquiry Card

British Tubes

Index of tubes from English Electric Valve Co., Ltd., Chelmsford, Essex, England, gives abridged data for all E.E.V. valves (tubes). Included are Rectifiers (Mercury vapor, Xenon, High Vacuum Ignitrons, Spark Gap), Triodes (Natural, Forced-air, Water and Vapor Cooled), Tetrodes, Thyratrons (Rare Gas and Hydrogen), voltage stabilizers, Klystrons, Magnetrons, TW tubes, TV Camera tubes, and BW oscillators.

Circle 171 on Inquiry Card

Resistance Welding

Tech data and welding information for users of resistance welded fasteners and parts. It contains dimensional info on weld nuts, screws, special purpose weld parts, etc. It contains an engineering section with detailed information on how to achieve optimum welds under various conditions. The Ohio Nut & Bolt Co., 33 First Ave., Berea, Ohio.

Circle 172 on Inquiry Card

Trimmer Capacitors

Bulletin CW, from Marstan Electronics Corp., 204 Babylon Turnpike, Roosevelt, Long Island, N. Y., illustrates and describes two of the company's lines of high voltage 3000 wvdc coax trimmer capacitors and insulating washers for commercial, industrial and military usage. Bulletin 359, 4 pages, describes a line of solid state economy series time delay relays.

Circle 173 on Inquiry Card

Time Interval Measurements

Data file No. 112, 14-pages, describes methods of making precise time measurements with digital electronic apparatus. Examples include: period of a signal, measuring pulse interval, phase difference, timing relay action, and determining velocity. Also: techniques for coping with noise and improving accuracy. Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Circle 174 on Inquiry Card

Digital Voltmeter

Two-color, four-page bulletin on V64 digital voltmeter is offered by Non-Linear Systems, Inc., Del Mar, Calif. The folder compares the full 4-digit V64 with pointer meters and 3-digit voltmeters.

Circle 175 on Inquiry Card

Tech Data

for Engineers

Miniature Connectors

A 6-page, 2-color catalog of the 4 basic series of Deutsch miniature connectors: DM series, solder-type; DS Series, snap-in type; Rack-and-Panel, both rectangular and cylindrical; and Hermetics. Catalog has cutaway drawings and specs. and a table showing mating combinations of DM and DS series. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 274 on Inquiry Card

Shaft Position Encoder

A 12-page brochure, "Shaft Position Digital Encoders With Magnetic Readout" from ASCOP Div., Electro-Mechanical Research, Inc., P. O. B. 44, Princeton, N. J., gives specs for the 13-bit, 8-bit, and incremental encoders. Operating principles are described and illustrated. Recommended, simplified transistor circuitry is given for interrogation playback, detection, and amplification of the new magnetic encoders. A conversion table—binary code to decimal or Gray codes —is included.

Circle 275 on Inquiry Card

Capacitors

Bulletin 2C describing stable, low temperature coefficient capacitors from Component Research Co., Inc., 3019 So. Orange Dr., Los Angeles, Calif. Capacitors are operable from −55 to 125°C with no voltage derating and will maintain their low dissipation factor, dielectric absorption, and high insulation resistance over the entire temp. range.

Circle 276 on Inquiry Card

Storage Monitor

Specification literature features, applications and specs of the storage monitor. The instrument uses a Hughes Tonotron direct-display storage tube to "freeze" the action of any TV frame. Several instruments together may be used to capture a sequence of frames for specific frame selection. Hughes Industrial System Div., Los Angeles Airport Station, Los Angeles 45, Calif.

Circle 277 on Inquiry Card

Telemetering Equipment

Data sheet from Dorsett Electronics Laboratories, Inc., 401 E. Boyd St., P. O. Box 862 Norman, Oklahoma, describes Models TMS-105, TMS-106, TMS-111, and TMS-100 telemetering systems. Applications range from balloons to missiles.

Circle 278 on Inquiry Card

New Tech Data for Engineers

Microwave Tubes

Catalog from Litton Industries, Electron Tube Div., 960 Industrial Rd., San Carlos, Calif., describes the company's line of microwave tubes. Included are Magnetrons, Klystrons, Traveling Wave Tubes, Carcinotrons, along with drawings, applications, and specs.

Circle 190 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or

Circle 161 on Inquiry Card

Diodes & Rectifiers

Tech bulletin on 15 clipper diodes and rectifier tubes from United Electronics, a subsidiary of Ling-Altec, 42 Spring St., Newark 4, N. J. Six page brochure includes electrical and mechanical specs, performance and test graphs, and dimensional drawings.

Circle 191 on Inquiry Card

Electron Tubes

Six-page, two-color catalog, No. 2230, from Central Electronic Manufacturers, Div., Nuclear Corp. of America, Denville, N. J., lists general specifications and characteristics for their line of power triodes, rectifier and clipper diodes, power triodes for pulse operation, gas noise source tubes, and TR tubes. Electrical specifications are detailed in tabular form.

Circle 192 on Inquiry Card

Oscillograph Recorders

Four page issue of the "Bodine Motorgram" (Vol. 40 No. 1), published by Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill., features an article on high speed oscillographic recorders. Another article discusses the operation and construction of an automatic telephone exchange time and temp. announcer. Also, an article on the speed control of fractional horsepower motors.

Circle 193 on Inquiry Card

Relay Manual

Featured are 30 types of relays (with 1,000 variations) for communications, computers, industry and the military. Included are line drawings, tables, and descriptive data. Also: data on pile-up relay types, variations in spring arrangement, timing, coil voltage, contact ratings, etc. Diaphlex Div., Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

Circle 194 on Inquiry Card

Radio Systems

Data Sheet 5915 from Farinon Electric Co., 416 D St., Redwood City, Calif., describes the type "PT" point to point radio systems using frequencies of 50 to 2300 MC. It includes overall characteristics, descriptions of transmitter, receiver, service channel, test equipment, alarms, etc. Block diagrams of typical "PT" transmitter and receiver are included.

Circle 195 on Inquiry Card

Sampling Relay

Catalog from James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill., illustrates and gives full technical details of the firm's new line of "Micro-Scan" relays designed for dc, asynchronous and synchronous switching of extremely low microvolt level to moderate level signal circuits such as found in digital, analogue and measurement applications.

Circle 196 on Inquiry Card

Toggle Switches

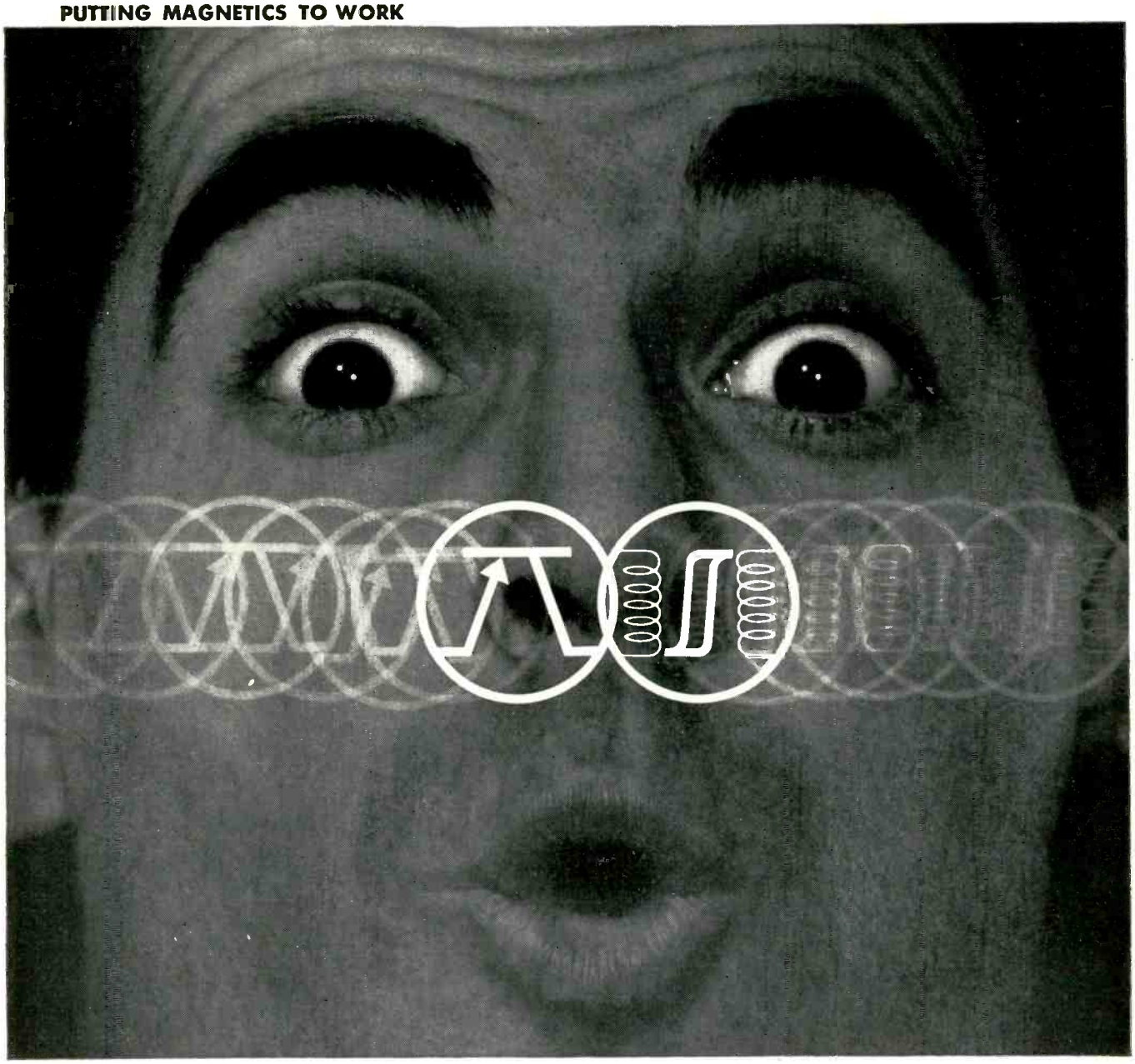
Catalog on high-performance toggle switches and toggle switch assemblies for use in airborne, mobile, marine, electronic, and commercial applications. Catalog 73d, 32-pages includes a wide selection of military versions that have been tested and approved under MIL-S-3950A, as well as pull-to-unlock, hermetically sealed, "electrical memory," rocker-actuated and miniaturized designs. Included are: detailed descriptions, photographs, diagrams, dimensional drawings and spec. tables. Micro Switch, Freeport, Ill.

Circle 197 on Inquiry Card

Data System

A 20-page booklet from Friden, Inc., San Leandro, Calif., describes the Friden Collectadata, a system of code-reading and code-punching units to facilitate the collection of data at a central processing point from various points of origin.

Circle 198 on Inquiry Card



Open your eyes to new amplifier designs!

See how to combine tape wound cores and transistors for more versatile, lower-cost, smaller amplifiers

Tie tape wound cores and transistors into a magnetic-transistor amplifier, and open your eyes to new design opportunities.

To start with, these are static control elements—no moving parts, nothing to wear or burn out. Next thing you find is that you reduce components' size—your amplifier is smaller and costs less. That's because between them the core and the transistor perform just about every circuit function . . . and then some.

For instance? The core has multiple isolated windings. Thus you can feed many inputs to control the amplifier. The core also has a square hysteresis loop, and thus acts as a low loss transformer. That means you save power. In addition, the core can store and remember signals—so time delay becomes simple.

There's no need for temperature stabilization, either. The transistor acts only as a low loss, fast, static switch—and in this function it has no peer.

How do you want to use this superb combination? As a switching amplifier—or a linear one? In an oscillator? A power converter (d-c to d-c or d-c to a-c)? You'll have ideas of your own—and if they involve tape wound cores, why not write us? Ours are Performance-Guaranteed.

Magnetics Inc., Dept. EI-81, Butler, Pennsylvania.

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Circle 54 on Inquiry Card

New Tech Data for Engineers

Transistor Circuits

Index of Application Lab Reports covers prevailing applications of transistor circuitry. The reports listed represent a selection of circuit applications of current industrial interest. They cover both general transistor application information and specific intelligence gleaned from tested circuitry used for applications of Micro Alloy Diffused-base (MADT), Micro Alloy (MAT), Surface Barrier (SBT), Silicon Surface Alloy (SAT), Medium Frequency, Medium Power Audio, Micro-Miniature and Pulse Amplifier. Documentation of test processes and results covered by each lab report is supported by curves, equations, schematics, projected, parameters, and theory. Philco Corp., Lansdale Div., Lansdale, Pennsylvania.

Circle 176 on Inquiry Card

Shift Register

Brochure from AMP, Inc., Harrisburg, Penna., describes the AMP-MAD Shift Register. The new line permits non-destructive output—dynamic and static—plus any serial/parallel input/output combination. Unit has temp. range from −40° to +75°C without compensatory equipment; each minor aperture offers an output level up to 100 mw at several volts. Immune to nuclear radiation, it is small and meets miniaturization requirements.

Circle 177 on Inquiry Card

Rectifier Handbook

Silicon rectifier handbook has seven chapters covering semiconductor theory, manufacturing methods, rectifier characteristics, rectifier circuits, test circuits, rectifier and filter circuit design, and application techniques. A supplementary section lists ratings and dimensions of Tarzian silicon rectifiers. Sarkes Tarzian, Inc., Semiconductor Div., Section 3002A, Bloomington, Indiana.

Circle 178 on Inquiry Card

Pulse Generators

Two-page bulletin describes Models 3450/Y and 3450C/X Pulse Generators. 3455C/Y provides 2 simultaneous pulses similar to flip-flop plate outputs, but at high power levels with independent attenuation. 3450C/X offers single pulse, pulse pair, or pulse train modes of operation. Fast rise pulses are controllable in rep. rate, delay from trigger, duration, amplitude, rise time and top slope. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Circle 179 on Inquiry Card

Design Guide Lines

Bulletin No. 101, from Baldwin Piano Co. and A R & T Electronics Inc., 1101 McAlmont St., Little Rock Ark. is called, "Guide Lines for the Design of Reliable Military and Industrial Equipment and Systems." The 18-page, pocket-sized manual starts with a detailed study of the Specifications and the Research Feasibility Report. It includes consideration of the overall functional, operational and environmental requirements and a study of all reports, instruction books and other possible sources of information on similar equipments and installations. Included is a selected list of recommended reading.

Circle 180 on Inquiry Card

Non-Acid Flux

New hydrazine flux leaves no rosin residue, is non-corrosive, non-hydroscopic and permits prefluxing. Flux is described in a tech bulletin from Fairmount Chemical Co., Inc., 136 Liberty St., N. Y. 6, N. Y.

Circle 181 on Inquiry Card

Laminated Plastics

Catalog covers Insurok laminated plastic sheets, rods, tubes and fabricated parts, their grades, properties, and sizes. The 8-page publication provides engineering data, product descriptions and uses for the complete line of Insurok laminates manufactured in NEMA and special grades. The Richardson Co., 2731 Lake St., Melrose Park, Ill.

Circle 182 on Inquiry Card

Standard Plugs

Sixteen-page catalog of standard Cannon plugs is a quick reference and/or ordering guide. It outlines the applications, performance, sizes etc. of the principal Cannon plugs. Schweber Electronics, 60 Herricks Rd., Mineola, L. I., N. Y.

Circle 183 on Inquiry Card

Missile Tracking

Brochure describes ROTI (Recording Optical Tracking Instrument), one of the largest and highest performing missile tracking systems in use today. It describes operational features and specs, and illustrates the resolution obtainable with the system. Electro-Optical Div., Perkin-Elmer Corp., Norwalk, Conn.

Circle 184 on Inquiry Card

Power Transistor

Data sheet on Bendix' new military-type germanium pnp power transistor, 2N1011. This new transistor meets MIL-T-19500/67(SigC). The max. collector-emitter voltage rating is 70 v. and the collector current rating is 5 a. It will dissipate 35 w at 25°C and 10 w at 75°C. Bendix Aviation Corp., Semiconductor Products, Red Bank Div., Long Branch, N. J.

Circle 185 on Inquiry Card

Fasteners

Two-color, illustrated, catalog describes the line of Huck fasteners. It includes discussion of driving cycles, strength data, typical applications, grip ranges, significant dimensional data, hole size recommendations and installation notes. Huck Manufacturing Co., 2480 Bellevue Ave., Detroit 7, Mich.

Circle 186 on Inquiry Card

Heat Exchanger

Bulletin No. 260, from Wakefield Engineering, Inc., 9 Broadway, Wakefield, Mass., discusses their series 5000 Semiconductor Heat Exchangers intended primarily for medium pressure forced air cooling systems. They require from 5 to 75 cfm of airflow and will create a head loss of from 0.5 to 1.0 in. of water. Semiconductors of any style may be accommodated. Bulletin includes technical information, formulae, graphs and outline drawings.

Circle 187 on Inquiry Card

Voltage Dividers

"Design Ideas" is the name of a new 4-page 2-color technical publication to be issued quarterly by Electro Scientific Industries, Inc., 7524 S. W. Matadam Ave., Portland 19, Ore. First issue discusses voltage divider accuracy and calibration.

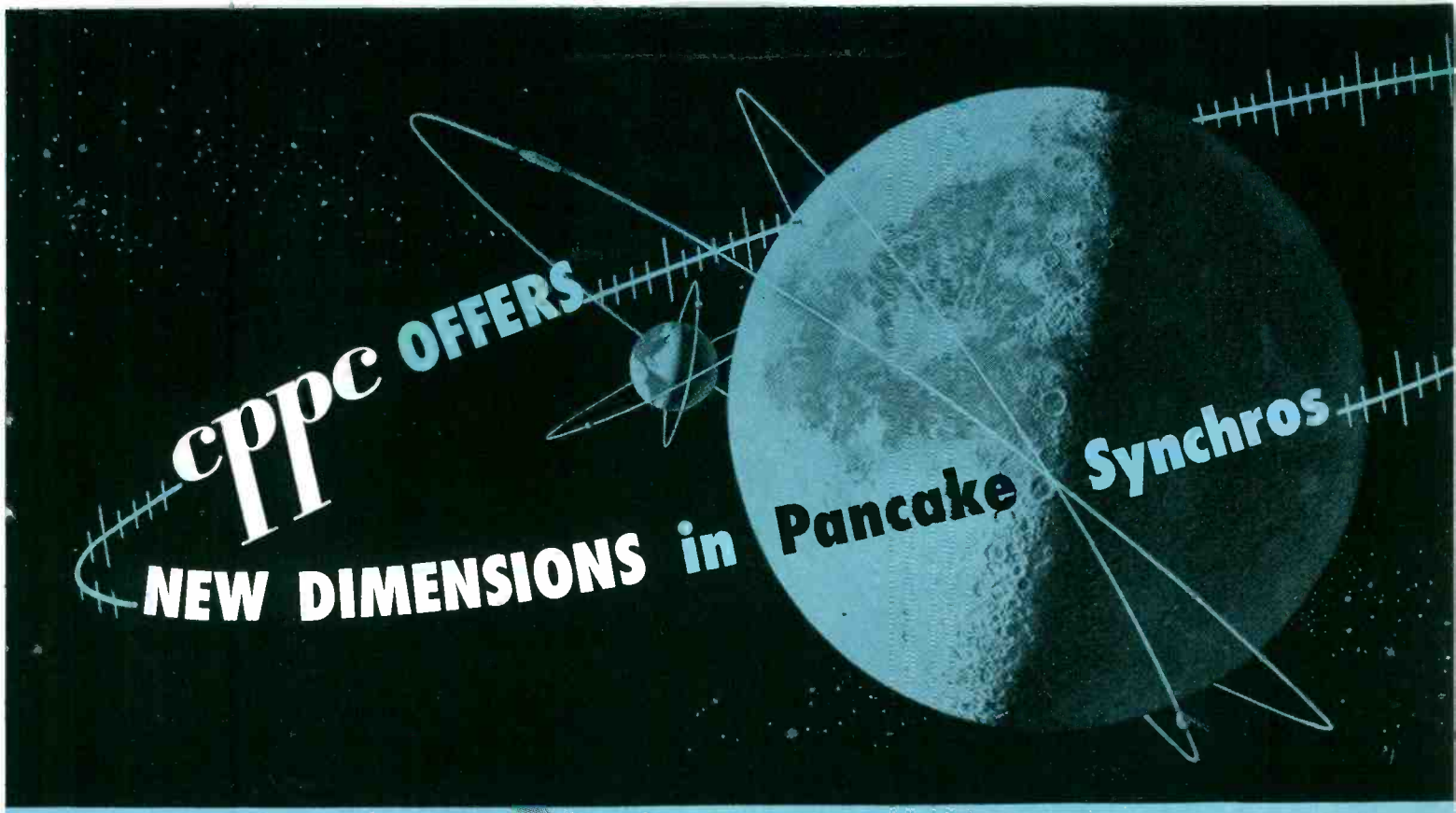
Circle 188 on Inquiry Card

Leak Detectors

Four-page brochure contains tables of conversion factors, formulae, performance charts, hints and other information for users of mass spectrometer-type leak detectors. Bulletin 1857 is from Analytical and Control Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 189 on Inquiry Card

Circle 55 on Inquiry Card ——→



cppc OFFERS NEW DIMENSIONS in Pancake Synchros

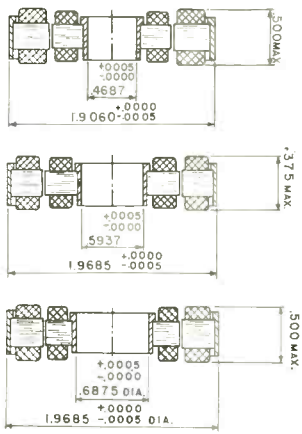
MOUNTING AND HOUSING DIMENSIONS TO ORDER. Here are a few typical configurations obtainable in aluminum, stainless steel, beryllium or zirconium alloys.

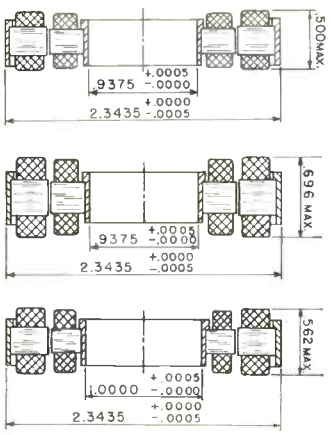
SIZE 23
Leads and terminals.

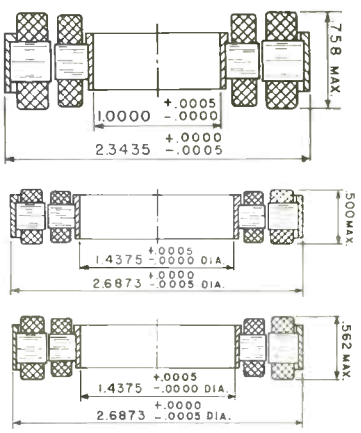
SIZE 28
Tandem unit. Transmitter and Resolver.

SIZE 37
Accuracy: ±4' max. error.

A WIDE VARIETY OF BORES AND STACK HEIGHTS, widths and diameters available from existing laminations. Below are some examples. Let us know your needs.







ENGINEERS—Pioneer with a leader in the field. Write David D. Brown, Director of Personnel. Dept. A3.

CLIFTON PRECISION PRODUCTS CO., INC. Clifton Heights, Pa.

Home Sales Office: 9014 West Chester Pike, Upper Darby, Pa. TWX Flanders, Pa. 1122

cppc

—or our Representatives.

Tech Data

for Engineers

Miniature Motors

Bulletin 135 describes ⅞ in. dia. permanent magnet precision miniature motors with integral planetary gear reducers in 21 ratios from 3.82 to 1 to 36873 to 1. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 199 on Inquiry Card

Ferrite Components

Short form catalog from Monogram Precision Industries, Inc., Cascade Research Div., 5245 San Fernando Road West, Los Angeles 39, Calif., lists over 85 models of microwave ferrite components. Included are waveguide and coaxial isolators, modulators, circulators, circulator switches, and phase shifters.

Circle 200 on Inquiry Card

Closed Circuit TV

A 112-page catalog of closed circuit television equipment for industry is designed as an aid in planning TV systems. Cameras, housings, lenses, monitors, switchers, microwave equipment, and the new RCA TV tape recorder are covered. Radio Corp. of America, ITV-Dept. 759, Bldg. 15-1, Camden 2, N. J.

Circle 201 on Inquiry Card

Precious Metal Electroplate

The two most important requirements for electroplated articles, resistance to corrosion either by body acids or by air oxidation, and resistance to mechanical or abrasive wear, are the subject of a six-page article from Sel-Rex Corp., Nutley 10, N. J. The article is called, "Testing and Evaluating Precious Metal Electroplate."

Circle 202 on Inquiry Card

Scientific Glassware

Catalog ML-61 covers Micro Scientific Glassware and Research Apparatus. Included are adapters, burettes, condensers, distillation and extraction apparatus, flasks, funnels, mantels, pipettes, reaction assemblies, stirrers, thermometers, syringes, and Micro accessories. Labglass, Inc., North West Blvd., Vineland, N. J.

Circle 203 on Inquiry Card

Sequential Scanner

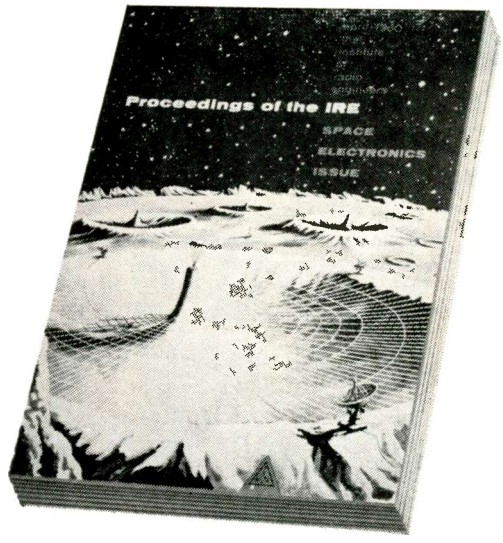
Four-page, 2-color brochure from Moore Associates, Inc., 2600 Spring St., Redwood City, Calif., describes the Monitron, an electronic scanner which automatically monitors from 8 to 256 on/off or go/no-go input signals and provides alarm or control functions at remote locations. Included are block diagrams and tech. specs.

Circle 204 on Inquiry Card

APRIL PROCEEDINGS FOCUSES ON

SPACE ELECTRONICS

VITAL NERVE CENTER OF MAN'S EXPLORATION OF THE UNIVERSE!



Man's escape from the confines of his planet offers him revolutionary opportunities for performing whole new ranges of scientific experiments, notably in such fields as astronomy, physics and geophysics. Electronics, because it provides the vital nerve system for such experiments, will be at the very center of these new exploits in space. Moreover, earth satellites, possibly in a 24-hour equatorial orbit, promise to open a new era in global communications in which almost limitless bandwidths may become available at relatively low cost.

Comprehensive Report On The Present And Future Role of Electronics In Space Exploits

In this important special issue are articles on propulsion, navigation and guidance, communication, tracking and surveillance, telemetry and instrumentation and measurements. There are over 50 of these studies, each one contributing to the radio-engineers' interest in space — for performing new scientific experiments, global communications and space travel.

This Space Electronics issue is another in the many services offered members of the IRE. Non-members of the Institute of Radio Engineers, however, are invited to reserve a copy of this vital report by returning the coupon below, today.

PARTIAL CONTENTS OF THIS APRIL SPACE ELECTRONICS ISSUE:

"The NASA Space Science Program"

"A Comparison of Chemical and Electric Propulsion Systems for Interplanetary Travel," by C. Salzer, R. T. Craig and C. W. Fetheroff

"Photon Propelled Space Vehicles," by D. C. Hock, F. N. McMillan, and A. R. Tanguay, Radiation, Inc.

"Interplanetary Navigation," by G. M. Clemence, USN Observatory

"Navigation Using Signals from High Altitude Satellites," by A. B. Moody, USN Hydrographic Office

"Inertial Guidance Limitations Imposed by Fluctuation in Gyroscopes," by G. C. Newton, Jr., MIT

"Propagation and Communications Problems in Space," by J. H. Vogelman, Dynamic Electronics-New York, Inc.

"Communication Satellites," by D. L. Jacoby, U. S. Army Signal Research & Development Lab.

"Interference and Channel Allocation Problems Associated with Orbiting Satellite Communication Relays," by F. E. Bond, C. R. Cahn and H. F. Meyer, Ramo-Wooldridge

"Solar Batteries," by A. I. Daniel, USASRDL

"Extra-Terrestrial Radio Tracking and Communication," by M. H. Brockman, H. R. Buchanan, R. L. Choate and L. R. Malling, NASA-California Institute of Tech.

"Tracking and Display of Earth Satellites," by F. F. Slack and A. A. Sandberg, AF Cambridge Research Center

"Interplanetary Telemetering," by R. H. Dimond, Radiation, Inc.

"The Telemetry and Communication Problem of Re-Entrant Space Vehicles," by E. F. Dirsa, Admiral Corp.

"Radiation and Instrumentation Electronics for the Pioneer III and IV Space Probes," by C. Josias, California Institute of Technology

"Applications of Doppler Measurements to Problems in Relativity, Space Probe Tracking and Geodesy," by R. R. Newton, The Johns Hopkins University

"High Speed Electrometers for Rocket and Satellite Experiments," by J. Praglin and W. A. Nichols, Keithley Instruments, Inc.

REMEMBERS THE MAN

THE INSTITUTE OF RADIO ENGINEERS
1 East 79th Street,
New York 21, N. Y.

Enclosed is $3.00

Enclosed is company purchase order for the April, 1960, issue on Space Electronics.

All IRE members will receive this April issue as usual. Extra copies to members, $1.25 each (only one to a member).

Name.....

Company.....

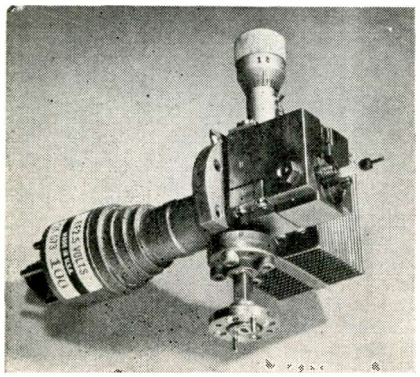
Address.....

City & State.....

New Products . . . for the Electronic Industries

KLYSTRON OSCILLATOR

Type QK673 is a mechanically tuned reflex klystron oscillator designed for operation in the 88,000 to 92,000 MC range with min. output of 3 mw. The r-f output is through

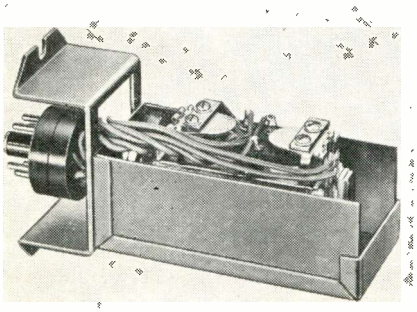


waveguide sealed by a mica window. Output flange mates with a standard UG387/U flange. Typical Operation: Resonator Voltage, 1400-1700 v.; resonator current, 40 ma; focus electrode voltage, —150 v.; reflector voltage range (4¾ Mode), —100 to —150 v.; power output (Min.), 3 mw; freq. range, QK673, 88,000 to 92,000 MC. Electronic Tuning (Min.), 90 MC. Raytheon Co., Microwave & Power Tube Div., Waltham 54, Mass.

Circle 211 on Inquiry Card

LATCH-IN RELAY

Latch-in-Relay, Class 11LP, has plug-in mounting and hold-down clamp. It is made of 2 miniature telephone type relays in a common support frame with plug-in mounting and hold-down clamp. Armatures are mechanically interlocked; when one armature is energized it releases the other and becomes "latched-in." Aside from the interlocking armatures and common mounting each relay is complete; the relays can be supplied for

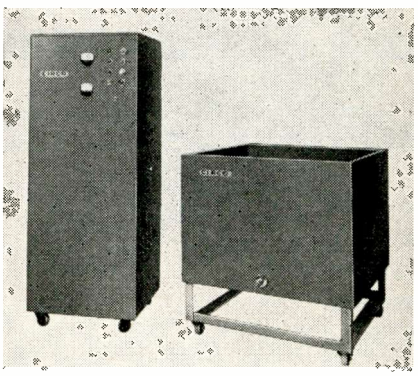


different operating voltages or currents and with entirely different contact arrangements. Magnecraft Electric Co., 3350H West Grand Ave., Chicago 51, Ill.

Circle 212 on Inquiry Card

ULTRASONIC CLEANER

Model BC-2500 ultrasonic cleaner is made up of ultrasonic generator Model PG2500 and cleaning tank Model T2500. Generator is 22 x 54 x 18 in. and weighs 350 lbs. Frequency



is 36-40 KC adjustable; input 6 kw, 220 v; or 440 v, 60 CPS, single phase, continuous high frequency output averaging 3 kw; peak output equal to 12 kw. Forced air ventilation has been included. Fluid capacity of cleaning tank is 75 gallons. Unit is designed for large missile parts, nuclear fuel elements, and other large industrial parts. Circo Ultrasonic Corporation, 51 Terminal Ave., Clark, N. J.

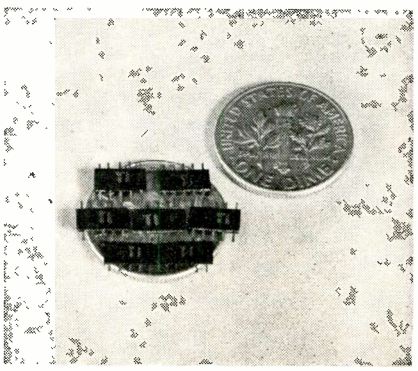
Circle 213 on Inquiry Card

! MORE !

The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phla., Penna. or Circle No. 161 on Inquiry Card.

SEMICONDUCTOR NETWORKS

Solid circuit semiconductor networks for application where miniaturization and reliability are of prime importance. The standard Solid Circuit, the TI Type 502, is a binary

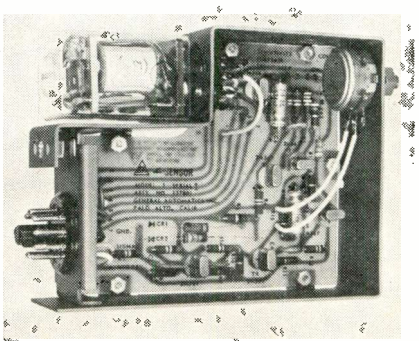


multivibrator capable of operation at a 200 KC repetition rate. It measures 0.250 x 0.125 x 0.031 in. and contains the equivalent of 16 conventional components. It operates with a 6-v power supply. The necessary input and output characteristics have been provided so that it can be interconnected for use as a shift register, binary counter, or set-reset flip-flop. Texas Instruments Incorporated, P.O. Box 312, Dallas, Tex.

Circle 214 on Inquiry Card

LIMIT SENSOR

Pass—fail conditions for a wide variety of process control measurements can be established with this transistorized device. The circuit reacts to voltages which become less than the limiting set point, but is insensitive to positive levels. With a hysteresis of less than 250 mv at 25°C, a reaction time of less than 50 msec, and an input impedance of 100K ohms, the device can be used with reference levels between ±250 v. to provide



limit indications with accuracies of better than 0.05%. The output is in the form of two 5a. SPDT contact closures. General Automatics, Inc., 2443 Ash St., Palo Alto, Calif.

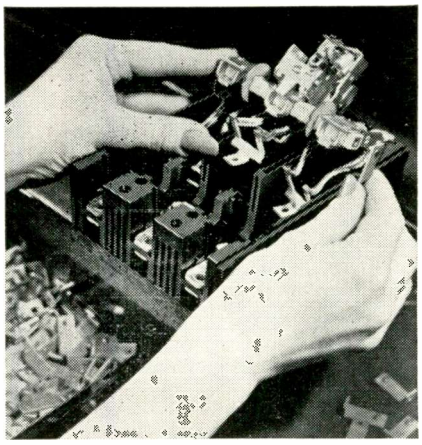
Circle 215 on Inquiry Card

Important facts to know about Laminated Plastics

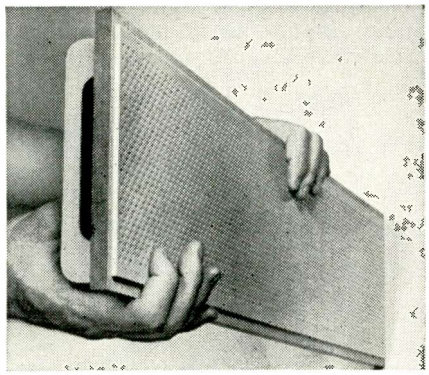
LAMINATED PLASTICS *What they are, where they can be used*

Taylor laminated plastics, also known as reinforced plastics, are thermosetting-type materials formed by impregnating paper, cotton cloth, asbestos, glass cloth, nylon or other base materials with synthetic resins and fusing them into sheets, rods, tubes and special shapes under heat and pressure. These materials exhibit a valuable combination of characteristics, including high electrical insulation resistance, structural strength, strength-to-weight ratio, and resistance to chemical reaction; also adaptability to fabricating operations.

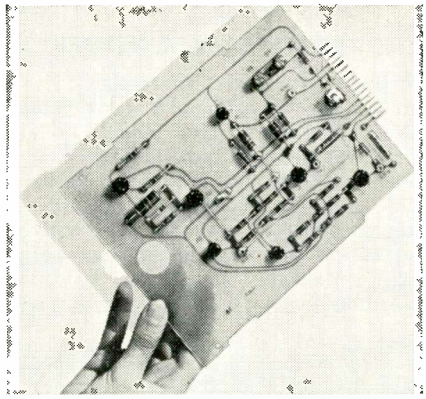
Types of laminated plastics made by Taylor
There are four basic types of Taylor laminated plastics commonly specified and used throughout industry today. They are as follows:



Phenolic Laminates. Paper, cotton fabric or mat, asbestos, glass cloth or nylon bases impregnated with phenol formaldehyde resins. These provide strength and rigidity, dimensional stability, resistance to heat, chemical resistance, and good dielectric characteristics. Some Taylor grades are excellent basic materials for gears, cams, pinions, bearings and other mechanical applications. Others are widely used in terminal boards, switchgear, circuit breakers, switches, electrical appliances and motors. Also in radios, television equipment and other electronic devices; and in missiles as nose cones, exhaust nozzles, and combustion chamber liners.

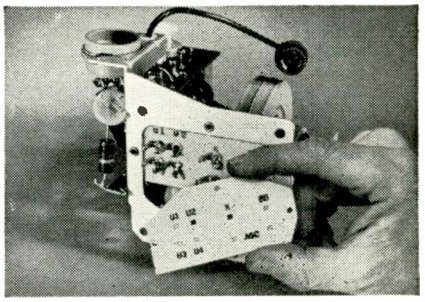


Melamine Laminates. Glass cloth or cotton fabric impregnated with melamine formaldehyde resin. Taylor melamine laminates have superior mechanical strength and are especially desirable for their arc-resistant qualities. Good flame and heat resistance, good resistance to the corrosive effects of alkalis and most other common solvents, besides other favorable characteristics. Typical applications include arc barriers, switchboard panels, and circuit-breaker parts in electrical installations.



Silicone Laminates. Continuous-filament woven glass fabric impregnated with a silicone resin. These laminates combine high heat resistance (up to 500°F. continuous) with excellent electrical and mechanical properties. They are primarily used in high-temperature electrical applications and high-frequency radio equipment.

Epoxy Laminates. Continuous-filament woven glass fabric or paper impregnated with epoxy resin. Glass-fabric grades are designed for use in applications requiring high humidity-resistance, good chemical resistance,



and strength retention at elevated temperatures. Paper grades are used under high-humidity conditions where resistance to acids and alkalis is required. Both grades are characterized by good dielectric strength, low dielectric losses, and high insulation resistance even following severe humidity conditions.

• • •

Recent technical advances in the bonding of various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities. It is now possible to bond virtually any compatible material with a laminated plastic to form a composite which combines the advantages of both. One of the first composite materials was a copper-clad laminate used for printed circuits. More recent composite laminates, usually manufactured to customer specification, include the following: Taylorite® vulcanized fibre-clad, rubber-clad, asbestos-clad, aluminum-clad, beryllium-copper-clad, stainless-steel-clad, magnesium-clad, and silver- and gold-clad. Any one of these materials can be sandwiched between sheets of laminates, too, and can be molded to fit specific requirements.

Send for complete information about any or all of these Taylor laminates. And remember Taylor's new selection guide will simplify your problems in choosing the right laminate for your specific application. Taylor Fibre Co., Norristown 53, Pa.

Taylor
LAMINATED PLASTICS VULCANIZED FIBRE

New Products

FLAME-RESISTANT EPOXY

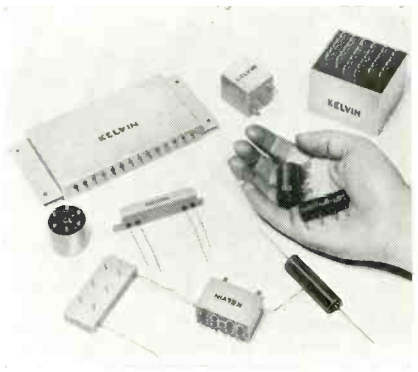
Flame-resistant epoxy, Epoxy #1202 for such applications as computers where flame-resistant properties are of vital importance. Properties: extinguishing time, 0.1 sec; thermal conductivity (cal/sec/cm²/c/cm), 9.2

x 10^{-4}; water absorption (24 hr.), 0.04%; weight loss (24 hr. at 150°C), 0.26; dielectric constant (1 meg.), 5.6; dissipation factor (1 meg.), 0.028; volume resistivity at 25°C is 1.3 x 10^{15}, at 125°C is 4.7 x 10^{12}, at 150°C is 3.1 x 10^{10}; insulation resistance (96 hr at 90% Rh and 95°F) is 9 x 10^{10}. Epoxy Products, 137 Coit St., Irvington, New Jersey.

Circle 216 on Inquiry Card

RESISTOR NETWORKS

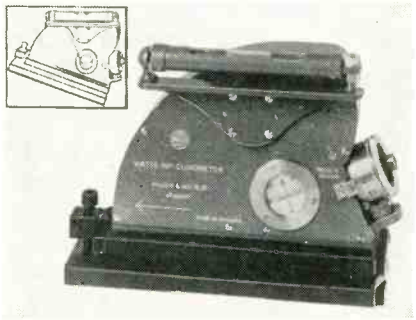
Resistor ratio matching accuracies to 0.005% with absolute tolerances of 0.01% featured. Standard temp. coefficient is 10 ppm. Distributed capacitance as low as 0.5 mmf and rise time as low as 0.1 μsec can be supplied depending upon network circuit configuration. Frequency range to 250 KC. Resistors noninductively wound. Can be provided in hermetically sealed cases, mounted on boards or encapsulated in high temp. epoxide resin. Can be used as summing networks, voltage division and other applications. Kelvin Electric Co., 5509 Noble Ave., Van Nuys, Calif.



Circle 217 on Inquiry Card

CLINOMETER

The Watts 90° Clinometer in modified form for special leveling and tilt testing requirements. Control bubble is increased in length and sensitivity —20 sec. sensitivity as standard—and mounted on a separate platform at the top of the instrument. The bubble mount can be set to any desired angle with reference to the instrument's scale. The Clinometer can be used to set up, adjust and control platforms, tilt tables, test fixtures, or indexing and leveling devices—to 20 sec. over 90° range, starting from any orientation. Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.



Circle 218 on Inquiry Card

INCREMENTAL VOLTMETER

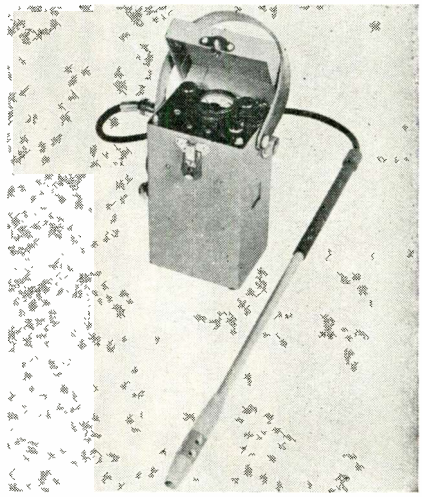
Battery-powered incremental voltmeter for the precision measurement of dc voltages. The Model 130 incorporates an offset voltage source variable from 0 to 509 v. and accurate to 0.1%. Dc voltages from 10 mv through 500 v. may be read with an error of indication not exceeding 0.2%. Features include the ability to read out both + and — voltages with equal facility, high off-null input resistance, and freedom from interference effects attendant with power line operated instruments. Belleville-Hexem Corp., 638 University Ave., Los Gatos, Calif.

Circle 219 on Inquiry Card

New Products

GAS DETECTOR

Model 504 is for quick accurate tests for the presence of gas. Calibrated in % of lower explosion limit, a reference chart gives absolute value of % gas in air. One control allows immediate zeroing for quick indica-

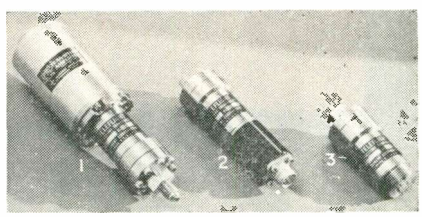


tion. Uses nickel-cadmium rechargeable battery. Built-in battery charger works from 110 v wall socket. Lid switch prevents accidental discharge. Units may be used 8 continuous hours without recharging. Standard 6 ft probe cable furnished—30 ft available. Case size is 3 x 4 x 8 in. and weight is 8 lb. Houston Instrument Corp., P. O. Box 22234, Houston, Texas.

Circle 220 on Inquiry Card

PRESSURE TRANSDUCER

Model 181 Pressure Transducer is for airborne applications where precise pressure measurements of 0.25% accuracy are required over a wide temp. range. Pressure ranges: 0-250; 0-300; 0-350; 0-500; 0-750; 0-1,000 psi. Measuring element is a one piece Ni-Span-C proving ring to which are bonded 4 precision strain gages, forming a Wheatstone Bridge. When the transducer is subjected to zero gravity



conditions, ring acts as a heat sink. High overload capacity is a standard feature. Application of 3 times rated full scale pressure will not damage the instrument. Taber Instrument Corp., North Tonawanda, N. Y.

Circle 221 on Inquiry Card

Sharper Definition... Improved Gray Scale... with

RAYTHEON "KILOLINE" RECORDING STORAGE TUBES

A Raytheon-designed tetrode gun insures higher resolution — 1,000 TV lines at 50% modulation — and improved control over beam cut-off in Raytheon's new CK7571/QK685 and CK7575/QK787 recording storage tubes. A new multiple collimating lens improves background uniformity and results in a signal-to-shading ratio of ten.

These advanced design features, plus low noise and stable operating characteristics, make Raytheon recording storage tubes ideal for frequency and scan conversion. Among the applications where these tubes play an important role are:

- Scan conversion for bright display and target trails.
- Slow-down video for transmission of still pictures over telephone lines.
- Stop motion to permit analysis of production machinery or to stop action in a sporting event.
- Signal-to-noise improvement of radar or other still pictures by integration.
- Conversion of television pictures from one transmission standard to another.
- Indication of moving targets by electrical comparison of pictures taken at different times.

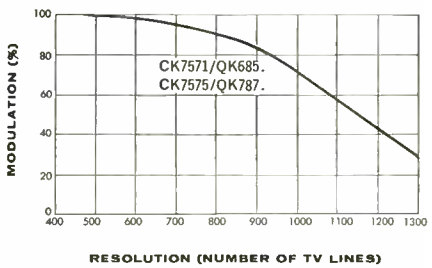
For scan conversion applications, both r.f. read-out and video cancellation techniques have proved equally effective with Raytheon single- and dual-gun storage tubes.

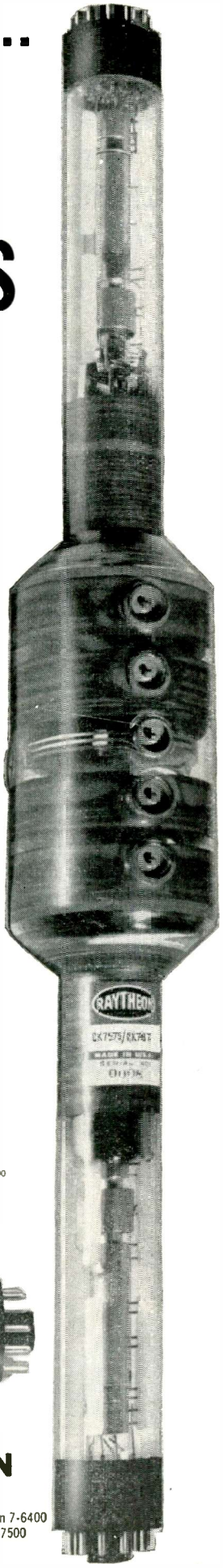
Raytheon's single-gun CK7571/QK685 and dual-gun CK7575/QK787 recording storage tubes are available from stock in sample quantities. Detailed technical data bulletins are yours for the asking — write direct to Dept. 2527.

TYPICAL OPERATING CHARACTERISTICS
CK7571/QK685 and CK7575/QK787

Anode Voltage	4,000 Vdc
Magnetic Focus Resolution	1,000 Lines (nominal)
Electrostatic Resolution	700 Lines (nominal)
Output capacitances:	
CK7571/QK685	12 $\mu\mu$f (nominal)
CK7575/QK787	27 $\mu\mu$f (nominal)
Maximum Deflection Angle	30 Degrees

TYPICAL RESOLUTION CURVE





RAYTHEON

INDUSTRIAL COMPONENTS DIVISION

57 Chapel Street, Newton 58, Massachusetts

Los Angeles — Normandy 5-4221 **Dallas** — Fleetwood 1-4185 **Chicago** — National 5-4000 **Orlando** — Garden 3-1553 **New York** — Wisconsin 7-6400
San Francisco — Fireside 1-7711 **Kansas City** — Plaza 3-5330 **Cleveland** — Winton 1-7716 **Baltimore** — Southfield 1-0450 **Boston** — Bigelow 4-7500

GOVERNMENT SALES: Boston — Bigelow 4-7500 • **Washington, D.C.** — Metropolitan 8-5205 • **Dayton** — Baldwin 3-8128

New Products

FILTER

Harmonic Adsorption Filter, Model 204A, for the SL band (1700 to 2400 MC) absorbs spurious and harmonic signals generated by high-power klystron and magnetron tubes. It is rated at 25 kw ave. power, and is

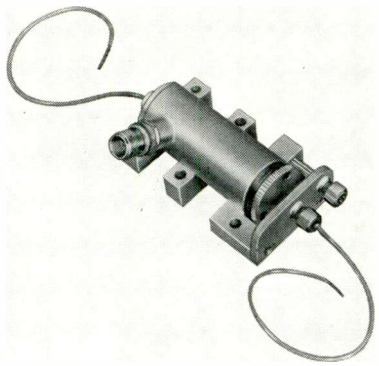
Sierra Model 204A Absorption Filter

can handle 1 megawatt of peak power. Insertion loss in the pass band is less than 0.1 db. VSWR is less than 1.1 in the pass band and less than 1.3 above the pass band. Attenuation above the pass band is at least 40 db for all frequencies from 3400 MC to 11,000 MC. Below, the attenuation is the same as RG-104/U. It meets military requirements and weighs 120 lbs. Sierra Electronics Corp., 3885 Bohannon Dr., Menlo Park, Calif.

Circle 222 on Inquiry Card

MICROWAVE COMPONENTS

Microwave subsystem for use in "C" band, consists of a "C" band triode local oscillator, two-cavity preselector, T-junction diplexer and coaxial mixer. Preselector, diplexer, mixer package measures 3½ in.³ and weighs 9 oz.

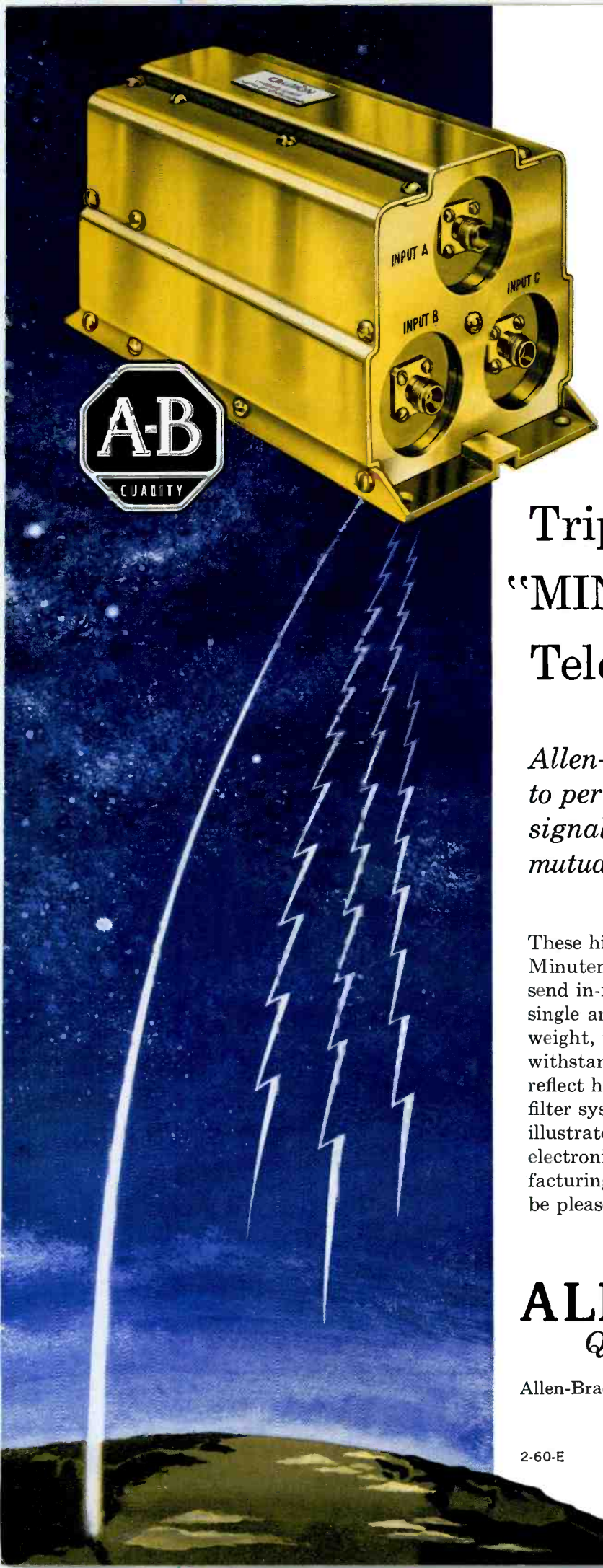


The oscillator tunes from 5400-5900 MC—measures 4 x 1½ x 1 in. and weighs approx. 9 oz. Subsystem is applicable to superhetrodyne systems with coaxial input. John Gombos Co., Inc., Webro Rd., Clifton, N. J.

Circle 223 on Inquiry Card

Circle 63 on Inquiry Card

Circle 64 on Inquiry Card →



SPECIFICATIONS

Range	Telemetering Band (216—260 Mcps)
Passband	±0.300 Mcps
Input Power	50 Watts max
Insertion Loss in Passband	≤1.25 DB at 125°C ≤1.15 DB at room temperature
VSWR in Passband	≤1.20
Isolation between Adjacent Channels at 5 Mcps Spacing	≥20 DB
Temperature Range	−65°C to +125°C
Vibration	For use in guided missiles; meets military vibration specs

Other power levels and higher frequency ranges can also be provided.

Triple Filter for "MINUTEMAN" Missile Telemetry System

Allen-Bradley Triplexer is designed to permit three simultaneous telemetry signals through one antenna without mutual interference.

These high-efficiency triple filters—employed in the Minuteman Test Program—enable three transmitters to send in-flight performance data simultaneously from a single antenna. Although extremely compact and light in weight, the Triplexer is ruggedly constructed to withstand shock and vibration—and it is gold plated to reflect high temperatures. This highly advanced filter system—developed and built by Allen-Bradley—illustrates their extensive experience in advanced electronic research, and capabilities in precision manufacturing. Allen-Bradley scientists and engineers will be pleased to cooperate in solving your problems.

ALLEN-BRADLEY

Quality Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.

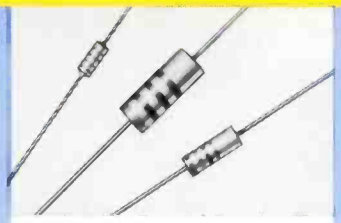
2-60-E

ALLEN-BRADLEY ELECTRONIC COMPONENTS

The standard of quality for long life and dependable performance

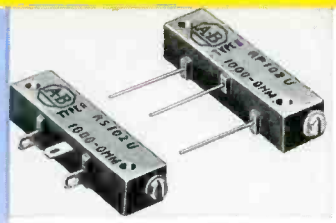
RESISTORS

HOT MOLDED COMPOSITION RESISTORS—Quality standard of the industry. Rated at 70°C in 1/10, ¼, ½, 1, and 2 watts. Res. to 22 meg. Tol: 5, 10, and 20%.



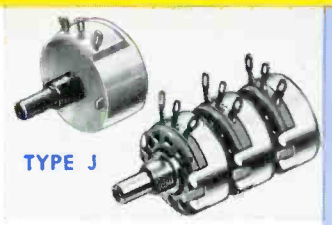
HERMETICALLY SEALED in ceramic tubes. Solid, hot molded resistor. ¼ And 1 watt units derate to 0 at 165°C; ⅛ watt unit to 0 at 120°C. Available in values to 22 meg.

METAL GRID PRECISION RESISTORS—Hermetically sealed. Noninductive. 1, ½, And ¼ watts at 100°C. Tolerances 0.1% to 1.0%. Temp coef ± 25 PPM/°C.

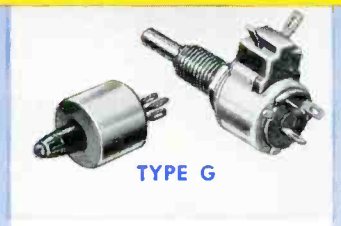


ADJUSTABLE FIXED RESISTOR with hot molded dual track resistance element. Quiet, stable. Rated ¼ watt, 70°C. Values to 2.5 meg. Molded case, length 1¼".

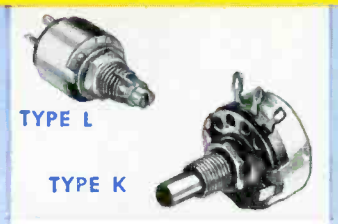
POTENTIOMETERS



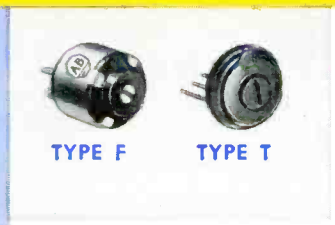
STANDARD—Type J. Solid molded element. Quiet, reliable. Rated 2 watts, 70°C. Values to 5 meg.—less than 10% change in 100,000 cycles. Exceeds MIL-R-94B.



MINIATURE—Type G. Solid molded element. Only ½" in diam. Plain or lock bushing; also with line switch. Rated 0.5 watt at 70° C. Values to 5 megohms. Exceeds MIL-R-94B.

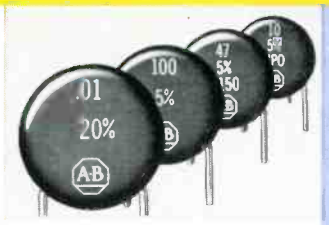


HIGH TEMPERATURE—Type K. Same as Type J but rated 3 watts, 70°C; 2 watts, 100°C; 1 watt, 125°C. Only 1" diam. Type L same as Type G but rated 0.5 watt, 100°C.



SPECIAL TYPES with solid molded elements. Type F for printed wiring boards has gold-plated terminals. Screwdriver adjustment. Thin Type T uses molded cover as actuator.

CAPACITORS



CERAMIC DIELECTRIC capacitors are ONE size—0.55 inch diam for most capacitance values. No "rundown" on leads. Made in many types. Quality appearance.

CERAMIC ENCASED capacitors for use where reliability and superior performance at high temp are important. Rated 500v DC at 150°C. Tol: 5%, 10%, and 20%.

FEED-THRU & STAND-OFF discoidal capacitors for VHF and UHF range. No parallel resonance effects at 1,000 Mcps or less. Nominal values 4.7 to 1,000 mmf.

BARE DISC ceramic capacitors for direct mounting in printed circuit boards. Mechanically strong to avoid breakage in handling, installing, and soldering.

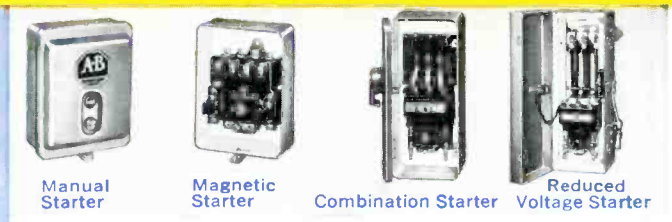
FERRITES

FERRITE CORES including lightweight flared yokes, cup cores, and others for TV. Also, U,E,L, O, and doughnut toroids. Wide range of sizes. All have uniform magnetic properties.

FILTERS

HIGH FREQUENCY low pass cascaded ceramic filters for elimination of radiation. Max ratings: 500v DC at 125°C; RF current 0.25 amp; DC or LF current 5 amp.

QUALITY MOTOR CONTROLS



Allen-Bradley also makes a complete line of manual and automatic, full voltage and reduced voltage starters—plus a full line of pilot controls, such as relays, limit switches, push buttons, pressure and temperature switches, and other devices. Allen-Bradley motor controls are universally recognized for their long life and reliability.

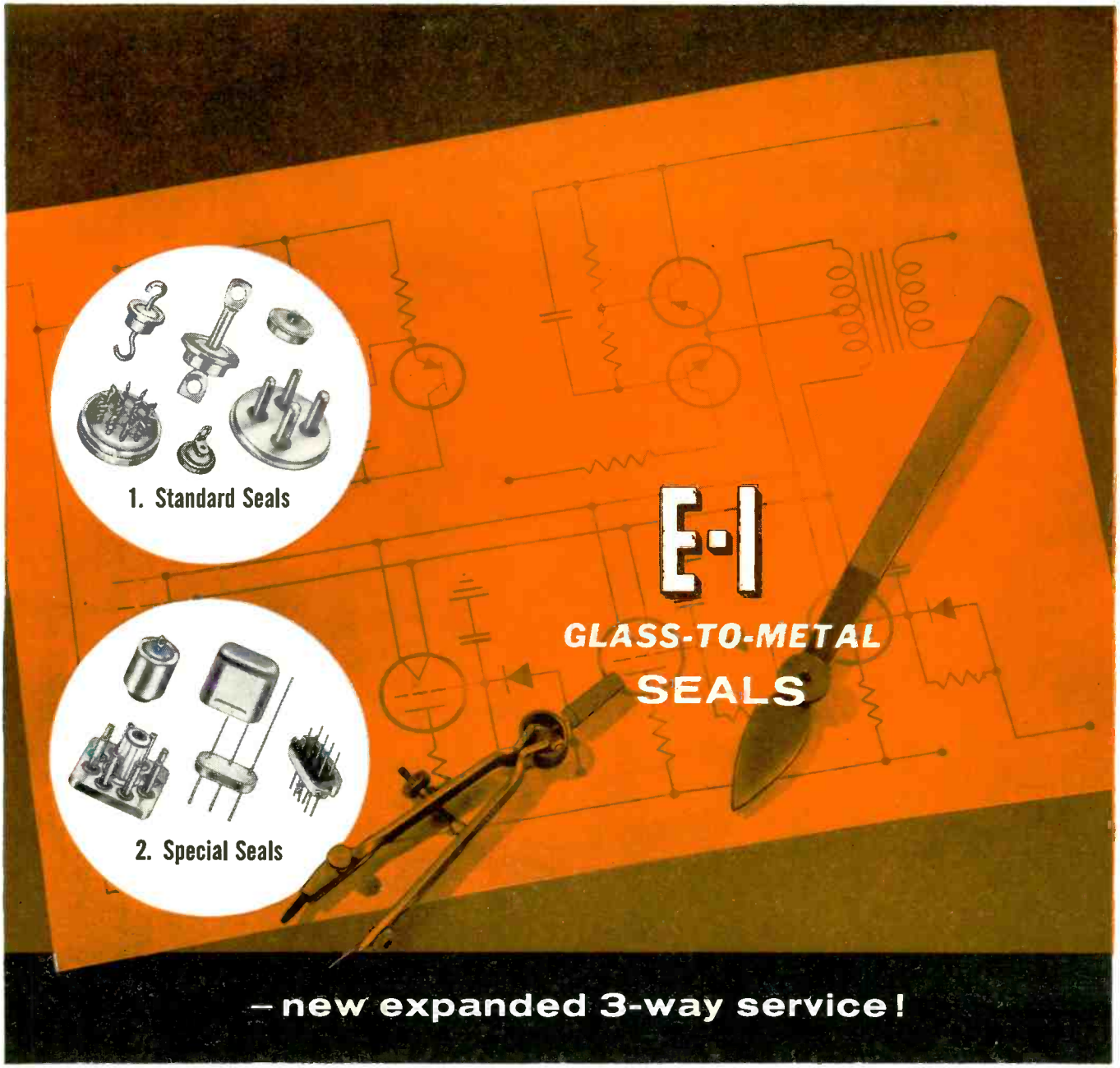
2-60-E

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

To simplify your design problems –



COMPLETE ENGINEERING AND SAMPLE SERVICE PLUS A NATIONWIDE NETWORK OF FIELD ENGINEERS–

E-I glass-to-metal seals are the industry standard for dependability . . . have been service-proven on vital space age projects and in critical commercial equipment. If you have a seal problem ask E-I for a recommendation. Sales engineers are located in all principal cities.

1. STANDARD SEALS —The most complete range of economical standard seals affords widest design latitude. Includes single lead terminals, headers, miniature closures and threaded end seals.

2. SPECIAL SEALS— For unusual requirements, E-I engineers will design seals to specifications or modify standard types for your particular application. Complete engineering facilities available.

3. CUSTOM SEALING — Complete facilities for sealing components or assemblies of your own manufacture. Send samples or drawings for quotations. Fast service on reasonable quantities.

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A Division of Philips Electronics & Pharmaceutical Industries Corp.

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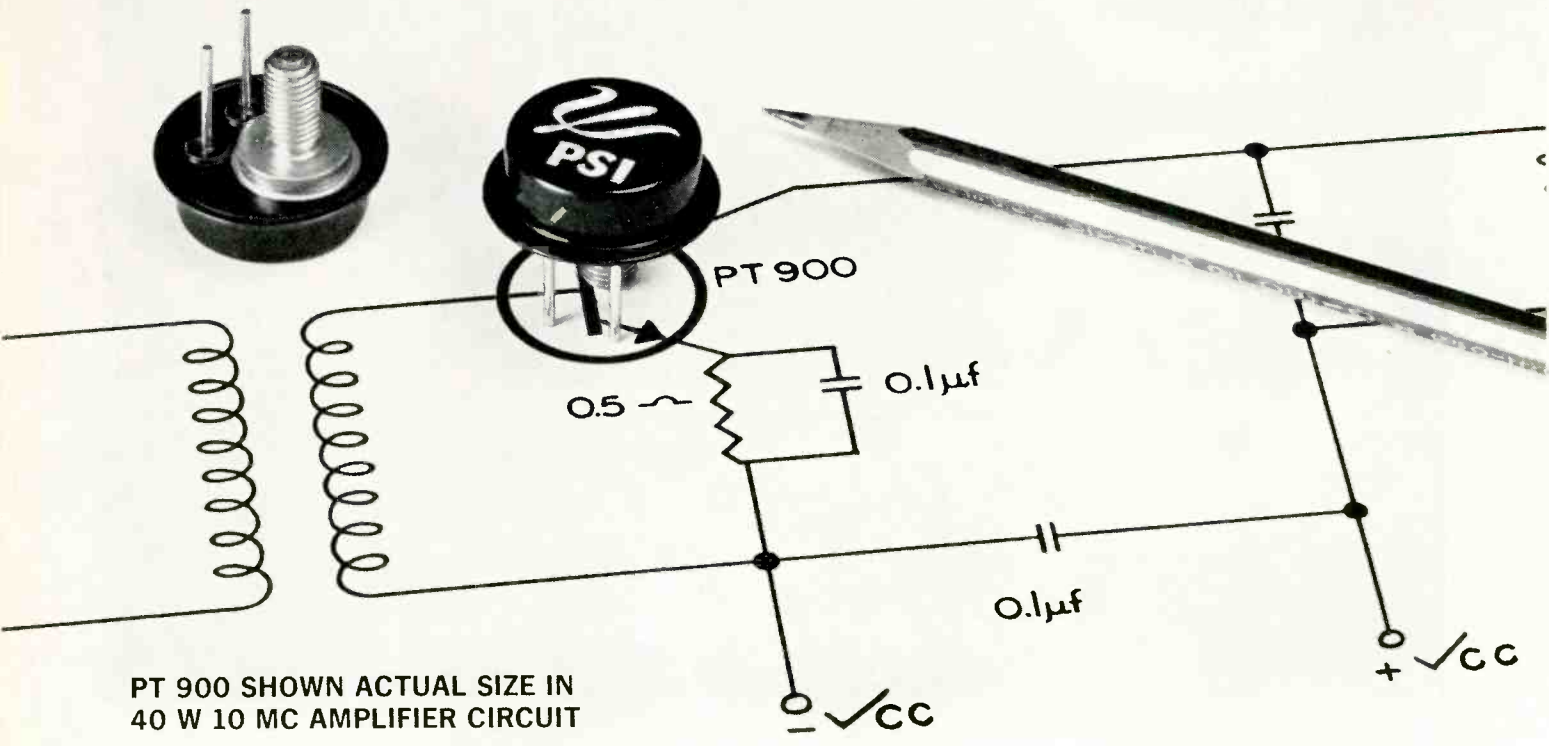
Available for evaluation...

the only silicon power transistors offering 100 w at 5 mc...less than 100 nanosecond* high current switching!



PT 900 SHOWN ACTUAL SIZE IN
40 W 10 MC AMPLIFIER CIRCUIT

*Millimicrosecond

10 Ampere High Frequency, High Speed, High Power Oscillators . . . Amplifiers . . . Switches . . . Converters

TYPES PT 900, PT 901

- 50 mc alpha cut off frequency
- 125 w at 25°C. case temp.
- 10 amp continuous at 25°C.
- 0.2 ohm saturation resistance

Pacific Semiconductors, Inc.
(A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.)
12955 Chadron Avenue
Hawthorne, California

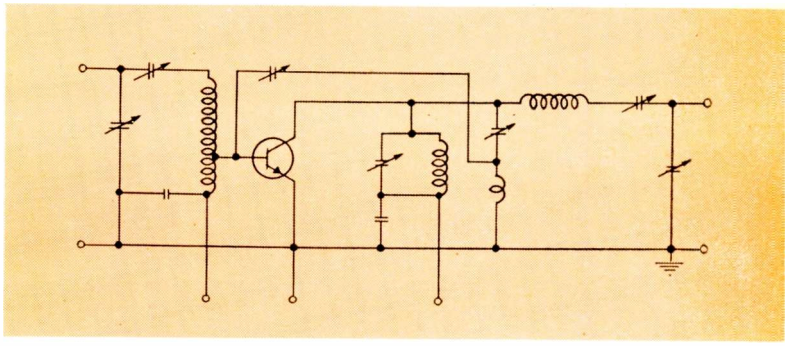
THESE SILICON MESA TRANSISTORS OFFER UNIQUE CAPABILITIES...

and all are available immediately in production quantities

NPN VHF Power Amplifiers and Oscillators

Types 2N1505, 2N1506

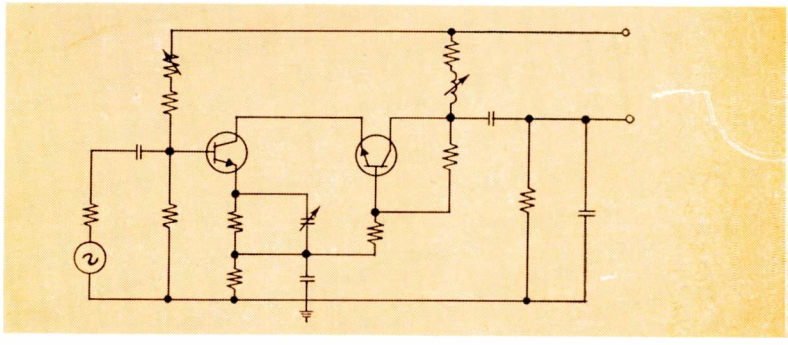
Specially designed for high frequency, high power operation at low supply voltages, these transistors give typical power outputs of 1 w at 70 mc and 500 mw at 200 mc. Highly efficient high frequency operation is assured by combining either type with a Hi Q Varicap frequency multiplier. *At right: Typical amplifier circuit for 200 mc power gain measurement.*



NPN VHF, High Voltage, High Power Amplifiers... Switches... Oscillators

Types 2N1335 thru 2N1341

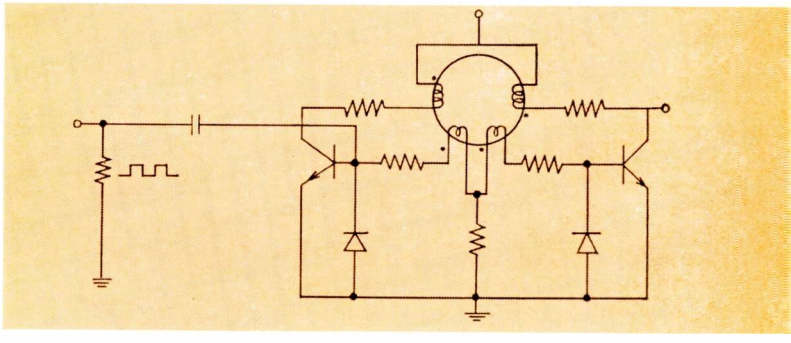
A unique combination of high voltage, high frequency and high power makes it possible for the first time to design video amplifiers with output voltages of 140 v and bandwidth of 10 mc. Other applications are power amplifiers, power oscillators and high voltage switches. *At right: Typical high voltage video amplifier.*



NPN High Speed, High Current Core Drivers and General Purpose Switches

Types 2N1409, 2N1410

Fastest switching time at high current ratings combined with extremely low saturation resistance make these units ideally suited for transistor-ferrite circuitry and many other computer applications. *At right: Transistor-core flip flop.*



TYPES 2N696 and 2N697 *are also immediately available from PSI.*

Circle 67 on Inquiry Card

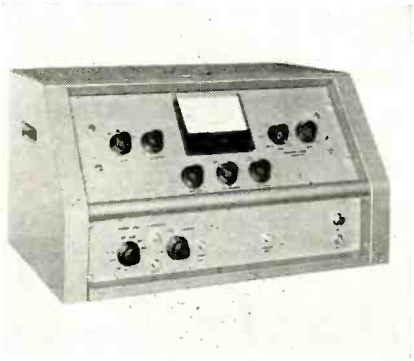
PSI

Write today for complete information and specifications on PSI silicon transistors. PSI regional or district sales offices are located in all major electronic centers. Consult your yellow pages.

New Products

ANALYZER

Crystal-Detector analyzer, a broadband, low-noise video amplifier, featuring gain stability and controlled bandwidth. Featured is calibrated voltage-gain from 10 to 20,000 in 20 db steps, with a gain stability of 0.05

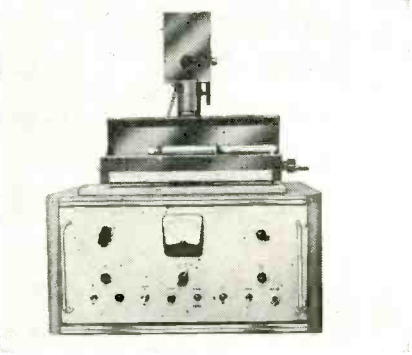


db per day (5% per month); calibrated bandwidth from 50 KC min. to 10 MC max; an overall sensitivity of —102 dbm for 10 MC bandwidth, yielding a min. noise figure of 1.8 db; complete selection of crystal loads from 100 ohm to 100 K ohm including provisions for external insertion of any desired load; and accurate biasing (forward and reverse) from 0 to 1.0 ma. Electronic Defense Lab., ITT Labs., 3702 E. Pontiac St., Ft. Wayne, Ind.

Circle 266 on Inquiry Card

MEASURING EQUIPMENT

Semiconductor lifetime measuring equipment in a single package. Lifetimes from 1 μsec up are measured. Equipment is shielded with extraneous noise eliminated and is self-contained. Only additional equipment

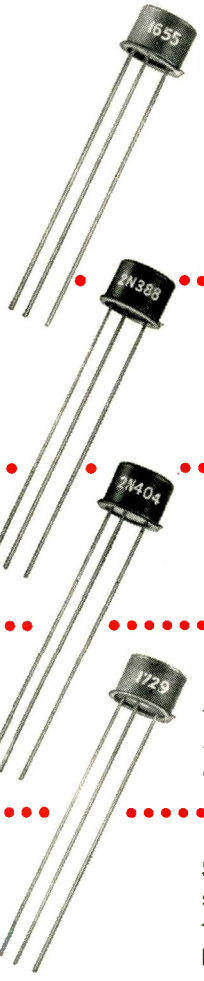


required is a good scope. Simple operation and fast results make equipment suitable for production testing of semiconductor materials. Electro Impulse Laboratory, 208 River St., Red Bank, N. J.

Circle 267 on Inquiry Card

NON-SECRET

USN·USAF·SAC standards are met by SYLVANIA TRANSISTORS



SYLVANIA-1655 . . . for example, is used extensively in POLARIS. Imagine the complexity of the electronic system that must obtain target data, translate it into launching information and transmit intelligence to the guidance system of the "bird." Here, there can be no compromise with reliability. That's exactly why SYLVANIA has become a principal source of supply for NAVY-type R-212 (SYLVANIA-type SYL-1655) PNP-transistors used in the Polaris "bird" and its underwater "nest."

SYLVANIA-2N388 meets all requirements of MIL-T-19500/65 (NAVY). Originated by SYLVANIA, this NPN unit is designed and controlled specifically for computer applications where reliability, high gain and rapid switching capabilities are needed.

SYLVANIA-2N404 meets all requirements of MIL-T-19500/20 (USAF). This Sylvania PNP-type incorporates many of the features of the ultra-reliable SYL-1655 used in Polaris.

SYLVANIA-1729 is an NPN switching-transistor developed especially for SAC PROJECT 465L, the world-wide digital communications system. SYL-1729 is further proof of SYLVANIA capability in the design, production—and delivery—of reliable semiconductors.

Sylvania is prepared to custom-design semiconductor devices to your specific requirements, too. Contact your Sylvania Representative. For technical data on current types, write Semiconductor Division, Sylvania Electric Products, Inc., Dept. **195**, Woburn, Mass.

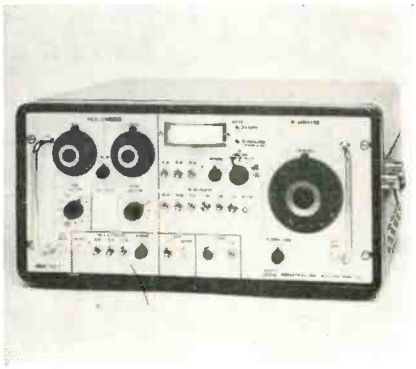
SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

New Products

SIGNAL GENERATOR

Pulse and CW Generator, Model PSX-1, produces video pulses, CW, and audio modulated CW signals. Phantastrons and comparators produce video pulses with a repetition rate that is adjustable from 50 to

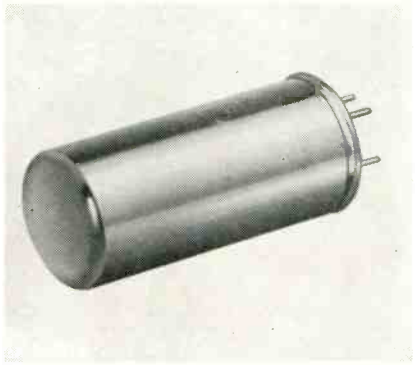


5000 CPS. Width of each pulse variable from 0.05 to 10 μsec; rise-and-fall time less than 0.02 μsec. Front panel control allows pulses to be advanced or retarded by 5 μsec relative to the output synchronization signal, a 50 v, one μsec pulse with ± polarity. CW oscillator and buffer circuits produce signal adjustable from 25 MC to 75 MC with an accuracy of 0.25%. Telonic Industries, Inc., Beech Grove, Ind.

Circle 268 on Inquiry Card

MINIATURE RELAYS

BR-1S relay series' coil sensitivity is 5 mw. Relays meet Mil R 5757C and Mil R 6106C except overload and will handle up to 2 a resistive at 32 vdc or 110 vac. The unit will not malfunction at 25g (11 msec) shock. The BR-1S will operate between −65°C and +85°C—the high temp. BR-2S



to +125°C. The 1¼ oz. relays will operate in 10 msec with 100 mw power to the coil and can be adjusted to drop-out at 90% of pull-in. Babcock Relays, Inc., 1640 Monrovia Ave., Costa Mesa, Calif.

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NOW—Two important contributions to printed circuit design—

The Microminiature Kernel ATE-34 Adjustoroid® and a New Line of Miniature Encapsulated Adjustoroids

Newest addition to the Burnell Adjustoroid line is the microminiature Kernel® ATE-34 and the miniature ATE-11, ATE-0 and ATE-4. One of the unique features of these new Adjustoroids is a flush slotted head providing for ease of adjustment and economy in height.

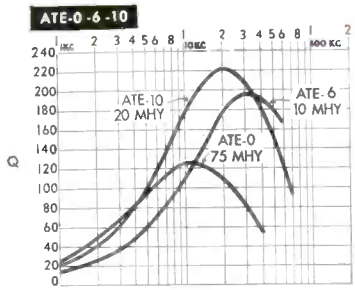
The new microminiature Kernel ATE-34 Adjustoroid and the miniature ATE-11, ATE-0 and ATE-4 are variable over a 10% range of their inductance. Fully encapsulated, they will withstand high acceleration, shock and vibration environments. All of the above meet MIL-T specifications, 27 Grade 4 Class R and MIL-E 15305 A. Write for Stock Sheet AT-34.

	Length/ Dia.	Hgt.	Wt.	Useful Freq. Range	Max. Q	Max. L. in hys
ATE-0	1 1/16"	1"	1 1/2 oz.	1 kc to 20 kc	10 kc	5 hys
ATE-4	1 5/16"	1 3/16"	3.5 oz.	1 kc to 16 kc	6 kc	15 hys
ATE-6	1 1/16"	1"	1 1/2 oz.	10 kc to 100 kc	30 kc	.75 hys
ATE-10	1 5/16"	1 3/16"	.1 oz.	3 kc to 50 kc	20 kc	.75 hys
ATE-11	3/4"	1 3/16"	.75 oz.	2 kc to 25 kc	15 kc	5 hys
ATE-12	3/4"	1 3/16"	.75 oz.	15 kc to 150 kc	60 kc	1 hy
ATE-34	27/64"	21/32"	.1 oz.	3 kc to 30 kc	55 kc	1 hy

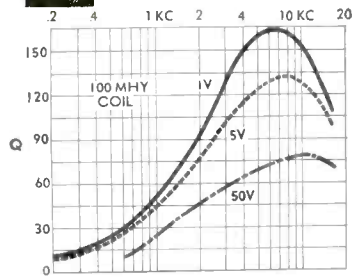
PAT. 2.762.020

FREQUENCY KCS

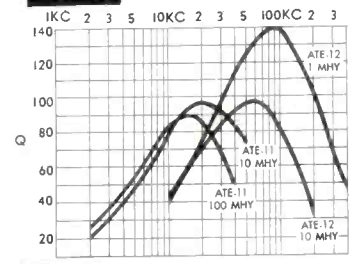
ATE-0 -6 -10



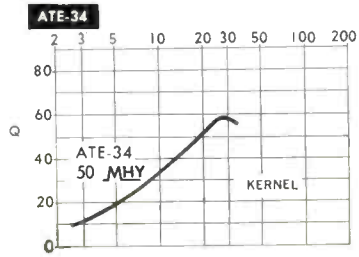
ATE-4



ATE-11-12



ATE-34



If you haven't already done so—send for your free membership in the Space Shrinkers Club.

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

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PElham 8-5000
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MUrray 2-2841
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This busy metropolitan area is the termination of over 1000 miles of microwave systems, providing reliable communications across town and country for the Western Union Telegraph Company. ANDREW's experience in research, development and manufacturing is the reason why the dependable performance of an ANDREW PS8-37, eight-foot Parabolic antenna was selected for this installation.

All ANDREW parabolic antennas conform to the newly proposed RETMA-FCC standards governing radiation patterns and side lobes, and they are *guaranteed* to give specified pattern and VSWR in your microwave system.

From a selection of over thirty stocked parabolic antennas, you can choose the type and size that will give optimum system performance with absolute mechanical and electrical reliability.

Microwave engineers have found ANDREW a valuable partner in planning their communication systems. A parabolic antenna computer for calculating system performance is available to you upon request. Write today for information and expert advice relative to your microwave antenna system requirements.

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Tele-Tech's ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • MAY 1960

SYSTEMS—WISE . . .

The U. S. Navy has formally accepted a Universal Digital Operational Flight Trainer (UDOFT), the first high-speed digital trainer for modern jet aircraft, from Sylvania Electric Products, Inc., New York, N. Y. The equipment can simulate the flight of supersonic aircraft, accept student pilot's commands and provide cockpit instrument and control reactions. The instructor can introduce new conditions such as engine failure, etc.

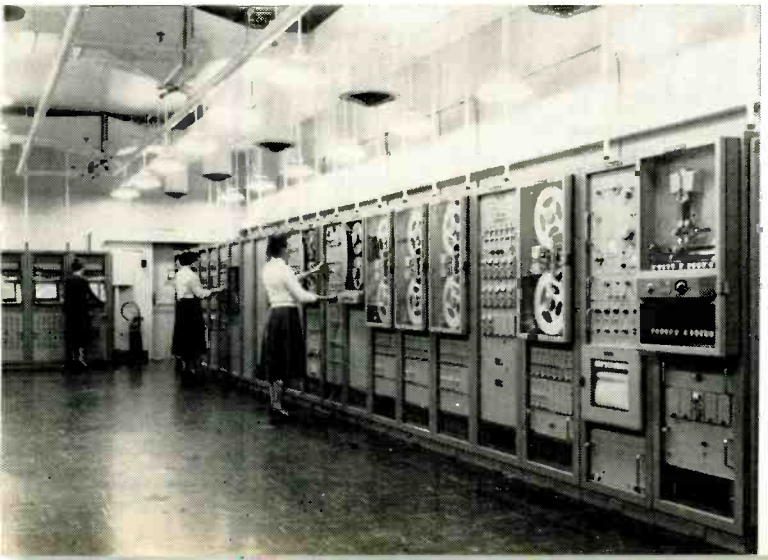
A pushbutton communications system linking 43 plants, laboratories, and branch sales offices in 17 states has been placed in operation by Minnesota Mining and Manufacturing Co., St. Paul, Minn. The system uses 10,000 miles of leased telegraph wires and equipment developed by Western Union. It can handle 2,600 orders and messages a day.

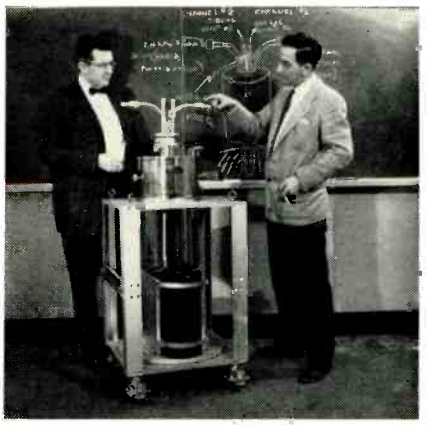
Leonard S. Schwartz, adjunct professor of electrical engineering at N.Y.U.'s College of Engineering, has received a contract from the U.S.A.F. Cambridge Research Center to carry on research in electronic feedback communications systems. He is seeking solutions to problems that arise when the feedback principle is combined with systematic encoding and decoding methods, including codes of the Hamming and Slepian groups.

The Franklin Institute, Phila., Penna., has completed a 1-year study for the U.S.A.F. on natural electromagnetic phenomena for space navigation. The method of navigation is based on the Doppler effect. The institute reported that in the electromagnetic spectrum, the visible range of frequency holds the greatest promise for early successful application to space navigation. Study also showed that the primary difficulty in using natural radiation is the very low signal level available.

DATA SYSTEM

Data acquisition and processing system built by Minneapolis-Honeywell for U. S. Navy's Allegany Ballistics Lab. Allegany, operated by Hercules Powder Co., is one of the development centers for the submarine-launched solid-fuel Polaris missile.





TWO-CHANNEL MASER

H. Scovil, Bell Telephone Labs, points out to R. DeGrasse input coax of the lowest-frequency traveling-wave maser ever built. For satellite communication, it operates at signal frequency of 2.4 KMC. Communication experiment, Project Echo, is being carried out with NASA.

The Florida Div., Radiation, Inc., has received contracts totalling $460,000 for Telegraph Distortion Measuring Systems (TDMS) from the Air Force and several Communications engineering companies. The system allows on-line evaluations of operating communications links without interrupting service and operates as a signal generator for clear and distorted signals.

A missile-borne TV camera, designed to report instantly the results of a missile firing has been successfully launched at the Army's White Sands Missile Range. The system tells immediately whether the missile has destroyed the target and the amount of damage created.

Stanford Research Institute engineers have designed a device which eliminates radio static caused when aircraft fly through snow or clouds of ice particles. The device allows noise-producing corona discharges to occur, but prevent the generated noise from reaching the antenna.

United ElectroDynamics, Inc., Pasadena, Calif., has been awarded contracts for a rainfall and river level telemetering system. The systems will be used to control water to the Panama Canal. Hydrologic data will be gathered at remote stations and transmitted by radio to Balboa Heights. The central station can interrogate remote stations separately.

Harold E. Fellows, President and Chairman of the Board of the National Association of Broadcasters, died March 8. He was associated with the NAB since 1951.

The Post Office Dept. is beginning work on the second phase of its investigation of the potential use of facsimile transmission for letter mail. IT & T has been awarded an R & D contract covering the engineering and procurement of prototype models of high-speed and high-volume facsimile transmitters and receivers and auxiliary machines and equipment for postal use.

For H-F Band Communications . . .

New System

By GEORGE A. SCHEER
Chief, Communications Development Branch
Communications & Navigation Lab.
Wright Air Development Div., ARDC
Dayton, Ohio

FOR the foreseeable future, as in the past, the cheapest and easiest way to obtain long-haul radio communications is to use the h-f region of the electromagnetic spectrum. By strict definition, this band is from 3 to 30 MC. We take the liberty of going somewhat above and below these actual numbers. Long distance propagation is obtained by one or more signal reflections between the earth's surface and the ionosphere.

Under normal conditions, observing the diurnal, seasonal and 11 year variations in ionospheric height and density, we can pick frequencies which will be supported by the ionosphere with minimum attenuation. Variations in the eleven-year sunspot cycle change the frequencies which may be used. The cycle also causes magnetic storms, located primarily about the north and south magnetic poles of the earth, and blackouts which may occur from time to time in the h-f region. Some studies have been made and other studies are continuing to determine if some high frequencies can get through the blackout areas.

Propagation Enemies

There are other enemies of high frequency propagation that arise. Some are man made and some are natural. Intentional or unintentional interference fall into the first category; certainly interference of the unintentional variety arises from the crowding in this portion of the spectrum. SSB techniques will help temporarily by eliminating carrier interference and utilization of less spectrum space.

Other natural troubles are due to turbulence and multiple layers in the ionosphere. These result in the reception of more than one signal from the original single signal, defined as multipath. This may be short term or long term, and is minimized with frequency diversity, time diversity and space diversity. Even so, there are times of considerable difficulty in getting the message through without repeats or changes in frequency or rerouting.

Transmission Studies

In the early 1950's work was begun in earnest to overcome most if not all of the shortcomings of the existent forms of modulation. The primary attack was through application of digital techniques other than frequency-shift-keyed radioteletype (FSK) and analogue voice. Studies of pulses transmitted over long distances showed that approximately the first millisecond was the original signal with no multipath. If, then, the information was taken from only the first millisecond of pulse duration, there generally would be no out-of-phase signal components arriving over longer distances to change the amplitude. This would take care of most short-time fades. The multipath might persist for 2 to 3 msecs., and the channel should not be used during this time if long term fades were to be overcome.

Obviously, waiting 3 msecs. for the multipath to die out before sending another pulse meant that ¾ of the channel capacity was being wasted in just waiting. If, however, we sidestepped in frequency just a few hundred cycles,

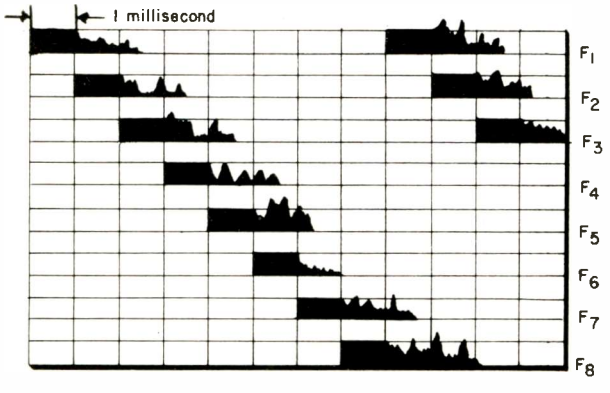
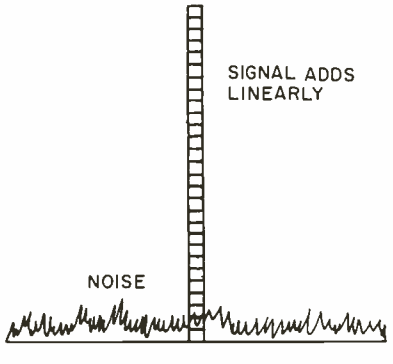


Fig. 1: Left fig. shows the QFM system using eight sidestepped channels. Channels are only a few hundred cycles apart. Right fig. shows that all signal elements add linearly.



The multipath problem can be minimized by sending signals that shift carrier frequency every millisecond. The shift is only a few hundred cycles and a maximum of eight shifts is required. This new system is called Quantized Frequency Modulation (QFM).

Defeats Multipath Effect

we could start the second pulse immediately after 1 msec. of the first pulse, and not worry about any multipath on the first frequency. Likewise, the third pulse could be started after 2 msecs., on still another sidestepped frequency, and our multipath problems would be practically nil. Thus it was that LONG ARM was born. Referring to Fig. 1, we see in diagrammatic form, the LONG ARM system, using eight sidestepped channels. No one channel is ever used more than once every 4 msecs. The portion of the signal distorted by multipath after the first millisecond is not utilized. A scheme such as this is known as Quantized Frequency Modulation (QFM).

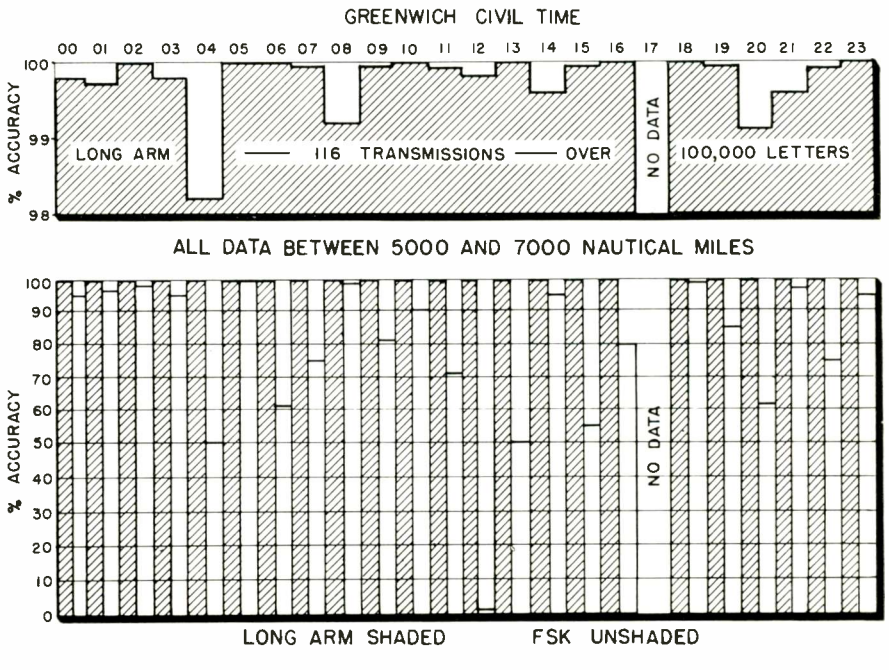
Adding Redundancy

The basic pulse rate on LONG ARM is 1000 pulses/sec with absolutely no dead time. So, in effect, the average power is actually the maximum power because there is always a pulse on the air. In fact, in the latest design, pulses actually overlap to save in bandwidth. At the present state of the art, we cannot use voice at a bit rate of 1000 pulses/sec. We can, however, send printed messages quite readily at such a rate.

Further considerations lead to the inclusion of redundancy in this new mode of modulation to insure good performance under very severe transmitting medium conditions. Also against interference other than multipath such as noise and other high frequency signals.

It was quite convenient to add message redundancy and come up with a system which still gave a speed of some 65 wpm. For simplicity we adapted the inherent bit rate to the standard teletype code for message insertion and readout. Our resultant redundancy was 28 to 1. Examining right portion of Fig. 1, we find that we must add all signal elements linearly for greatest protection against noise and other interference. We therefore wait for outputs from delay lines to be presented simultaneously before we reconstruct the teletype band. While our signal adds linearly in this process, the noise adds RMS. We also find, under many conditions, that we can

Fig. 2: Actual test results of QFM and FSK are compared for long hauls. Both were on same frequency.



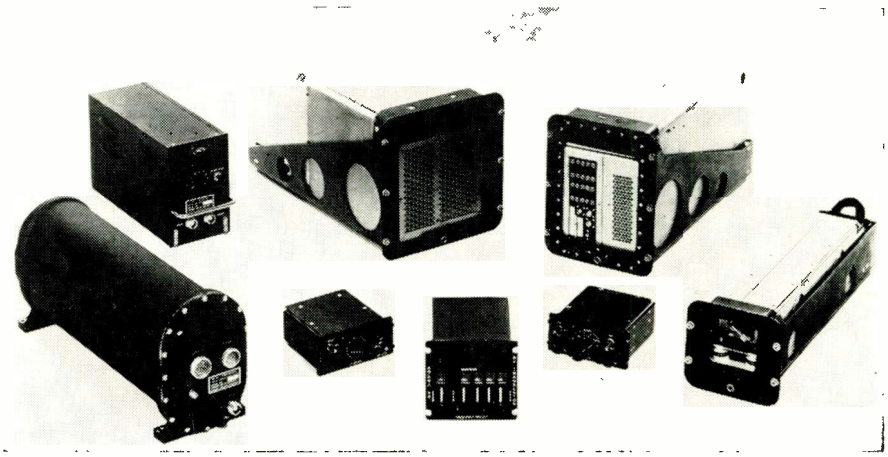


Fig. 3: The hardware to be used with the LONG ARM system is shown. The equipment is only a converter and not a complete system. It is intended to be used with existing and future sets.

Multipath Effects *(Continued)*

lose half of our pulses and still have 100% message accuracy. The system is further enhanced because we look, at any one instant, at only about 500 CPS of bandwidth rather than the entire used spectrum, thus combating only the noise present on a narrow-band basis rather than the entire band utilized.

We have found that for shorter hauls and good transmission conditions, we do not often require a signal redundancy as high as 28 to 1. We have designed the system with flexibility in mind, and can provide manual selection in flight of only two channels, the upper or lower four, or the maximum of eight. Reduced number of channels results in savings in bandwidth as follows:

No. QFM Channels	Signal Redundancy	Bandwidth Required	Words/Min
2	7:1	1.5 KC	65
4	14:1	3.5	65
8	28:1	7.5	65

Since 1954, the LONG ARM system has been flown extensively to prove its capabilities. It has been tested at Fairbanks, Thule, the Mediterranean, Belem, Natal, England, Hawaii and Guam with ground stations at WADC and Los Angeles. Fig. 2 shows actual test results, taken with an error counter, over the longest hauls. For comparison purposes, FSK was used at the same power level, on the same frequency and in the same time period to insure validity of results. No data were obtained at 1700 Z simply because no flights were made at this hour. All others are composites of several or many flights. The top portion of the Fig. is a consolidation of all LONG ARM data on the flight test between WADC and Hawaii and Guam. It is significant indeed that the plot is all above 98% message reliability.

The efficacy of LONG ARM techniques against interference is illustrated in the plot for 1200 Z. The FSK signal used for comparison was reduced to 1.1% message accuracy due to the unexpected operation of a commercial teletype station on the exact frequency. With this same interference, there was no effect on the LONG ARM message. This holds for all types of interference except sophisticated, intentional jamming.

Using the QFM technique we have bought something relatively new in the area of equipment reliability. Most electronic equipments fail completely if one insignificant component part such as a capacitor fails. This is because everything is normally arranged in series. True, this buys minimum size and weight in any equipment. But, in LONG ARM, because we need parallel redundancy to make the system work at all, we have gained in inherent equipment reliability in case of component failures.

We have already said we do not normally need the full redundancy that is built in eight parallel QFM channels. This is reflected in the ability of the equipment to continue to operate and communicate if defects occur in one or more of the i-f amplifiers, for example. The good ones continue to operate. If transmission medium conditions are not maximally severe, the message will still get through, and probably at almost 100% accuracy. We are not necessarily at the mercy of a single vacuum tube or diode or capacitor failure if this failure occurs in paralleled circuitry such as i-f stages.

Although the message reliability of the LONG ARM technique is higher than any known system of this kind, and attenuation is not so important as with analogue systems such as voice, propagation is still supported wholly by the ionosphere and frequencies must be selected on that basis. True, the frequency may go considerably below the MUF still with good results, but the frequency used should conform to usual standard practices for h-f operation.

System Hardware

The design of the service test hardware brings us to a story other than the LONG ARM Technique, and a short mention of the philosophy will be made here. It occurred to us that we could provide utmost utility by providing the most flexibility possible. Here the R-F Translator concept was born. We simply provided the common elements needed in any high-frequency radio transmission and reception system and designed them to accept any foreseeable modulation technique. In the future then, only the terminal equipment associated with any new modulation technique need be added without changing the basic system.

Such a scheme is advantageous from a purchasing and logistics standpoint because of the fact that every airplane carrying the h-f facility would have identical, common basic components. These are the frequency standard, the frequency synthesizer, the receiver-driver, the power amplifier, the antenna coupler and control, and

(*Continued on page* 156)

WASHINGTON News Letter

PRIORITY PROGRAM—A scheduling or priority program under which the FCC plans to devote first attention to the most pressing problems as rapidly as they are ready for consideration by the Commissioners has been developed under the direction of the new FCC Chairman, Frederick W. Ford. He succeeded John Doerfer when the latter resigned. Chairman Ford told ELECTRONIC INDUSTRIES that while the "priority list" program is not entirely new at the FCC, the scheduling plans would be more comprehensive than previously. They would be "farther in advance," and better coordinated.

ALLOCATIONS NUMBER ONE PROBLEM—Chairman Ford noted that frequency allocations is the number one problem before the FCC. The primary concern is that almost half of the frequency space below 1000 megacycles is devoted to television. The FCC chieftain declared that spectrum space must be obtained to relieve the pressure, particularly in the safety-special and non-broadcast radio services. He described the latter as important to the "economic progress, safety, and comfort" of Americans. He also referred to the Bell System's pending broadband mobile radio system proposal. He said that it should be considered on the basis of the long pull.

NEW FCC NOMINEE—Edward K. Mills, Jr., a New Jersey attorney and a key official of the General Services Administration was selected by President Eisenhower to fill the unexpired term (lasting until June 30, 1961) of former FCC Chairman John C. Doerfer. Mr. Mills, along with Commissioner Robert E. Lee, faces Senate confirmation, but no difficulty for either nominee is anticipated. Commissioner Lee, as previously reported in this column, is nominated for a second seven-year term. Mr. Mills with his long government experience is deemed well-qualified for the Commission.

ADVISER TO PRESIDENT—An attempt has been made to break the stalemate in the area of studies or changes in government policy dealing with radio spectrum use by the government. Interested government agencies have been asked to comment on a proposed executive order which would set up an Adviser to the President on radio frequency usage. The Adviser's responsibilities would be principally for study and investigation. They would include the making of recommendations to the President on the allocation of frequency space for government use. The Adviser also would study the role of the federal government in the management of U.S. telecommunication resources and the existing practices of dividing frequencies between government and non-government users.

SPACE PROBLEMS—Radio frequency requirements of the rapidly developing art of space telecommunications indicate the need for a "dynamic approach to (international) administrative control and to spectrum conservation" to assure the "effective utilization of the entire spectrum." This was stated in a special report prepared at the request of Senator Lyndon Johnson (D., Tex.), as Chairman of the Senate Committee on Aeronautical & Space Sciences. The report declared that the control of frequencies for space requires global administration that transcends "jurisdictions of purely local regulatory authorities." Peaceful exploration and use of outer space, the report emphasized, includes use of satellites in the precision forecasting of weather, use of space vehicles in worldwide radio communication and television transmission, launching of manned space vehicles, and firing of exploratory probes into interstellar space.

AIR FORCE PROCUREMENT—In its budget for the fiscal year 1961, beginning July 1, the U.S. Air Force requirements for ground electronics and telecommunications equipment and systems will cost approximately $800,700,000. The procurement total for the Air Force includes $114,100,000 for alert and warning requirements, of which $107,300,000 is for the ballistic missile early warning system (BMEWS) program. Another $134,500,000 has been asked for equipment to support missile-launching activities, extensions and modernizations to the Air Force "communications complex" (AIRCOM), the Strategic Air Command control system, and other facilities.

National Press Building
Washington 4

ROLAND C. DAVIES

CENTRALIZATION of supervision and coordination of the test ranges, tracking stations and other technical facilities used in the missile and space programs was announced by the Secretary Defense. The function will be within the Office of the Director of Defense Research and Engineering because of the over-all responsibilities of that office in the areas of research, development, test and evaluation. The purpose of the centralization is to use national resources more effectively by eliminating unnecessary duplication in ground stations, tracking networks and other facilities. Development of new instrumentation will be coordinated through this office. Maj. Gen. Donald N. Yates is being assigned as Deputy Director of Defense Research and Engineering (Ranges and Space Ground Support).

CUES for Broadcasters

A 45 RPM Adapter

LAWRENCE L. PRADO, JR., Ch. Eng., WPEP, Taunton, Mass.

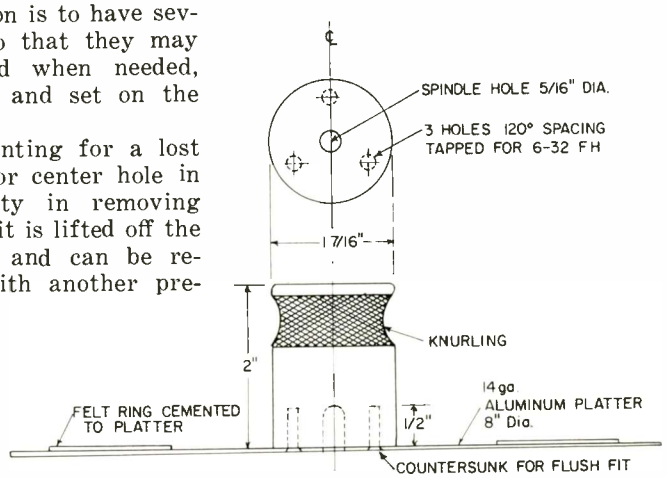
Repeated loss and misplacing of 45 RPM adapters, plus difficulty in use when playing 45 RPM records brought about the following change of procedure at WPEP. A complete adapter-platter that permitted pre-loading of the record, plus ease of handling and unlikely loss has made this unit quite practical.

Actual platter was made from 14-gauge aluminum chassis bottom plate. The 8-in. diameter is about ideal for 45 RPM records and was cut-out with a modified circle cutter. Actually any saw could be used, such as a saber saw and finishing up rough edge with rasp and emery paper. Since aluminum of this nature is quite soft, it is easily worked. Felt circle is cemented to platter to form a ring 1½ in. wide, with the inner edge of the circle being approximately 2 in. from spindle hole center.

Adapter is made from solid aluminum, steel or brass stock 1½ in. in diameter. This diameter will have to be reduced to about 1 7/16 in. to allow a slip-fit of all records, regardless of make. Entire adapter is easily made on a lathe, including drilling of spindle hole, shaping and knurling of finger portion. This latter step is most important for ease of handling. Three holes, 120° apart, are drilled into the bottom of the adapter and then are tapped for 6-32 flat head machine screws. Countersinking of the aluminum platter is necessary to provide a smooth and flat surface when the adapter and platter are assembled. Spindle diameters seem to vary slightly with different makes of turntables so that it is best to determine which turntable has the largest diameter spindle and make spindle hole in adapter to fit. Since present adapters in use may be worn oversize, it is suggested that new measurements be made with micrometer caliper for accuracy.

In use the adapter-platter is simple to pre-load while it is right in front of the operator. The best method of operation is to have several such units so that they may be pre-loaded and when needed, merely picked up and set on the regular turntable.

There is no hunting for a lost adapter, fishing for center hole in record or difficulty in removing record. Entire unit is lifted off the regular turntable and can be replaced at once with another pre-loaded unit. Improved traction is obtained for the 45 RPM record with this method and slippage or binding of record at adapter is eliminated. Drawing shows completed unit and bottom view of adapter with all necessary measurements.



Record adapter can be pre-loaded. It features improved traction.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate will be paid for material used.

Multipath Effects

(*Continued from page* 153)

control panels. Hardware is shown in Fig. 3. This is the Radio Set AN/ARC-68(V). The (V) in the nomenclature indicates that the composition of the radio set is variable. In the illustration, we have a choice of using the SSB converter or the digital converter.

In the future, as new modulation techniques are developed, they can be implemented by adding more converters, without change to the basic translator. The R-F Translator is being procured for B-58 type aircraft with only the SSB converter to provide the needed long distance communications facility.

The overall system is AN/URC-15(V), including the airborne AN/ARC-68(V), and the ground counterpart AN/GRC-49 which ties into the AN/FRC-44 being installed for single sideband operation in SAC. Operational Test and Evaluation of the system is scheduled in SAC and AWS utilizing ground stations at RADC and at Eielson AFB, Alaska, to begin in the near future. In the meantime, the equipment is being shaken down through flight test in WADC aircraft, much of it overseas.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Summary

While we have bought the LONG ARM technique in a particular subsystem configuration, it is emphasized that LONG ARM is only a converter which may be applied to any radio set with a linear power amplifier. Believing that future communications over long distances will be enhanced by QFM printed message techniques, modifications required in airborne single sideband Radio Sets AN/ARC-58 and AN/ARC-65 to accept digital messages are being determined. This will avoid obsolescence of big inventories and permit direct application of digital converters developed as part of AN/ARC-68(V) if and when the need arises.

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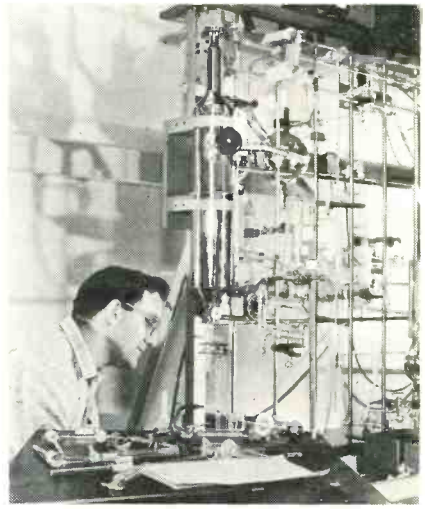
New Products

SHIELDED DEWAR

A 1½-liter, non-nitrogen, shielded dewar. Tests show that 1600 cc of liquid helium have lasted for almost 20 hours. The unit features three windows. Two are mounted in the

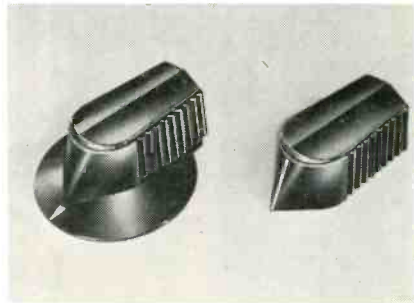


side of the helium reservoir, permitting visibility of spectra at 180° angles. The third is installed in the bottom of the reservoir. Dewar is designed for research in microwave spectrometry, superconductivity studies, low temperature chemistry, nuclear research, etc. Hofman Laboratories, Inc., Hillside, N. J.

Circle 224 on Inquiry Card

CONTROL KNOBS

Bar knob styles virtually eliminate parallax by using sloping pointers. Available from standard stock, series 70 bar knobs are in black or gray, with or without dial skirts, and in



either mirror or non-reflective matte finish. Colors available. Control knobs meet military specifications. Mechanical component Sales, Commercial Apparatus and Systems Division, Raytheon Company, Waltham 54, Mass.

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Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 1

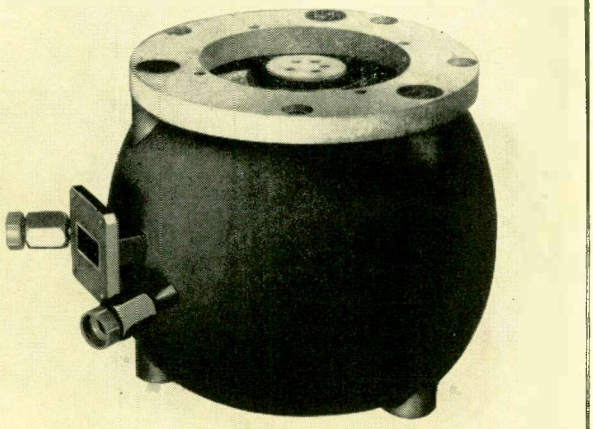
RAYTHEON "M"-TYPE BACKWARD WAVE OSCILLATORS

Electronically tunable at high power levels
for a wide range of microwave applications

Where extensive frequency mobility is required, the efficient crossed-field, "M"-type backward wave oscillator is highly versatile. Introduced more than eight years ago, it has been perfected by Raytheon and is now being economically mass produced. Hobbing of the slow-wave structure, a Raytheon-developed technique, assures precision construction necessary for consistently reproducible performance from tube to tube.

Typical of the "M"-type BWO's available from Raytheon is the QK-634A, an X-band tube which features all ceramic-and-metal construction for reliable operation under extreme environmental conditions.

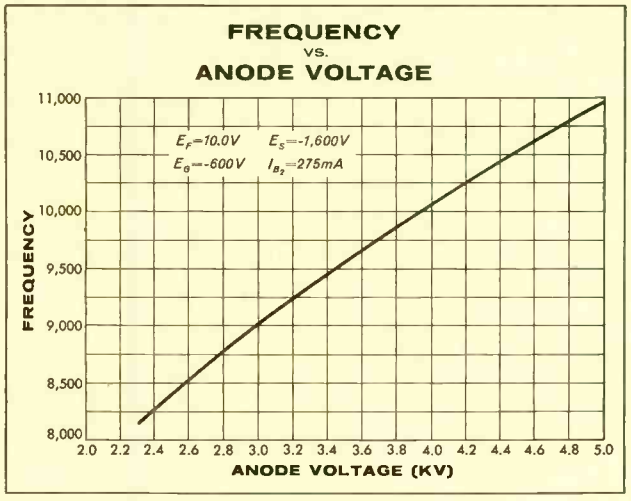
The QK-634A has a nominal power output of 200 to 250 watts and is electronically tunable over its entire frequency range. Precise determination of the radiated spectrum is accomplished by adjusting the voltage applied to either the anode or the sole. Amplitude modulation is also accomplished electronically. Small and compact, the QK-634A can be mounted in any position.

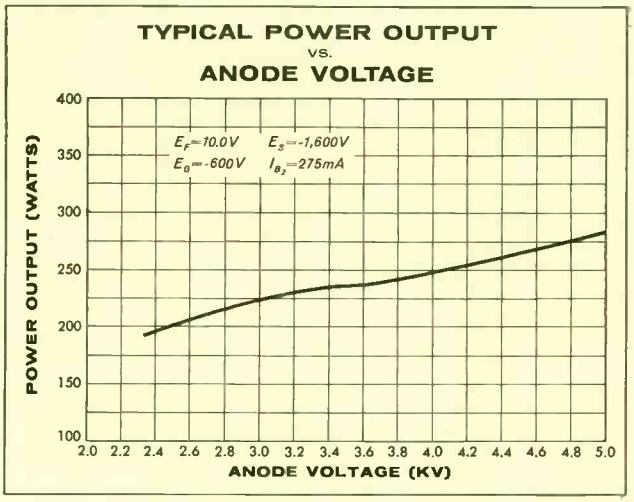


QK-634A Backward Wave Oscillator

Typical Operating Characteristics--QK-634A

Frequency Range .....8,150 to 11,000 Mc
Power Output .....150 watts (min.)
200 to 250 watts (nom.)
Output Flange .....Mates with UG40A/U modified for clearance holes
Tuning Sensitivity .....1.0 Mc/V





Other unclassified BWO's in this series include the QK-625 and QK-659, which cover the 2,500-4,450 Mc band.

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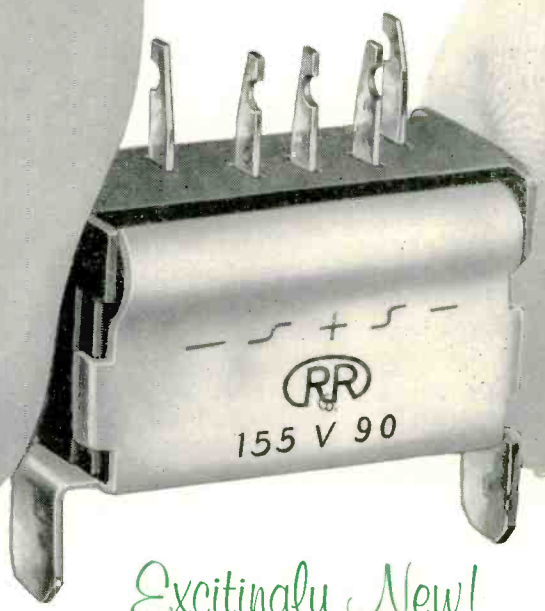
RADIO RECEPTOR MINIATURE

SELENIUM RECTIFIER BRIDGE



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Further technical data is available upon request to Section EI-5.

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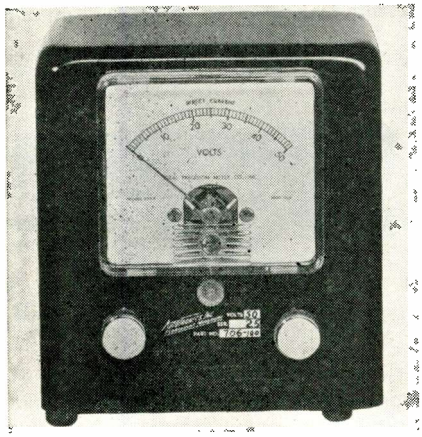
New Products

POWER SUPPLY

Transistorized Power Supply for lab use features these specs: Physical Dim., 5 x 5 x 6 in. Electrical Specs: input voltage, 95 to 135 vac, RMS 60 CPS, single phase; output voltage range, 0-50 vdc continuously variable; output current, 0 to ½ adc;

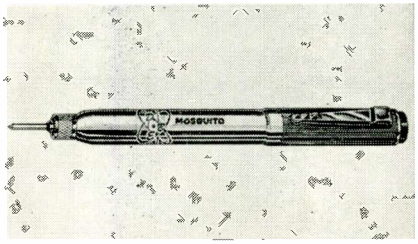


regulation, 0.02% no load to full load (adjustable from a 1 v increase to a 1 v decrease, no load to full load); drift, after an initial stabilization period of 15 sec, the output voltage does not change more than 0.07 v above the desired setting (this change due to internal temp. rise); ripple, 4 mv RMS (worst case-max. voltage, full load); line regulation, 0.01% for a 35 v RMS change in input voltage the output voltage changes 0.002 vdc. Autotronics Inc., Dept. 23, Box 208, Florissant, Mo.

Circle 226 on Inquiry Card

SIGNAL INJECTOR

The Mosquito, signal injector, is pocket-sized and self-contained. Applications include testing of radio, TV sound, tape recorders, movie projectors (sound) telephone circuits, hearing aids, amplifiers, capacitors, coded practice oscillator, oscilloscope voltage calibrator and time calibrator, pick-up cartridges, etc. It can be coupled



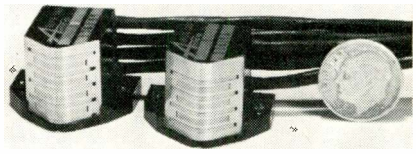
to magnetic pick-ups and circuits without leads. Frequency range is from basic mid-audio frequency to high radio frequencies in harmonics (approx. 1.5 KC). Don Bosco Electronics Inc., 56 Route 10, Hanover, N. J.

Circle 227 on Inquiry Card

New Products

TAPE RECORDER HEAD

A 4 track and a 3 track unit are interlaced for 7 tracks of info. storage, require a min. of record current and have high reliability. Specs include: Inductance, 4.5 mh ± 10%; Resistance, greater than 15 ohms;

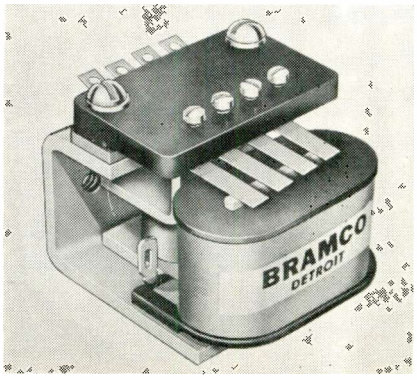


Resonant frequency with 50 mmf shunt greater than 200 K; All tracks record such that a standard tape can be reproduced within ± 1½ db; Freq., 100 CPS to 25.6 KC at 15 ips, 125 KC bias; Bias current, 4.0 va RMS; Record current, 0.45 va RMS; Cross talk due to transformer action between adjacent tracks is down at least 50 db. throughout the freq. range. Applied Magnetics Corp., P. O. B. 425, Santa Barbara Airport, Goleta, Calif.

Circle 228 on Inquiry Card

RESONANT REED RELAYS

Resonant Reed Relays have four channels with frequencies from 315 CPS to 405 CPS. Sensitivity is 3 mw with a bandwidth of 6 CPS. Contact rating is 50 ma at 67½ volts. The



field coil impedance is 27,000 ohms. The unit has a closure time of 75 milliseconds. This unit measures less than 1½ inches all dimensions. Bramco, Inc., 4501 Belvidere Avenue, Detroit 14, Mich.

Circle 229 on Inquiry Card

FROM **Transitron**...INDUSTRY'S BROADEST LINE OF

CONTROLLED RECTIFIERS & SWITCHES

(11/16)

(7/16)

TSW30
TSW60

SILICON CONTROLLED RECTIFIERS are now available in both the 7/16" hex and 1 1/16" hex base packages. Replacing thyratrons and magnetic amplifiers in many applications these rugged devices offer greater reliability and increased efficiency. Some typical applications are:

- industrial control
- lighting control
- solid state inverters
- overvoltage protection
- short circuit protection

Write for Bulletin TE-1356

THE TRANSWITCH is a new bi-stable silicon computer element that can be turned *OFF* with a gate current. Extremely uniform electrical characteristics over a wide current range (2-50 ma) permit the device to fulfill low level logic and medium power needs. The device is designed for:

- miniaturized memory circuit
- ring counters
- shift registers
- controlled rectifier driver
- flip-flop equivalent

Write for Bulletin TE-1357A

TYPE	PIV	Max. average amps Forward current at 25°C case	at 100°C case	Hex size of Package
TCR 520	50	20	10	1 1/16
TCR 1020	100	20	10	1 1/16
TCR 1520	150	20	10	1 1/16
TCR 2020	200	20	10	1 1/16
TCR 2520	250	20	10	1 1/16
TCR 3020	300	20	10	1 1/16
TCR 3520	350	20	10	1 1/16
TCR 4020	400	20	10	1 1/16
TCR 510	50	10	5	1 1/16
TCR 1010	100	10	5	1 1/16
TCR 1510	150	10	5	1 1/16
TCR 2010	200	10	5	1 1/16
TCR 2510	250	10	5	1 1/16
TCR 3010	300	10	5	1 1/16
TCR 3510	350	10	5	1 1/16
TCR 4010	400	10	5	1 1/16
TCR 503	50	5	2	7/16
TCR 1003	100	5	2	7/16
TCR 1503	150	5	2	7/16
TCR 2003	200	5	2	7/16
TCR 2503	250	5	2	7/16
TCR 3003	300	5	2	7/16
TCR 3503	350	5	2	7/16
TCR 4003	400	5	2	7/16

SPECIFICATIONS AND TYPICAL CHARACTERISTICS (at 25°C Unless Otherwise Stated)

		Typical	Maximum		Test Conditions
Saturation Voltage	V_S	1.0	1.5	Volts	I_C = 50 mA
Forward Leakage Current	I_F	0.1	10	μA	AT RATED VOLTAGE
Reverse Leakage Current	I_R	0.1	10	μA	AT RATED VOLTAGE
Forward Leakage Current	I_F	20	50	μA	at 125°C
Gate Voltage to Switch "ON"	$V_{G\ on}$	0.7	1.0	Volts	R_L = 1 K
Gate Current to Switch "ON"	$I_{G\ on}$	0.1	1.0	mA	R_L = 1 K
Gate Voltage to Switch "OFF"	$V_{G\ off}$	1.2	4.0	Volts	I_C = 50 mA
Gate Current to Switch "OFF"	$I_{G\ off}$	7.0	10	mA	I_C = 50 mA
Holding Current	I_H	2.0	5.0	mA	R_L = 1 K

See Transitron at the AFCEA Show, Booth 157-158

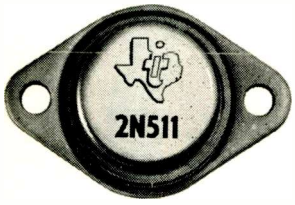
Transitron
electronic corporation • wakefield, massachusetts

"Leadership in Semiconductors"

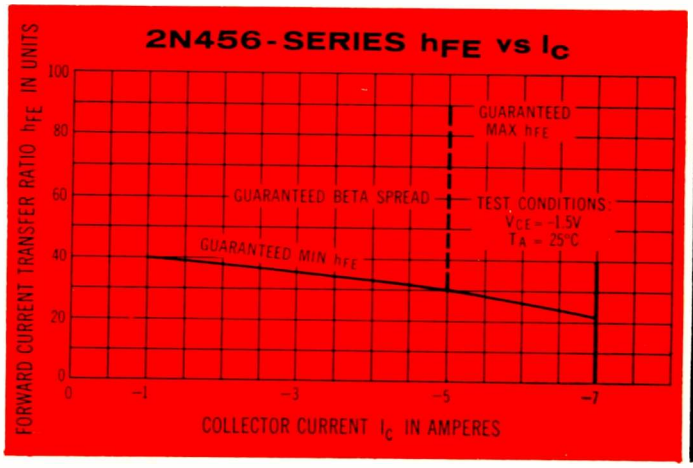
SEE YOUR LOCAL AUTHORIZED TRANSITRON DISTRIBUTOR FOR QUANTITIES FROM 1-999.

FULL LINE OF HIGHEST BETA GER

New TI high-efficiency emitter gives you high beta germanium power transistors!



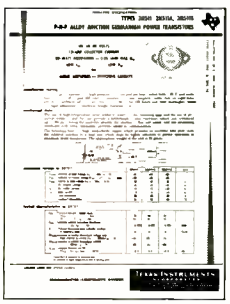
Now minimum and maximum betas are guaranteed from 20 to 60 at the maximum current rating of I_C = 25 amps in new TI 2N514 series transistors. New high efficiency emitter makes possible greatly improved specifications for TI 2N456, 2N511, 2N512, 2N513, 2N514, and 2N1021 series alloy-junction germanium power transistors.



TI gives you design leadership in quality germanium power transistors

INCREASED BETA THROUGH HIGH-EFFICIENCY EMITTER

Emitter efficiency can be improved by increasing the ratio of resistivities between the emitter and base region. For example, when a 10 ohm-centimeter resistivity germanium wafer is used as the base material, it is advantageous to have less than a .01 ohm-centimeter resistivity emitter regrowth region. Since initial doping of the germanium crystal establishes base resistivity, the ratio can be changed only by varying the emitter material. TI utilizes an emitter material that results in a lower emitter resistivity and an increased emitter efficiency, plus providing the higher beta at high currents.



Optimum reliability for all TI germanium power transistors is assured by . . . 100% testing . . . 100% temperature cycling . . . 100% hermetic seal testing . . . continuous and intensive quality assurance program. Write on your company letterhead for germanium power transistor specifications.

GERMANIUM

POWER/SWITCHING/DEFLECTION CIRCUIT

TRANSISTORS

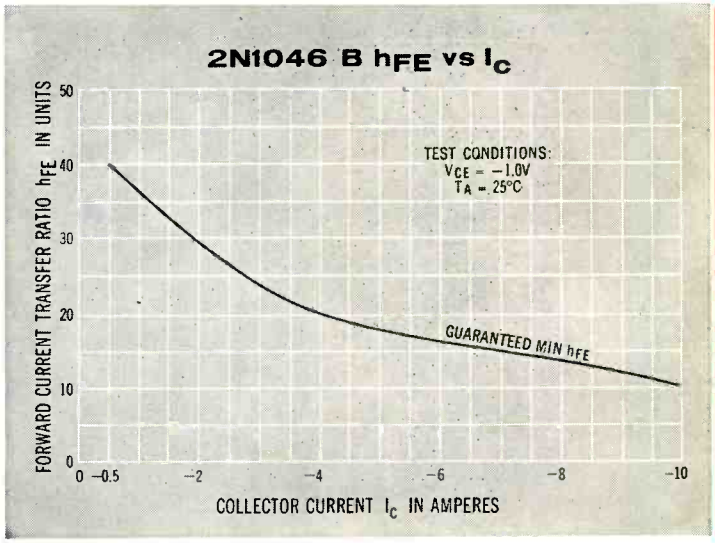
TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 · DALLAS, TEXAS

MANIUM POWER TRANSISTORS

New high current 2N1046-A-B give you high frequency/dissipation/voltage with high beta!

New TI 2N1046B germanium power transistors give you 10 amp I_C with typical 18 mc f_T* . . . 130 volt BV_{CBO} . . . guaranteed beta of 10 at 10 amp I_C . . . 30 watt dissipation . . . high frequency/high current operating characteristics. The 2N1046 series alloy-diffused P-N-P transistors provides maximum reliability for your core driving, hi-fi amplification, and other high frequency power applications.

f_T* *Frequency at which common base current gain of the device is unity.*



Call on your nearest TI distributor or sales office for immediate delivery of TI germanium power transistors including the 1-amp 2N1038 series and the 3-amp 2N1042 series power transistors.

TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25°C

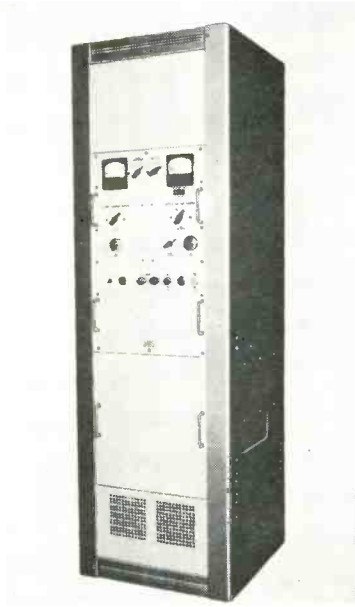
Type	Dissipation at 25°C watts	Collector to Base Voltage-v max	Collector to Emitter Voltage min BV_{CEO}	Emitter to Base Voltage-v min BV_{EBO}	Collector Current Amps max	h_{FE} @ I_C min	h_{FE} @ I_C max	Collector Reverse Current I_{CO} max ma	Collector Reverse Current I_{CO} max v	Typ R_{CS} @ I_C ohms	Internal Cutoff Frequency avg f_T
2N456A	50	−40	−20	−20	−7	30 @ 5a	90	−0.5	−20	0.040 @ 5a	430 kc
2N457A	50	−60	−30	−20	−7	30 @ 5a	90	−0.5	−30	0.040 @ 5a	430 kc
2N458A	50	−80	−40	−20	−7	30 @ 5a	90	−0.5	−40	0.040 @ 5a	430 kc
2N1021	50	−100	−50	−20	−7	30 @ 5a	90	−0.5	−50	0.040 @ 5a	430 kc
2N1022	50	−120	−50	−20	−7	30 @ 5a	90	−0.5	−60	0.040 @ 5a	430 kc
2N511	80	−40	−20	−30	−25	20 @ 10a	60	−2	−20	0.025 @ 10a	260 kc
2N511A	80	−60	−30	−30	−25	20 @ 10a	60	−2	−30	0.025 @ 10a	260 kc
2N511B	80	−80	−40	−30	−25	20 @ 10a	60	−2	−40	0.025 @ 10a	260 kc
2N512	80	−40	−20	−30	−25	20 @ 15a	60	−2	−20	0.033 @ 15a	280 kc
2N512A	80	−60	−30	−30	−25	20 @ 15a	60	−2	−30	0.033 @ 15a	280 kc
2N512B	80	−80	−40	−30	−25	20 @ 15a	60	−2	−40	0.033 @ 15a	280 kc
2N513	80	−40	−20	−30	−25	20 @ 20a	60	−2	−20	0.038 @ 20a	300 kc
2N513A	80	−60	−30	−30	−25	20 @ 20a	60	−2	−30	0.038 @ 20a	300 kc
2N513B	80	−80	−40	−30	−25	20 @ 20a	60	−2	−40	0.038 @ 20a	300 kc
2N514	80	−40	−20	−30	−25	20 @ 25a	60	−2	−20	0.040 @ 25a	350 kc
2N514A	80	−60	−30	−30	−25	20 @ 25a	60	−2	−30	0.040 @ 25a	350 kc
2N514B	80	−80	−40	−30	−25	20 @ 25a	60	−2	−40	0.040 @ 25a	350 kc
2N1038	20	−40	−30	−20	−3	20 @ 1a	60	−125μa	−20	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1039	20	−60	−40	−20	−3	20 @ 1a	60	−125μa	−30	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1040	20	−80	−50	−20	−3	20 @ 1a	60	−125μa	−40	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1041	20	−100	−60	−20	−3	20 @ 1a	60	−125μa	−50	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1042	20	−40	−30	−20	−3	20 @ 3a	60	−125μa	−20	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1043	20	−60	−40	−20	−3	20 @ 3a	60	−125μa	−30	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1044	20	−80	−50	−20	−3	20 @ 3a	60	−125μa	−40	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1045	20	−100	−60	−20	−3	20 @ 3a	60	−125μa	−50	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1046	30	−100	−50	− 1.5	−10	40 @ 0.5a		−1	−40	0.500 @ 1a	15 mc min
2N1046A	30	−140	−50	− 1.5	−10	20 @ 4a		−1	−40	0.125 @ 4a	15 mc min
2N1046B	30	−140	−50	− 1.5	−10	10 @ 10a		−1	−40	0.050 @ 10a	15 mc min

Circle 83 on Inquiry Card

New Products

POWER SUPPLY

For electrolytic capacitor forming and aging, model CS-58TRM72B, is rated at 2 to 300 vdc, 0.6 to 30 a. Power supply is current-limited and voltage-regulated. Pre-selected current is maintained during the initial

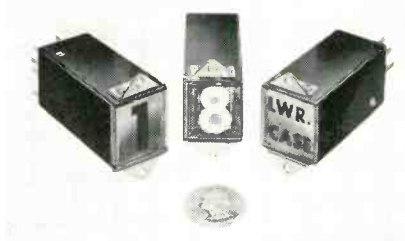


charging interval to within ±2.0%. Voltage rises in proportion to increasing load impedance to pre-selected level. Voltage is then maintained within ±0.5%. Ripple will not exceed 0.2 v RMS. Unit is 22 in. wide, 24 in. deep, and 82 in. high. Magnetic amplifier circuitry is transistor driven —no vacuum tubes are used. NJE Corp., 20 Boright Ave., Kenilworth, N. J.

Circle 230 on Inquiry Card

DIGITAL DISPLAY

Miniature incandescent digital readout displays the digits 0 through 9 on a common 1 x 1 in. area. Type LD-11 presents high density white-on-black (or black-on-white) numerals. It uses a lenticular optic technique which eliminates the need for pro-



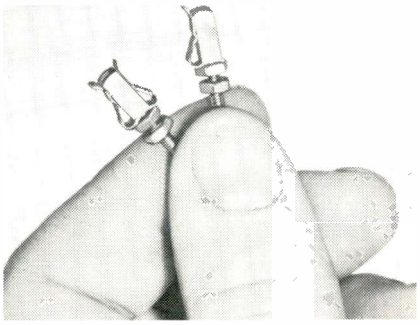
jection lenses. Other features are modular construction for direct panel mounting and small size. It uses a 2½ v. bulb. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

Circle 231 on Inquiry Card

New Products

TEST CLIP

Single or double, spring tension Test Clip with hex nut for adjustment of tension. Panel area for a single unit (2-41) is approx. 3/16 x ⅛ in. Area for a double Test Clip (2-42) is approx. ¼ x ⅛ in. Mounting stud

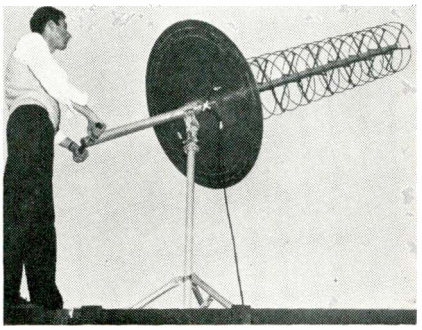


extends ⅜ in below adjusting nut. Parts are nickel plated brass, with the spring made of nickel plated and heat treated beryllium copper. They are designed for rapid connection and positive contact without manually opening and closing jaws. Unit simplifies testing of resistors, transistors, capacitors, and other pig-tail type components. Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.

Circle 234 on Inquiry Card

TRACKING ANTENNA

Bifilar helical antenna for short and medium range tracking achieves significantly increased gain over standard eight turn helix. The Bifilar design uses two interlaced eight turn elements in the space formerly occupied by one element. Antenna side lobes are substantially reduced.



Gain (Type 52000-2) is measured at 14 db for 240-260 MC and 13 db for 215-240 MC. VSWR is less than 1.8:1. Andrew California Corporation, 941 East Maryland Avenue, Claremont, California.

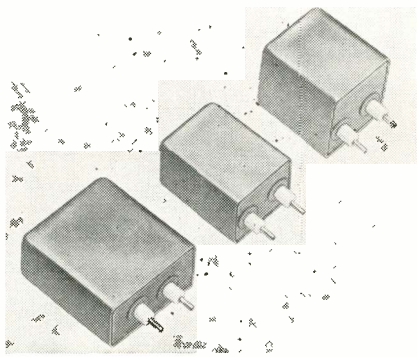
Circle 235 on Inquiry Card

Circle 86 on Inquiry Card →

New Products

HIGH TEMP CAPACITORS

Three new types of high-temperature motor-starting capacitors utilize Mylar, Teflon, and Mica dielectric. Working temp. range for Mylar type is −65 to +300°F; for the Teflon

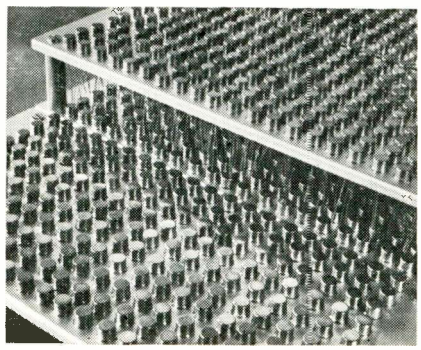


type, −65 to 400°F and for the Mica type, −65 to +700°F. All three types available in capacitance range of 0.05 mfd and up. Mylar and Teflon types are wound of thin metallized film for maximizing miniaturization. Mica type is wound of aluminum foil and pure Mica ribbon. All are encapsulated with thermoplastic polyamide or thermosetting epoxy resins. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

Circle 232 on Inquiry Card

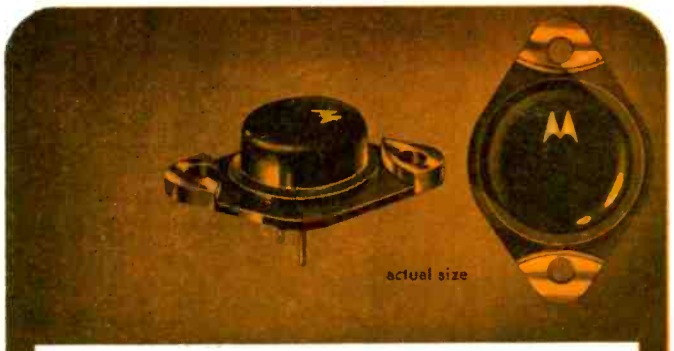
SILICON MESA TRANSISTORS

Series of high current, fast switching silicon mesa transistors numbered RT5001 through RT5004. Current capability is 1 a. Devices are rated up to 100 v. and have low saturation resistance typically less than 3 ohms at 500 mA. A wide range of applications is possible due to controlled beta



linearity, and the fact that typical dc current gain is within 75% of the max. value from 100 ma to 1 a. New types are in JEDEC TO-5 packages. Rheem Semiconductor Corp., 350 Ellis St., Mountain View, Calif.

Circle 233 on Inquiry Card



INDUSTRIAL POWER TRANSISTORS

3 AMP

MAXIMUM RATINGS					Electrical Characteristics		
Type Number	BV_{CBO} volts	BV_{CES} volts	T_J °C	I_C amps	h_{FE} @ I_C amps min	h_{FE} @ I_C amps max	I_C amps
2N1359	50	40	100	3.0	35	90	1
2N1360	50	40	100	3.0	60	140	1
2N379	80	60	100	3.0	35	90	1
2N618	80	60	100	3.0	60	140	1
2N1362	100	75	100	3.0	35	90	1
2N1363	100	75	100	3.0	60	140	1
2N1364	120	100	100	3.0	35	90	1
2N1365	120	100	100	3.0	60	140	1
2N297A	80	50	100	3.0	40	100	.5
2N297A (SIG. C)	80	50	100	3.0	40	100	.5
2N1011	80	80	100	3.0	30	75	3
2N1011 (SIG. C)	80	80	100	3.0	30	75	3

New 5 AMP

MAXIMUM RATINGS					Electrical Characteristics		
Type Number	BV_{CBO} volts	BV_{CES} volts	T_J °C	I_C amps	h_{FE} @ I_C amps min	h_{FE} @ I_C amps max	I_C amps
2N1529	40	30	100	5	20	40	3
2N1530	60	45	100	5	20	40	3
2N1531	80	60	100	5	20	40	3
2N1532	100	75	100	5	20	40	3
2N1533	120	90	100	5	20	40	3
2N1534	40	30	100	5	35	70	3
2N1535	60	45	100	5	35	70	3
2N1536	80	60	100	5	35	70	3
2N1537	100	75	100	5	35	70	3
2N1538	120	90	100	5	35	70	3
2N1539	40	30	100	5	50	100	3
2N1540	60	45	100	5	50	100	3
2N1541	80	60	100	5	50	100	3
2N1542	100	75	100	5	50	100	3
2N1543	120	90	100	5	50	100	3
2N1544	40	30	100	5	75	150	3
2N1545	60	45	100	5	75	150	3
2N1546	80	60	100	5	75	150	3
2N1547	100	75	100	5	75	150	3
2N1548	120	90	100	5	75	150	3

10 AMP

MAXIMUM RATINGS					Electrical Characteristics		
Type Number	BV_{CBO} volts	BV_{CES} volts	T_J °C	I_C amps	h_{FE} @ I_C amps min	h_{FE} @ I_C amps max	I_C amps
2N627	40	30	100	10.0	10	30	10
2N628	60	45	100	10.0	10	30	10
2N629	80	60	100	10.0	10	30	10
2N630	100	75	100	10.0	10	30	10
2N1120	80	70	100	10.0	10	50	10
2N1120 (SIG. C)	80	70	100	10.0	10	50	10

New 15 AMP

MAXIMUM RATINGS					Electrical Characteristics		
Type Number	BV_{CBO} volts	BV_{CES} volts	T_J °C	I_C amps	h_{FE} @ I_C amps min	h_{FE} @ I_C amps max	I_C amps
2N1549	40	30	100	15	10	30	10
2N1550	60	45	100	15	10	30	10
2N1551	80	60	100	15	10	30	10
2N1552	100	75	100	15	10	30	10
2N1553	40	30	100	15	30	60	10
2N1554	60	45	100	15	30	60	10
2N1555	80	60	100	15	30	60	10
2N1556	100	75	100	15	30	60	10
2N1557	40	30	100	15	50	100	10
2N1558	60	45	100	15	50	100	10
2N1559	80	60	100	15	50	100	10
2N1560	100	75	100	15	50	100	10

25 AMP

MAXIMUM RATINGS					Electrical Characteristics		
Type Number	BV_{CBO} volts	BV_{CES} volts	T_J °C	I_C amps	h_{FE} @ I_C amps min	h_{FE} @ I_C amps max	I_C amps
2N1162	50	35	100	25	15	65	25
2N1163	50	35	100	25	15	65	25
2N1164	80	60	100	25	15	65	25
2N1165	80	60	100	25	15	65	25
2N1166	100	75	100	25	15	65	25
2N1167	100	75	100	25	15	65	25

SELECT YOUR SPECIAL INDUSTRIAL POWER TRANSISTORS FROM MOTOROLA'S STANDARD TYPES

With NEW 5 AMP and NEW 15 AMP Series MOTOROLA Now Offers 72 Power Transistors

No need to waste valuable time searching for costly "specials" to meet your specific design requirements. With 72 different power transistors, Motorola now has a standard device to fit nearly every special need. You can now design equipment with the assurance that the power transistor you specify is immediately available from the industry's most dependable line of transistors. You save time and money . . . and receive outstanding performance when you specify Motorola.

Only Motorola power transistors offer both:

- **90 watts power dissipation**
- **.8 °C/W maximum thermal resistance**

plus V_{CE} of 30 to 100 volts, operation to 100°C junction temperature, four-point control of collector breakdown, 100% stabilization bake for 100 hours at 125°C and thorough production lot reliability tests.

Motorola's complete line of power transistors is available for immediate delivery at your Motorola Semiconductor distributor.

FOR COMPLETE TECHNICAL INFORMATION and applications assistance contact your Motorola Semiconductor district office:

BOSTON 385 Concord Ave., Belmont 78, Mass. . . . . IVanhoe 4-5070
CHICAGO 39, 5234 West Diversey Avenue . . . . . AVenue 2-4300
DETROIT 27, 13131 Lyndon Avenue . . . . . BRoadway 3-7171
LOS ANGELES 1741 Ivar Avenue, Hollywood 28, Calif. . . . . HOllywood 2-0821
MINNEAPOLIS 27, 7731 6th Avenue North . . . . . LIberty 5-2198
NEW YORK 1051 Bloomfield Ave., Clifton, N.J. . . . . GRegory 2-5300
from New York . . . . . WIsconsin 7-2980
SAN FRANCISCO 1299 Bayshore Highway, Burlingame, Calif. . . . . DIamond 2-3228
SYRACUSE 101 South Salina . . . . . GRanite 4-3321

MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

Circle 88 on Inquiry Card

New Products

NOISE DIODE TUBE MOUNT

Tube mount, DB-140, provides means for coupling a gas diode source to a standard-size waveguide. The gas diodes are sources of random noise for use in measuring the overall noise

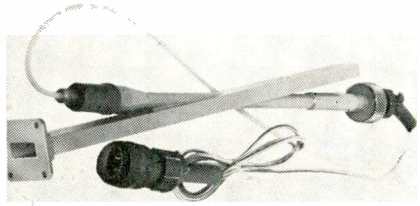
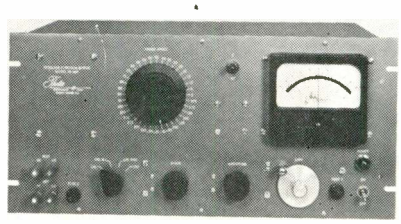


figure of microwave receivers. Unit is used with standard tubes. Mis-match will not exceed 1.15 VSWR. It is supplied with a 4-ft. cable terminated with an AN-3106B-18-22P connector for direct connection to power supply. Units are equipped with a waveguide terminated in a matched load. Sizes cover frequency range from 2.60 to 40 KMC. DeMornay-Bonardi, 780 Arroyo Pkwy., Pasadena, Calif.

Circle 236 on Inquiry Card

ERROR DETECTOR

Deviation from the ideal sine or cosine output-function of precise computing resolvers is directly displayed as a percentage error. Resolver function bridge, Model RF-1, will test any resolver regardless of electrical or physical characteristics. Each resolver winding may be fully measured and recorded in less than 2 min. It



contains its own phase-sensitive voltmeter and phase reference. Specs: Range, 0° to 360° in 5° increments; instrument error, 0.002% or less. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.

Circle 237 on Inquiry Card

FOR TOP RELIABILITY

MILITARY AND INDUSTRIAL

HERMETIC AUDIO AND POWER COMPONENTS... FROM STOCK

UTC stock hermetic units have been fully proved to MIL-T-27A, eliminating the costs and delays normally related to initial MIL-T-27A tests. These rugged, drawn case, units have safety factors far above MIL requirements, and are ideal for high reliability industrial applications. Listed below are a few of the hundred stock types available for every application. Industrial ratings in bold.

Typical Miniature Audios

RC-25 Case
61/64 x 1-13/32 x 1-9/16
1.5 oz.

Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response 2 db (Cyc.)	Max. level dbm
H-1	Mike, pickup. line to grid	TF4RX10YY	50, 200CT, 500CT	50,000	0	50-10,000	+ 5
H-2	Mike to grid	TF4RX11YY	82	135,000	50	250-8,000	+18
H-5	Single plate to P.P. grids	TF4RX15YY	15,000	95,000 CT	0	50-10,000	+ 5
H-6	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	95,000 split	4	200-10,000	+11
H-7	Single or P.P. plates to line	TF4RX13YY	20,000 CT	150/600	4	200-10,000	+21
H-8	Mixing and matching	TF4RX16YY	150/600	600 CT	0	50-10,000	+ 8
H-14	Transistor Interstage	TF4RX13YY	10K/2.5K, Split	4K/1K split	4	100-10,000	+20
H-15	Transistor to line	TF4RX13YY	1,500 CT	500/125 split	8	100-10,000	+20

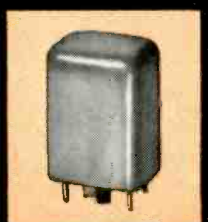
Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-20	Single plate to 2 grids, can also be used for P.P. plates	TF4RX15YY	15,000 split	80,000 split	0	30-20,000	+12
H-21	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	80,000 split	8	100-20,000	+23
H-22	Single plate to multiple line	TF4RX13YY	15,000	50/200, 125/500	8	50-20,000	+23
H-23	P.P. plates to multiple line	TF4RX13YY	30,000 split	50/200, 125/500	8 BAL.	30-20,000	+19
H-24	Reactor	TF4RX20YY	450 Hys.-0 DC, 250 Hys.-5 Ma. DC, 6000 ohms 65 Hys.-10 Ma. DC, 1500 ohms				
H-25	Mixing or transistors to line	TF4RX17YY	500 CT	500/125 split	20	40-10,000	+30

Typical Compact Audios

RC-50 Case
1-5/8 x 1-5/8 x 2-5/16
8 oz.

Typical Subminiature Audios

SM Case
1/2 x 11/16 x 29/32
.8 oz.



Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-31	Single plate to 1 grid, 3:1	TF4RX15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF4RX13YY	10,000	200	3	300-10,000	+13
H-33	Single plate to low imp.	TF4RX13YY	30,000	50	1	300-10,000	+15
H-35	Reactor	TF4RX20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF4RX15YY	25,000 (DCR800)	1,000 (DCR110)	.5	300-10,000	+10
H-39	Transistor Interstage	TF4RX13YY	10,000 CT (DCR600)	2,000 CT	2	300-10,000	+15
H-40A	Transistor output	TF4RX17YY	500 CT (DCR26)	600 CT	10	300-10,000	+15

Type No.	HV Sec. CT	DC MA*	Military Rating Fil. Secs.	DC MA*	Industrial Rating Fil. Secs.	Case
H-80	450	120	6.3V,2A	130	6.3V,2.5A.	FA
H-81	500/550	65/55	6.3V,3A-5V,2A	75/65	6.3V,3A.-5V,2A.	HA
H-82	540/600	110/65	6.3V,4A.-5V,2A.	180/100	6.3V,4A.-5V,2A.	JB
H-84	700/750	170/110	6.3V,5A.-6.3V,1A.,5V-3A.	210/150	6.3V,6A.-6.3V,1.5A.-5V,4A.	KA
H-89	850/1050	320/280	6.3V,8A.-6.3V,4A.,5V-6A.	400/320	6.3V,8A.-6.3V,4A.-3V,6A.	OA

Typical Power Transformers

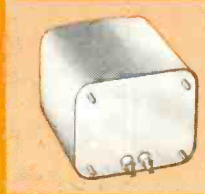
Pri: 115V 50/60 Cyc.
*Choke/Cond. inp.

Type No.	Sec. Volts	Amps.	Test Volts	Case	Type No.	Sec. Volts	Amps.	Test Volts	Case
H-121	2.5	10(12)	10 KV	JB	H-131	6.3 CT	2(2.5)	2500	FB
H-122	2.5	20(26)	10 KV	KB	H-132	6.3 CT 6.3 CT	6(7) 6(7)	2500	JA
H-125	5	10(12)	10 KV	KB	H-133	6.3 CT	7(8)	2500	HB
H-130	6.3 CT	.6(.75)	1500	AJ	H-134	6.3 CT	10(12)	2500	HA

Typical Filament Transformers

Pri: 105/115/210/220V except H-130 (115) and H-131 (115/220) 50/60 Cyc.

Typical Filter Reactors



Type No.	MIL Type	Ind. @ MA Hys.	DC	Ind. @ MA Hys.	DC	Ind. @ MA Hys.	DC	Ind. @ MA Hys.	DC	Res. Ohms	Max. DCV Ch. Input	Test V. RMS	Case
H-71	TF1RX04FB	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	TF1RX04HB	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	TF1RX04KB	11	200	10	230	8.5	250	6.5	300	90	700	2500	KB
H-77	TF1RX04MB	10	300	9	350	8	390	6.5	435	60	2000	5500	MB
H-79	TF1RX04YY	7	800	6.5	900	6	1000	5.5	1250	20	3000	9000	7x7x8

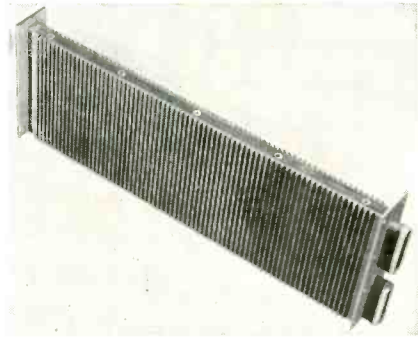
And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION
150 Varick Street, New York 13, N. Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

New Products

HEAT EXCHANGERS

Cold-plate heat exchangers for aircraft, ground support equipment, airborne, and industrial and electronic applications. Unit uses corrugated aluminum strips brazed to the face plates to provide conductive media for



the flow of liquid or gaseous coolants. The max. air pressure drop (corrected to NASA std. cond.) is 3.46 in. H_2O at a rated air flow of 2 lbs. per min. at an amb. temp. of 160°F. Min. heat removal capacity is 8.5 BTU per min. (150 w). Horkey-Moore Associates, 24660 Crenshaw Blvd., Torrance, Calif.

Circle 238 on Inquiry Card

TUBE TESTER

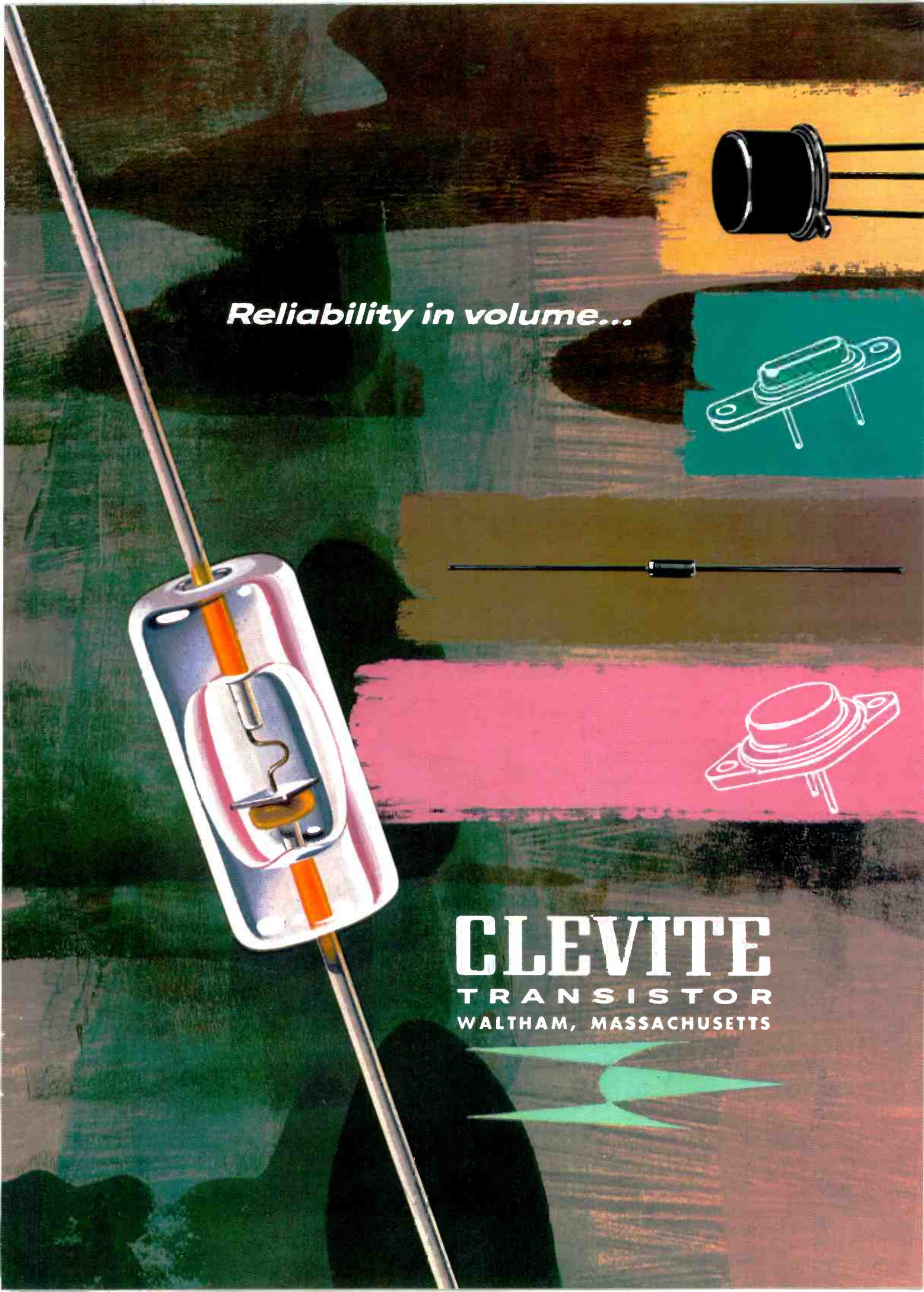
Tube tester, Model 211, is a flexible, obsolescence-proof tube tester. It checks all octal, loctal, 9-pin and miniature tubes for shorts, leakages, opens and intermittents as well as for quality. Shorts or leakages between any two elements in the tube can be detected. It checks magic eye, and voltage regulator tubes as well. It checks each section of multi-purpose

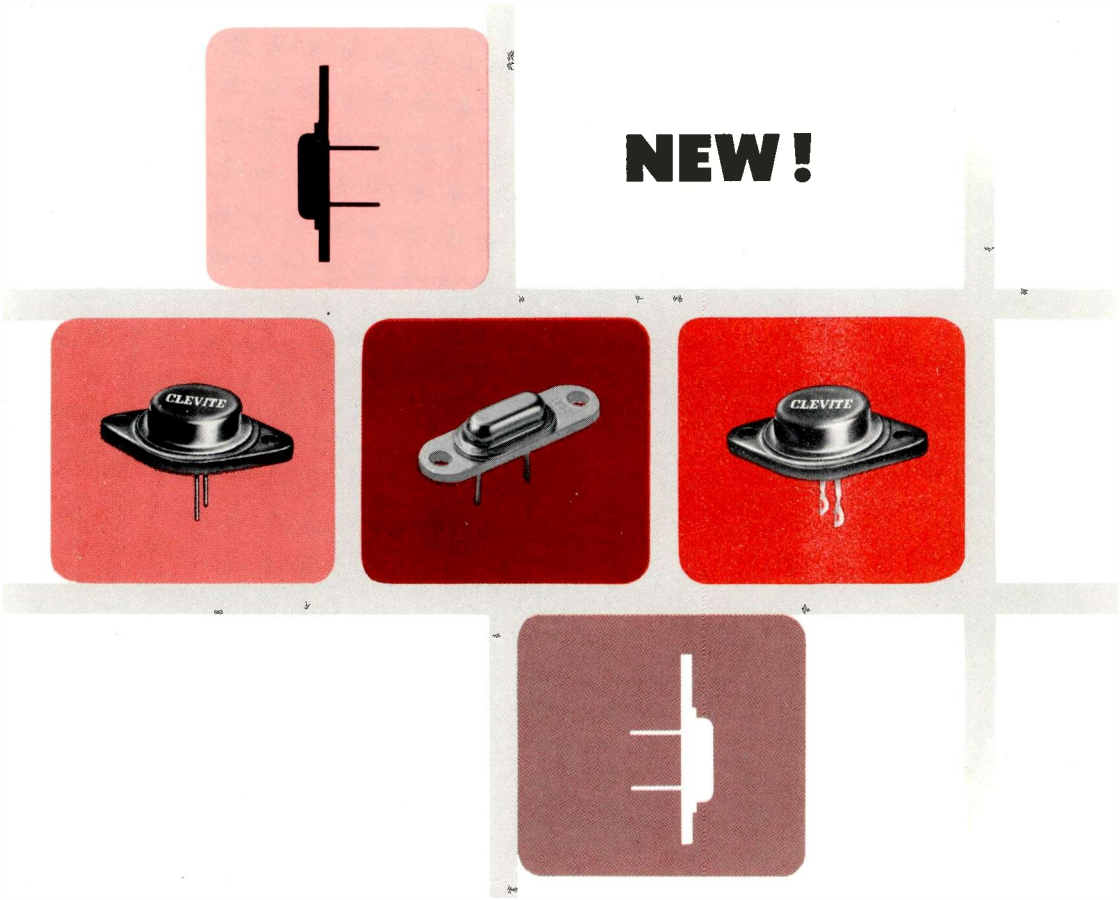
tubes separately. Quality is indicated directly on a 2 color meter dial using the standard emission test. It uses an etched panel and a high impact bakelite case. Electronic Measurements Corp., 625 Broadway, New York 12, N. Y.

Circle 239 on Inquiry Card

Circle 93 on Inquiry Card

Circle 94 on Inquiry Card ——→


Reliability in volume...
CLEVITE
TRANSISTOR
WALTHAM, MASSACHUSETTS



ADVANCED DESIGN POWER TRANSISTORS FROM CLEVITE

Three new lines of germanium power transistors by Clevite feature new advances in controlled gain spread, fully specified collector-to-emitter voltage characteristics and low current leakage — even at maximum voltages and high temperatures.

The new 8 ampere switching series can be used to replace the older, more costly ring-emitter types in 3 to 8 ampere service.

The new 25 ampere switching type offers exceptionally low saturation voltage and is available with either pin terminals or solder lugs.

The new Spacesaver design not only affords important savings in space and weight, but its significantly improved frequency response means higher audio fidelity, faster switching and better performance in regulated power supply applications. Its low base resistance gives lower input impedance for equal power gain and lower saturation resistance, resulting in lower "switched-on" voltage drop. Lower cut off current results in better temperature stability in direct coupled circuits and a higher "switched-off" impedance.

CLEVITE NOW OFFERS THESE COMPLETE LINES

Switching Types	Amplifier Types
5 ampere	2 watt
8 ampere	4 watt
15 ampere	2 watt Spacesaver
25 ampere	
3 ampere Spacesaver	

All Clevite germanium power transistors are designed for low thermal resistance, low base input voltage, low saturation voltage and superior current gain.

For latest data and prices or application assistance, write for Bulletin 60 . . .

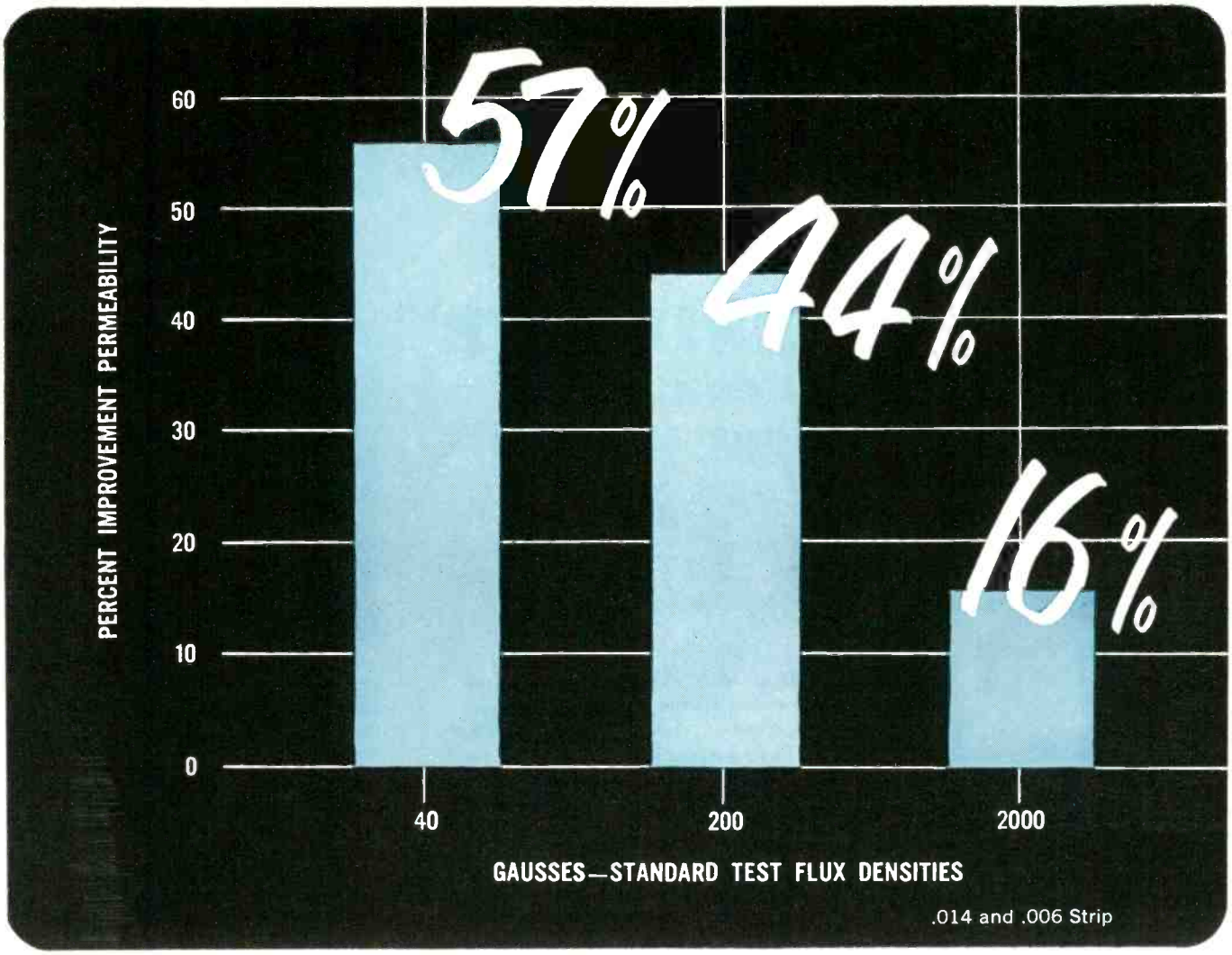
A DIVISION OF CLEVITE CORPORATION

Reliability in volume . . .

CLEVITE TRANSISTOR

254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330

Experience**—the added alloy in **A-L Electrical Steels



Greater permeability for Allegheny Ludlum's AL-4750...and it's *guaranteed*

promises more consistency, higher predictability for magnetic cores

AL-4750 nickel-iron strip now has higher *guaranteed* permeability values than ever before. For example, at 40 induction gausses AL-4750 now has 57% higher permeability than in the past, using the standard flux density test.

This greater permeability means better consistency and predictability for magnetic core users . . . and allows careful, high performance design.

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. EI-5.*

7491

ALLEGHENY LUDLUM

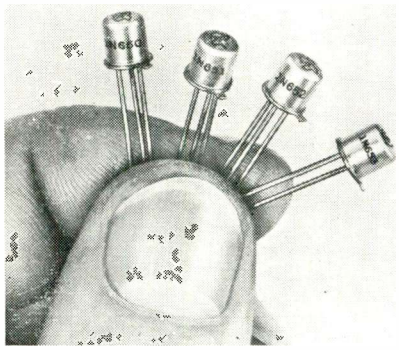
STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4

New Products

TUNNEL DIODES

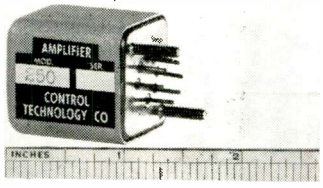
Gallium arsenide tunnel diodes, 4 units designated the 1N650 Series. The tunnel diodes are for applications in high speed computer circuitry such as logic circuits, amplifiers, oscillators, and general computer purposes. The Series, in JEDEC TO-18 case, provides peak currents up to 10 ma ±2%, large voltage swings, highest peak to valley ratios (greater than 15 to 1), guaranteed forward voltages up to 1.1 v ±5% and high temp. operation to 150°C. Texas Instruments Incorporated, P.O. Box 312, Dallas, Tex.



Circle 240 on Inquiry Card

ISOLATION AMPLIFIER

Isolation Amplifier, Model 250, is 1 x 1 x 1⅛ in. high. Input impedance is 200,000 ohms and output impedance is 1,000 ohms. Gain of amplifier is unity. Amplifier uses silicon transistors and operates on standard 28 vdc power. Internal signal limiting prevents overdrive or phase shift for high input signals. Operates from −55 to 125°C and under MIL E 5272 environmentals. Isolated input and isolated output make this unit ideal for computer, servo, and automation applications. Control Technology Co., 1186 Broadway, New York 1, N. Y.



Circle 241 on Inquiry Card

We'll make ONE or ONE MILLION for you

Regardless of the nature of the piece or of the quantity, it is usually good business to let us fabricate your laminated plastics part or parts.

We have the material in stock or can make it quickly, including any modifications necessary to improve it for your purpose. You save time. You have no decisions to make on tolerances, dimensional allowances, clearances on tools, or speeds and feeds to use. Spoilage is not your concern.

Since we make our own special tools, dies or jigs, they are our design problems, not yours. It may be possible to save money by molded-laminated or molded-macerated procedures. We'll tell you.

All you have to do is pay the bill. And this is painless because special tools and skills keep it low. Call your Synthane representative — in any principal city—for a quotation or write Synthane Corp., 11 River Road, Oaks, Pa.

You furnish the print—we'll furnish the part

SYNTHANE CORPORATION OAKS, PENNA.

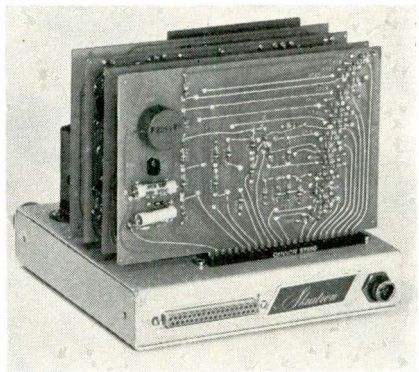
Sheets • Rods • Tubes • Fabricated Parts
Molded-laminated • Molded-macerated

Circle 98 on Inquiry Card

New Products

CHARACTER GENERATORS

The Series 2000 Alphadyne Character Generator supplies all 10 digits, 9 letters and 3 symbols. All transistorized, the unit is approx. 6 x 6 x 6 in. and consumes less than 5 w. Characters can be written as fast as



40,000/sec. The Series 3000 Alphadyne Character Generator provides full alpha-numeric—all 10 digits, all 26 letters and 4 symbols. This series is also completely transistorized, is approx. 6 x 6 x 6 in. and consumes less than 5 w. Characters can be written as fast at 17,000/sec. Skiatron Electronics and Television Corp., 180 Varick St., New York 14, N. Y.

Circle 242 on Inquiry Card

DC-DC CONVERTER

Unit exceeds requirements of most telemetry applications for regulation, output noise, and efficiency of 250, 150 and 5 v power supplies. It replaces the 3 power supplies formerly needed for airborne systems and furnishes excitation to the sub-carrier oscillators and telemetry transmitters as well as a calibration voltage. It offers

70% min. eff. at 24-32 vdc input with output regulation of ±3% at 250 vdc (250 ma), ±1.5% at 150 vdc (100 ma) and ±0.1% at 5 vdc (100 ma). Temco Aircraft Corp., P. O. Box 6191, Dallas, Texas.

Circle 243 on Inquiry Card

Bourns Trimpot®
Puts the Proof in Humidity-Proof

NUMBER 5—RELIABILITY SERIES

Plunging a potentiometer into near-boiling water is just one of the ways Bourns puts the proof in humidity-proof. Every Trimpot unit made takes this 60-second bath with the water simmering at 90°C. Air expanded by the heat creates four pounds of pressure inside the potentiometer—enough to cause bubbles—if it leaks. Only if the unit is completely leak-free does it pass the test.

Bourns humidity proofing starts at the beginning—with original design and selection of materials. The plastic chosen for Trimpot cases, for example, displays the unusual properties of high insulation resistance and extremely low moisture absorption.

Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot does more than "resist" moisture; it keeps moisture out.

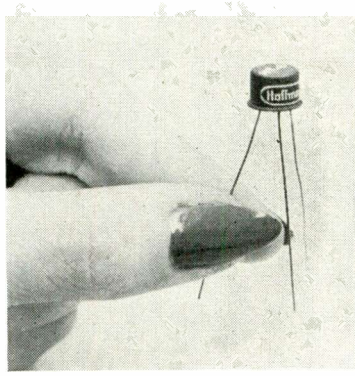
For more information about the industry's largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.

Exclusive manufacturers of Trimpot®, Trimit®, and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

New Products

TUNNEL DIODES

Line of silicon tunnel diodes are commercially available for "breadboarding." They are designed to operate in a temp. range of —85°C to +200°C. 10 types, HT-1 through HT-10 are offered. Differences in types

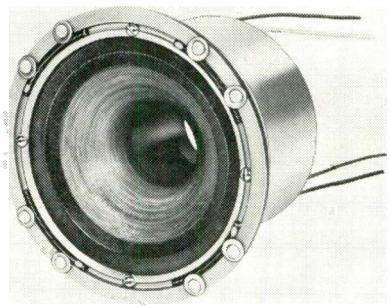


are peak current and negative resistance. Typical negative resistance is 220 down to 39 ohms. Peak voltage is 65 mv and valley voltage is 420 mv at peak currents ranging from 1.0 to 5.6 ma. Min. peak-to-valley ratio is 3.5:1. Each diode is furnished with an 8½ x 11 in. voltage/current plot. They are housed in JEDEC TO-5 envelopes. Semiconductor Div., Hoffman Electronics Corp., 1001 Arden Dr., El Monte, Calif.

Circle 244 on Inquiry Card

ENCAPSULATED YOKE

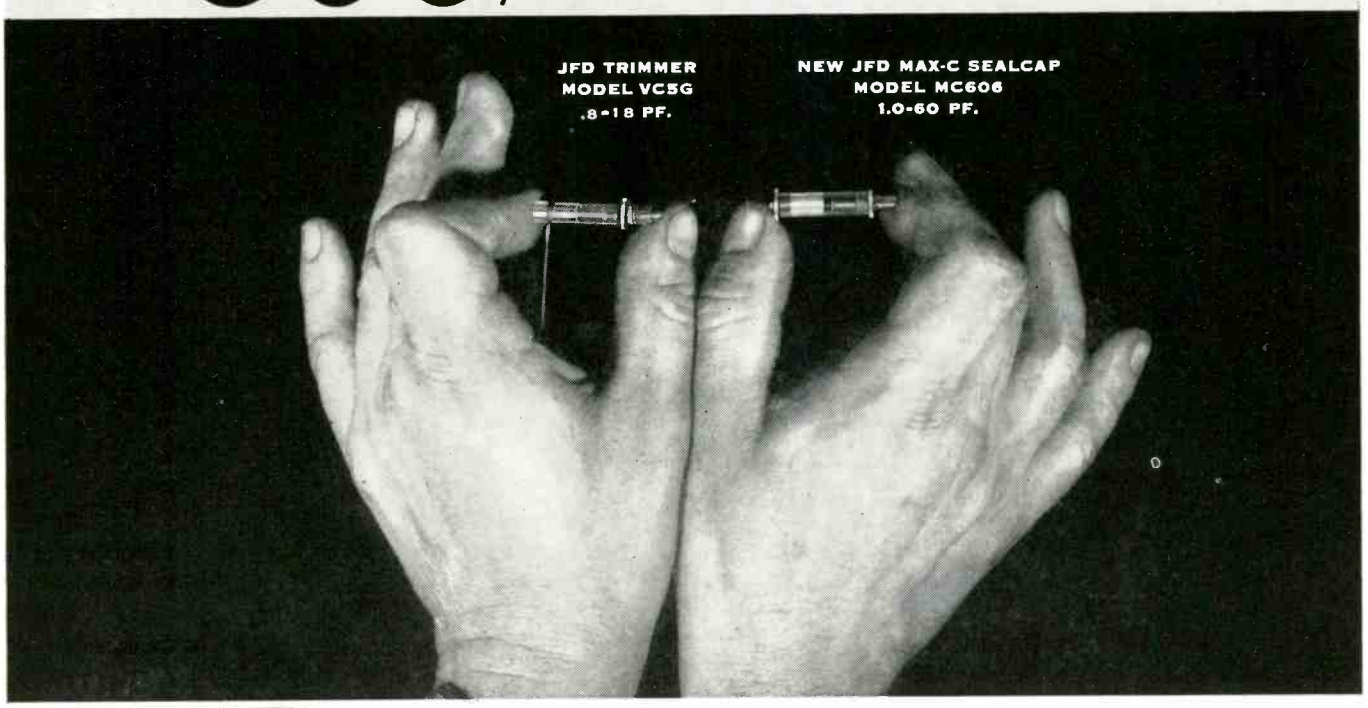
Epoxy encapsulated ferrite core deflection yoke for ⅞ in. neck dia. 70° C.R. tubes. For transistorized military and industrial TV raster and similar applications, Type Y59 has single ended coils of high inductance to resistance ratio. Flat face CRT pincushion distortion is corrected by 4



anti-pincushion magnets without linearity deterioration. Magnets are preadjusted and pre-aligned. Impedance range from 110 μh up. Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill.

Circle 245 on Inquiry Card

300% INCREASE IN RANGE NO INCREASE IN SIZE!



JFD MAX-C® MINIATURE TRIMMER SEALCAP®

Now you can cut precious inches and ounces from your assemblies with space-saving, weight-saving MAX-C Sealcaps.

The surprising increase in range of the Max C trimmer capacitor is obtained by embedding the electrode band in the glass cylinder. This design provides the thin dielectric required for a large capacitance range while retaining the ruggedness and mechanical strength of a heavy wall glass tube.

Included in the Max C design is the Sealcap construction which provides the additional stability safeguard of a completely sealed interior.

MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

Model	Min.	Max. (PF)	Distance Beyond Panel	Maximum Diameter
MC601	1.0	14.0	29/64"	5/16"
MC603	1.0	28.0	11/16"	5/16"
MC604	1.0	42.0	29/32"	5/16"
MC606	1.0	60.0	1 5/32"	5/16"
MC609	1.0	90.0	1 3/4"	5/16"

The Max C retains all the advantages of glass tubular trimmers: Working voltage of 1000 VDC, Insulation Resistance of 10^6 megohms, Q of 500 at 1MC, operating temperature range of −55°C to +125°C, and high stability. It meets or exceeds the applicable performance and environmental requirements of Mil-C-14409A.

Escape from the design limitations of conventional trimmers by specifying JFD MAX-C Sealcaps for your current and projected circuitry. Write today for the complete catalog describing MAX-C Sealcaps and other JFD precision electronic components. Other JFD components are...

FOR PANEL MOUNTS AND PRINTED CIRCUIT MOUNTING

SEAL CAP TRIMMER CAPACITORS	MINIATURE TRIMMER CAPACITORS
GLASS OR QUARTZ DIELECTRIC	LUMPED CONSTANT DELAY LINES
DISTRIBUTED CONSTANT DELAY LINES	PULSE FORMING NETWORKS
FILTERS	METALIZED INDUCTORS
LC TUNERS	

Detailed data sheets on any of these components selected from the extensive J.F.D. line are yours for the asking. Our engineering staff is at your service for consultation on your particular application.

Pioneers in electronics since 1929

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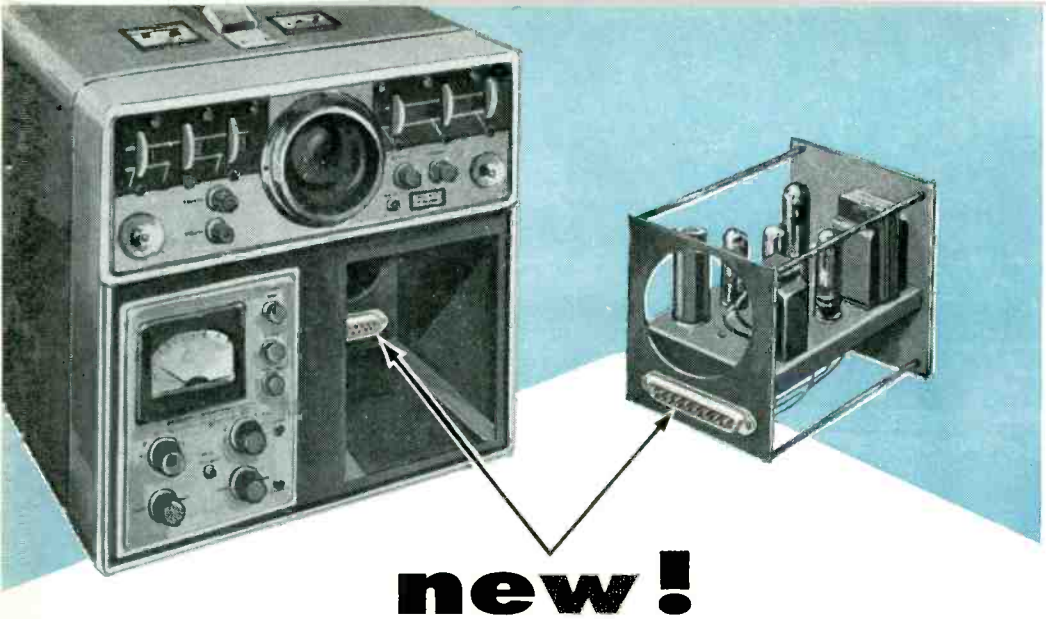
15 Moore Street, New York, N. Y.

Circle 102 on Inquiry Card



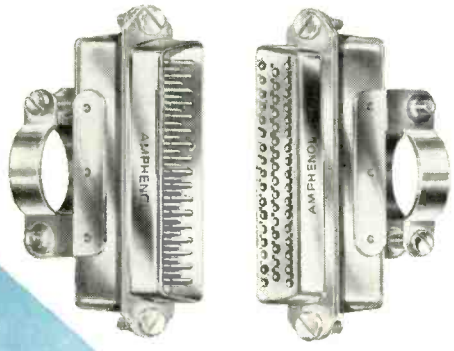
new!

Min Rac 17

miniature rack & panel connectors with POKE HOME® contacts

Solve space, weight and size problems with AMPHENOL's new Min Rac 17 connectors, true miniatures with the "Big Plus" advantage of Poke Home contacts! Min Rac 17's are rack & panel connectors ideally suited for today's compact chassis designs, connectors half the size and weight of standards, delivering full size efficiency. And with the patented Poke Home contact concept (U.S. Pat. 2,419,018), Min Rac 17's are easily, reliably assembled—contacts are crimped or soldered outside the connector body, then "poked home" for assembly.

Min Rac 17's are available in 9, 15, 25, 37 and 50 contacts in rack & panel, cable-to-chassis and cable-to-cable designs. Contacts are gold plated. Shells may be ordered with clear chromate or gold iridite finish.



These remarkable connectors are available now—write for full catalog!

AMPHENOL CONNECTOR DIVISION
1830 S. 54th AVE., CHICAGO 50, ILLINOIS
Amphenol-Borg Electronics Corporation

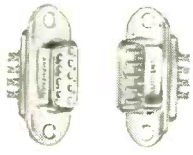
Circle 125 on Inquiry Card

Another New AMPHENOL CONNECTOR LINE

is now Available through your

Authorized Amphenol Distributor

Min Rac 17



AMPHENOL DISTRIBUTOR DIVISION
Amphenol-Borg Electronic Corporation
BROADVIEW, ILLINOIS

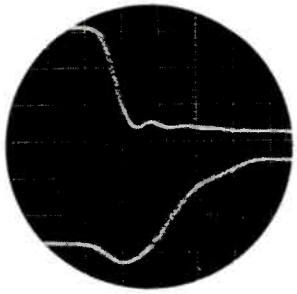
Circle 126 on Inquiry Card

USE THIS NEW hp 185A 500 MC oscilloscope

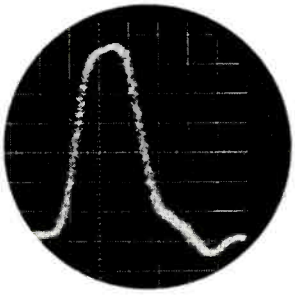
now for these important measurements:

- Analyze millimicrosecond pulses
- Measure transistor response time
- Make fractional millimicrosecond time comparisons
- Measure diode switching time
- Determine pulse jitter
- Make permanent X-Y plots
- Measure memory-unit switching
- Measure uhf voltage amplitude

hp 185A Sampling Oscilloscope with
hp 187A Dual Trace Amplifier



Bright, clear dual pulse presentation on *-hp-* 185A's big 5" scope face. Top trace shows pulse from mercury pulser applied to 2N1385 mesa transistor. Bottom trace shows responding turn-on of transistor. Dip in bottom trace at start of turn-on results from capacitance. Scope sweep speed is 1 mμsec/cm.



Brilliant, steady trace of a 2 millimicrosecond pulse on the 185A 5AQP cathode ray tube face.

6362

IMPORTANT FEATURES: Less than 0.7 mμsec rise time. 500 MC pass band; bright steady traces even at rep rates down to 50 cps. Sensitivity 10 mv/cm to 200 mv/cm; vernier increases sensitivity to 3 mv/cm. Sweep times 10 mμsec/cm to 100 mμsec/cm with expander to 0.1 mμsec. Front panel delayed sync pulse for triggering circuits under test. Dual channel input. 10 cm vertical display. High sensitivity, wide dynamic range. 100,000 ohm probe minimizes circuit disturbance. X-Y recorder output. Time-amplitude calibrators, beam finder, panel similar to conventional scopes.

FOR COMPLETE DETAILS of this totally new, easy-to-use instrument, call your hp representative or write direct.

hp 185A 500 MC Oscilloscope, $2,000.00
hp 187A Dual Trace (plug-in) Amplifier, $1,000.00

Data subject to change without notice. Prices f.o.b. factory

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1026B Page Mill Road, Palo Alto, California, U.S.A.
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Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

hp over 300 fast, accurate measuring instruments

Circle 104 on Inquiry Card

New Products

CAPACITORS

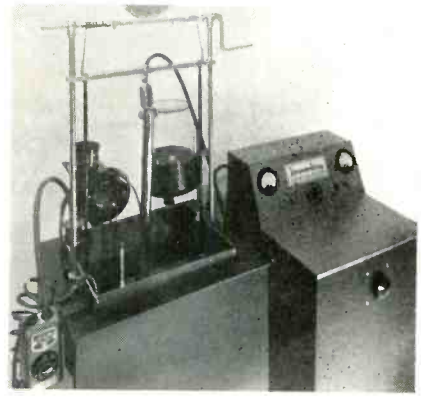
Precision film capacitors with good characteristics over the −55°C to 125°C temp. range. Capacitance change is less than 1%. From 25°C to 125°C the capacitance change is less than +0.3% and zero +30 ppm

/°C temp. coefficient, which remains stable with repeated temp. cycling. Insulation resistance is greater than 10^{13} ohms. Dielectric absorption is less than 0.0003 (measured with a charging voltage of 44 v. for 30 sec.). Dissipation factor remains less than 0.0003 over entire temp. range and a wide range of frequencies. Standard tolerance 2%. Component Research Co., Inc., 3019 S. Orange Dr., Los Angeles 16, Calif.

Circle 248 on Inquiry Card

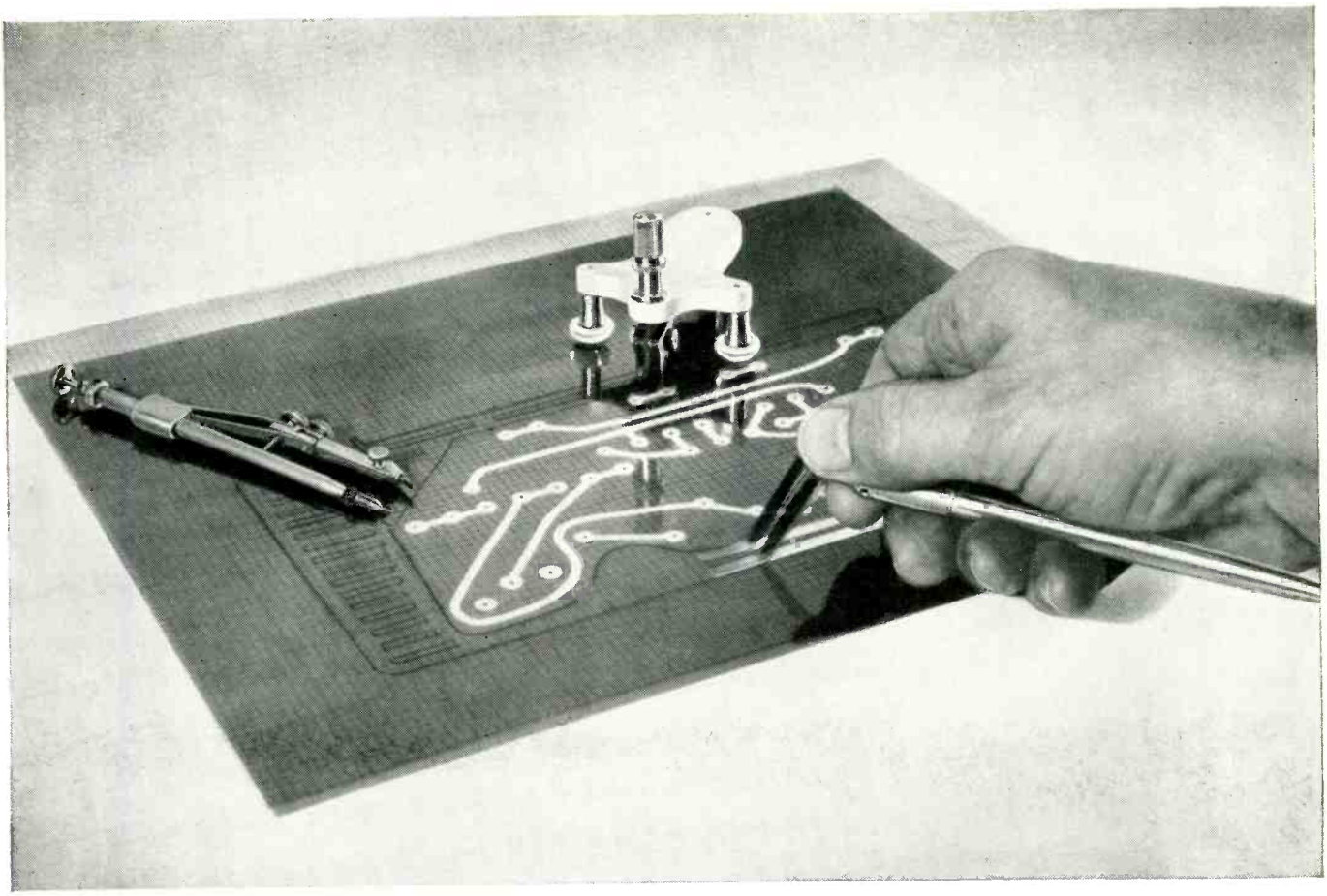
ELECTROPLATERS

Three new models in tool room electroplaters feature an attachment which reduces set-up and stop-off time and insures precision plating. The attachment is a hoist which raises and lowers a plastic coated table into a self-controlled hard chrome plating solution. This table holds the parts



and acts as a current deflector preventing buildup on ends and edges of the parts being plated. The models are K-50, K-100 and K-250. Krome-King Div., National File Co., 530 N. Cedar St., Lansing 12, Mich.

Circle 249 on Inquiry Card



CUT 'N' STRIP:
THE MODERN WAY TO MAKE PRINTED CIRCUIT MASTERS

It's fast, easy, remarkably accurate with STABILENE® Film and specially-designed tools by K&E

The Cut 'N' Strip method is one of today's most efficient ways of making masters. Pads and runs are dependably accurate—there's no ink to run, no tape to stretch, pile up, shrink, or pull away on curves. What's more, Cut 'N' Strip eliminates time-consuming photographic steps—in some cases, you can skip *all* intermediate photography! Here's all you do in an average Cut 'N' Strip operation . . .

1. Draw Your Rough Layout in pencil on the *back* of a sheet of STABILENE Cut 'N' Strip Film, placed face down on a grid underlay. The film is transparent, so you don't need a light table. The pencil side of STABILENE has the famous K&E "Engineered Surface" — easy to draw on, cleanly erasable. Erase and redraw until layout is correct; then . . .

2. Turn the Sheet Face Up and cut the lands and runs in the film's transparent, but actinically opaque, red coating. Two unique K&E instruments are used: the first, a compass-like cutter which scores both lands and drill centers in a simple one-two operation, from a *single* tool position; the other, a double-bladed precision cutter, adjustable to various path widths, specially designed for cutting circuit runs.

3. Peel Off the Red Coating with a knife or tweezers. For a *negative*, peel *inside* the outlines you've cut. For a *positive* peel away everything *but* the circuit paths! Errors can be quickly repaired with special K&E opaquing fluid. Simply touch the line, let it dry, then cut and peel again. STABILENE Cut 'N' Strip Film cuts clean, yields sharp outlines for crisp reproduction, can be exposed directly onto the laminate. And, STABILENE'S size-holding stability is unsurpassed.

K&E Supplies Everything Needed for the Cut 'N' Strip technique: STABILENE Cut 'N' Strip Film No. NR136-2 with pencil back and red strip-off front, touch-up fluid No. CS 3056, and a complete layout tool kit, No. 3322. For more information on Cut 'N' Strip and other techniques, plus free samples of STABILENE, clip and mail the coupon below . . . today.

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NEW YORK • HOBOKEN, N. J. • DETROIT • CHICAGO
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KEUFFEL & ESSER CO., Dept. EI-5 Hoboken, N. J.

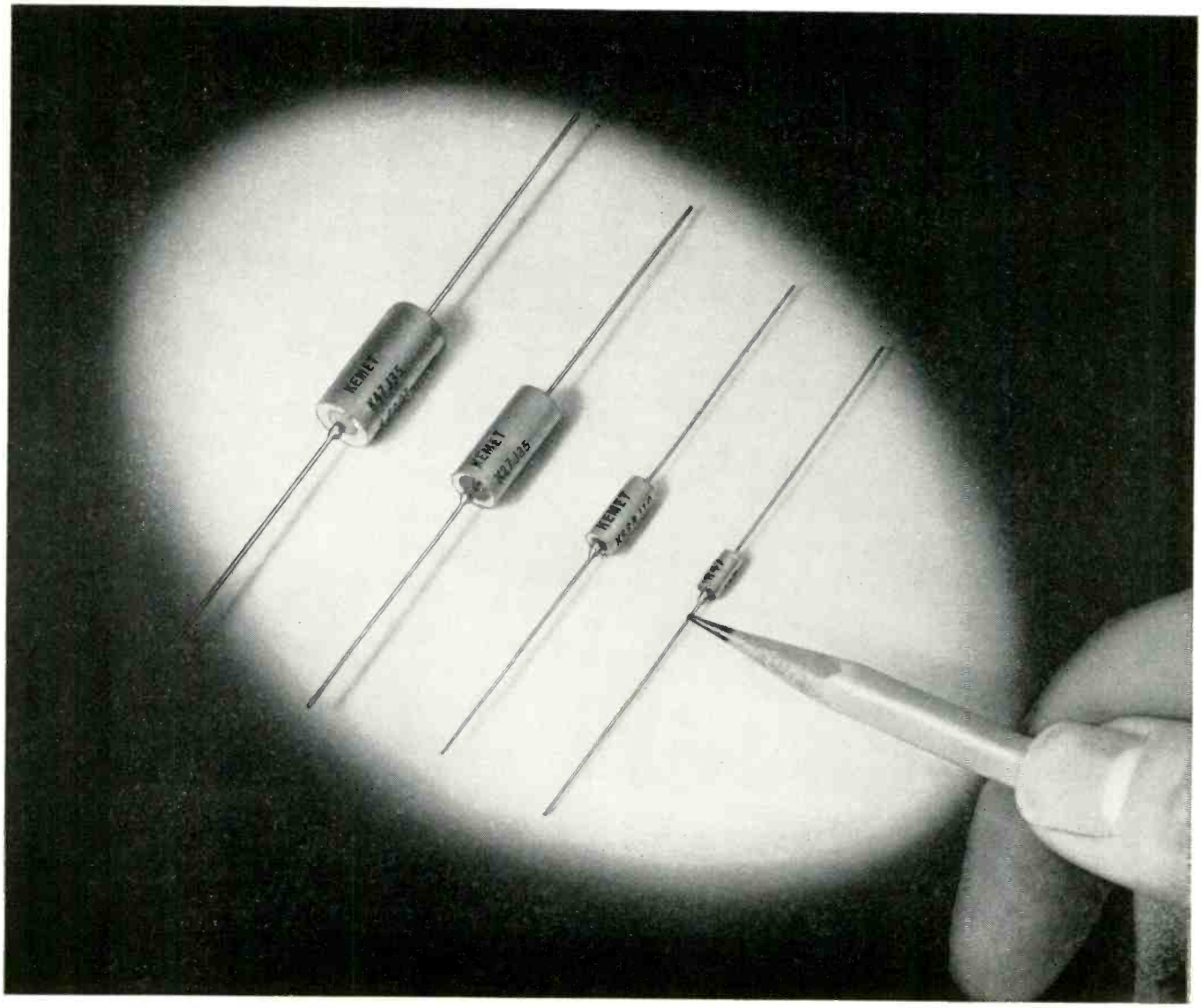
Please send me free samples of STABILENE® Cut 'N' Strip Film, plus K&E brochure "Preparing Printed Circuits on STABILENE Film"

Name & Title_____

Company & Address_____

1510

Circle 106 on Inquiry Card



KEMET COMPANY EXPANDS ITS SOLID TANTALUM CAPACITOR LINE!

These new, smaller sized J-series capacitors — an addition to the proved and accepted H-series solid tantalum line—comply with and in many instances exceed the requirements of MIL-C-26655 (USAF).

For example, these capacitors are available in capacitances up to 22 microfarads at working voltages of 50 volts at 85 degrees C. At 125 degrees C., they operate at two-thirds of the 85 degree C. working voltage. Available with or without insulating sleeves, the new J-series capacitors maintain the excellent low leakage current characteristics associated with the H-series line, even though they occupy about ⅓ of the space of the earlier types.

These new capacitor designs are made possible by the advanced research facilities available at Union Carbide Corporation, plus the fact that "Kemet" is not dependent on other suppliers for the mining or processing of tantalum.

For literature, write Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION CARBIDE

Circle 107 on Inquiry Card

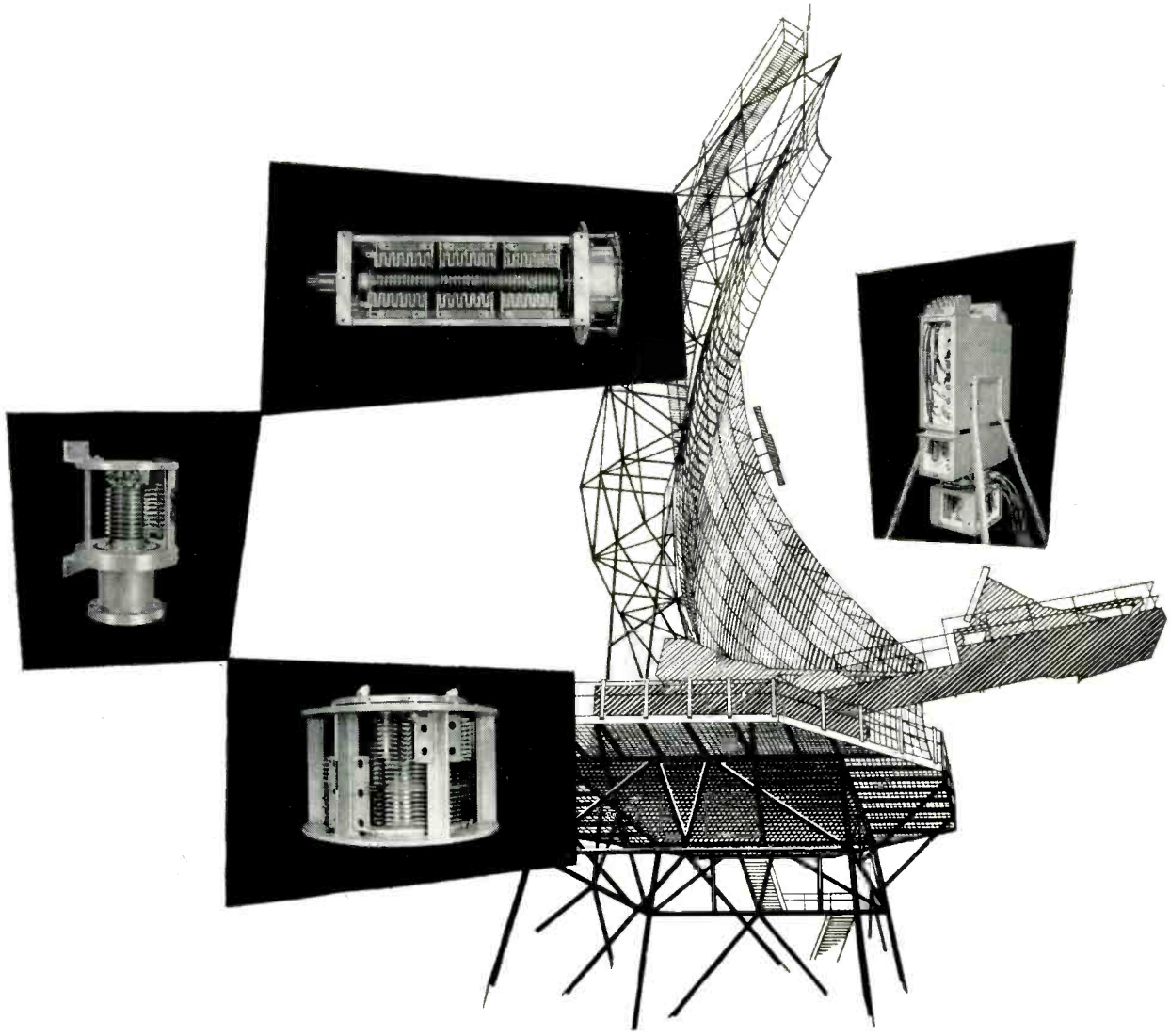
Thousands of Slip Ring Assemblies for Rotating Radar Antenna Systems

That's the Breeze Corporations' experience record in designing and producing slip ring assemblies for radar applications ranging from small shipboard and airborne antenna mounts to five-story-high giants used in ground early warning systems. With this experience record behind it, the Breeze organization is well-staffed and equipped to design and produce a slip ring assembly for any radar application.

Because many of these applications require assemblies having similar size and operating characteristics, Breeze offers a line of standard assemblies with ring envelope diameters from 1" through 10½". These are flat, stacked assemblies of fabricated construction and are built from off-the-shelf components for rapid delivery at reduced costs.

Breeze also produces flat, concentric and cylindrical custom slip ring assemblies for radar application requirements which include general purpose control and power, radio frequency and video, high voltage and switching. Depending upon the application, Breeze custom assemblies are made by any of the basic methods of production: fabricated, electroplated and plastic molded.

You'll want a copy of the new 28-page Catalog 66SR which describes and provides operating data on a wide range of Breeze custom units and drawings and specifications of all standard slip ring assemblies.



BREEZE MARK

BREEZE CORPORATIONS, INC.

700 Liberty Avenue, Union, New Jersey • Telephone: MUrdock 6-4000

Manufacturers of electrical, electro-mechanical and hydro-mechanical components and systems and fabricated metal products.

Circle 108 on Inquiry Card

New Products

INDICATOR

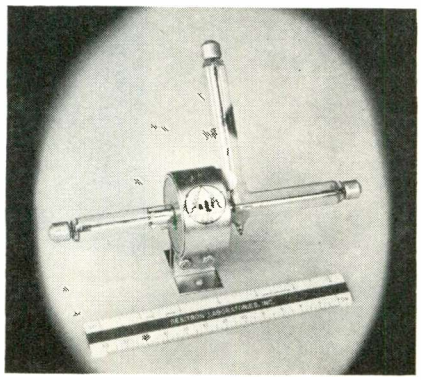
Miniature elapsed time indicator, Model 1440, uses a decimal type counter with large characters for readout. It presents only three digits at a time and makes its presentation on a single reading line. Each of the

three white numerals is ⅛ in. high. Indicator provides readings from 000 to 999 hrs. with return to 000 in one-hour increments. Overall dia. is 0.670 in. Length is 1⅞ in. and weight is 1.8 oz. Input is 115 v at 400 CPS, single phase. Current is 10 ma. It meets Mil-E-5272. Bowmar Instrument Corp., 8000 Bluffton Rd., Fort Wayne, Indiana.

Circle 250 on Inquiry Card

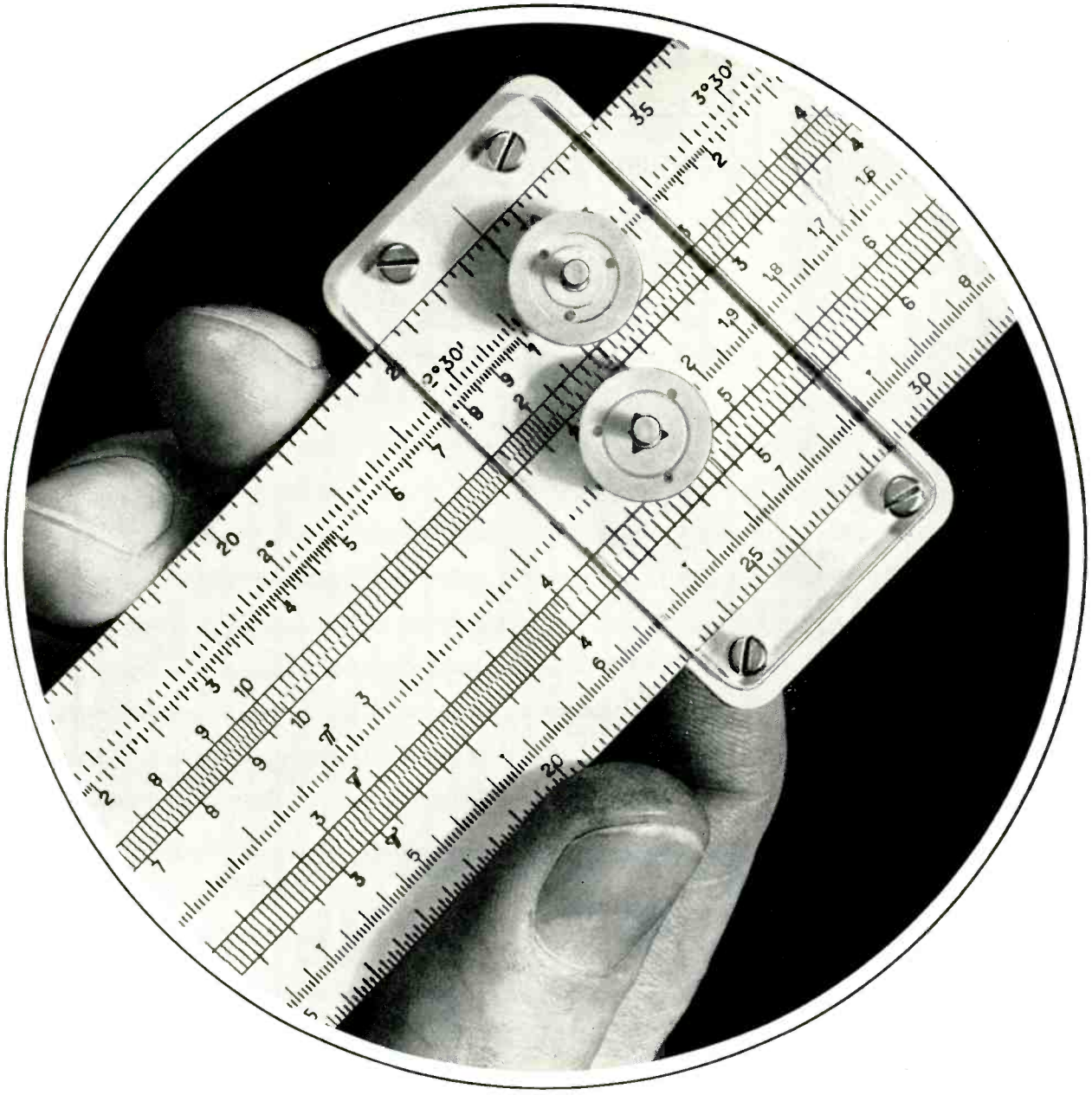
VACUUM RELAY

High voltage, high vacuum relay, Model 35 can switch up to 35pkv, ac or dc in air and is ideally suited for switching high-powered radar pulse networks, dielectric testers, high voltage power supplies, x-ray apparatus,



etc. This standard model is supplied with a 24 vdc actuating coil. Actuating coils with other voltage requirements can be supplied. Resistron Laboratories, Inc., 2908 Nebraska Ave., Santa Monica, Calif.

Circle 251 on Inquiry Card



NOW MINIATURE DISC CATHODES HAVE FAST WARMUP TOO

The vital difference between the miniature (.090 in. OD shank) disc cathode you see above and the one you have been using is the triangular hole in the ceramic. The cathode shank touches the ceramic at only three points. Actually there is 60% less contact area than with round hole ceramics. So heat doesn't escape as fast. The cathode warms up faster. The TV picture comes on quicker.

Superior introduced the triangular hole .490-in.-dia. ceramics for miniature disc cathodes just a year ago. Now this feature is being offered in miniature disc cathodes with .365-in.-dia. ceramics, too.

The triangular hole grips the cathode shank firmly and locks it in place. Embosses above and below the ceramic prevent both rotation and longitudinal movement. A shadow groove in the ceramic is standard to protect against sublimation leakage.

Write for dimensional drawings and samples. Superior Tube Company, 2502 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

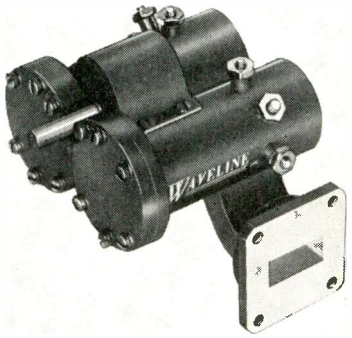
NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts

New Products

WAVEGUIDE FILTERS

Line of microwave waveguide filters. Standard configurations are available for band pass, high pass, low pass, band reject, and other types. Shown is a tunable two section dual TE_{111} mode preselector filter designated for operation in the 8500 to 9600 MC

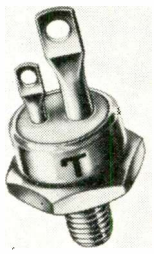


range. A 30 MC nominal bandwidth is provided at an insertion loss of 1.8 db max. and a rejection of 55 db minimum at F_o +60 MC and 40 db. minimum at F_o −60 MC. Waveline Inc., Caldwell, N. J.

Circle 253 on Inquiry Card

CONTROLLED RECTIFIERS

Line of pnpn controlled rectifiers and switches includes: a bi-stable silicon computer element, the Transwitch, which can be turned off with a gate current; and silicon controlled rectifiers in both the 7/16 in. hex and the 11/16 in hex base packages.



Current range of the Transwitch is 1-50 ma. It eliminates the need for two transistor "flip-flop" design, reducing size and number of components. Controlled rectifiers can replace thyratrons and magnetic amplifiers. Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

Circle 252 on Inquiry Card

new freedom for TV-IF designers thanks to 6 new **Amperex AMPLIFRAME*** tubes

NOW all AMPLIFRAME IF tubes are automatically mass-produced for maximum uniformity and lower cost

NOW Ampliframe tubes will provide 55% higher gain-bandwidth product than conventional IF tubes

NOW compare the performance of Ampliframe tubes with conventional IF types and consider what this added design freedom means to you

IF	GAIN	BANDWIDTH
3 x AMPLIFRAME	3500	4.5 mc
3 x Conventional	3500	2.5 mc
2 x AMPLIFRAME	1200	2.5 mc
2 x Conventional	350	2.5 mc

OUTSTANDING FEATURES SHARED BY THE 6 NEW AMPEREX TV-IF AMPLIFRAME TUBES

- 9-pin construction; 2 cathode leads
- internally shielded
- low microphonics
- internally neutralized screen grid

*AMPLIFRAME, a new concept in electron tubes, designed and mass produced exclusively by Amperex, incorporate the unique frame grid...the closest approach to the ideal "Physicists' grid"–electrical characteristics but no physical dimensions. The frame grid results in: **• higher transconductance per milliampere • tighter G_m and plate current tolerance • low transit time • low capacitances • lower microphonics • rugged construction**

specifications

AMPLIFRAME Type 6EJ7 sharp cut-off pentode
transconductance—15,000 micromhos at 10mA
grid voltage for 625 micromhos: 9.5 V
heater current 300 mA; heater voltage 6.3V
low capacitances—input 10 $\mu\mu$f; output 3 $\mu\mu$f; plate to control grid <0.005 $\mu\mu$f
AMPLIFRAME Type 4EJ7
controlled warmup series-version of 6EJ7
heater current 450 mA; heater voltage 4.4 V
AMPLIFRAME Type 3EJ7
controlled warmup series-version of 6EJ7
heater current 600 mA; heater voltage 3.4 V

AMPLIFRAME Type 6EH7 remote cut-off pentode
transconductance—12,500 micromhos at 12mA
heater current 300 mA; heater voltage 6.3 V
AMPLIFRAME Type 4EH7
controlled warmup series-version of 6EH7
heater current 450 mA; heater voltage 4.4 V
AMPLIFRAME Type 3EH7
controlled warmup series-version of 6EH7
heater current 600 mA; heater voltage 3.4 V

ask Amperex

for Ampliframe applications assistance on RF and IF TV circuitry.

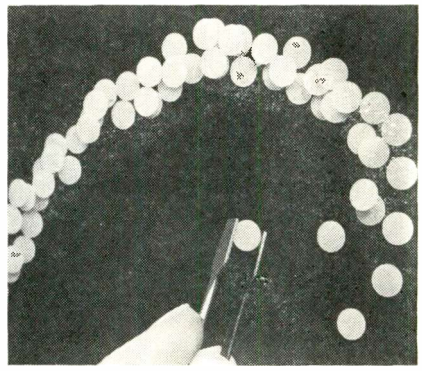
AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long Island, N. Y.

Circle 113 on Inquiry Card

New Products

SEMICONDUCTOR GETTERS

Moisture getters for semiconductors comprise the initial volume application of the company's porous, or "thirsty" glass. Getters are placed in semiconductor enclosures because

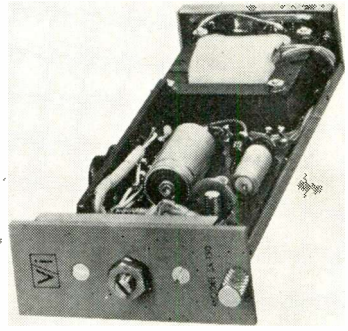


of a tendency of such devices to become less efficient in the presence of moisture, even if present in minute quantities. The "thirsty" glass that is used contains billions of sub-microscopic holes that have an average dia. of about 40 angstrom units, or 1/6 of one-millionth of an in. One pore would have to be enlarged about 12,000 times to admit a human hair. Corning Glass Works, Corning, N. Y.

Circle 254 on Inquiry Card

STRAIN GAGE POWER SUPPLY

Isolated strain gage power supply, Model SR 150. This solid-state supply features 0.1% regulation. The output is floating, at an internal impedance of less than 0.2 ohm. Noise to ground is less than 10 microvolts peak to peak, when measured with a



350 ohm bridge. The leakage resistance is in excess of 10,000 megohms. It has all desired qualities of a transducer supply. Video Instruments Co., Inc., 3002 Pennsylvania Ave., Santa Monica, Calif.

Circle 255 on Inquiry Card

Your most productive dollars can be life insurance dollars!

The dollars you invest in Business Life Insurance are *working dollars.* They can *make* money for you and they can *save* money for you.

An Ætna Life plan can increase the value of your business estate by protecting against the shrinkage due to estate taxes and transfer expense, for example. It can provide working capital when you need it most. It is the most *economical* way to guarantee continuity and management stability of your business if there is a death in the ownership. It can attract and hold good men.

Ætna Life's exclusive Business Planning Service will make sure your Business Life Insurance dollars are working to capacity for you. These experts, working through your attorney, will help you establish a plan or review your present arrangements. Your Ætna Life office makes their services available without cost or obligation.

Ætna Life Business Insurance plans work for you!

- **Improve credit**
- **Strengthen personnel relations**
- **Attract desirable employees**
- **Give you a source of emergency capital**
- **Assure liquidity**
- **Offer you income and estate tax advantages**
- **Protect your firm *and* your family if death occurs**

ÆTNA LIFE
INSURANCE COMPANY
Hartford 15, Connecticut

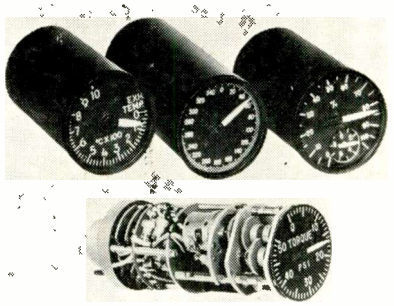
Affiliates: Ætna Casualty and Surety Company
Standard Fire Insurance Company

Circle 51 on Inquiry Card

New Products

SERVO INDICATORS

Modular construction of subminiature servo indicators uses standard stock parts for prototype and limited production applications. Indicators include several possible configurations; integrally lighted, vernier pointer and

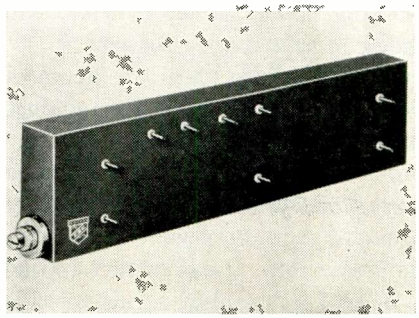


dial presentation, and high input impedance transistorized indicators. The basic module is the gear box in which up to seven 0.0937 dia. shafts are mounted in ABEC-7 ball bearings. Gear ratio is to 65,000/1 with precision 2 stock gears. Component module uses standard plates for mounting size 8 or size 10 rotating component. Dial section, another module also uses standard parts. Servo Development Corp., 567 Main St., Westbury, N. Y.

Circle 256 on Inquiry Card

VARIABLE DELAY LINE

Continuously variable Delay Line, Model 72-17, for printed board mounting. Typical design features include: Delay, 0.5 μsec.; impedance, 1,000 ohms; rise time, 0.1 μsec.; attenuation, 10% maximum; maximum voltage, 500 volts peak; resolution, less than



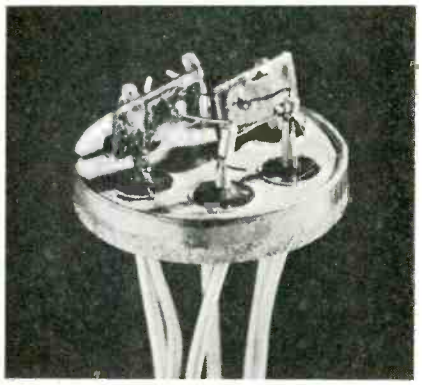
0.001 μsec. Also available custom-built in many electrical characteristics to specs. Terminals and holding tabs are provided. ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

Circle 257 on Inquiry Card

New Products

MULTI-HEADED TRANSISTORS

Multi-headed transistors are combinations of types of transistors presently in use. They may include pnp, npn, audio frequency, amplifier computer, converter, general purpose,

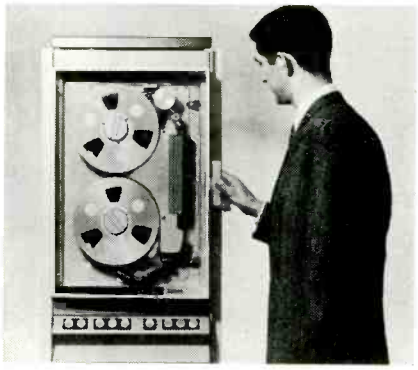


high frequency, low frequency, and other types. The combination of these individual transistors within the multi-headed package creates no interference. There is no contact with other transistors within the package since they remain as individual as if they were in their own package. Electronic Transistors Corp., 9226 Hudson Blvd., North Bergen, New Jersey.

Circle 270 on Inquiry Card

RECORDING SYSTEM

Wideband recording system has even greater frequency response than the Videotape® recorder. The AR-300, an airborne unit, is for recording only. The FR-700 is for recording and reproducing. Both can record 2 channels of wideband info over the frequency spectrum from 10 CPS to 4 MC with flat amplitude response to within 3 db. All solid-state and etched circuitry are used. The system can also record 2 aux. channels with a



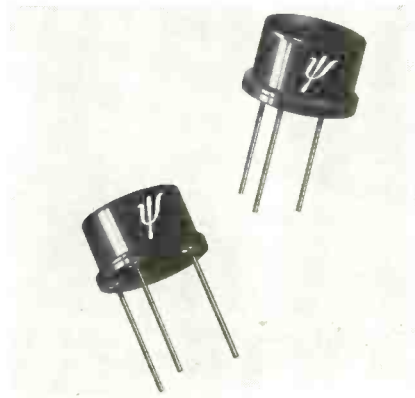
freq. response from 200 CPS to 15 KC. Tape is 2 in., 1.0 mil Mylar base. Reels carry 38 ft. Tape speeds are 12½ or 25 IPS. Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

Circle 271 on Inquiry Card

New Products

POWER TRANSISTORS

Very high frequency silicon mesa power transistors can deliver 1 w power output at 70 MC with a 28 v. collector voltage. Two new types, 2N1505 and 2N1506 have 3 w col-

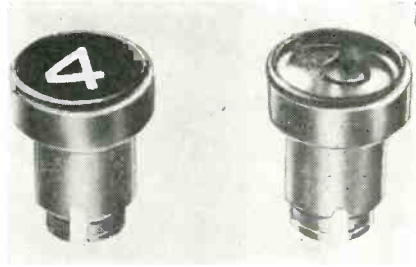


lector dissipation, 40 v. collector to emitter rating, and low collector capacitance. Type 2N1505 operates as an oscillator at 70 MC with a power output in excess of 1 w at an efficiency of 45%. Type 2N1506 has a typical power gain of 12 db at 70 MC. With a useful power output of 1.0 w. At 200 MC the 2N1506 has a power output of 30 MW. Pacific Semiconductors, Inc., 10451 W. Jefferson Blvd., Culver City, Calif.

Circle 260 on Inquiry Card

PUSHBUTTON CAPS

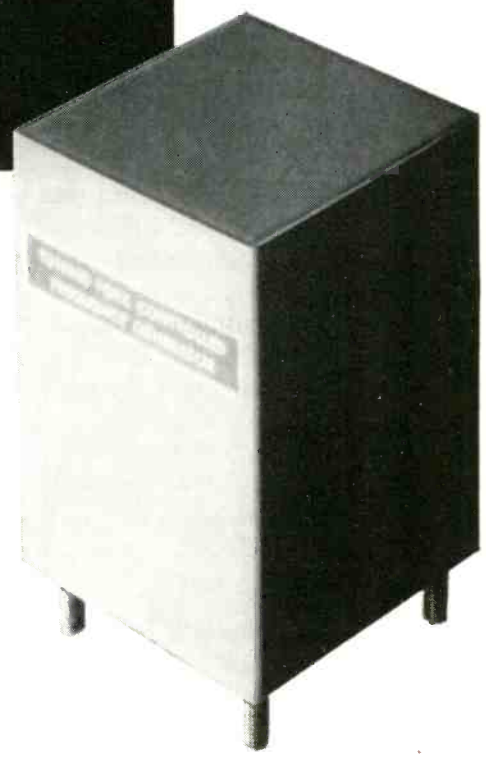
Aluminum caps for Micro Series 50PB and other similar pushbutton switches. Caps are manufactured to close tolerances to withstand rough industrial treatment and environments, and the specially designed one-



piece aluminum body will reduce breakage and excessive wear. Top of cap has 9/16 in. dia. plastic insert for luminous indication of any circuit in use. Sel-Set Machinery Corp., Dept. PB, Box 1035, Salem, Ore.

Circle 261 on Inquiry Card

TUNING FORK CONTROLLED PRECISION FREQUENCY PACKAGES



FROM 1.0 TO 4,000 CPS.

Overall accuracies from ±.05% to ±.01% over −55°C to +85°C range, and to ±.001% from zero °C to +75°C, **without** use of ovens.

Silicon and germanium transistorized. Sinewave, squarewave and pulse outputs. 18, 20, 24, and 28 volt DC inputs.

Conservatively designed **reliable** units, potted in silicone rubber and hermetically sealed, for operation under **MIL** environmental conditions.

PHONE EDgewood 3-1700, or TWX WBRY 5103, or write:

PHILAMON LABORATORIES INC.

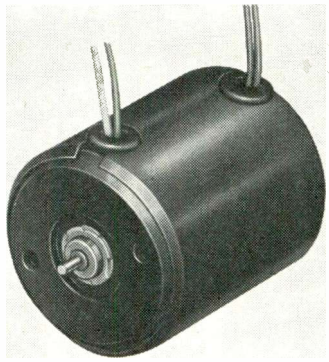
90 HOPPER STREET, WESTBURY, LONG ISLAND, N.Y.

Circle 120 on Inquiry Card

New Products

SYNCHRONOUS MOTOR

Subminiature synchronous motor, SM-1, features jewel bearings. It is 1 in. in dia. x 1 13/64 in. long and weighs 1.7 oz. Operating at 115 v with a max. power input of 2½ w,

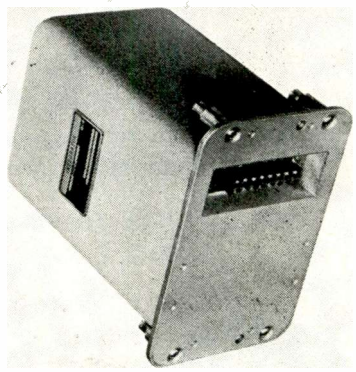


the SM-1 has a speed of 3000 RPM and a power factor of 0.9. Rotation is reversible. The motor meets the military requirements for temp. altitude, vibration, and shock, as prescribed by MIL-E-5272B. Waltham Precision Instrument Co., 221 Crescent St., Waltham 54, Mass.

Circle 246 on Inquiry Card

INTEGRATOR

ARPI-7 Precision Integrator for use in airborne stable platforms, inertial systems, tracking systems, computers, flight control systems, etc. Characteristics include: Input range, ±25 vdc; output range, limited only by choice of readout device; output scale factor, 0.04 Rev./sec of output shaft, per v. input; input impedance, 100K ohms min.; threshold, 0.5 mvdc;



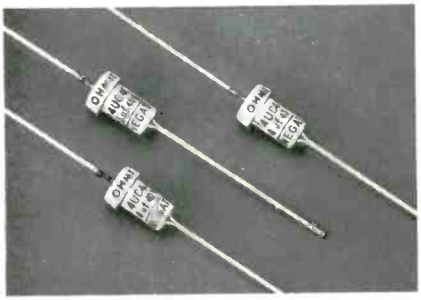
linarity, 0.01% of indicated value or 0.5 mv referred to input; drift, 0.5 mv at input; temp. range, —55 to 70°C; bandwidth, 5 CPS. The Aeroflex Corp., Aeroflex Labs Div., 34-06 Skillman Ave., Long Island City 1, N. Y.

Circle 247 on Inquiry Card

New Products

TANTALUM SLUG CAPACITORS

Ohmite Series TS capacitors meet MIL-C-3965B for tantalum slug electrolytic capacitors, Styles CL44, uninsulated and CL45, insulated, case size T1. Mil requirements have been met for all voltage and capacitance

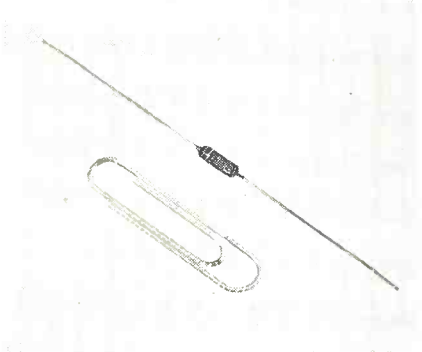


ratings and for all "grades" (vibration test requirement) called for in the size furnished by Ohmite. Featured are lok leakage and power factor. Ohmite Manufacturing Co., 3963 Howard St., Skokie, Illinois.

Circle 258 on Inquiry Card

DIODE/RECTIFIERS

Designed to operate at temp. to 200°C, subminiature silicon diode/rectifiers are in hermetically-sealed glass case (MP 100 through MP 600). Of fused junction construction, with pigtail leads, they meet military specs, cover range from 100 to 600 v. peak inverse, and operate at amb. temp. from −65° to +200°C. At 200°C and 225 peak inverse voltage, max. average rectified current is 50 ma. Because of their size (0.300 in.



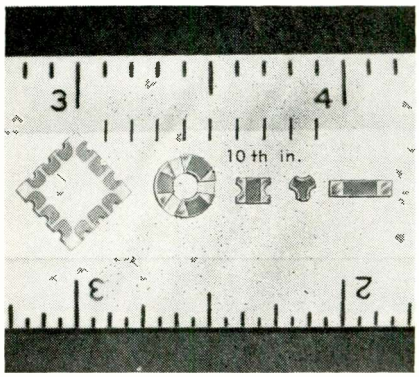
long and 0.105 in. in dia.) they are suited for applications in miniaturized, as well as standard, equipment. General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J.

Circle 259 on Inquiry Card

New Products

MODULE RESISTORS

Micro-Miniature Module Resistors can be supplied on substrates to most 3-dimensional configurations and physical size is limited only by the ability to handle parts. Common forms include rods, plates, and semi-circular

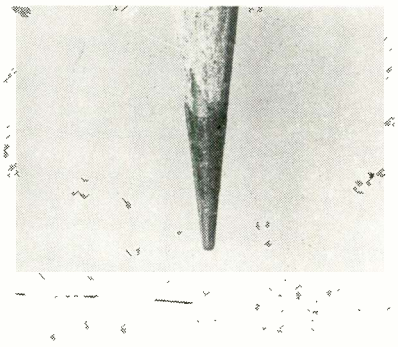


elements. Substrates may be of mica, glass, ceramic, or quartz. Single or multi-element resistors can be deposited on a single substrate. Power rating and resistance values are a function of element size and shape. There are no "catalog sizes." All units are designed to specs. Filmohm Corp., 48 West 25th St., New York 10, N. Y.

Circle 264 on Inquiry Card

MINIATURE BULB

Microminiature Pinlite is an incandescent lamp that measures 0.015 in. in dia. and 0.062 in. in length. Furnished with axial platinum leads 0.003 in. in dia. it produces a bright pin-point of light. Features include: Operates on 1.5 vdc, 15 milliamperes. Applications include, missiles, computer read-out, meter pointer visual



aid, high frequency indicator to 3000 MC, low voltage, low current circuit performance indicators for transistorized circuits and in medical electronics. Kay Electric Co., 14 Maple Ave., Pine Brook, New Jersey.

Circle 265 on Inquiry Card

Circle 123 on Inquiry Card

FUNCTIONAL DIAGRAM OF ONE CHANNEL

NEW

Reeves INSTRUMENT CORPORATION

MODULAR

PARALLEL SUMMATION AMPLIFIERS

for resolver applications

FEATURES:

- Up to five parallel inputs per channel.
- Extreme flexibility in design and installation provided by separate packaging of amplifier and summing resistor circuits.
- Resistor package can be mounted either above or below chassis.
- Amplifier module plugs into resistor assembly.
- Dual channel transistorized amplifier and dual summing resistor circuits individually packaged.
- Summing resistors supplied to customer specifications. Values range from 50,000 ohms to 5 Megohms. Feedback resistor maintained at 500,000 ohms.

Designed for use with precision compensated resolvers such as the Reeves' Size 11 series, these booster amplifiers are ideal for use in resolver computer chains.

Write on company letterhead for complete Data File No. 305

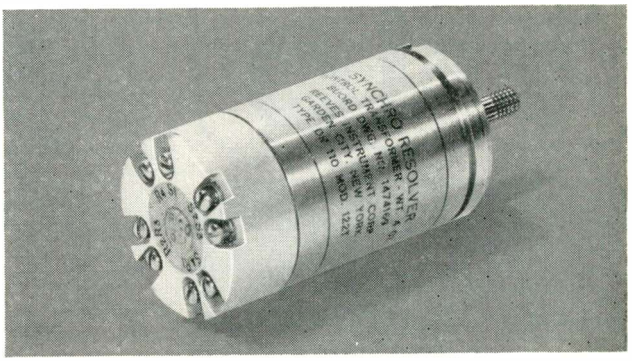
ELECTRICAL SPECIFICATIONS

1. Number of Inputs	4 per channel (provision for 1 extra if required)
2. Input Impedance	50 K to 5 Megohms (depending on transfer ratio)
3. Maximum Output Voltage	26V R.M.S.
4. Power Requirements (both channels)	45 V.D.C. @ 16 MA
5. Operating Temperature Range	−55°C to + 105°C
6. Voltage Transfer Ratio (amplifier input to resolver rotor output)	0.1 to 10 (as required) accuracy: ±.05% @ 25°C ±0.1% over operating temperature range

REEVES SIZE 11 PRECISION RESOLVERS

With functional accuracy of standard units better than 0.05%, these are the preferred resolvers in the field today for miniaturized airborne, platform, computing, data transmission, and other resolver applications calling for highest performance and utmost reliability over extended environmental ranges.

Reeves Size 11 Resolvers, of this exceptional quality, are now available in production quantities . . . a part of Reeves complete line of precision Resolvers and Phase Shifters in standard and miniature sizes and types.



Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America • Roosevelt Field, Garden City, New York

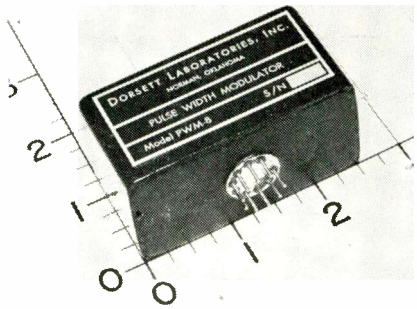
6RV60

Circle 124 on Inquiry Card

New Products

PDM KEYER

For telemetering, sampling circuit requires a sample time of less than 20% of max. pulse duration. The PWM-8 uses +20 v at 5 ma, or −20 v at 30 ma. Input impedance is 3 megohms or greater (effective). A

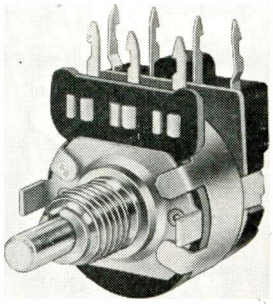


change of 1% or less in pulse width results when 30K is in series with the PWM-8. Output is 0 to +5 v in a rectangular wave form, clamped to ground. Pulse rise and decay time is less than 2 μsec each. Pulse duration adjustment range is from 85 to 200 μsec at 0 v input; and from 550 to 750 μsec at 5 v input. Dynamic range is greater than 600 μsec. Dorsett Electronics Laboratories, Inc., P.O. Box 862, Norman, Oklahoma.

Circle 262 on Inquiry Card

POTENTIOMETERS

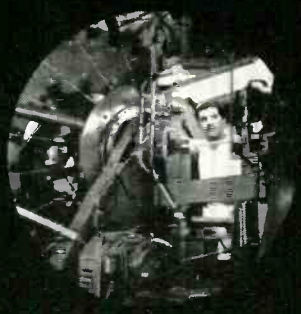
Series of ⅝ in. dia. miniature compact composition variable resistors. Resistance range is 250 ohms thru 2.5 megohms linear taper, wattage rating ¼ w thru 100,000 ohms and 2/10 w over 100,000 ohms at 55°C derated to no load at 85°C, voltage rating 750 vac bushing to terminals

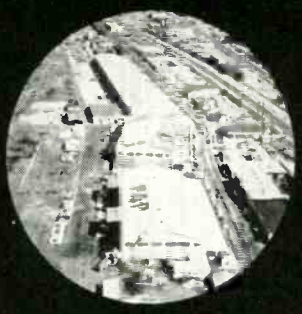


for 1 min. high pot test and 500 vdc operating max. 350 vdc across end terminals and 280° rotation without switch, 315° with switch. Chicago Telephone Supply Corp., Elkhart, Indiana.

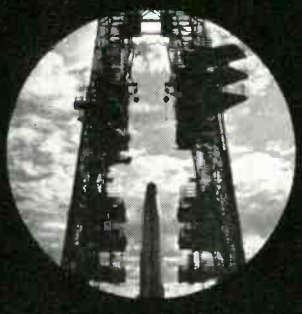
Circle 263 on Inquiry Card

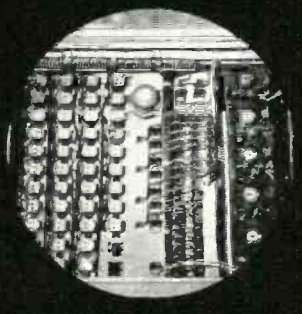
Circle 122 on Inquiry Card →



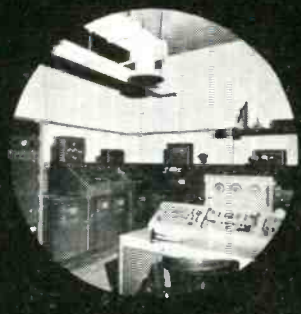
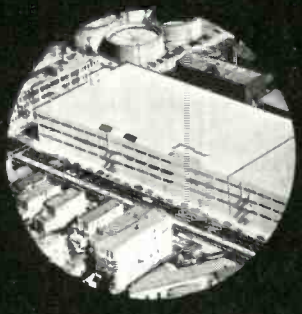



AUTOMATION PRODUCTS, INC. *presents* **"OPERATION**

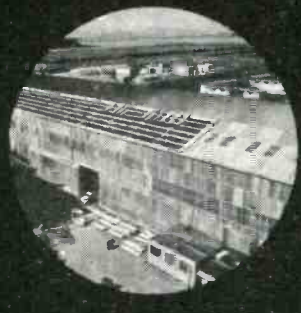





TURN-KEY" *an integrated Architectural, Engineering and*

Electronic capability for Planning, Design, Construction




and Activation of automated Military and Industrial Facilities.

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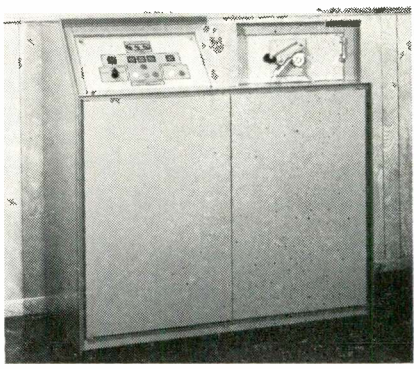
PACIFIC AUTOMATION PRODUCTS, INC.

1000 Air Way, Glendale 1, California · Phone: CHapman 5-8661

New Products

AUTOMATIC TEST EQUIPMENT

UACTE, Universal Automatic Checkout, Control, and Test Equipment, can check out components like circuit boards, black boxes, sub-assemblies, and systems. It can measure these inputs: Dc voltages—0 to 999 v,

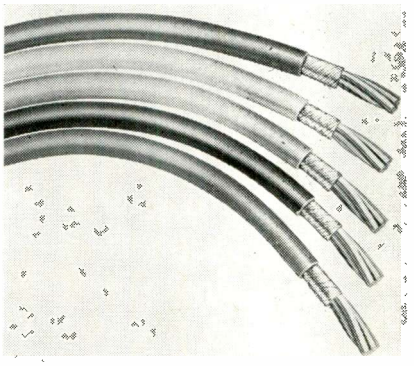


±, accuracy 0.25%; ac voltages, 0 to 999 v RMS, 10 CPS to 10 KC, accuracy, 0.25% of full scale of ranges. Time, coincidence of pulse type responses variable from 0 to 99 sec. Freq., 0 to 100 KC to 1 count. Outputs: Dc voltages, 0 to 25 v in 100 mv increments, accuracy, 0.1% when loaded with 10,000 ohms. Ac voltages, 0 to 25 v RMS, 400 CPS in 100 mv increments, accuracy 0.1%. Modulated 400 CPS suppressed carrier, 0 to 25 v, 400 CPS modulated at freq of 1 to 10 CPS at 1 Cycle increments. Pacific Automation Products, Inc., 1000 Air Way, Glendale, Calif.

Circle 272 on Inquiry Card

PLASTIC JACKETED CABLE

Plastic jacketed cables are in color to supply the need for positive identification by color coding of multiple conductor finished cables. The plastic jackets are in the standard color



shades that have been adopted by the industry. Color plastic jackets are available in any size and number of conductors. Lenz Electric Manufacturing Company, 1751 No. Western Avenue, Chicago 47, Illinois.

Circle 273 on Inquiry Card

Microwave Component News from SYLVANIA

TW-956H—1/2 ACTUAL SIZE

Now... solve TWT space and temperature problems

Magnetically shielded, temperature compensated TWTs

Sylvania research offers you two new S-band traveling-wave tubes of the permanent magnet focused type—TW-4002F and TW-956H – which give you these unique advantages:

Magnetically shielded – not affected by proximity to magnets and magnetic materials such as other TWTs, solenoids, and hardware. This permits close packing without hazard of performance loss.

Temperature compensated – they operate from −65°C to +72°C with minimum degradation of performance, and without requiring heater blankets.

Periodic PM focusing – they do not require weighty, space-and-power consuming solenoids.

Broad band – they have a relatively flat frequency response over an octave, from 2.0 to 4.0 KMC.

Electrically superior characteristics – at room temperature they have the following specifications:

TW-4002F – small signal gain is 37 db minimum; CW rf power output (saturation) is 10 milliwatts minimum

TW-956H – gain with 0.1 milliwatt input is minimum 37 db; CW rf power output (saturation) is 2 to 5 watts

COMPACTNESS – they are about 15" long, have 1.4" capsule diameter, weigh 3 pounds

RUGGEDNESS – specially designed for airborne and missile applications

Sylvania Electric Products Inc. – Special Tube Operations
500 Evelyn Ave., Mountain View, Calif.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

GENERAL SYSTEM

PRD's brand new Broadband Attenuators

FEATURES:

- Short insertion length
- Full *60 db* attenuation range
- *Minimum* insertion loss
- Compact Tape readout
- Precision accuracy

Once again, to meet the present and future needs of microwave engineers, PRD has produced a completely new concept in test equipment. Here is a *rotary vane attenuator* in a radically modern package: small, light, rugged ...and *precise*—to fill all your needs from 3.95 to 40 kmc. The 101 series of Broadband Attenuators features a precise, compact, low-backlash drive and easy-to-read tape readout. Levelling screws quickly adjust to match transmission line heights. A simple adapter is available for panel mounting.

SPECIFICATIONS:

VSWR: 1.15 maximum

Attenuation Range: 60 db

Accuracy: ±0.1 db or ±2%, whichever is greater, from 0 to 50 db; ±3% from 50 to 60 db.

The table below indicates maximum insertion loss and dimensions.

Type No.	Freq. Range	Max. Insertion Loss	Insertion Length	Height	Depth
G 101	3.95 — 5.85	0.5 db	18⅞	6⅝	7⅜
C 101	5.3 — 8.2	0.5 db	14⅞	6⅝	7⅜
H 101	7.05 — 10.0	0.5 db	11⅜	6⅝	7⅜
X 101	8.2 — 12.4	0.5 db	9	6⅛	6¼
U 101	12.4 — 18.0	0.7 db	7 11/16	5⅛	6¼
K 101	18.0 — 26.5	0.7 db	7⅝	5⅛	6¼
A 101	26.5 — 40.0	1.0 db	6 13/16	5⅛	6¼

data subject to change without notice

To find out more about the new PRD 101 Series of Broadband Attenuators contact your local PRD representative, or phone, write, or wire:

PRD ELECTRONICS INC.
A Subsidiary of Harris-Intertype Corporation
Formerly Polytechnic Research & Development Co., Inc.
Factory and General Office: 202 Tillary Street, Brooklyn 1, New York, ULster 2-6800
Western Sales Office: 2639 So. La Cienega Blvd., Los Angeles 34, Calif., UPton 0-1940

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ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

A

51 Aetna Life Insurance Company—Business life insurance
20 Airborne Accessories Corporation—High-temperature capacitor
112 Alford Manufacturing Company — Line stretchers
157 Alite Division U. S. Stoneware—Ceramic-to-metal seals
96 Allegheny Ludlum—Electrical steels
64 Allen Bradley Company—Triple filter for telemetry system
65 Allen Bradley Company—Resistors, Potentiometers, capacitors, ferites, filters, quality motor controls
86 Allied Radio Corp. — Transistor diode, rectifier, resistor, capacitor distribution
307 American Electrical Heater Company—Soldering irons
97 American Rectifier Corporation—Speed controls, power supplies
36 American Super-Temperature Wires, Inc. —Teflon insulated hook-up wire
45 American Time Products, Inc.—Frequency standards
27 AMP Incorporated—Shift register
113 Amperex Electronic Corporation—Electron tubes
311 Amperite—Delay relays, ballast regulators
103 Amphenol-Borg Electronics Corporation, Cable & Wire Division—Low loss cable
125 Amphenol-Borg Electronics Corporation, Connector Division — Miniature rack panel connectors
126 Amphenol-Borg Electronics Corporation, Distributor Division—Connector Distribution
100 Andrew Corporation—Parabolic antennas
31 Arnold Engineering Company, The — Power cores
147 Arnold Magnetics Corp.—Toroidal coil winder
312 Astron Corporation—Tantalum capacitor
68 Automatic Timing & Controls, Inc.—Countdown controllers, elapsed time indicator, time delay relay, differential transformers

B

127 Babcock Relays, Inc. — Subminiature magnetic latching relay
30 Ballantine Laboratories, Inc.—Voltmeter
128 Barker & Williamson, Inc.—Audio oscillator, distortion meter, dip meter
6 Beckman/Berkeley Division — Counter display
14 Bendix Aviation Corporation, Red Bank Division Semiconductor — Diffused-alloy power transistors
129 Biwax Corporation—Epoxy formulations
157 Boehne, Inc., H. O.—Precision electrical, electro mechanical and electronic equipment
73 Boonton Electronics Corp.—RF voltmeter
41 Borg Equipment Division, Amphenol-Borg Electronics Corp.—Turn counting dials
12 Bourns, Inc., Trimpot Division—Potentiometer trimmer
108 Breeze Corporation, Inc.—Slip ring assemblies
121 Bruno-New York Industries Corp.—Pigtailoring machine
71 Burnell & Company, Inc.—Adjustable toroidal coils
48 Brush Instruments Division of Clevite Corp.—Direct writing recording systems
49 Brush Instruments Division of Clevite Corp.—Chart paper for recording systems
139 Bussmann Mfg. Division, McGraw-Edison Company—Fuse & fuseholders

C

29 CBS Electronics—Diffused silicon diodes
15 Centralab Electronics Division of Globe-Union Inc.—Linear motion variable resistor
142 Cinema Engineering, Division Aerovox Corp.—Precision wire-wound resistors
50 Cinch Manufacturing Company — Connectors
149 Clare & Company, C. P.—Sealed contact reed relays
94 Clevite Transistor—Power transistors
95 Clevite Transistor—Power transistors
55 Clifton Precision Products Company, Inc. —Synchros
101 Columbus Electronics Corp. — Silicon rectifiers
304 Communication Accessories Company—Low-pass, high-pass and band-pass filters
52 Conrac, Inc.—Television monitors
70 Consolidated Vacuum Corporation—Vacuum pumping system
8 Control Switch Division Controls Company of America—Switches
81 Curtiss Wright Corporation — Stepping motors

D

158 Dade County Development Department —Industrial area survey
24 Dale Products, Inc.—Precision resistors
34 Delco Radio Division of General Motors —Static inverters and converters
137 Delco Radio Division of General Motors —High current transistors
155 Dymo—Hand embossing tool

E

132 Efcon Inc.—Film and paper capacitors and solid tantalum capacitors
308 EICO Electronic Instruments—Kits & electronics catalog
310 Elastic Stop Nut, Aga Division—Time/delay/relay
66 Electrical Industries — Glass-to-metal seals
89 Elgin—Advance Relays, Elgin National Watch Company—Relays
35 ESC Corporation—Lumped-constant delay line

F

318 Fairchild Controls Corporation Components Division—Pressure transducer
16 Fairchild Semiconductor Corporation—Silicon planar transistor
319 Freed Transformer Co., Inc. — Incremental inductance bridge & variable test voltage megohmmeter
58 FXR, Inc. — Temperature compensated power meter

G

40 General Electric Power Tube Dept.—Coaxial ignitron
115 General Electric Receiving Tube Dept. —Ceramic tubes
22 General Electric Semiconductor Division —Silicon controlled rectifiers
60 General Instrument Corporation—Silicon diodes
74 General Products Corporation — Solid-block terminal boards
116 Gertsch Products, Inc.—Frequency meter
160 Grainger, Inc., W. W.—Electric motors
91 Graphic Systems—Visual control board
150 G-V Controls Inc.—Thermal relay

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **MAY 1960**

Please send me further information on the items I have circled below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
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119 IMC Magnetics Corporation—Servo motors
39 Indiana General Corporation—Magnet & ferites
90 Industrial Division, Chamber of Commerce, Hollywood, Florida—Industrial advantages
320 Industrial Electronic Engineers, Inc.—Rear-projection type digital displays

PROFESSIONAL ENGINEERING OPPORTUNITIES

512 Bell Aircraft Corporation
511 Bendix Aviation Corporation, Kansas City Division
504 Boeing Airplane Company, Wichita
509 Garrett Corporation, The
502 Gates Radio Company
507 General Electric Communication Products
505 General Electric Defense Systems Department
503 Kearfott Division General Precision, Inc.
510 Magnavox Co., The
508 Motorola Inc.
506 National Cash Register Company, The
501 National Cash Register Company, The, Electronics Division

47 Industrial Products-Danbury Knudsen Div. Amphenol-Borg Electronics Corp. —RF connectors
153 Industrial Test Equipment Co.—Phase meter
57 Institute of Radio Engineers, The—Space electronics issue
23 International Electronic Research Corporation — Heat-dissipating electron tube shields
42 International Resistance Co. — Carbon composition resistors in strips
32 ITT Industrial Products Division of ITT —Frequency standards

J

143 Jerrold Electronics Corporation — R.F. test equipment
140 Jettron Products Inc.—Magnetron connectors
102 JFD Electronics Corporation—Trimmer capacitor
111 Johnson Co., E. F.—Collet knobs
309 Jones Division, Howard B., Cinch Manufacturing Company—Plugs & sockets
26 Jones Electronics Co., Inc., M. C., Sub. of Bendix Aviation Corporation — Calorimetric wattmeter, coaxial tuner, freed-through wattmeters, RF load resistors

K

117 Kay Electric Company—RF voltage calibrator
114 Kearfott Division General Precision Inc. —Microwave sub-systems
28 Keithley Instruments Inc.—High-speed research micro-microammeter
107 Kemet Company, Division of Union Carbide Corp.—Tantalum capacitor
80 Kester Solder Company — Resin-core solder
106 Keuffel & Esser Company—Printed circuit masters film

L

109 Lavelle Aircraft Corporation—Modules, chassis, racks and consoles for electronic systems
56 Lenz Electric Manufacturing Co.—Multiple cables for all purposes

M

105 Magnetic Amplifiers, Inc.—Static inverters
54 Magnetics, Inc.—Tape wound cores
301 Marconi Instruments—Q-meter
38 Markite Corporation—Potentiometers
145 McMillan Laboratory, Incorporated — Absorbers
146 Microwave Associates, Inc.—Diodes low-noise
21 Minnesota Mining and Manufacturing Company Mincom Division—Magnetic tape instrumentation recorder/reproducer
133 Minnesota Mining and Manufacturing Company Magnetic Products — Protected plastic magnetic tape
88 Motorola Semiconductor Products Inc.—Power transistors

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61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
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N

151 Newark Electronics Corporation—Industrial electronic catalog
313 Newman Corporation, M. M.—Spirally-cut plastic tubing
84 Nothelfer Winding Laboratories, Inc.—Transformers, reactors

P

122 Pacific Automation Products, Inc.—Engineering assistance
67 Pacific Semiconductors, Inc. — Silicon mesa transistors
17 Pacific Semiconductors, Inc. — Silicon diodes
120 Philamon Laboratories, Inc. — Tuning fork, frequency generator
9 Philco Lansdale—Silicon mixer diodes
131 PRD Electronics Inc.—Broadband attenuators

R

1 Radio Materials Company—Subminiature disc capacitors
79 Radio Receptor Company, Inc.—Selenium rectifier bridge
134 Rahm Instruments — Pressure transducers
62 Raytheon Industrial Components Division—Recording storage tubes
78 Raytheon Company, Microwave and Power Tube Division—Backward wave oscillators
124 Reeves Instrument Corp.—Booster amplifiers for resolver applications
63 Revere Corporation of America—Multiconductor cables
72 Rohn Manufacturing Co.—Communication tower

S

138 Sarkes Tarzian, Inc., Semiconductor Division—Silicon rectifiers
11 Scintilla Division Bendix Aviation Corp.—Ignition systems, electrical connectors and fuel cell cabling
93 Sealectro Corporation—Teflon terminals
87 Sifco Metachemical, Inc.—Selective plating for electronic components
75 Sonotone Corp. — Miniature and subminiature tubes for all purposes
144 Spectrol Electronic Corporation—Single-turn & multi-turn
99 Speer Carbon Company, Jeffers Electronics Division — Fixed composition capacitors
7 Sprague Electric Company—Film capacitors
2 Sprague Electric Company—Resistors
33 Stackpole Carbon Company—Resistors
315 Stanpat Company—Adhesive based drafting aid
4 Stevens Manufacturing Company, Inc.—Thermostats
85 Stromberg-Carlson, A Division of General Dynamics—Telephone quality relays
61 Struthers-Dunn, Inc.—10-ampere relay
110 Superior Tube Company—Miniature disc cathodes
69 Sylvania Electric Products Inc., Semiconductor Division—Transistors
314 Sylvania Electric Products Inc., Semiconductor Division—Microwave diodes
130 Sylvania Electric Products Inc., Special Tube Operations — S-band traveling-wave tubes
302 Sylvania Electric Products Inc., Electronic Tubes Division—Electron tubes
303 Sylvania Electric Products Inc., Electronic Tubes Division—Electron tubes
98 Synthane Corporation—Laminated plastics

T

154 TA Mfg. Corp.—Standard instrument cases
59 Taylor Fibre Co.—Laminated plastics
135 Tektronix, Inc.—General-purpose oscilloscopes
317 Telectro Industries Corp.—Modular magnetic tape systems
44 Telechrome Manufacturing Corp.—Special effects generator
83 Texas Instruments Inc., Semiconductor-Components Division — Germanium power transistors
321 Thomas & Betts Co., The—Cable ties and straps
43 Times Wire & Cable Company, Inc.—Wire & cable
136 Tinsley Laboratories, Inc. — Corning glass filters
82 Transitron Electronic Corp.—Controlled rectifiers & switches
306 Tru-Ohm Products—Power rheostats
46 Tung-Sol Electric Inc. — Germanium switching transistors

U

316 Ultrasonic Industries Inc.—Ultrasonic cleaner
152 U. S. Components, Inc.—Miniature connectors
92 United Transformer Corporation — Hermetic audio and power components

V

141 Varian Associates — Potentiometer recorders
19 Victoreen—Electron tubes

W

123 Waveline, Inc.—Microwave test equipment, waveguide switch
53 Wayne Kerr Corporation — Universal bridge
148 Webber Manufacturing Co., Inc.—Environmental chambers
13 Westinghouse Electric Corp., Semiconductor Department—Rectifier, transistors and special semiconductor devices
77 White Industrial Division, S. S.—Air abrasive unit

X

159 X-Acto, Inc., Handicraft Tools, Inc., Div.—Precision knives.

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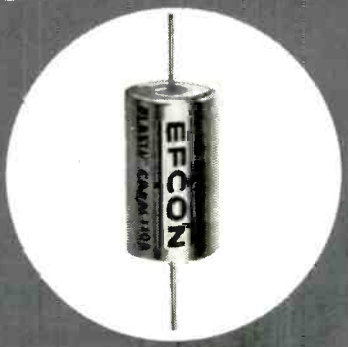

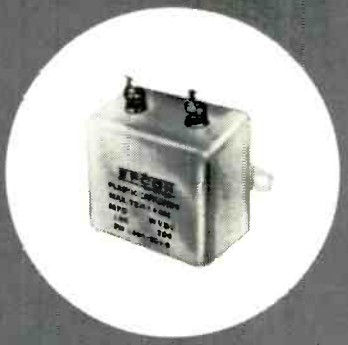

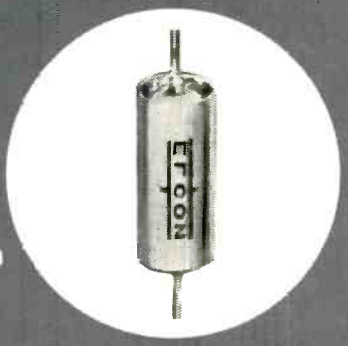

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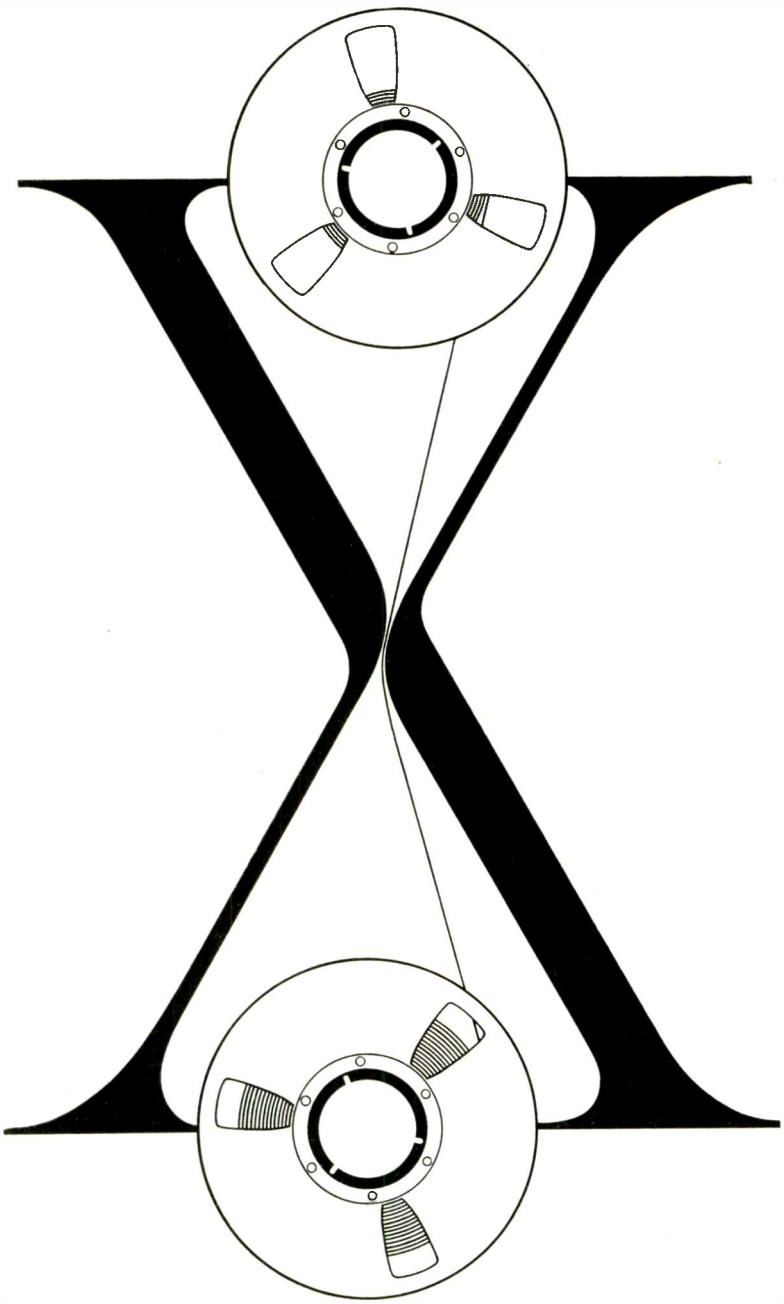
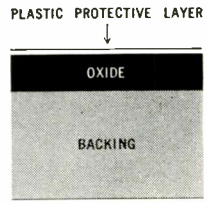


IN THAT NARROW LITTLE LIFELINE OF DATA known as magnetic tape, a miss is magnified into a mile. A missed bit, or one picked up by error is confusing, frustrating and time-consuming. If you're in doubt about the kind of performance you're getting, perhaps "SCOTCH" BRAND Sandwich Tapes can solve some of your tape and equipment problems.

The exclusive construction of the Sandwich Tapes combats the causes of error because it eliminates the source—oxide rub-off and head build-up. Tests prove it wears a minimum of 10 times as long as ordinary tapes before it errs. As a by-product, you can rely on it to drastically reduce maintenance and replacement costs on equipment.

The Sandwich is constructed as shown in the diagram at the right. The famous "SCOTCH" BRAND high potency oxide coating is sandwiched between a tough polyester base and a 50 micro-inch layer of plastic. Since the oxide is never in contact with the head, tape movement is smooth and low in friction—easy on both tape and equipment. Oxide can't rub off and distort valuable data.



Yet, the real meat of this remarkable Sandwich is the "SCOTCH" BRAND high potency oxide coating. Even under the protective plastic, the oxide's potency is quite sufficient to pick up 500 pulses per inch—and give desirable high-frequency response in many AM, FM and PDM applications. Sandwich Tape is but one of the developments to come out of 3M research—the same research responsible for "SCOTCH" BRAND Video Tape—the first video tape in commercial use.

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ANTENNAS, PROPAGATION

Ratio of Powers Transmitted in Waves which are Induced by a Slot in a Surface Covered by a Dielectric Layer. D. V. Shannikov. "Radiotek," 15 No. 2 (1960). 7 pp. The problem of the field induced by a slot in a surface covered with a dielectric layer is examined theoretically. The results thus obtained hold for any thicknesses or permittivities of the dielectric. They provide an evaluation of the distortions produced by a dielectric layer in slot antennas and of the efficiency of a slot for inducing ground waves. The formulas thus obtained indicate that the dielectric layer not only affects the radiation resistance of the slot, but also transfers a considerable part of the energy into the ground wave. (U.S.S.R.)

Wide Band Paraboloid Antennas Using Helices as Radiators for Decimetric Waves. "Nach. Z." March 1960. 6 pp. (Germany.)

CIRCUITS

Generalized Operator Characteristics of Filters and Modulators. M. Ya. Kaller. "Radiotek" 15, No. 2 1960). 9 pp. Generalized operator characteristics of filters and modulators show that each possible resolution of the signal into its components corresponds to a combination of a filter and a modulator. The idealized characteristics of these devices are obtained from the generalized characteristics by substituting in them the appropriate resolution of the signal. This approach clearly shows the frequency-time symmetry of the devices and facilitates the changing over of systems from frequency to time discrimination. These methods could also be applied to other types of discrimination. This method also provides a more correct estimation of the functions of various units by means of their equivalent circuits. (U.S.S.R.)

An Analysis of Tripping Methods for Blocked Relaxation Oscillators. V. V. Grigorin-Ryabov. "Radiotek" 15, No. 2 (1960). 9 pp. A method of tripping blocked relaxation oscillators by means of amplitude characteristics of nonlinear quadripoles is suggested. The existence of several zones within whose limits the amplitude of the tripping voltage can be chosen is shown. The relationship between the minimum pulse-front steepness of the tripping voltage and the optimum value of the internal impedance of the voltage source is given and the effect of the isolating capacitor on the tripping is analyzed. Above technique of analyzing the tripping of blocked relaxation oscillators provides a unified theory applicable to the majority of known relaxation oscillators, gives a more precise analysis of their operation and facilitates their design. (U.S.S.R.)

The Performance and the Design of Ring Modulators, H. Bley. "Nach. Z." March 1960. 8 pp. A new quasilinear method for a clear explanation of the performance and the design of ring modulators has been derived from an experimental basis. (Germany.)

The Performance of Filter Networks Consisting of a Equal Half-sections, W. Herzog. "Nach. Z." March 1960. 10 pp. It is shown that the transfer constant of half-sections can be expressed by means of one input impedance value for an open-circuit load. (Germany.)

Usefulness of Zawels' Practical Equivalent Circuits, O. Muller. Formulas for the parameters h and y are given for Zawels' equivalent circuit described in W. Benz' paper. These formulas furnish simple relations to find the components of the equivalent circuit. (Germany).

Estimating the Volume of Traffic by a Simple Formula, A. Jipp. "J. UIT." Jan. 1960. 4 pp. (France.)

Practical Transistor Circuits, A. Petitclerc. "el. & auto." March 1960. 3 pp. Two practical transistor circuits are analyzed. The first one is a photographic flash, using a single transistor and fed by a rechargeable battery. The second one is a stabilized power supply. It has good performances, uses three transistors and can provide currents up to 300 MA under 6 to 25 v. (France.)

Distortion in Class A-B Push Pull Amplifier, I. S. Docherty and R. E. Aitchison. "Proc. AIRE." Dec. 1959. 5 pp. The fourier coefficients of the current waveform for a single valve or transistor working under varying bias conditions (from class A through various degrees of class AB operation to pure class B) are evaluated as a function of the angle of flow of the output current. (Australia.)

Temperature Stabilization of Transistors in Class B Amplifiers, K. L. Webber. "Proc. AIRE." Dec. 1959. 8 pp. This paper is intended to highlight the specific problems involved in the stabilization of class B amplifiers. In this case, normal methods of stabilization cannot be used to their fullest extent without excessive loss of signal power. (Australia.)

Linear Network Synthesis, G. C. Brown. "El. Tech." Mar. 1960. 5 pp. The rational fraction approximation is obtained directly in terms of the pole-zero locations in the p-plane by a process of successive approximation. The method differs from other known successive approximation techniques in being purely graphical apart from a final numerical relaxation process. A simple step-by-step account is given of the practical procedure. (England.)

Junction Transistor Circuits, J. J. Ward. "El. Tech." Mar. 1960. 7 pp. This article presents a method of calculating current drift due to changes of junction temperature in a direct-coupled transistor circuit with series negative feedback. A brief comparison between this circuit and circuits using parallel feedback is made. (England.)

The Parametric Amplifier, Part 2, C. R. Russell. "Brit. C&E." Mar. 1960. 5 pp. The first part of this article was devoted to a basic explanation of the mechanism of the parametric amplifier and to the characteristics of amplifiers of the semiconductor diode and ferrite type. This part of the article is devoted to a review of the main features of

REGULARLY REVIEWED

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AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institute of Radio Engineers

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Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institute of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elecktrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechniczne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences, USSR

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beam parametric amplifiers of the longitudinal space-charge wave and the transverse-field type. Some general comments on noise figure measurements on parametric amplifiers are also given. (England.)

Negative Feedback in Frequency-Changers, D. G. Tucker. "El. Tech." Mar. 1960. 3 pp. Two different forms of negative feedback are discussed. One is the usual kind, with only passive elements in the feedback path: the other has an active element in the feedback path, with characteristics identical to those of the forward path. Both can give good constancy of overall gain. (England.)

Negative-Capacitance Amplifier Noise, Max Robinson and J. Weinmann. "El. Tech." Mar. 1960. 3 pp. The inherent limitations of negative-capacitance feedback, due to the finite time constant and internal noise of an actual amplifier, are discussed. It is shown that the limitation, caused by noise, applies to any circuit that is designed to reduce the input RC time constant. (England.)

Reproduction of Magnetic Tape Records through the Hall Effect, F. Kuhrt, et al. "El. Rund." Nov. 1959. 2 pp. The authors describe a reading head for the reproduction of tape-recorded information in which, contrary to conventional inductive reading heads, the Hall effect is utilized to convert the remanence of the magnetic tape into a voltage (Germany.)

A New Coaxial Resonator Filter, K. G. Dean & A. G. Hancock. "Proc. AIRE." Oct. 1959. 10 pp. A new type of band-pass filter using loop-coupled coaxial resonators, which has an m-derived type of characteristic, is described. A design analysis is given and it is shown that the performance may be described in terms of an equivalent lattice network; good agreement is shown between the insertion-loss characteristic of an experimental filter and the calculated performance. (Australia.)

Compensation of Direct Coupled Amplifiers Against Drift Caused by Heater Voltage Fluctuations, Felix Gutmann. "Proc. AIRE." Nov. 1959. 3 pp. The output of a thermopile, indirectly heated from the same source which supplies the heater(s) of a direct coupled amplifier, is fed back either into the input circuit or in series with the indicator, e.g., a meter, in a polarity to compensate the zero drift due to heater voltage fluctuations. The drift is reduced to less than 1/3 without sacrificing sensitivity. (Australia.)

Low-Distortion Sine-Wave Generator, Arthur R. Bailey. "El. Tech." Feb. 1960. 4 pp. The article describes the development of a very low-distortion oscillator covering the frequency range of 10 c/s to 100 kc/s with a distortion of less than 0.02% Over the majority of the range the distortion is less than 0.01%. (England.)

COMMUNICATIONS

Certain Relations in Optimum Signal Detection Systems, L. S. Gutkin. "Radiotek" 15, No. 2, (1960). 11 pp. (first part). Approximate relations for determining the sensitivity of optimum signal detecting systems on a background of white noise are derived. The error of the relationships thus obtained does not exceed 0.5-1 db, if the probabilities of the detection errors do not exceed 10%, and the former error tends asymptotically to zero if the probabilities decrease. The analysis is carried out for a binary (or signal channel) and multialternative (or multichannel) detection of three types of signals: those known accurately, those with a random phase and slowly fluctuating signals. A comparison of different instances of detection is given. (U.S.S.R.)

Programme Switching, Control, and Monitoring in Sound Broadcasting. "BBC Mono." #28. 1960. 28 pp. This paper discusses the factors which influence the choice of efficient and economical switching systems, and presents the development of designs suitable for the various densities and types of traffic which occur in the sound broadcasting system of the British Broadcasting Corp. Details of inter-regional land line or radio link connections are not discussed. (England.)

New Stereophonic Broadcasting System, G. D. Browne. "Brit. C&E." Mar. 1960. 2 pp. Consideration has been given for some time to the practicability of providing stereophonic transmissions of sound broadcasts and a new system, developed at the Mullard Research Laboratories, was demonstrated in London during February. This is a fully compatible time-multiplex system which has been developed by the author and his colleagues. A simple receiver design is one of the many advantages claimed. (England.)

COMPONENTS

Criteria of Reliability of Automatic Relay Devices with Radioactive Emitter, A. G. Vasiliev, et al. "Avto i Tel." Feb. 1960. 9 pp. The paper deals with the criteria of reliability of automatic relay devices with radioactive emitters. The connection of the parameters of the relay devices with the probability of the relay stay in the given state and with the average number of false switching in a time unit is explained. (U.S.S.R.)

Exploitation Estimating of Life-Time of Contact Equipment, D. A. Abdullaev. "Avto i Tel." Feb. 1960. 6 pp. Life-time of contact equipment is determined as dependent on its operation mode and the preset permittable number of switchings. Based on the life-time, the increase of one-element exploitation expenditure is estimated. (U.S.S.R.)

Numerical - To - Electrical Transducer, A. K. Zavolokin. "Avto i Tel." Feb. 1960. 6 pp. A block-diagram of a device for converting numerical values into proportional voltage or current is described. The device is based on using the principle of intermittent transformation to time intervals. The transducer performance is analyzed and some ideas concerning the design of such devices are explained. (U.S.S.R.)

Electronic Co-Ordinate Transformer, J. Gonzales-Ibeas and V. Aleixandre. "E. & R. Eng." Oct. 1959. 6 pp. The authors describe a totally electronic analogue calculating unit designed to obtain the modulus of a vector and the value of the sine and cosine as a function of the rectangular components of that vector. By adding 2 sinusoids, the amplitudes of which are proportional to the rectangular coordinates and which are 90° out of phase, another sinusoid is obtained, the amplitude of which is proportional to the modulus and the phase-shift proportional to the argument of the vector. (England.)

COMPUTERS

Storage of Pulses with an Unstable Repetition Frequency. M. I. Finel'shtein. "Radiotek" 15, No. 2 (1960). 4 pp. The effect of the instability of the pulse repetition frequency on the selection of the bandwidth of the frequency characteristic ridges of pulse registers is examined. The equivalent number of pulses which provide an improvement in the signal

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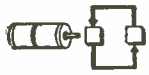
to noise ratio and the permissible value of instability in the repetition frequency are determined. It is shown that with a given pulse repetition frequency and a relatively unstable pulse modulating frequency, the value of the latter should be made small for a large gain in the signal to noise ratio. (U.S.S.R.)

Statistical Methods of Determining Process Dynamic Characteristics with Noises and Analysis of Random Processes with Infra-Low Frequencies, P. Leonov and L. N. Lipatov. "Avto i Tel." Feb. 1960. 11 pp. A computer for calculation of estimates of some statistical characteristics of stationary random functions and of characteristics of linear systems is considered. (U.S.S.R.)

Logarithmic Conversion of Continuous Values into Digital Data (A contribution to the theory of quantization). "Prace ITR." Vol. III, No. 2(8). 7 pp. The author deals with a possibility of designing an equipment to convert continuous values into digital data, based on the phenomenon of loading a capacitor through a resistance. Such a solution permits logarithmic transformation of one value into another. Simple mathematical relations pertaining to the proposed equipment are given. (Poland.)



CONTROLS

Optimum Control of a Non-Linear System, Sun Tsjan. "Avto. i Tel." Jan. 1960. 12 pp. There are analyzed transient processes, optimum as to their highspeed, in the automatic control system including a rotary generator and a dc motor. The motor excitation voltage is considered as the second independent control parameter. The methods of synthesis of the optimum control device are proposed. For example the synthesis of simplified second and third order systems is described. (U.S.S.R.)

The Application of the Describing Function for Investigations into the Stability of Sampled Data Control Systems, W. Oppelt. "rt." Jan. 1960. 8 pp. The transient response of the sampler and hold circuits to a sinusoidal input is represented by the fundamental component of the Fourier expansion of the response. This enables the amplitude and frequency dependent gain components to be plotted separately on the complex gain plane (a modification of the Nyquist Locus) for sampled data control systems. (Germany.)

A Method for the Optimum Control of Systems with Dead Time, H. Schliessmann. "rt." Dec. 1959. 4 pp. The author studies the behavior of a proportional controller with feedback in a control loop having dead time. If the feedback is designed to be an analogue of the controlled plant and provided the controller is suitably dimensioned, it should be possible to compensate for a step disturbance occurring at the output end of the controlled plant after no more delay than the dead time, without overshoot. The drawbacks and limitations of this method are discussed. (Germany.)

Determination of Magnetic Conduction in Systems with Cogged Rotor and Stator, L. S. Sribner. "Avto. i Tel.' Jan. 1960. 7 pp. There is proposed the method of calculating electromagnetic systems with cogged rotor and stator when the width of rectangular notchings is equal to the width of cogs. Magnetic conductance of leakage fluxes through lateral sides, and edges of cogs is taken into consideration. Magnetic resistance of a magnetic circuit is taken into account too. (U.S.S.R.)

Motor Speed Stabilization in the Ward Leonard Motor-Generator Set with the Application of a Simple Magnetic Amplifier as an Exciter. "Prace ITR." Vol. 15, No. 3. 42 pp. The present paper analyzes the work of an automated Ward Leonard motor generator set with a simple magnetic amplifier working as an exciter. First, a review is given of most important schemes of Ward Leonard motor generator sets with the application of a magnetic amplifier, as well as the principle of operation of such a system in which the motor speed should be constant irrespectively of load variations. (Poland.)

GENERAL

Electrical Analogies of Mechanical, Acoustical and Mechano-Acoustical Systems. "Prace ITR." Vol. III, No. 2(8). 62 pp. Electrical systems analogous to mechanical, acoustical and mechano-acoustical systems are formed on the basis of mechano-electrical analogies; acoustical and mechano-acoustical systems are being therefore reduced to corresponding mechanical systems. These latter are then replaced by electrical circuits. Petinent methods are given by applying symbolic calculus on the assumption of mechanical force, acoustic pressure, particle velocity and volume velocity varying sinusoidally. (Poland.)

A Criterion for the Existence of Multiple Roots or of an Even or Odd Number of Conjugate Complex Pairs of Roots in Algebraic Equations, R. Hofmann. "rt." Sept. 1959. 3 pp. It is shown how, for rational polynomials, the square of the product of the differences of the roots can be obtained closed by means of the coefficients. This product gives a clue to the existance of at least one multiple root and it also indicates whether the number of conjugate complex pairs of roots is even or odd. (Germany.)

Electroluminescent Cell Applications, Rolf B. Lochinger & M. J. O. Strutt. "E. & R. Eng." Nov. 1959. 9 pp. The efficiency of some types of electroluminescent (El) cells (i.e., the ratio of the power transformed into visible light to the electrical input power) was measured at various frequencies. Some oscillatorcircuits were investigated with negative results. The time constants of some photo-conductors were investigated theoretically and experimentally. (England.)

Jet Power Effect in Hydraulic Amplifier of the Nozzle-Flapper Type, I. M. Krassov, B. C. Turbin. "Avto i Tel." Dec. 1959. 6 pp. The results of the test investigation of a hydraulic nozzle-flapper type amplifier at different combinations of its parameters are given. The main problem of the investigation is the determination of the jet power effect on the flapper. A brief description of the devices tested, of the programme and the technique of the test is presented. (U.S.S.R.)

Inversing Used to Transform—Class Switching Systems, I. L. Oifa. "Avto i Tel." Dec. 1959. 6 pp. Graphical inversing of plane diagrams is made by the transfiguration method. Possibility of using the method when inversing space diagrams is proved. Although inversing of space diagrams does not lead to getting duality the method is valuable because it allows to transform plane diagrams into space ones. (U.S.S.R.)

MATERIALS

Some Aspects of the Stability of Permeability of Ferrites, R. Smith. "Proc. AIRE." Dec. 1959. 4 pp. This paper deals in brief with some of the more well-known sources of variation of ferrite permeability, and also discusses the lesser known phenomenon of the effect of an intense unidirectional magnetic field and subsequent demagnetisation on the permeability. (Australia.)

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Sources

Evaluation and Use of Military Specifications for Electronic Parts and Materials, L. F. Bennett. "Brit. C&E." Mar. 1960. 3 pp. This article explains the American MIL specifications which are rapidly becoming accepted for electronic parts and materials for the Nato countries. During World War II, engineers first realized the need for standardization of parts and materials. Standard specifications known as the "MIL" or Joint Service Approved Specifications are now in use. The format of these specifications is discussed in detail with an explanation of each section. Then follows advice on specification usage and a clarification of some misconceptions. (England.)

Whiskers, J. E. Gordon. "Brit. C&E." Mar. 1960. 4 pp. Certain long thin needle crystals have come to be called whiskers because of their hair-like appearance and because sometimes they grow out of a substrate. Although whiskers have been known in various forms for a long time as a nuisance or as a curiosity, it is only comparatively recently that their unusual properties have been recognized. (England.)

Investigations on Period of Activity of Mould-Destroying Compounds, Barbara Panfil. "Prace ITR." Vol. III, No. 2(8). 5 pp. Preliminary investigations are reported on period of activity of three fungicides contained in varnishes produced by the paints and varnishes factory in Wloclawek. The mould destroying properties as a function of time have been determined. (Poland.)

MEASURE & TESTING

Certain Problems of the Theory of Reliability of Radio-Electronic Equipment, B. R. Levin. "Radiotek" 15, No. 2 (1960). 8 pp. (Paper read at the Sci. Tech. Soc. of Radio and Electronics on October 31, 1958.) The mathematical theory of reliability gives the engineer the possibility of estimating the reliability of a system from statistically known reliabilities of its elements. This paper provides general relationships for determining the reliability of systems. Asymptotic estimations of values characterizing the reliability of systems for exponential, Rayleigh and normal laws of distribution of the reliability of their elements are derived. A method of estimating the time required for replacement of the faulty elements is indicated. (U.S.S.R.)

A Teleprinter Distortion Spectrometer, G. Funk. "Nach. Z." Mar. 1960. 5 pp. An electronic measuring device is described which indicates the reference distortions of the individual step onsets of teleprinter signals. The total distortion range from −50% to +50% is subdivided into 40 partial ranges of 2.5% each by means of a time scale produced in the equipment. (Germany.)

A Low Conductivity Magnetic Flowmeter, D. R. Lynch. "El. & Comm." Mar. 1960. 2 pp. Simple design changes extend range of magnetic flowmeter system. (Canada.)

RADAR, NAVIGATION

The Importance of Constant Frequencies in CW-Radar Techniques and Methods for Achieving a High Frequency Stability, W. Hersog. "Nach. Z." Jan. 1960. 6 pp. After defining of frequency fluctuations in systems employing a compensation method or the Dopper effect. The frequency stability required for navigation systems is mentioned. (Germany.)

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Sources

SEMICONDUCTORS

Industrial Applications of Semiconductors, J. M. Lambert. "el. & auto." March 1960. 5 pp. Junction diodes can be used with advantage in rectifying circuits. However, peculiar characteristics of semiconductors make it compulsory to pay particular attention to eventual overvoltages and overcurrents. A set of practical curves solves quickly and easily common problems associated with the usual single-phase rectifying circuits. (France.)

Silicon Power Regulators, T. R. Pye. "Brit. C&E." Mar. 1960. 2 pp. (England.)

TELEVISION

The Equipment of the BBC Television Film Studios at Ealing. "BBC Mono." No. 27, Jan. 1960. 27 pp. BBC film production facilities for the Television Service are based at the Television Film Studios, Ealing Green, London, W.5. This monograph describes the operations which are involved and the facilities provided. Descriptions of the technical equipment and areas are included, together with some discussion on the differences between cinema film production methods and television film operations. (England.)

The Effect of Camera Optics on a Television Channel, D. Frenzel. "Nach. Z." Jan. 1960. 8 pp. After the introduction of a term "frequency response for lenses" and an explanation of measurement methods for the "Three dimensional frequency" reproduction, the results from measurements on several lenses are reported and the relationship between the fidelity of reproduction and the aperture as well as the inclination angle of the principal axis is discussed. A list of literature gives a general survey of the appropriate literature. (Germany.)

TRANSMISSION

Waveguides with a Parallelogram Cross Section, A. Ya. Yashkin. "Radiotekh," V. 15. No. 1 (1960). 4 pp. The knowledge of the properties of waveguides with parallelogram cross sections is of practical importance for determining tolerances in the manufacture of rectangular waveguides, and estimating the possibility of their use as transmitting and matching devices. In this article systems of characteristic equations are developed in cartesian and cylindrical coordinates thus providing the possibility of calculating the lower critical type H waves for any waveguide with a parallelogram cross section. The calculations are made on the basis of representing the cross section as a step figure. Some of the calculations are compared with the available experimental data. (U.S.S.R.)

Bipolar Type Negative-Impedance Repeaters Connected with Unloaded Lines, G. Tamburelli. "Alta Freq." Oct.-Dec. 1959. 30 pp. This paper discusses the application of negative-impedance repeaters to unloaded lines; it gives the highest gain compatible with typical conditions of stability. The repeater is supposed to be inserted either at the end or at the middle of the line, in cases of a line terminated either by its characteristic impedance or by a resistance of 600 ohms. (Italy.)

Sources

Methods for Measurements and Adjustments for the Equalization and Supervision of Carrier-Frequency Systems on Symmetrical Cable Pairs, M. Bidlingmaier, et al. "Nach. Z." Jan. 1960. 8 pp. Suitable measurements methods for the leveling and supervision of carrier-frequency systems on balanced lines have been designed. Simplification and reduction of the test service played an important part in the development of the methods. The measurement equipment designed on this principle has been very successful in practical operation during recent years and has simplified the problem of maintaining the quality for carrier-frequency transmissions as recommended by CCITT. (Germany.)

Waveguide Bend, D. Wray and R. A. Hastie. "El. Tech." Feb. 1960. 8 pp. It is often necessary in microwave transmission and test equipment to introduce bends in the waveguide so that the assembly can be fitted into standard cubicles or on to test benches. Such bends, if uncompensated, are equivalent to unwanted circuit elements, and may seriously modify the electrical performance. (England.)

TUBES

Evaluation of Noise Properties of Ultra High Frequency Tubes, B. I. Kurilin. "Radiotekh." 14. No. 12 (1959). 1 p. Normally the noise property of tubes is determined by their equivalent noise resistance and cathode to grid conductance, the latter quantity being a function of frequency. It is proposed to calculate the noise properties of tubes by means of a parameter which only depends on the construction of tubes. A list of Soviet UHF tubes with relevant noise parameters is appended. (U.S.S.R.)

A Range of Pulsed Magnetrons for Centrimetre and Millimetre Waves, J. Verwel & G. H. Plantinga. "Phil. Tech." #1, 1960. 9 pp. Four experimental magnetrons are described for wavelengths of 32, 12, 8 and 4 mm, and with peak outputs of 1100, 70, 80 and 40 kw, respectively. The four magnetrons have virtually the same geometrical proportions. Considerations of similarity show that the wavelength is then proportional, and the magnetic field inversely proportional, to the linear dimensions, and that at the same anode voltage and current the same power is generated. (Netherlands, in English.)

Mathematical and Statistical Methods of Considering Life Data and Their Application to Electron Valves, A. Deixler and E. Rusch. "Nach. Z." Dec. 1959. 6 pp. The increasing application of complicated electronic equipment emphasizes the question of reliability which is subtantially determined by the life of components. The applicability of a simple mathematical law for the life is investigated by means of a statistical model test. Model tests and results from observations on valves lead to considerations according to which life data can be expressed by simple statistical aids. (Germany.)

Power Relations in Tetrode Oscillators at Super-High Frequencies, V. S. Mikhailov. "Radiotek." 14, No. 9, (1959). 6 pp. In this and his previous article in "Radiotek" 12, No. 12 (1957), the author attempts to establish the relations between the electron current and the field of the output resonator in a tetrode oscillator at super-high frequencies. The effect of electron inertia in the anode screened-grid region on the operation of a tetrode oscillator at super-high frequencies is examined. Formulas are obtained for calculating the electron and general efficiency of the oscillator with power amplification and frequency multiplication. These formulas are useful for calculating the operating conditions of the output circuit and for investigating certain types of amplitude modulation. (U.S.S.R.)

Thermistors . . .

(*Continued from page* 118)

Editor, ELECTRONIC INDUSTRIES:

I am very grateful for the opportunity to read Mr. Armstrong's comments and thank you for this privilege. Every author is pleased to obtain comments on his published information. Each comment, even if critical, produces satisfaction and stimulates further thinking.

We have not been complacent in accepting the pleasant result, that the constant B decreases substantially with the temperature, thus extending the application range of our thermistor to much lower temperatures than expected for constant B. Similar considerations as those made by Mr. Armstrong have been made and a quantitative analysis of new experiments is under way.

I have written the theoretical and experimental evidence which gives some hint as to what might be the reason for the observed apparent dependence of B upon temperature. I could not avoid becoming highly theoretical. As far as the comments of Mr. Armstrong are concerned, they touch our explanations in a formal sense.

Our reply tries to explain that we were aware of these possibilities when the paper was presented in Philadelphia. However, we did not see fit to go into these details neither for the audience nor for the readers of *Electronic Industries.*

Here's our explanation:

Considerations To Explain the Apparent Increase Of the Material Constant B In Thermistors With Increasing Temperature

The apparent drastic drop of the constant B in low temperature thermistors has been baffling us. Further, it has stimulated some theoretical considerations and a few model experiments to arrive at some explanations. We, too, have tried to include the temperature dependence of the mobility into the equation for the temperature dependence of the resistivity. Our first effort in this direction was frustrated by the theoretical relationship between mobility and temperature for nonpolar covalent crystals, which is determined mainly through lattice scattering:

$\mu = T^{-3/2}$ which can be derived from the complete equation:

$$\mu = \frac{2^{1/2}\, 6^{1/3}}{4\,\pi^{5/6}} \cdot \frac{N^{1/3}\, e\, h^2\, k^2\, \Theta^2\, M}{m^{5/2}\, C^2\, (kT)^{3/2}}$$

where, μ = atomic mass, and
N = density of unit cells
C = a special scattering parameter
Θ = Debye temperature

It is true that most thermistor materials are polar compounds with ionic bond, possibly with some con-

tribution of valence bond superimposed. However, in this case the experimental data indicate reciprocal relationship between μ and T, which is even empasized by an exponential function.

Examples: BaO $\mu_L = 0.9 \; e^{750/T}$ (Single Crystal)
MgO $\mu_L = 0.72\, e^{1710/T}$
NiO $\mu_L = 60 \; e^{700/T}$ (Mobility of Holes)
ZnO $\mu_L \approx T^{-3/2}$

The preceding equations are valid for pure or relatively pure materials in polycrystalline or monocrystalline form. Thermistors often deviate much from this ideal condition, more than that, they normally represent multicomponent systems which might in some cases form new homogeneous phases of more complex structure (spinels).

However, since there is normally a surplus of one or the other component, the individual phases cannot be considered as pure, but doped with the concentration of the other phase up to the limit of the solid phase solubility.

The mobility of the carriers in doped (extrinsic) semiconductors is less temperature dependent than in pure (intrinsic) semiconductors. The classical experiments of Debye and Conwell[1] show, for a doping with As corresponding to $2 \cdot 10^{15}$ acceptors/cm^3, a reversal of the usual. Mobility decreases with increasing temperature. Mobility vs. temperature curves below this doping concentration run much flatter than $T^{-3/2}$. The maximal mobility increase for heavily doped Ge, resistivity approximately 10^{-2} ohm•centimeter, is 80% between 10 and 200°K.

The mobility of carriers in impure semiconductors is determined by several scattering processes: (a) ionized impurity scattering, (b) neutral impurity scattering, (c) scattering by lattice dilation, and (d) collision between conductivity electrons or holes. Superimposed upon these processes is the lattice scattering by the acoustical vibrations of the lattice atoms, an effect which is dominating for pure (intrinsic) semiconductors. For these various scattering processes, the mobility is determined by the following formulas:

(a) Ionized impurity scattering (formula by Conwell and Weisskhopf):

$$\mu_I = \frac{2^{7/2}\,\epsilon^2\,(kT)^{3/2}}{\pi\, 3/2\left[m^{(N)^{1/2}}\,(qZ)^3\,N_I\right]} \qquad \frac{1}{\ln\left[1+\left(\frac{3\,\epsilon\,kT}{q^2\cdot N_I^{1/3}}\right)^2\right]}$$

N_I = density of ionized impurities of charge q
$m^{(N)}$ = density of states effective mass
ϵ = dielectric constant

(b) Neutral impurity scattering (practically independent of temperature):

$$\mu_n = \frac{1}{20}\,\frac{m_n\cdot e^3\cdot 8\pi^3}{N_N\,\epsilon\,h^3} = \frac{2}{5}\,\frac{m_n}{N_N\,\epsilon}\cdot\left(\frac{e\pi}{h}\right)^3$$

N_N = concentration of neutral impurity per cm^3
m_n = effective mass of a conduction electron

(*Continued on page* 224)

ϵ = relative dielectric constant

The mobility contribution due to lattice dilation is proportional to T, but plays a minor role in impurity semiconductors. The temperature influence of the collisions between holes or electrons on the mobility can also be considered as second order compared to the other processes.

A quantitative analysis of the observed mobilities in impure Ge with regard to the various contributions of scattering has been made by Debye and Conwell. No information of similar completeness exists for oxide systems. Experimentally, it is known that the mobility in NiO doped with Li increases substantially, following an exponential law with an activation energy of 0.10 ev. However, the absolute value of the mobility at 300°K is rather small

$$\left(\frac{.004\ cm^2}{\text{volts second}}\right)$$

compared with values between 100 and 1000

$$\frac{cm^2}{\text{volts second}}$$

for "pure" NiO. In this case, only 2p holes produce conduction. There is, indeed, a chance that several thermistor systems show a similar mobility increase, though this chance becomes less convincing, the higher the temperatures. On the other hand, an increase of the so-called apparent B is also observed in certain systems at higher temperatures. Therefore, it is worthwhile to consider the possibilities which might decide that the observed apparent increase of B is a real one.

Influence of the Temperature on the Energy Cap E_g

All experimental and theoretical evidence indicates that the temperature coefficient of the energy gap is always negative. The following compiles a few of the experimental data:

Energy Gap Temperature Coefficient (All values in 10^{-4} ev)

Si	*Ge*	*InP*	*InAs*	*InSb*
−4.4	−4.0	−4.6	−3.5	−2.7

GaP	*GaAs*	*GaSb*	*AlSb*
−5.4	−4.9	−3.5	−3.5

The decrease of E_g with the temperature can either be explained by the heat expansion of the lattice or the broadening of the energy levels at the bottom of the conductive band and at the top of the valence band, at least as far as polar crystals are concerned, due to collisions between electron and phonons. However, the last effect is quite small in nonpolar crystals. For crystals which have a more polar character and can be even partially considered as ionic, the following Table gives evidence that the energy gap is decreasing with the temperature:

TABLE

	E_g-Optical (ev)	E_g-Thermal (ev)	$(\delta E_g/\delta T)$ Optical (ev)
ZnO	3.3		$-13 \cdot 10^{-4}$
ZnS	3.55–3.77	3.77	$-4.6 \cdot 10^{-4}$ (77°K)
			$-8.5 \cdot 10^{-4}$ (800°K)
ZnS	3.60–3.64		
ZnSe	2.58–2.66		$-7.0 \cdot 10^{-4}$
ZnTe	2.15		
CdS	2.38–2.48		$-4.6 \cdot 10^{-4}$
CdSe	1.74		$-5.0 \cdot 10^{-4}$
CdTe	1.41–1.47	1.43–1.57	$-3.6 \cdot 10^{-4}$

There is only one experimental case found (Cronemeyer[2]) in which an increase of the energy gap was found. It increased in stoichiometric single crystals of TiO_2 from 3.05 ev to 3.67 ev at temperatures above 1200°K. An explanation of the effect is given in terms of band theory.

Conclusions

All the previous considerations fail to give a satisfactory explanation for the partially very steep increase of the material constant B with the temperature in commercial thermistor materials. Our recent experimental investigations suggest that two causes are possible for the increase:

(1) Inhomogeneity of the material which results in a multitude of individual energy gaps.

(2) At lower temperatures only electrons or holes are excited across the smallest gap.

With increasing temperature the density of states becomes larger when electrons can be excited across the larger gaps. It might be useful to compare this phenomenon with a system of smaller or larger bells against which the wind blows. At first the smallest bells will start to ring, however, contributing only a relatively small amount of acoustical energy. With increasing wind velocity the larger bells will fall in the concert and give much more sound energy than the small bells. Naturally this is still an example and should not be translated literally. Another formal explanation for the increase of B can be found in grain boundary conduction prevalent to bulk conduction at low temperature. Also in this case the semiconductor has a spread of energy gaps.

The effective barrier height for a series arrangement of barriers along a conductive path has been derived by Henisch[3]:

$$E = E_0 + \frac{S}{2\,kT}$$

This formula holds true for barriers in series with bulk grains. In many cases the grain boundaries are better conducting than the grains and act in parallel with the grains. In this case,

$$E = E_0 - \frac{S}{2\,kT}$$

It is highly probable that this is the final explanation for our observed effects.

H. B. SACHSE
Research Director
Keystone Carbon Co.
St. Mary's, Pa.

1. Deype and Conwell, *Physical Review*, 93, 693, 1954.
2. Cronemeyer, *Physical Review*, 87, 876, 1952.
3. Henisch, *Philosophical Magazine*, 42, 734, 1951.

New Products

MULTIMETER

Transistorized, electronic DC Multimeter is battery operated and portable. It provides full-scale readings from 100 mv to 1,000 v. Accurate readings can be made down to the

10 mv range. It has 12 current measurement ranges, for full scale readings from 1μa to 300 ma. Five resistance ranges with center scale readings varying from 10 ohms to 100,000 ohms. It has excellent sensitivity, high impedance of 11 megohms and 3% voltage accuracy. Battery life is more than 400 hrs. Motorola, Inc., Communications and Industrial Div., 4501 West Augusta Blvd., Chicago 51, Ill.

Circle 279 on Inquiry Card

OSCILLOGRAPH

Model 603, oscillograph, records up to 50 channels of test data on a 12 in. wide record. Speeds variable from 0.05 to 170 IPS. It uses light-beam type galvanometers with accurate response up to 6000 CPS. Direct writing process with trace writing capability in excess of 30,000 IPS. It requires no chemicals, powders, or heat. It features: forward and reverse record drive; 12 in. viewing table; 350 ft. paper, full width tim-

ing lines produced optically, and optical grid lines produced simultaneously with galvanometers traces. Midwestern Instruments, P. O. B 7186, Tulsa, Oklahoma.

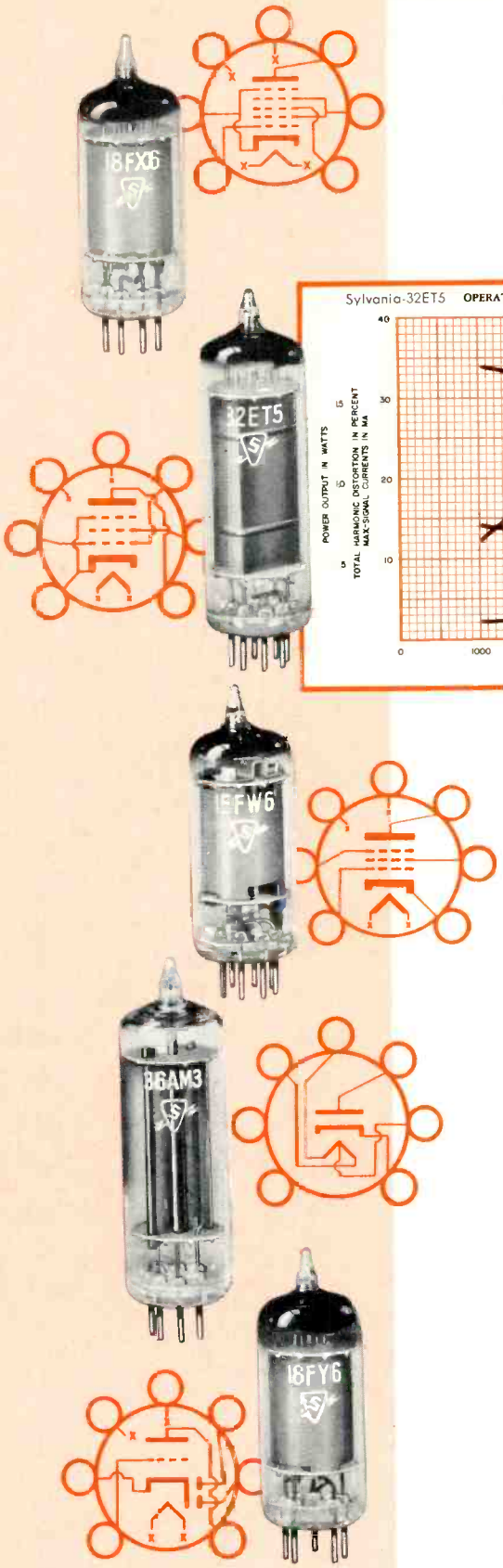
Circle 280 on Inquiry Card

Electron Tube News ...from SYLVANIA

Cool operation sparks home-radio sales when you design around

SYLVANIA 100-mA ALL-AMERICAN FIVE

Originated by Sylvania—the 100-mA All-American Five requires ⅓ less heater power, opens new design possibilities and offers significant merchandising opportunities. Now, tube layout is comparatively unrestricted, cabinet styling is more flexible. Cost reductions in cabinetry, circuitry and components are within easy grasp. Tube reliability is enhanced. Printed circuit techniques can be used advantageously. Here, then, are important advances in home radio design—made possible by the Sylvania 100-mA All-American Five.



Named to the All-American Five are: 18FW6, semi-remote cut-off pentode; 18FX6, pentagrid converter; 18FY6 high mu triode-double diode; 32ET5, beam power pentode; and the 36AM3, half-wave rectifier—a tube complement with proven field experience.

Lower ambient temperatures increase design flexibility and offer substantial economies. Radio cabinets utilizing this carefully mated complement show temperature reductions of 20-25%. The area of the power output tube shows an even greater temperature decrease—as much as 30%. As a result, less expensive plastics can be used. Vertical chassis can be designed without special heat shielding. Placement of the power output tube is no longer critical because of heat—wide, outside "berths" are unnecessary—designs can be compact. Printed circuit boards may be used without deterioration in set life and performance caused by high ambient temperatures.

Tube reliability is increased. Sylvania heater design of the 100-mA line provides for more balanced distribution of the heater voltages in the heater string. Surge voltages across individual tubes are minimized.

Sylvania 100-mA All-American Five can be used in existing 150-mA designs with a minimum of redesign time. The 100-mA tube complement presents many advantages that can be directly translated into consumer benefits and increased home radio sales.

New developments in the 100-mA line. Sylvania is developing further tube complements that will incorporate the inherent advantages of a cooler-operating 100-mA line. These include a four tube line for home radio sets, a complement for FM radio receivers, and two new types that hold exciting possibilities for quantity-produced Hi-Fi.

Your local Sylvania Sales Engineer will gladly give you the whole story on the Sylvania 100-mA line. Call him or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 195, 1740 Broadway, New York 19, New York.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

ARNOLD/TOROIDAL COIL WINDER

sets up quickly...easy to operate...
takes wide range of wire sizes

SPECIFICATIONS:

- Min. finished hole size: .18 in.
- Max. finished toroid O.D.: 4.0 in.
- Winding speed: 1500 turns/min.
- Wire range: AWG 44 to AWG 26
- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: ¼" I.D. to 4" O.D. to 1½" high

LABORATORY USE

- Change wire and core size in 45 sec.

PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

includes all rings, counters and accessories

immediate delivery. literature on request

ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif.
VErmont 7-5313

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Environmental Chambers
AND LOW TEMPERATURE FREEZERS

FOR CONTROLLED ATMOSPHERIC CONDITIONS
Temperature • Altitude • Humidity

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It's one of the most helpful brochures ever published for users of environmental chambers and low temperature freezers.

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Aging of Steel
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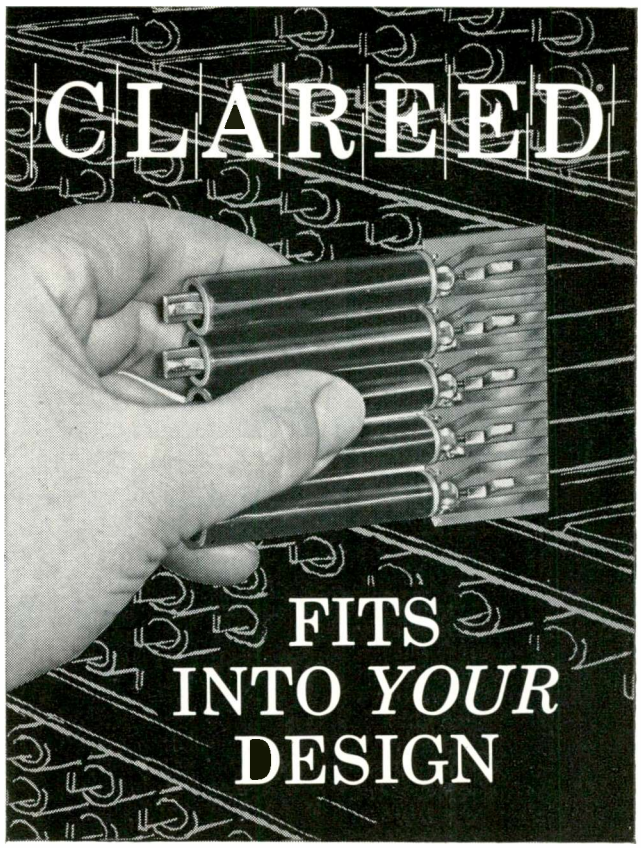
RANGES

Temperature: —225° F. to + 1000° F. (Any temperature desired in this range)
Altitude: 0 to 500,000 ft.
Humidity: 20% to 95%
Capacity: Any size for any application

WEBBER MANUFACTURING CO., INC.
P.O. Box 217E • Indianapolis 6, Ind. • Phone: MElrose 2-1378
Circle 148 on Inquiry Card



CLAREED Sealed Contact Reed relays put you . . . the designer . . . in the driver's seat. They are simple in design, flexible in assembly. They are packaged and mounted to comply with *your* mechanical design configuration . . . even on your own circuit board. CLAREED relays are ideal components for transistor-drive applications, computers, data-processing and other high speed equipment.

Contacts are hermetically sealed in inert gas. Tens of millions of operations are assured since contact contamination is completely precluded. Hundreds of millions of operations are possible when operated up to ½ rated load.

ACTUAL SIZE / Basic element of CLAREED relays is this switch capsule. A pair of magnetically operated contacts is hermetically sealed in a glass capsule, in an atmosphere of inert gas. The capsule combines extreme simplicity and long life. It has excellent low-level characteristics.

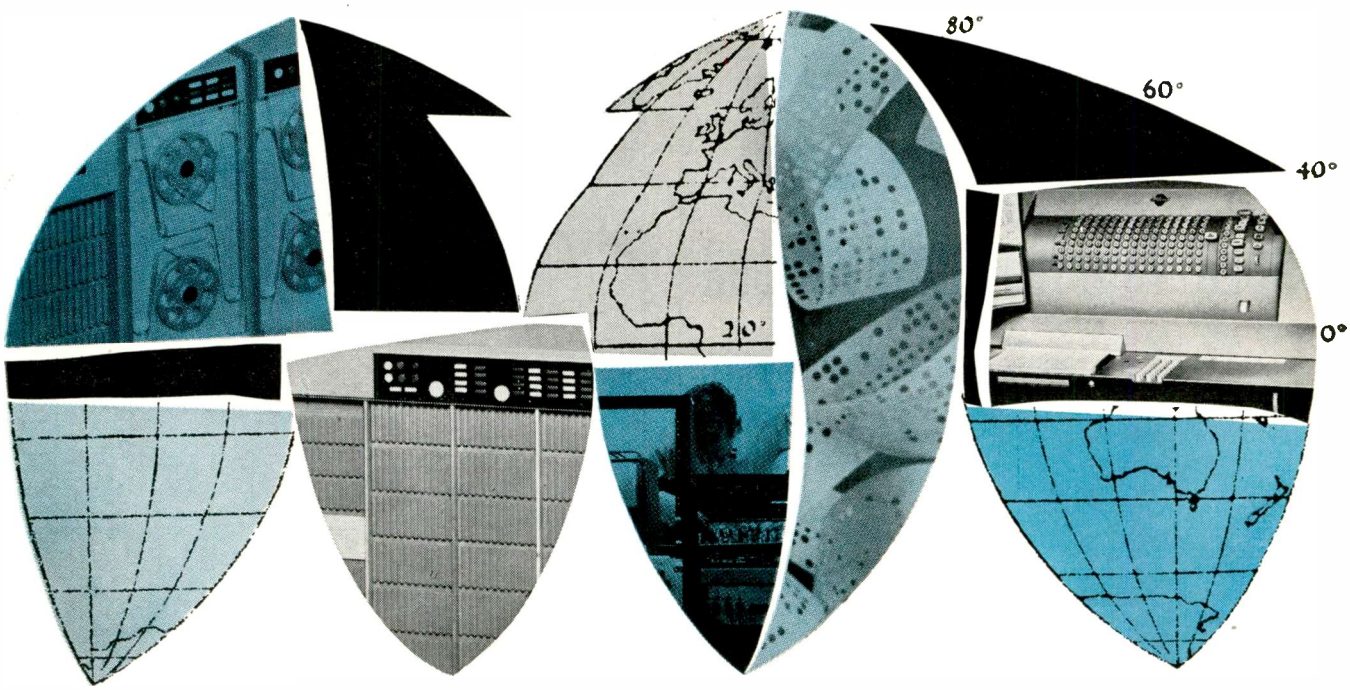
If you use relays, it will pay you to know all about CLAREED . . . an entirely new concept in relay design. Address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario • Cable Address: CLARELAY. *Send for Bulletin CPC-5.*

CLARE

When only the best is good enough

Circle 149 on Inquiry Card

← Circle 303 on Inquiry Card



Commercial expansion at National creates

IMPORTANT DIGITAL COMPUTER R&D POSITIONS IN LOS ANGELES

TRANSISTOR CIRCUITS ENGINEERS —
Senior and Intermediate
Highly creative positions are available in circuit analysis and design. Duties include advanced mathematical studies in transistor circuitry, evaluation of transistor circuitry, component studies and keeping abreast of computer circuit advances. Circuit analysis ability and solid understanding of transistor theory essential. E. E. degree required.

ELECTRONIC DESIGN ENGINEERS —
Senior and Intermediate
To form new group in design of general-purpose digital buffers. Three to five years' logical and transistorized circuit design of digital equipment preferred, with additional background in ferrite magnetic core memories.

ELECTRONIC PRODUCT DESIGN ENGINEERS
To form nucleus of a new product engineering and manufacturing liaison group. Positions require 2-3 years of electronic design experience, preferably in digital computing equipment or transistor circuits.

SENIOR PROGRAMMERS
For development of advanced automatic programming techniques for a general-purpose data processor, acceptance testing, etc. Experience should include construction of auto codes, service-type routines, simulators or diagnostic routines.

TEST EQUIPMENT ENGINEERS —
Senior and Intermediate
To form nucleus of new electronic digital test equipment design-development group. Applicants must have at least 3 years' pertinent experience and some familiarity with digital applications of transistors and/or magnetic cores.

RECENT GRADUATES
Excellent opportunities for recent graduate engineers with 6-18 months' experience. Positions are in the areas of transistor circuit and magnetic circuit techniques, logical design.

Please send resume to N. E. Powell, Personnel Manager

National*
The National Cash Register Company
ELECTRONICS DIVISION
1401 E. El Segundo Blvd., Hawthorne, Calif.
*Trade mark reg. U. S. pat. off.

Circle 501 on "Opportunities" Inquiry Card

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Retirement Policies Due for Changes

Traditional retirement policies of the nation's corporations are slowly crumbling. Several large companies, Consolidated Edison Co. and American Cyanamid Co. for example, have stretched mandatory retirement ages from the traditional 65 to 68 or higher. An International Relations News survey (230 W. 41st St., N. Y., N. Y.) of 28 U. S. corporations reveals a softening of attitudes; 25% of the firms already have instituted flexible retirement systems, and 25% more make frequent exceptions to retirement at 65. The survey points out that the number of workers in the highly productive, eagerly sought 35-44 age group will shrink slightly during the next 10 years. But, the number of older workers will increase 20% and the number of younger workers by 46%.

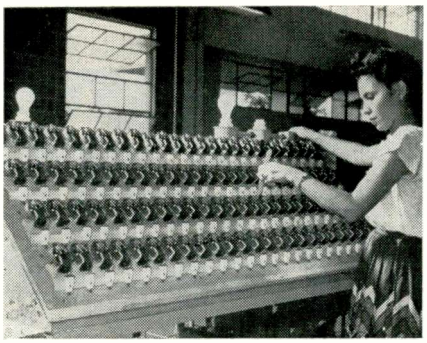
Several job performance studies by the Dept. of Labor reveal that older worker's productivity is as good as that of his younger counterpart. Another study shows older workers to be good re-training risks.

In deciding whether an older worker is still good for his job, most companies that don't have a compulsory cut-off age rely upon work performance. One company reports a star salesman over 78 years old. One large manufacturer requires department heads to fill in questionnaires periodically about employees they supervise who are 65 and over. Questions asked include: Is the worker performing well? Is he absent much? Do you recommend his retention? On this basis the employee may be permitted to remain long past his normal retirement day.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 209.

Puerto Rico's "Operation Bootstrap" Pushes Electronic Industries

The electronics and electrical products industry in Puerto Rico has played an important part in the expansion of the Commonwealth's industry under the "Operation Bootstrap" plan. From a single plant employing 16 people in 1948, this industry has grown to 45 plants employing over 3,000 people by the end of 1958. In the first ten months of 1959, ten plants were started which manufacture products such as: strain gages, transducers, precision wire resistors, circuit breakers, switch gear components, TV picture tubes, photo-electric cells, photograph pick-up elements, and universal motor armatures.



Final motor test (electric shavers) at P. R. Precision Tool Corp., Vega Alta, P. R. Puerto Rico has a reservoir of trained technicians. Commonwealth offers special advantages for firms locating on the island.

The profit picture is bright. For 1958, net profits as a percent of sales average 37.4%. While enjoying the benefits of American citizenship, currency, Federal Courts, Postal Service, Armed Forces and tariff protection, Puerto Rico has always been outside the federal tax system, thus federal taxes do not apply in Puerto Rico. In addition, under the provisions of the Industrial Incentive Act of 1954, electrical products manufacturers in Puerto Rico are, in most cases, free from Commonwealth taxes for the first 10 years of operation.

Industrial space in new one-story factory buildings is available throughout Puerto Rico on a lease or purchase basis from the Puerto Rico Industrial Developing Company. Yearly rentals are as low as $0.50 per sq ft. of floor space. There is a substantial reservoir of factory-trained workers available to fill key spots in new plants. In addition, the labor force, as of October 1959, was composed of 618,000 men and women of which, approximately, 84,000 (13.6%) were unemployed.

U. S. companies having operations in Puerto Rico include: Wel-

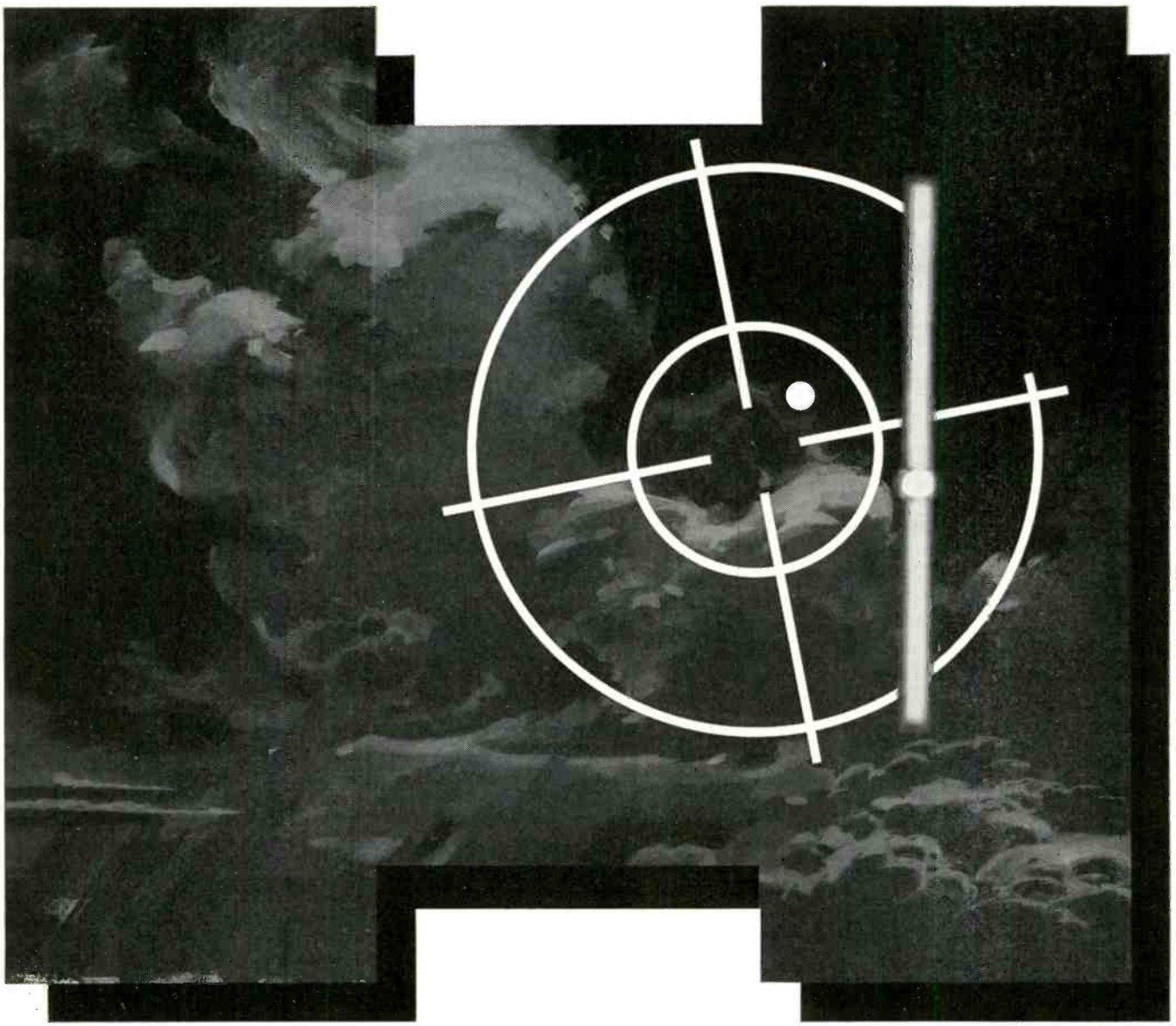
(*Continued on page* 248)

Wanted—Watch Makers

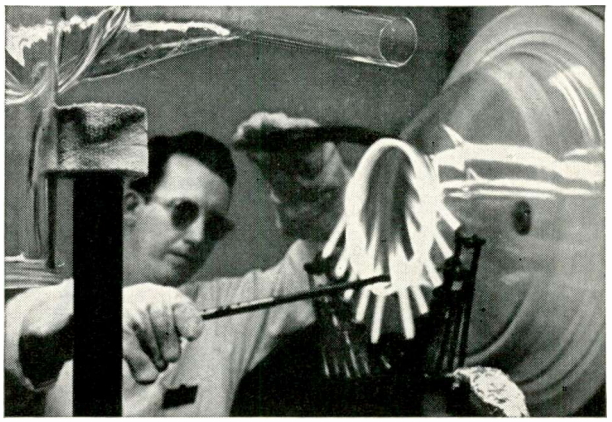
"The pirating of skilled watch makers is becoming a must for the nation's instrument makers," says Dorothy Vogel, Vice Pres. and Gen. Mngr. of Colvin Laboratories, East Orange, N. J. "Precision watch makers," she says, "are among the few skilled workers outside the instrument field who have the experience and ability required to hand-assemble fine and delicate instruments." It is no secret, she says, "that we and similar manufacturers have been getting their specialists from the watch making industry."

The shortage of this type of skilled worker in the instrument field can be attributed to the increased demand for closer tolerances and more accurate instruments. A missile's performance, for example, often depends on the accuracy of a hand-assembled instrument.

How to take a longer look



The development of advanced electron tubes is just one of the many projects now under way at the Hughes Research Laboratories in Malibu, California.



at air space

The problem presented to Hughes engineers: Build an airborne navigation, target acquisition, armament control system of far greater dimension than ever before.

Hughes engineers solved this challenging problem with several important state-of-the-art advances. One of the most significant was the development of a unique and highly advanced Traveling Wave Tube. This tube's two outstanding advantages: 1) higher power to provide greater range; 2) broader frequency band width for greater operational flexibility.

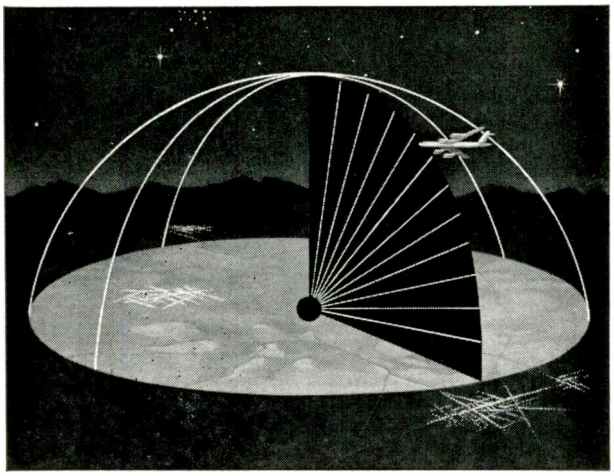
In addition, Hughes engineers designed a radar system that will discriminate against ground return and will detect targets at extreme ranges. Designed to operate in a "hard" counter-measures environment, the radar system was augmented with infrared detection and tracking.

This, and many other Hughes activities in virtually every area of advanced electronics provide the far-seeing engineer with a wide choice of interesting assignments.

A few representative project areas include: advanced data processing systems, molecular electronics, hydrofoil systems, anti-submarine warfare systems, advanced 3-D surface radar systems, space vehicles, nuclear electronics, miniaturized communication systems, ballistic missiles, infrared devices—and a great many others.

The commercial activities of Hughes have many interesting assignments open for imaginative engineers to perform research, development, manufacturing of semiconductors, storage tubes, microwave components, radiation devices, and microwave tubes.

Whatever your field of interest, you'll find Hughes' diversity of advanced projects gives you widest possible latitude for professional and personal growth.



FRESCANAR is a Hughes development that gives umbrella-like radar protection. It positions radar beams by electronic rather than mechanical means.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	RF Network Engineering
Infrared	Microwave & Storage Tubes
Solid State Physics	Communications Systems
Digital Computers	Inertial Guidance
Reliability & Quality Assurance	Field Engineering
Systems Design & Analysis	Circuit Design & Evaluation

Write in confidence to Mr. R. A. Martin
Hughes General Offices, Bldg. 6-C5, Culver City, Calif.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu, Oceanside, Santa Barbara and Los Angeles, California; Tucson, Arizona

Decimal classification system provides the most versatility in sorting, and cataloging technical articles. With proper subdivisions it is a simple matter to find all the material published on a given subject.

A Filing System for

TWO types of information supplied by technical periodicals are essential for advancement in research, development, design, and production:

1) Detailed descriptions of latest developments in components, arrangements, and methods; published in magazines years before a description is taken up by engineering handbooks.
2) Worked out solutions of special problems, too uncommon to be treated at all in handbooks.

Considering the broad background of modern industry, we can suspect that somebody else, before us, has been faced with almost any one of our special problems. Others may even have put considerable effort into working out details to a high degree. Results of such efforts are likely to have been published in a previous issue of a periodical.

Nevertheless, we utilize only a fraction of the immense help these publications offer. Most engineers are too busy to read their periodicals in every detail. Therefore, some only concentrate on topics with which they are presently concerned. Others glance over every feature carelessly. Either way, a great amount of information is missed on subjects or details which might be useful to know sometime in the future.

Besides this, human memory is not perfect. How many of the details you read today will you remember a year later? And how much after three or five years? What can be done when we run across a problem that was discussed long ago in a periodical? How can we find a particular article if, at the best, we vaguely remember to have read about the matter sometime ago?

Let us take an example:

How can a designer approach a specific unusual problem? We assume that he realizes he has a good chance to find a ready solution somewhere in the periodicals of his library. They are all there, more than a hundred nicely bound books, each containing an annual set of one of a dozen different magazines.

There are two common ways: Either he knows from experience that a search through previous periodicals is a time-consuming and sometimes fruitless job. Thus he tries to solve the problem by himself. In most cases, this means wasting time by duplicating other people's effort.

The other way is to try to find previous publications on the same problem. This usually means going through a great number of annual indices of the various periodicals related to the subject. Each index may refer to several similar publications, each of which has to be dug out. Examining them, he may find that most do not answer the very specific problem. Or at least, the question remains: further back, could there not be a more suitable solution? This procedure usually wastes many hours.

Could there be a third, a better way? Can you imagine how convenient the following system would be:

Your previous year's periodicals are not bound as annual sets. Instead, each issue has been taken apart, and the various articles are classified and kept in folders according to subject. Moreover, you have a clearly subdivided index to tell you which section of which folder contains all material on a specified subject.

In this way, you have in less than a minute, complete information about your specified problem at hand, out of all issues of the various competent magazines, from all your previous issues. Whether you want to study the problem intensively, to compare previous solutions, or only to look for a little detail, it will always be worthwhile to use this file.

Among the agencies interested in the problem of indexing technical articles the most vitally concerned are the libraries. A joint study is being conducted by the two principal library associations to come up with an answer. For details on the progress, write:

Mrs. Marjorie R. Hyslop, Chairman
Committee on Special Classifications,
Special Libraries Association,
31 East Tenth St.,
New York 3, N. Y.

or

Mrs. Phyllis A. Richmond, Chairman
Cataloging and Classification Section
Resources and Technical Services Div.,
American Library Association
50 E. Huron St.,
Chicago 11, Ill.

By KLAUS H. JAENSCH
Sr. Electronics Engineer,
Stromberg-Carlson Co.,
Rochester 3, N. Y.

Technical Articles

Saving Engineering Time

Benefit of the suggested filing system can be expected to influence every stage of our industry.

In the phases of research, development, design, and production engineering, millions of engineering hours could be saved.

The largest item in this estimate is engineering time wasted by duplicating efforts on problems which have already been discussed in professional magazines. A smaller item is the time consumed by occasional attempts to search through previous issues for a certain subject.

Another saving to be expected is in making the services of young engineers more productive from the beginning. The same applies for senior engineers changing to a different field. The relevant experience of both consists mainly of basic engineering, as can be rechecked in text-books and engineering handbooks. Professional periodicals can supply them with up-to-date knowledge in their specialized new field. But, to make immediate and full use of this source, the various subjects have to be easily accessible.

Index To The Subject

As the basis of the filing system, an index to the subject has to be established. A decimal classification system is believed to be the most versatile. There are different possibilities of dividing the material into major branches. The author composed an index of this kind for his own use. It is shown herewith as an example, but not at all as an incontestable pattern. Only in the first branch, subdivision is carried out to a practicable degree.

Since the benefit of the system increases with the number of publications citing the same index, the goal is to establish a nation-wide accepted index. This index could preferably be worked out by a joint effort of major publishers, industrial and professional organizations, and the Department of Commerce's technical information service.

The final decimal index to the subject should be reprinted periodically. Besides it, the individual magazines may publish other indices in the customary shape for their own material, as an alphabetical, and one by authors. Usually terming issue and page, these indices should now refer to the category of the Decimal Index as well.

The first index may comprehend the Electrical field only, from which the system originated. After it proved worthwhile, other fields will probably join with similar indices. This may be coordinated by a prefix to the code number, for example, letter E for Electrical, M for Mechanical, S for Science, and others for Chemistry, Medicine, Construction, Industrial Organization.

Each Article Classified

The second requirement takes even less effort. The editor has to classify each article he publishes

Filing System *(Continued)*

according to the decimal index. The proper code number may be printed above the headline.

For the purpose of separating articles, we have to dispense with the fancy arrangement of pages which became common since several years: Features should preferably start on the right-hand page of the open book. No two worthwhile articles should overlap on a page. Inserted smaller advertisements can always fill up a leaf. Preferential full-page ads may be placed on a right-hand side, and may be marked by the index-code as well. This would make them useful as a permanent reference for the subscriber, and would accomplish the desire of the advertiser in the best way.

Effort of Subscriber

Reading through the magazine, one will hardly notice the change. The subscriber is free to keep the issues the old way, if he prefers to do so.

On the other hand, he may start to take advantage of the new filing system any time. To do this, the periodical issues are taken apart, and the articles of each

(*Continued on page* 238)

Classification Index for Reference Material—Electrical Field

10 ELECTR. COMPONENTS

11 Connect. & Transmiss. Comp.
- 11-1 Materials
  - -11 Conduct. Mat.
  - -14 Insult. Mat.
- 11-2 Wire & Cables
- 11-3 Connectors
- 11-4 Printed Circuits
- 11-5 Chassis, Modules
- 11-7 UHF Wave Guides
- 11-8 Antennas

12 Switches & Relays
- 12-1 Elements of Switches
- 12-2 Manual Sw.
- 12-3 Fuses
- 12-4 Thermo & Spec. Sw.
- 12-5 Relays
- 12-6 Rotary, & XY Sw.
- 12-7 Choppers
- 12-8 Electronic Switches

13 Resistors
- 13-1 Metallic Res.
- 13-3 Non-Metallic Res.
- 13-8 Non-Linear Res.

14 Capacitors
- 14-1 Fixed Cap.
- 14-2 Variable Cap.
- 14-8 Voltage Variable Cap.
- 14-9 Theory of Cap.

15 Inductors & Magnet. Comp.
- 15-1 Power & Audio Tr. & Chokes
- 15-2 HF Transf. & Chokes
- 15-4 Memory Cores
- 15-6 El.-Magnets & Solenoids
- 15-7 Perman. Magnets
- 15-8 Magnet. Shielding
- 15-9 Magnet. Theory

16 Tubes, Transistors, Rectifiers
- 16-1 Control Tubes
- 16-2 Transistors
- 16-3 Rectifiers
- 16-4 Picture Tubes
- 16-8 Special Tubes

17 Transducers
- 17-1 Photo Transd.
- 17-2 Radiation Det.
- 17-3 Crystals
- 17-4 El.-Mech. Transd.
- 17-8 Other Transd.

18 Other Electr. Components
- Batteries
- Illumination Comp.

20 ELECTR. DEVICES

21 El. Motors & Generators
22 Meters
23 El.—Acoust. Devices

28 Networks: Tank; Filter; Delay-Line

30 ELECTRON. CIRCUITS & APPARATUS

31 Power Supplies
32 Oscillators
33 Amplifiers, VTVM
34 Wireless Transm. & Receivers
35 Electron. Counters
36 Oscilloscopes, Recorders
38 Electron. Measur. Apparatus
- 38-1 Reactance
- 38-2 Freq., Time, Phase
- 38-3 RF Power
- 38-4 HiPot Test
- 38-5 Tube, Transistor Test
- 38-6 Automatic Test
- 38-8 Other Measur. & Test App.

40 El. PRODUCTS & UTILITIES

41 El. Power Stations & Transm.
42 Telephone, Telegraph
43 Radar
44 Remote & Automatic Control
45 El. Appliances
46
48 Other El. prod. & util.

50 INDUSTRIAL

51 Tools, Machine Tools
52 Production Methods
54 Autom. Production
56 Packing, Shipping
57 Personnel
58 Financial

60 OTHER SCIENCES

61 Mathematics
62 Mechanics
63 Chemistry
64 Optics
65 Medicine

Filing System

(*Continued from page* 236)

sorted out in a prepared file. Any kind of file can be used. For the individual subscriber, a few bookfolders may be convenient. At the beginning, he may divide his file into major branches only. In the files in which most material accumulates, he may start separating subdivisions by sheets of cardboard. As soon as the material exceeds the capacity of a folder, a new one can be inserted.

For libraries, labeled covers for the various subdivisions, kept in filing drawers, may be preferable. Since the decimal code is printed on the head of each article, filing can even be done by office helpers not familiar with the subject. After the system has been established, one person should be able to maintain the file for more than a dozen of periodicals. In larger plants, one copy of each periodical may be filed immediately in a central place (library). Various departments may file separately, after their own additional copies are circulated.

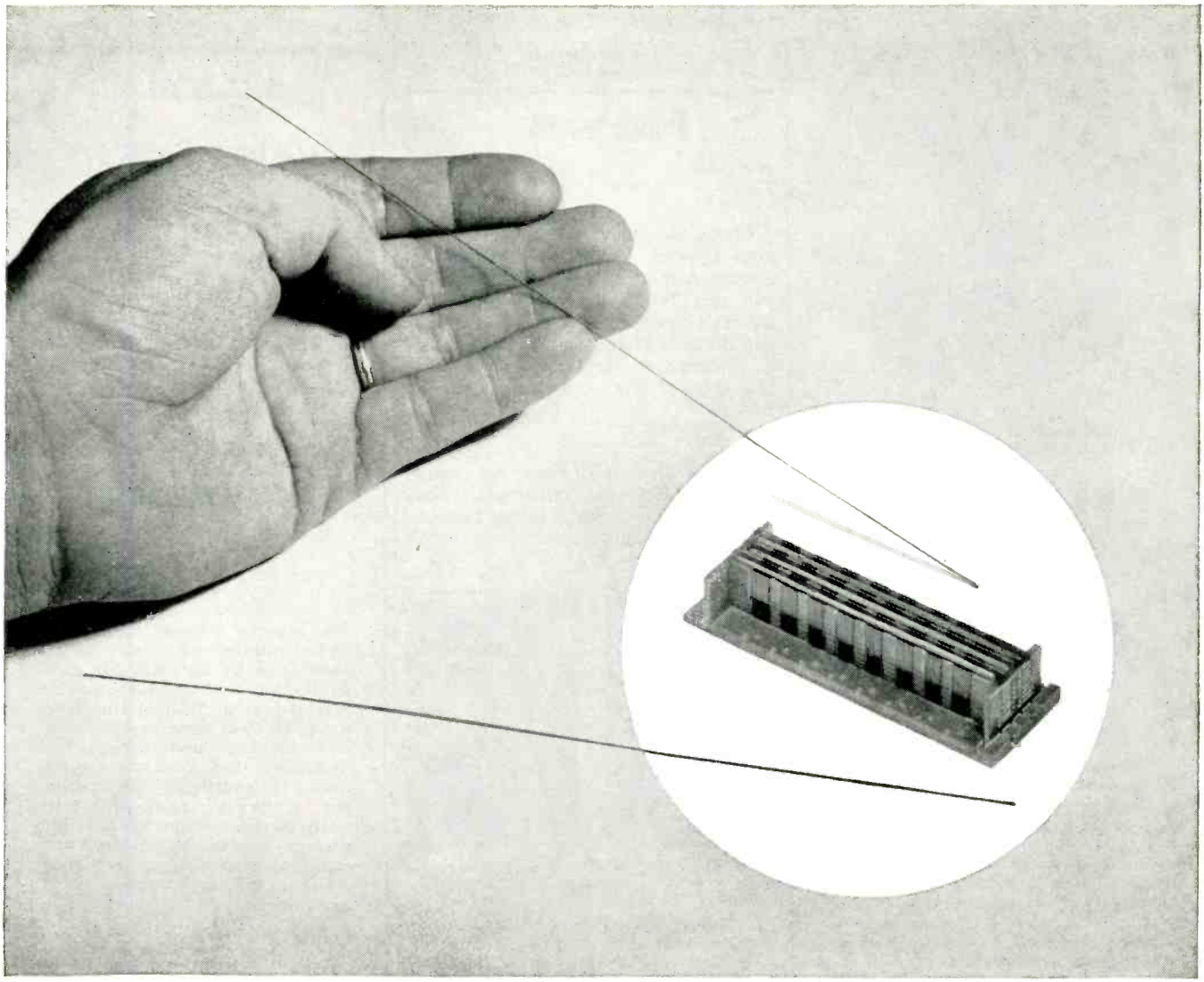
The system would even save time in reading periodicals. The individual does not need to read the entire issue as thoroughly if he can be sure to find particular subjects he may be interested in at some other time.

For further increased benefit, various other technical information could be kept in the same file. This applies to reprints of former articles, brochures on products, and general publications of special manufacturers, instruction manuals of instruments and machinery, reports about own developments, and similar worth-while material.

New Research Laboratory

General Telephone & Electronics Laboratories, Inc., a subsidiary of General Telephone & Electronics Corp., is acquiring land in Palo Alto, Calif., for future research facilities.

Donald C. Power, Chairman and Chief Executive Officer of GT&E said that "it would be premature to discuss when the new labs would be built, but the purchase affords us a site in an area of high technical and academic skills.



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ADVANCED ENGINEERING DEVELOPMENT: High-speed switching circuits, random access memory systems, circuit design (conventional, printed, etched), advanced electron beam type storage. The location of the new NCR Research and Development Center is progressive, energetic Dayton, Ohio. Facilities are extensive—a veritable "city within a city."

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Industry News

Clyde Skeen, Vice-President, Weapons System Program Management, Boeing Airplane Co.'s Aerospace Div., will join Temco Aircraft Corp., Dallas, Tex., as Executive Vice-President and General Manager, and **Dr. Charles K. Hager** has been named Section Manager of the Automatic Controls Div.

Robert Goldsmith has been promoted to Manager, Contract Engineering at Associated Testing Laboratories, Inc., Caldwell, N. J.

R. Goldsmith

S. Wiesner

Sidney Wiesner, is now Quality Control Manager at Rheem Semiconductor Corp., Mountain View, Calif. He was formerly with General Transistor Corp.

Robert E. Dailey, Assistant to the Vice-President and General Manager of the Telecommunications Div. of the Stromberg-Carlson Co., Rochester, N. Y., has been named Assistant to the Director of the Communications Industries Div., Business and Defense Services Administration, U. S. Department of Commerce.

John K. Rondou, has been named Vice-President and General Manager of Computer-Measurement Co., Sylmar, Calif., a div. of Pacific Industries.

William Smallwood has been appointed Superintendent of Production Control for Ratigan Electronics, Inc., Glendale, Calif.

James A. McBride is now Vice-President-Finance of Monogram Precision Industries, Inc., Culver City, Calif.

Executone, Inc., New York, has elected **Frederick Zissu** and **Richard I. Palmer** to the Board of Directors.

Industry News

James S. McDonnell, Jr., President of the McDonnell Aircraft Co., has been elected Chairman of the Board of Governers of the Aerospace Industries Assoc. Other officers named: **J. V. Naish**, President of Convair, elected Vice-Chairman of the Board; **Leland D. Webb** and **George F. Hannaum**, both AIA Staff Executives, re-elected as Vice-Presidents, with Mr. Webb continuing as Manager of the West Coast office of the AIA and Mr. Hannaum as Assistant General Manager of the AIA. **Harrison Brand, Jr.** was renamed as Secretary-Treasurer, and **Samuel L. Wright** was re-elected as Assistant Secretary.

Rudolph J. Napolitan has been named General Manager of the National Electronics Conference. He was formerly General Sales Manager of A.R.F. Products, Inc., and Assistant General Sales Manager of Permoflux Corp.

ESC Corp., Palisades Park, New Jersey has announced the appointment of **Seymour M. Miller** to its management staff as a Time Study and Methods Engineer. He was formerly with General Instrument Corp.

S. Miller

H. Berglund

Herman G. Berglund has been elected a Vice-President of Victoreen Instrument Company, Cleveland, Ohio.

The election of **Ross D. Siragusa, Jr.**, and **Harris Hesketh** as Vice-Presidents of Admiral Corp., Chicago, Ill., has been announced.

The election of **Robert E. Lewis**, President of Sylvania Electric Products Inc., as a Trustee of the Polytechnic Institute of Brooklyn has been announced.

James O. Weldon and **Lee D. Webster** have been elected to the Board of Directors of Ling-Altec Electronics, Inc. They were also named to the Executive Committee, and Mr. Webster was promoted from Vice-President to Executive Vice-President. **G. Emerson Pray** has been elected a Vice-President.

Industry News

Roderic L. O'Connor, a former Assistant Secretary of State, has been elected to the Board of Directors of CIRA States Limited and of CIBA Pharmaceutical Products Inc.

The election of **Ernest W. Williams Jr.**, Professor of Transportation in the Graduate School of Business at Columbia University, as a Director of ACF Industries, Inc., has been announced. He has served with a number of government agencies, including the National Resources Planning Board, the War Production Board, the Bureau of the Budget, the National Security Resources Board, the first Hoover Commission, the President's Committee on Transportation Policy and Organization (the Week's Committee), and the Office of Defense Mobilization, for which he still acts as consultant.

Harry G. Mason is now Assistant Secretary of Tung-Sol Electric Inc., Newark, N. J.


H. Mason


G. Bieging

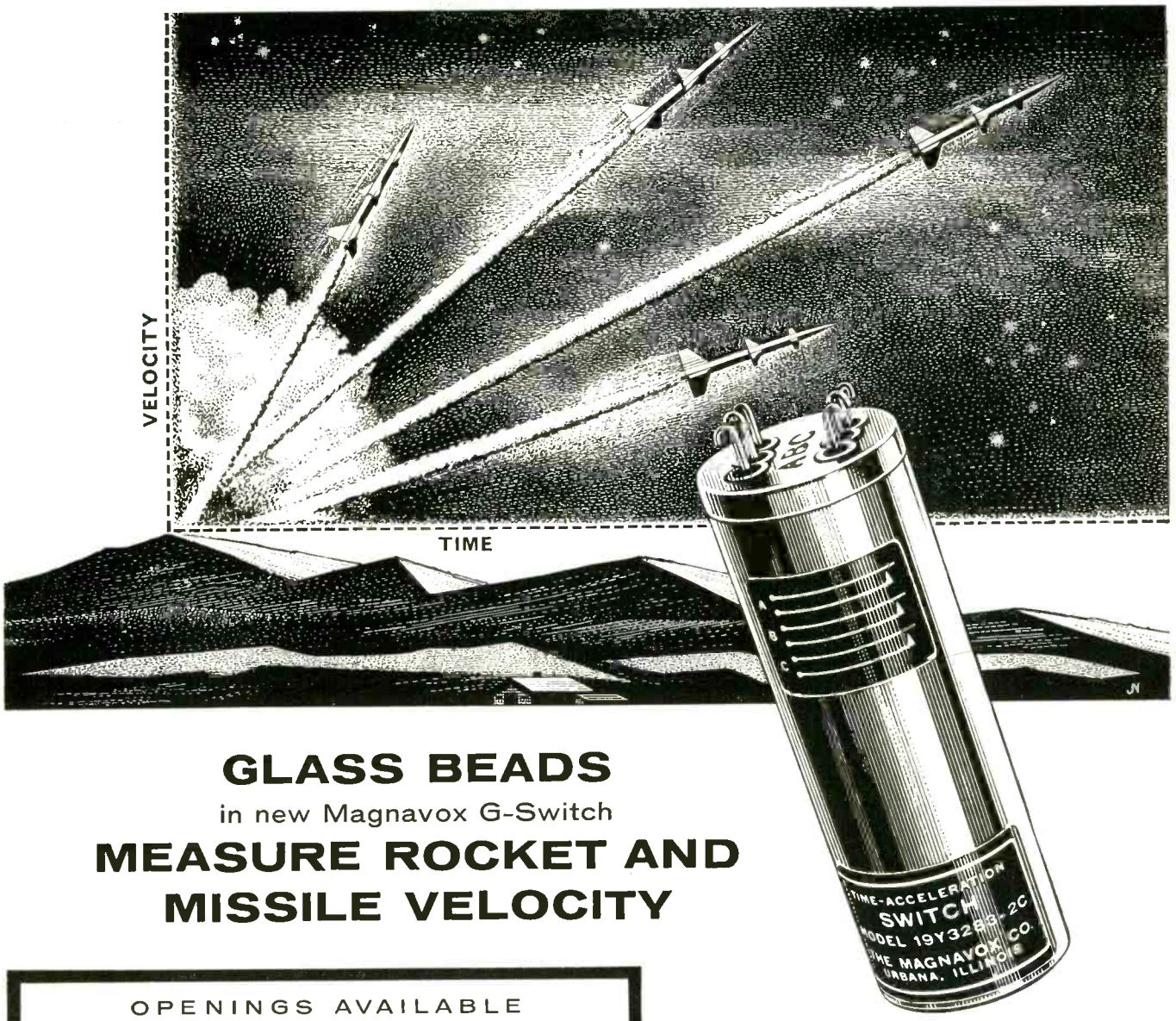
Glen P. Bieging has joined Packard Bell Electronics Corp. as Vice-President, Marketing, of the company's new Defense and Industrial Group.

R. W. Gilbert, Vice-President, Research and Development, Industrial Products Group, Daystrom, Inc., has been named a Fellow of the IRE "for applications of electronics to measurement techniques."

Malcolm C. McWeeney has been appointed Manager, Data Processing Systems Operation, Electronic Data Processing Div., Radio Corp. of America.

Jack Larsen is now Manager of the Special Projects Dept. of General Devices, Inc., Princeton, N. J.

John M. Thompson, Chief of the Test Facilities Lab. at Rome Air Development Center, has resigned his government post to become Vice-President and General Manager of Itemlab Inc., Port Washington, N. Y.



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Circle 510 on "Opportunities" Inquiry Card

News of Mfrs' Representatives

REPRESENTATIVES WANTED

Manufacturer of wire and cable wants representatives in the Chicago area, the Denver, Utah, New Mexico area and in the Upstate New York area. Contact: Richard A. Hyer, Sales Manager, U. S. Wire and Cable Corp., Progress and Monroe St., Union, N. J.

The Williams Equipment Co., Metairie, La., is now sales representative in the New Orleans area for Automatic Timing & Controls, Inc., King of Prussia, Pa.

Mid-Eastern Electronics, Inc., has appointed **Houser Assoc.**, Washington 5, D. C., to handle its line in Virginia, Maryland, West Virginia and the District of Columbia.

Key Electronics, Inc., Hollywood, Calif., is now representative for Bill Jack Scientific Instrument Co., Solana Beach, Calif.

The appointment of **R. S. Puleo**, Lynbrook, L. I., N. Y., as sales representative in the New York City-Northern New Jersey area has been announced by Valpey Crystal Corp., Holliston, Mass.

Instruments for Industry, Inc., Hicksville, N. Y., has appointed 2 new sales representatives. They are: Parrish Electronics, Denver, Colo., and the **Ben Z. Rubin Co.**, Oak Park, Ill.

New representatives for Universal Transistor Products Corp., Westbury, L. I., N. Y., are: **M. Clifford Agress**, Valley Stream, N. Y., in Northern New Jersey, Metropolitan New York, Lond Island and Southern New York including Westchester County territory; **Northwest Sales and Engineering**, Seattle, Wash., in Northern California, Oregon, Washington, Montana, Idaho and Alaska territory; and **Zaslow Sales Co.**, West Hartford, Conn., in the New England territory.

Skysweeper, Inc., McHenry, Ill., has appointed **Mel Foster**, Minneapolis, Minn., as representative in the Twin Cities area.

Kyokuto Boeki Kaisha, Ltd. (Far East Mercantile Co., Ltd.), Tokyo, is now sales representative for Computer Control Co., Inc., in Japan.

National Semiconductor Corp., Danbury, Conn., has appointed 2 new representatives. **Arthur L. Perkins Co.**, Syracuse, will cover upper New York state. In the New England area, **Sales Engineering Co.**, Newtown, Conn., will provide technical and sales service representation.

News of Mfrs'
Representatives

The appointment of new field sales representatives by Harco Laboratories, Inc., has been announced. They are: **C. M. Sallee & Associates**, Atlanta, Ga., in North and South Carolina, Georgia, Mississippi, Alabama, and Florida; **The John W. Richardt Co.**, Pine Brook, N. J., in northern New Jersey, southern New York state and metropolitan New York; **The Hyde Electric Co.**, Denver, Colo., in Idaho, Montana, Wyoming, Western Nebraska, Utah, Colorado, Arizona, and New Mexico; **The Electronic Applications Co.**, Syracuse, N. Y., in northern New York state; **Paul R. Sturgeon, Inc.**, Boston, Mass., the entire New England area; and **The G. W. Moler Co.**, Erlton, N. J., in Maryland, Delaware, Virginia, District of Columbia, eastern Pennsylvania and southern New Jersey.

The Electric Products Div. of Vickers Inc., St. Louis, Mo., has appointed **W. G. Kerr Co.**, Pittsburgh, as representative in parts of Maryland, West Virginia and Ohio in addition to all of Pennsylvania. Two new semiconductor representatives are: **Wilson H. Zimmerman**, Syracuse, N. Y., in New York, excluding New York City and several adjacent counties; and **Harold L. Newnan**, San Mateo, Calif., in Northern part of California as far south as Monterey.

Thomas Electronics, Passaic, N. J. has appointed **Ridgway Associates, Inc.**, Chicago, Ill., as representative in Indiana, Illinois, Wisconsin, Minnesota, Ohio, Kentucky, West Virginia and Western Pennsylvania.

New representatives for Atohm Electronics, Sun Valley, Calif., are: **Ridley Associates**, Chicago, covering Illinois and Wisconsin, and **Paul A. Bjork**, San Diego, handling San Diego County.

Advanced Acoustics, Inc., Nutley, N. J., has appointed **Fields & Simon Sales Co.**, Montclair, N. J. as sales representative for Metropolitan New York and Northern New Jersey.

The Jack Berman Co., Los Angeles, Calif., is now rep for Tru-Ohm resistors and rheostats in the southern California area and the Arizona area.

Roburn Agencies, Inc., New York, N. Y., is now export rep for Electronic Instrument Co., Inc.

Kiva Sales Co., Phoenix, Ariz., has become rep for Mid-Eastern Electronics, Inc. for the entire state.

Scientific Sales Engineering Co., Atlanta, Ga., will now serve as southern rep for General Measurements Co., Inc.

Personals

George V. Woodrow, Jr., is now Director of Weapons Systems Engineering for Philco Corp.'s Government and Industrial Group, Phila., Pa.

Data-Control Systems, Inc., Danbury, Conn., has appointed **William S. Schueler** Head of the company's Design Engineering Group within the Research and Engineering Div.

Frank H. Bower has joined the Semiconductor Div., Sylvania Electric Products Inc., Woburn, Mass., as Engineering Administrator.

Dr. P. S. Christaldi has joined G-V Controls Inc. of Livingston, N. J., as Manager of Engineering. He had been Product Manager, Nuclear Systems, for Curtiss-Wright Corp.

Raymond E. Lafferty is now Chief Engineer at Boonton Electronics Corp.. Morris Plains, New Jersey. He was formerly Assistant Chief Engineer at the Daven Co.


R. Lafferty


J. Weseloh

John W. Weseloh has been appointed Chief Engineer of the U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J. He was formerly Deputy Chief Engineer.

Solomon Charp is now Manager of Navigation and Control Equipment for General Electric's Missile and Space Vehicle Dept. in Phila., Penna. He was formerly a member of the research staff of the Franklin Institute in Phila.

Microtran Co., Inc., Valley Stream, New York has announced the appointment of **Charles A. Langabeer** as Chief Transformer Design Engineer.

R. C. Jones has been named Acting Supervisor of the newly formed Plasma Physics Branch at the Physical Sciences Laboratory of Melpar, Inc., Falls Church, Va.

Allen G. Gatfield is now Assistant Director of Engineering at Rixon Electronics. He was formerly Project Manager of ITT Laboratories' Components and Instrumentation Laboratory.

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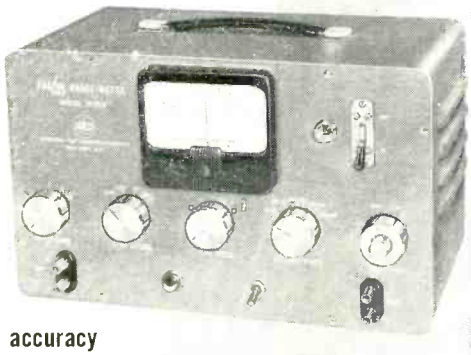

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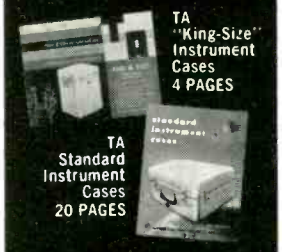

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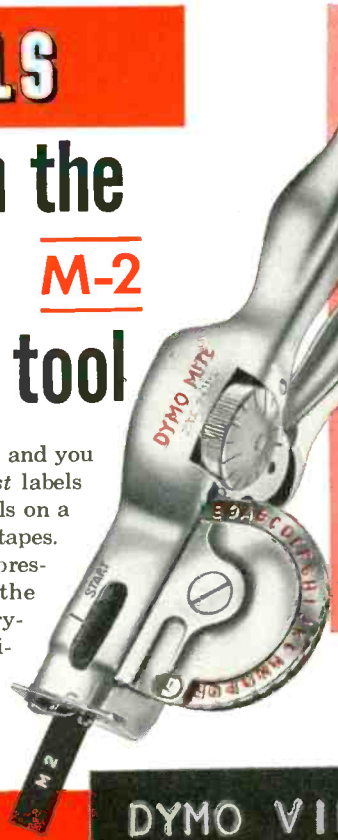

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"Bootstrap"

(*Continued from page* 231)

ler Electric Mfg. Co., General Electric, Proctor Electric, Weston Electrical Instrument, National Video, Sprague Electric, and Potter Instrument.

For more information on "Operation Bootstrap" write to: Commonwealth of Puerto Rico, Office of Public Relations, Economic Development Administration, 666 Fifth Ave., New York 19, N. Y.

Campus Recruiters Are Doing A Good Job—But!

Most campus recruiters do a good job for their companies, but there is ample room for improvement in recruiting practices. This was pointed out in two surveys by the American Management Association, 1515 Broadway, New York, N. Y.

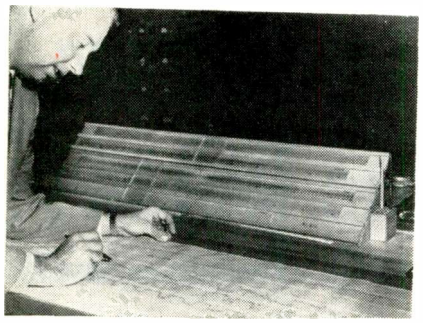
Both surveys—one of college placement officers and the other of company personnel executives—are part of a research report on employment interviewing practices to be published by AMA later this year.

Suggestions made by placement officers include: recruiters should spend more time discussing a candidate's interests and qualifications and less time on information about the company that can be presented in written form; recruiting literature should include specific job descriptions rather than generalizations and "glamorizing"; students should be told what the beginning job will be like so they will not feel "railroaded" when they are assigned menial tasks.

Placement officers at liberal arts colleges had a few points of their own: in spite of all that has been said by top management, there is still too little emphasis on general education; recruiters are afraid of the student who is "different" even though he could turn out to be their best bet on a long-term basis; since the broadly-trained liberal arts graduate doesn't fit neatly into a pattern, recruiters are often at a loss about how to deal with them.

Suggestions for improvement originating with company spokesmen include: plan better to know what jobs actually will be available; provide more plant participation in recruiting; improve briefing of recruiters before they reach the campus; broaden recruiters' knowledge of company-wide activities; and improve literature sent to the campus.

DATA FROM VANGUARD 1



Dennis Faherty, engineer at Ft. Myers, Fla. Minitrack station, marks chart of data telemetered from Martin Co.'s Vanguard 1 satellite. In orbit two years, artificial moon has traveled 281,495,400 mi.

David Sarnoff Fellowships

Ten employees of RCA have been awarded graduate study fellowships for 1960-61. The fellowships, increased in value from $3,500 each to as high as $6,000, include full tuition and fees plus an allowance for books, a stipend of $2,500 to $4,000 depending upon the Fellow's marital status, and $1,000 as an unrestricted gift to the university.

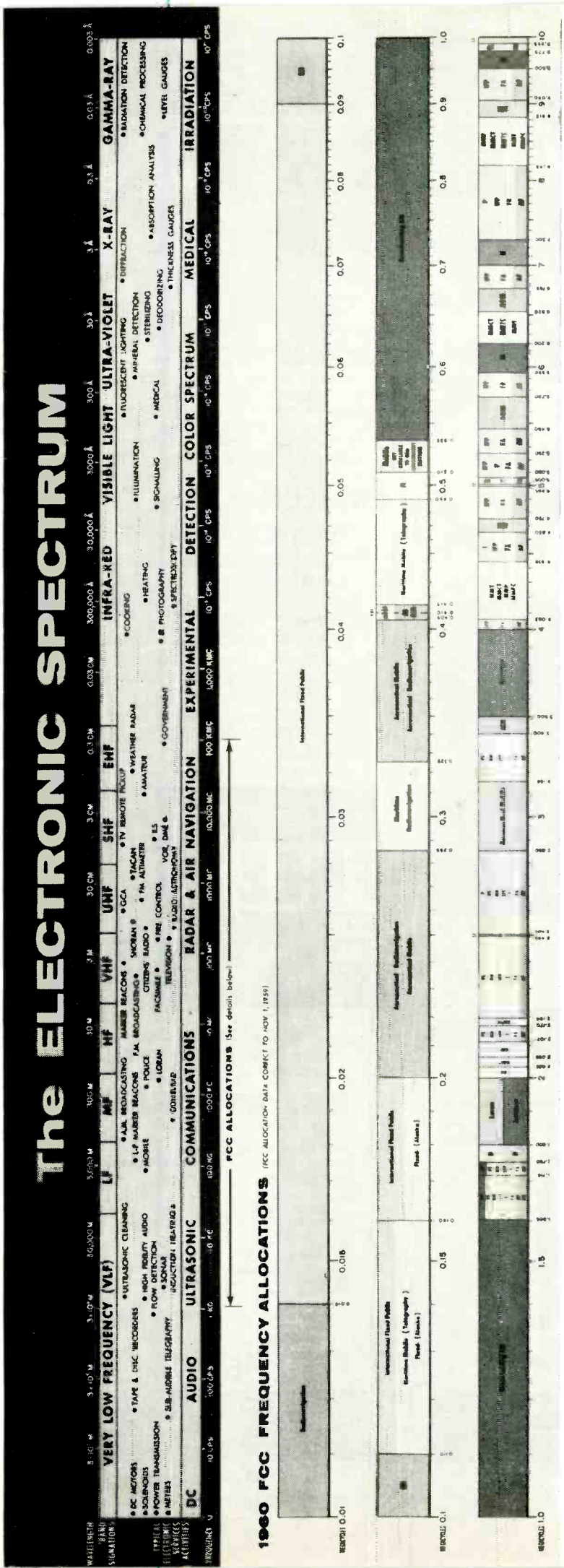
The Fellows, three are receiving the awards for the second time, will pursue graduate studies in chemistry, physics, electrical engineering, mathematics, business administration, and dramatic arts. Recipients are employed by RCA Laboratories, RCA Defense Electronic Products, RCA Electron Tube Div., RCA Semiconductor and Materials Div., RCA Service Co., and the National Broadcasting Co., Inc.

Name Change

Bendix Aviation Corporation will change its name to THE BENDIX CORPORATION about June 1. The change is being made to reflect the interest of the company not only in aviation products but in a number of other fields such as: automotive, electronic, nuclear, missile and space, marine, machine tool, and industrial products.

Young EE of '59

Kenneth H. Olsen, 33-year-old Chief Officer of Digital Equipment Corp., Maynard, Mass., has been honored as "Young Electrical Engineer of 1959" by Eta Kappa Nu, national electrical engineering honor society. Digital Equipment Corp. specializes in products for the digital computer field.



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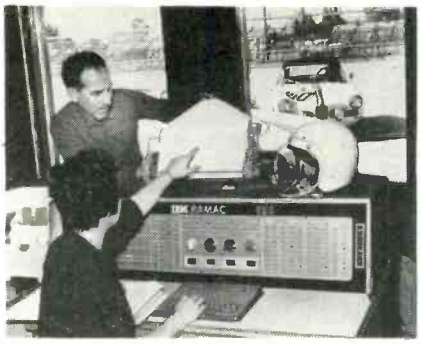

L. Comito (racing driver) checks test report printed by IBM RAMAC 305 data processing system scoring the 12-hr Sports Car Endurance Race at Sebring, Fla. It will tell the official standings of all cars while the race is in progress.

WESCON

(*Continued from page* 15)

ics Investment Management Corp.).

Registration: G. Goldenstern (Hoffman Electronics) and Harry J. Delaney (Hughes Aircraft).

Technical Program: Richard G. Leitner (System Development Corp.) and Harper O. North (Pacific Semiconductors).

Visitors Services: Al J. Rissi and C. T. "Cap" Kierulff (Kierulff Electronics).

Welding

(*Continued from page* 102)

machined area. For example, with a 11,000°F temperature at the target point, a temperature of only 550°F is registered 39/millionths of an inch from the edge of the cut.

The flexibility of design used in the machine, and the precise focusing of the electron beam, permit welding of complex shapes in hard-to-weld metals. A major improvement in the welding of reactor cores for atomic energy installations has been one of its major benefits.

Electronics manufacturing appears to be a particularly promising area for the Zeiss process because of the accelerated development of micro-miniaturization of electronic components. Some of these components, which will be vitally necessary to future developments in space and other technologies, require working with tool diameters so small as to be unfeasible for mechanical processing.

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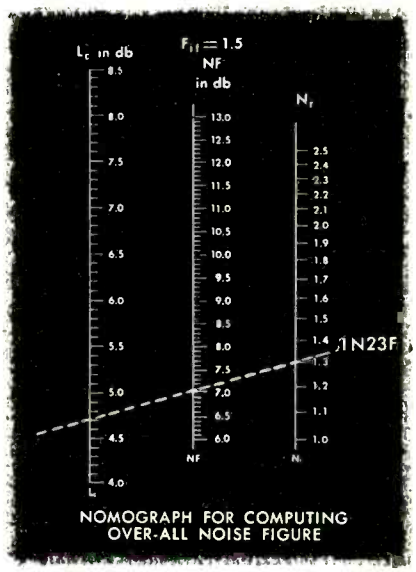
1N21F, 1N21RF	6.0	—	—
1N23F, 1N23RF	7.0	—	—
1N78D, 1N78RD	7.5	5.7	1.3
1N26C, 1N26RC	9.5	7.5	1.5
1N53C, 1N53RC	9.0	6.5	2.0



NOMOGRAPH FOR COMPUTING OVER-ALL NOISE FIGURE

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Sealed Relay

(*Continued from page* 109)

reed is mounted cantilever style in either end of the glass capsule and positioned within extremely precise tolerances. The switch can be made to close with as little as ¼ watt applied to the magnetic coil. The Clareed switch can operate in as little as .8 milliseconds, and it can release in .25 milliseconds.

Only 3¼ inches long, the Clareed capsule offers valuable space savings, especially when mounted in groups with a common coil or on printed circuit boards. The simple, rugged construction permits them to withstand 40 g's shock, and they can be operated in any position.

New Electronics Center

Bendix Aviation Corp. has acquired a 650,000 ft² site in the San Fernando Valley for a new "electronics center." It will be used for the development of military and industrial electronic systems. First building is scheduled for completion early in 1961.

Coming Events

(*Continued from page* 11)

May 25-26: Conf. on Refractory Metals, AIME, Wayne State Univ., Detroit, Mich.

May 25-27: Nat'l Specialists Meeting, Guidance of Aerospace Vehicles, IAS; Boston, Mass.

May 26-27: 14th New England Regional Conf., AIME & Met. Soc. of AIME; Statler-Hilton Hotel, Boston, Mass.

May 31-June 2: Frequency Control Symposium, U. S. Army R&D Labs (Signal Corps, Monmouth, N. J.); Shelburne Hotel, Atlantic City, N. J.

June 1-3: 6th Annual Instrumental Methods of Analysis Symp., ISA; Montreal, Canada

June 2-3: 4th Annual Summer Conf. on Vacuum Metallurgy, New York Univ., College of Engineering; On Campus, New York, N. Y.

June 5-9: Annual Meeting and Aviation Conf., ASME; Statler-Hilton Hotel, Dallas, Tex.

June 6-8: MHI New England Show, Material Handling Institute, Inc.; Commonwealth Armory, Boston, Mass.

June 7-11: Int'l Congress on Microwave Tubes, Munich, Germany

June 8-11: Annual Meeting, Nat'l Soc. of Professional Engineers, Statler Hotel, Boston, Mass.

SOME HIGHLIGHTS OF 1960

Aug. 23-26: WESCON, IRE, WCEMA; Ambassador Hotel & Memorial Sports Arena, Los Angeles, Calif.

Oct. 10-12: National Electronics Conference, AIEE, IRE, Ill. Inst. of Tech., EIA, SMPTE; Hotel Sherman, Chicago, Ill. Arthur H. Streich, National Electronics Conf., 184 E. Randolph St., Chicago, Ill.

Nov. 14 - 16: Mid-America Electronic Convention (MAECON), IRE, Kansas City, Mo.

Nov. 15-17: Northeast Res. & Eng. Meeting (NEREM), IRE, Boston, Mass.

Dec. 11-14: Eastern Joint Computer Conf., IRE, AIEE, ACM; Hotel New Yorker, New York, N. Y.

Abbreviations

ACM: Assoc. for Computing Machinery
AFOSR: Air Force Office of Scientific Research
AIEE: American Institute of Electrical Engineers
AIME: American Institute of Metallurgical Engineers
ARS: American Rocket Society
ASME: American Society for Mechanical Engineers
ASTE: American Society of Tool Engineers
EIA: Electronic Industries Association
EJC: Engineers Joint Council
ERA: Electronic Representatives Association.
IAS: Institute of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NAB: National Association of Broadcasters
NASA: National Aeronautical and Space Agency
ONR: Office of Naval Research

Trimmer

(*Continued from page 91*)

or 36 ohms. Therefore, the desired resistance value can be achieved within an accuracy of ±0.072% or ±18 ohms.

Another example would be to use a 20K resistor in series with a 5K T-Pot. The 5K T-Pot has a resolution of 0.22% or 11 ohms. The adjustability of the series T-Pot and resistor between 20K and 25K would be in 11 ohm increments or ±0.022%. This method gives an additional component, but gives an extreme in adjustability and retains the desirable stability achieved only by the use of wirewound resistive components.

These methods, Fig. 2, have the advantages of using relatively wide tolerance components to achieve results that can be equalled only with the most closely controlled fixed components. This concept is easily overlooked because we normally do not associate precision with variables.

ELECTRONIC INDUSTRIES Advertisers — May 1960

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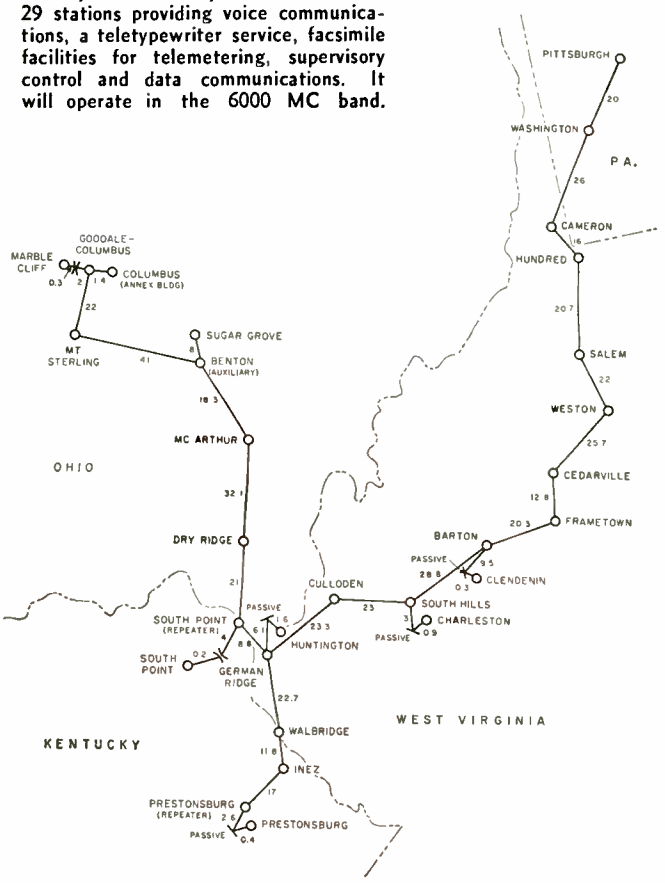
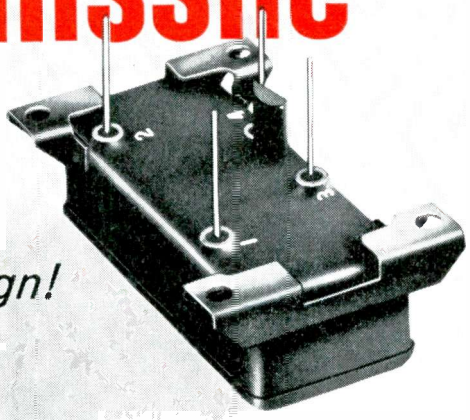
GAS LINE MICROWAVE

A four-state, 470-mile microwave communications system is being built by Collins Radio Co., Dallas, Tex., for the Columbia Gas System. The system will cost about $1,500,000. It will have 29 stations providing voice communications, a teletypewriter service, facsimile facilities for telemetering, supervisory control and data communications. It will operate in the 6000 MC band.



The most precise, sturdiest thermal relay ever built... best for missile applications

. . . from the leader in thermal relay design!



Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

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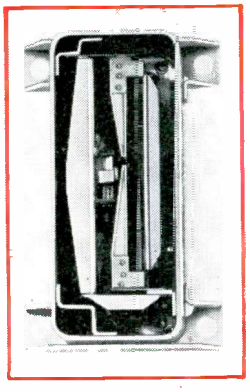


SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)
Setting Tolerance: ±5% (±¼ sec. min.)
Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)
Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.
Power Input: 4 watts. Rated for continuous energization at 125°C.
Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms
Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.
Vibration: Operating or non-operating, 20 g up to 2000 cps
Shock: Operating or non-operating, 50 g for 11 milliseconds
Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.
Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

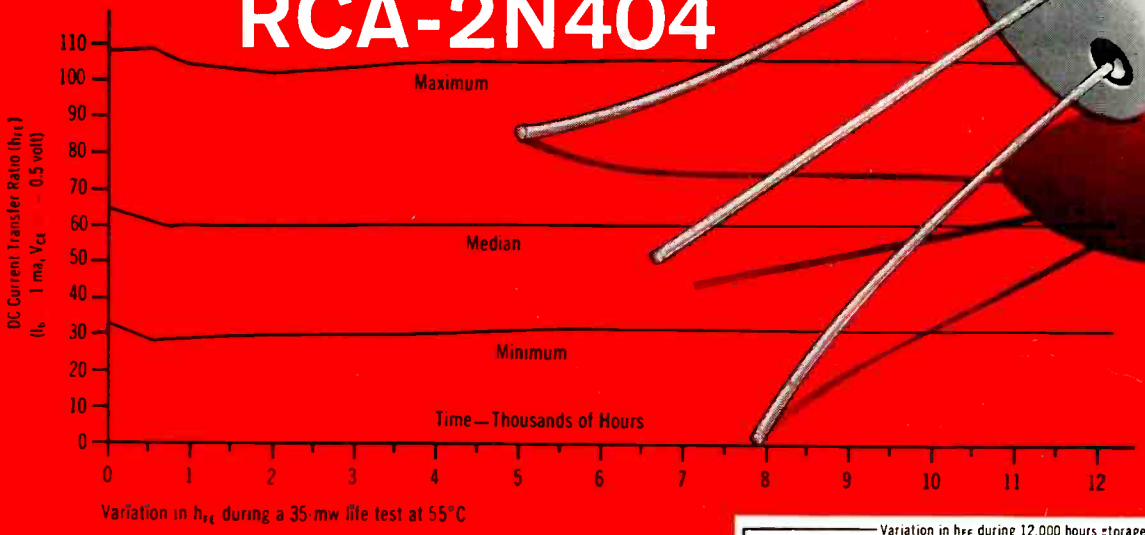
Circle 150 on Inquiry Card

G-V®

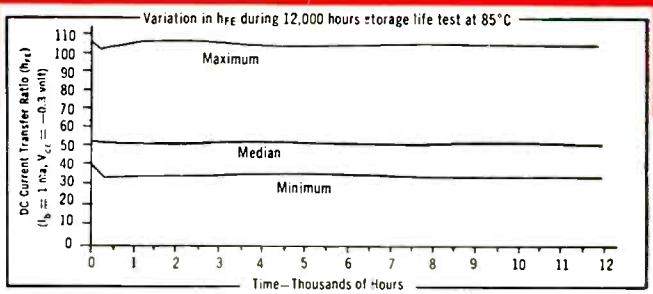
Now Check these Proofs of Reliability...

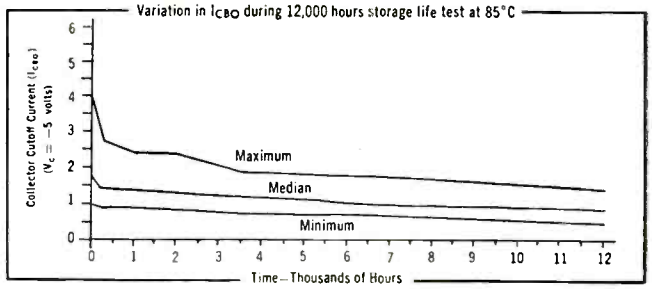
12,000-hour life tests...
long term in-circuit performance...

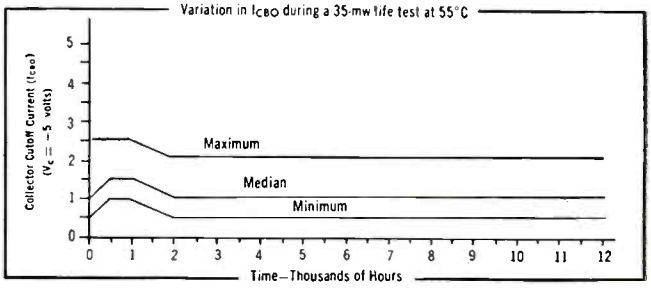
RCA-2N404



Variation in h_{FE} during a 35-mw life test at 55°C







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Here are the results:

(1) Representative samples of the RCA-2N404 computer transistor have now passed 12,000 hours of operating life at *maximum* ratings. The curves at the right show the remarkable stability of transistor parameters over this exceptional time period.

(2) Samples from every lot of RCA-2N404 transistors are tested at *maximum* ratings for 1,000 hours. During 1959, almost 6,000,000 transistor test-hours at 85°C junction temperature were logged.

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