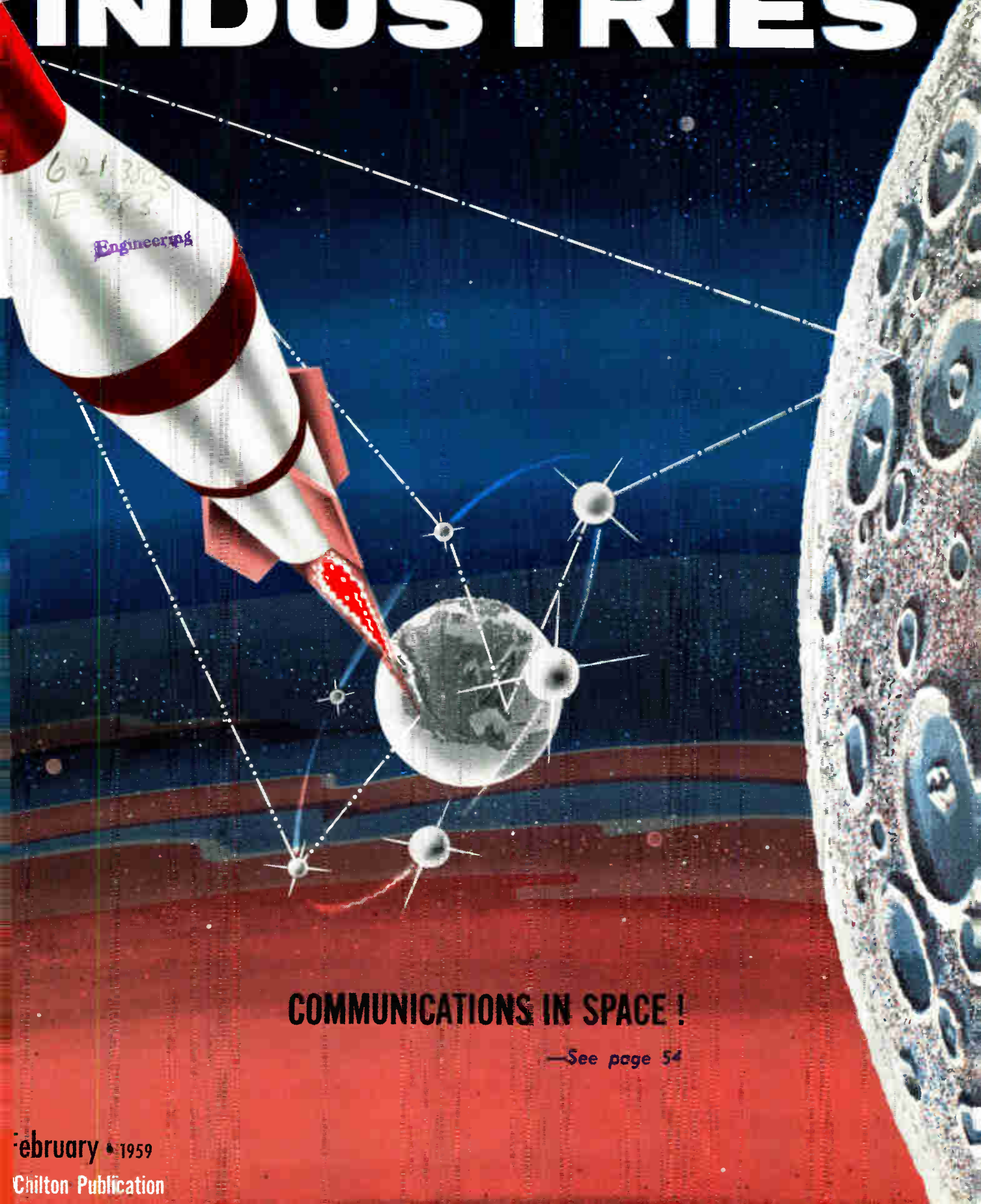


# ELECTRONIC INDUSTRIES

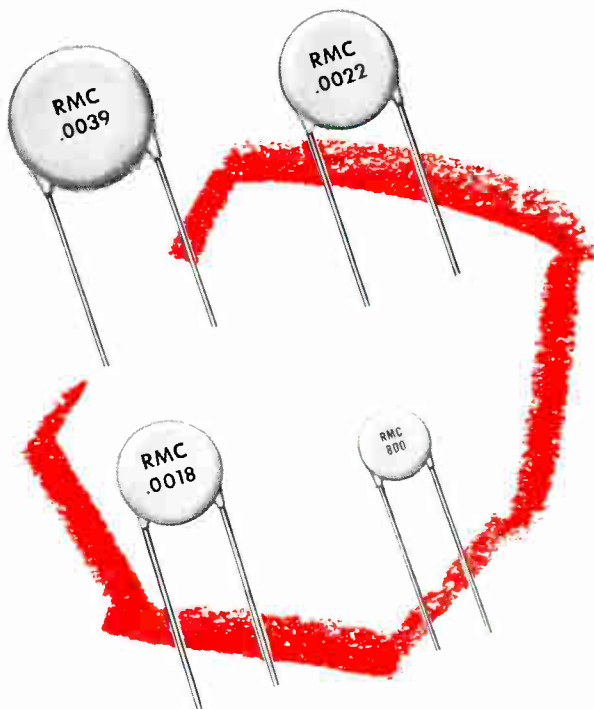


**COMMUNICATIONS IN SPACE !**

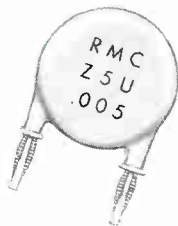
—See page 54

February • 1959

Chilton Publication



**NEW**



## FIN-LOCK LEADS... for printed wire circuits

Fin-Lock leads provide an absolute lock into printed circuit boards and permit either automatic or hand assembly. Crimping of leads is eliminated and stand up position is assured. Designed for holes from .040 to .052, Fin-Lock leads are stopped in holes over .052 by the unique shoulder design. These new leads are available on all DISCAPS of standard voltage, rating and spacing at no increase in price.

# RMC

## TYPE JL DISCAPS

**EXTENDED  
TEMPERATURE  
RANGE...  
CLOSE  
TOLERANCE**

Where application calls for ceramic capacitors with great stability over an extended temperature range, type JL DISCAPS should be specified. Between  $-55^{\circ}\text{C}$  and  $+110^{\circ}\text{C}$  JL DISCAPS show a capacity change of only  $\pm 7.5\%$  at  $25^{\circ}\text{C}$ . Type JL DISCAPS are a quality replacement for paper or general purpose mica capacitors at a savings in cost. Your inquiry is invited.

DISCAP  
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CAPACITORS

**RMC**

**RADIO MATERIALS COMPANY**

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GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.  
Two RMC Plants Devoted Exclusively to Ceramic Capacitors  
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# ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher

• BERNARD F. OSBAHR, Editor

## The NSRC

In previous editorials we have mentioned the fact that the United States government is today the largest purchaser of the gross national electronic product. We have also mentioned the desirability of changing this condition by raising the output ratio of the consumer-commercial-industrial segments of the industry. Accomplishing this would provide greater stability to the industry and greater job security for all. Sporadic cutbacks, cancellations, and changes in military procurement can lead to great upheavals in organizations who depend on this activity as a primary source of income, especially the smaller ones. Ideally, only about 25% of the annual business volume of any organization should be devoted to military and government products. Actually many organizations today use a 40% figure and a good many of the smaller ones will run to as high as 90%. In view of these conditions we have become acutely sensitive to any suggestions or actions which would tend to improve the business dollar volume of the non-government segments of our industry. At the annual Radio Fall Meeting in Rochester last October 27, 28 and 29 Dr. W. R. G. Baker's recommendation for the formation of a National Stereophonic Radio Committee (NSRC) was announced. The extract from the NSRC charter printed below defines what this committee will accomplish.

The function of the NSRC will be to make detailed technical studies of the several possible methods of providing compatible stereophonic sound for the

AM, FM and TV broadcast services. The objective of these studies will be:

1. To clarify the technical issues as between the several possible systems for each of these services.
2. To verify the technical conclusions through appropriate field tests and obtain such information as may be necessary for channel utilization purposes for the determination of the choice of standards.
3. To delineate appropriate signal specifications for the several services based upon the best scientific information and field test data available to the committee.

The NSRC intends to obtain this information as a service to the public, the FCC and the industry. Results of its studies will be made public as soon as studies have been completed.

The establishment of practical standards for providing compatible stereophonic sound for AM, FM and TV broadcast services will, we feel, open a vast new consumer market. It will make stereo sound commonplace in the home . . . easily available to the average man. It will do much to improve the stability of our industry. We shall therefore follow the activities of NSRC closely and will be giving it every encouragement we can. Mr. C. S. Lloyd, General Electric Co., Auburn, has been named NSRC chairman and the technical panels are now being formed. Next month we'll show what the organization looks like and summarize technical problems that must be undertaken.

## Perforated

In response to many reader requests, we have now arranged to perforate the pages in the editorial forms of each month's issue. This will enable readers to remove and file those articles and features that they desire to retain for reference purposes. Because ELECTRONIC INDUSTRIES has a high pass-along circulation, some readers may find

that they are not receiving complete issues. Our Reader Service department will be glad to supply tearsheets or reprints of any articles appearing in future issues of ELECTRONIC INDUSTRIES upon request. The new service starts in March. We'd appreciate knowing how you like it, and any suggestions as to how we can be of further service.



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# ELECTRONIC INDUSTRIES

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February, 1959

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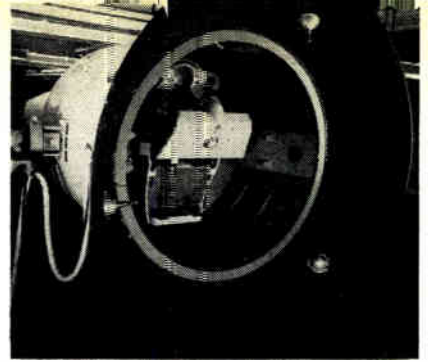
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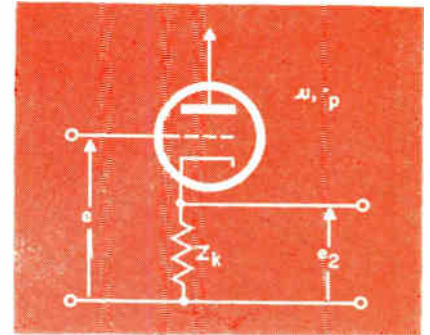
"Man-In-Space"

### SPACE—AND ITS PROBLEMS!

#### Communicating in Space

page 54

At the present state of the art only line-of-sight transmission seems feasible for space communications. For space-to-space communications, the problem seems fairly simple. But for space-to-earth communications the presence of earth's surface and atmosphere modifies the picture in a rather complex manner.

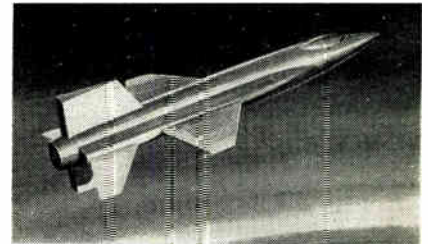


Unity-Gain Amplifiers

#### Design for 'Man-in-Space'

page 59

The space capsule to carry man into orbit around the earth, for which National Aeronautics and Space Administration (NASA) last month awarded a contract to McDonnell Aircraft Co., has been the subject of extensive research for some time under various NASA research contracts. Under one of these contracts, GE's Missile and Space Vehicle Dept. last year designed and built a space capsule for NASA, complete with instrumentation, communication, guidance and retro rocket. A look at this design provides an interesting preview of the capsule that will eventually carry man into space.

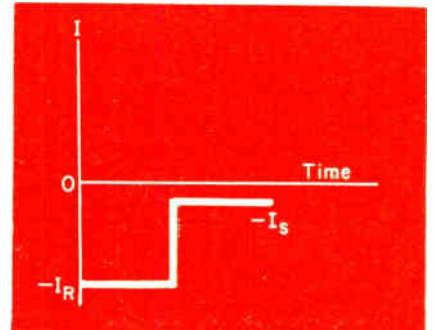


Surviving In Space!

#### Survival Aspects of Space Travel

page 60

From the electronics aspect the significant demand of space travel is that information must be gathered from a very great distance to provide time for the human crew members to think and act. From the distances involved it is obvious that survival will increasingly depend on the reliability and accuracy of high speed automatic control systems.



The Zener Diode

#### Unity-Gain Amplifiers Improve Operation

page 69

Because high-gain feedback amplifiers are often required for flexibility and precision, the reliability and economy of the cathode follower must be sacrificed. Two unity-gain amplifiers offering significant improvements are presented.

#### Circuit Losses in the Transistor AF Amplifier

page 74

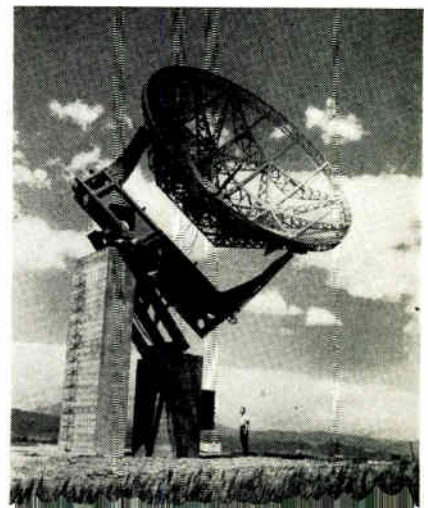
It is well known that proper bias circuit design will stabilize the transistor operating point against variations of the ambient temperature. The bias circuits should also be analyzed in light of their effect on the circuit losses of the stabilized resistance-capacitance coupled transistor amplifier, and particularly their effect on the preceding stage.

#### Understanding the Zener Diode

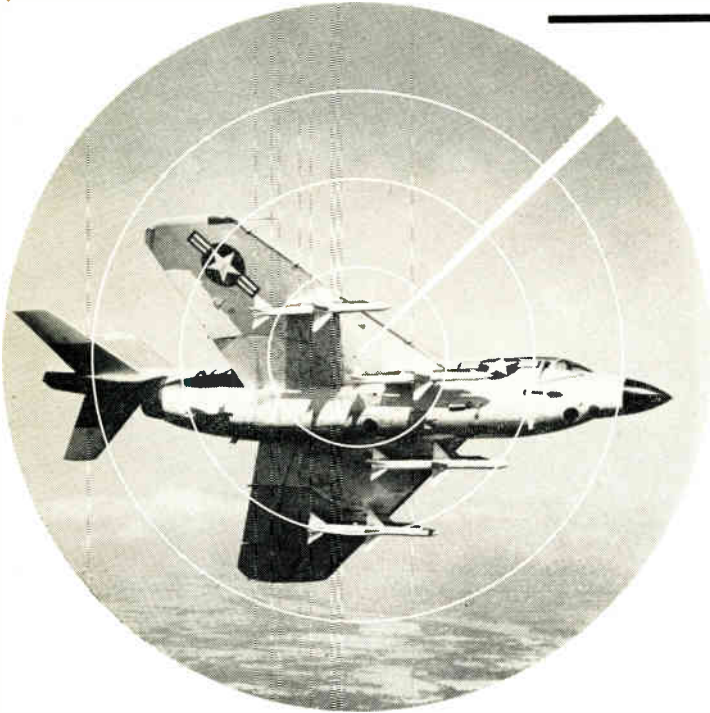
page 78

One of the new developments in the semiconductor art is the use of the reverse current breakdown characteristics of silicon diodes for voltage regulation. Information about control of the breakdown voltage and the factors which determine the output voltage changes in response to fluctuations in regulator current is given to aid engineers in understanding the operation and selection of zener diodes.

#### Space Communications



# RADARSCOPE



## NEW NAVY MISSILE

Sparrow III, Navy's second generation air-to-air missile is now operational in the Western Pacific. Developed by Raytheon, the electronically controlled missile offers exceptional aiming leeway.

**TV EQUIPMENT MANUFACTURERS** are looking confidently to an end in the 6-year decline of broadcast equipment sales. The sales of closed-circuit TV systems have finally risen to a point where they can take up the slack in the broadcast picture, and further increases more than 6-fold are predicted for the next ten years. Another optimistic note is that an increasing number of broadcasters are showing interest in replacing their old equipment with more reliable and more compact transistorized replacements.

**SMALL BUSINESS** received \$3,243,000,000 in payments for defense subcontract work during FY 1959 from 286 military prime contractors enrolled in the defense small business subcontracting program. Small business thus received 19% of the military receipts of the reporting companies during the year. This was down 2% from 1957.

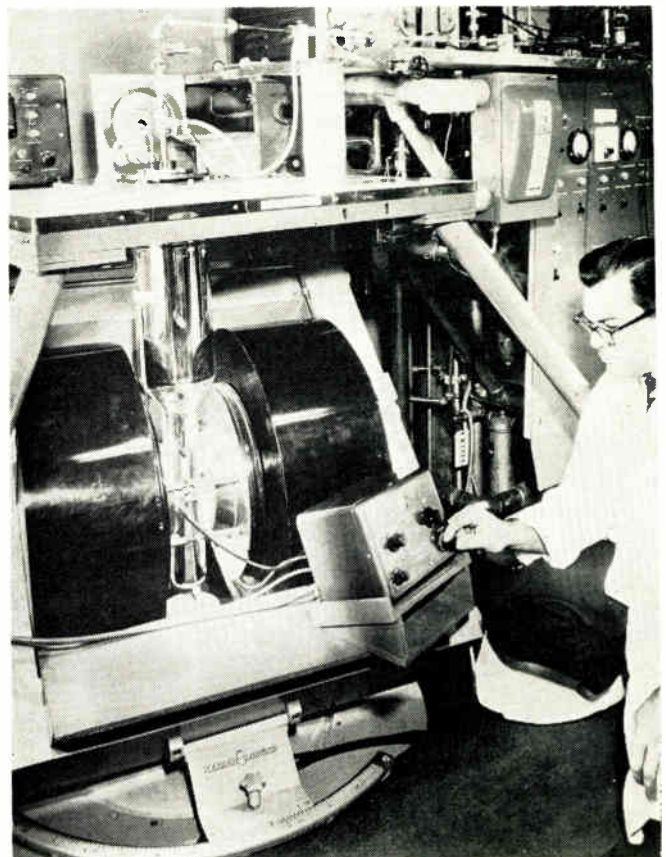
**FM STATIONS** are finally on the move, riding the crest of the booming interest in hi-fi and stereo. Nearly 100 FM stations were authorized last year, with 34 going on the air and bringing the year end total to 571. Subsidiary services, such as background music and storecasting, are also opening the door to profitable operation of FM outlets. As of this writing FM is still looked to as the medium for stereo transmissions, though considerable experimentation is going on with AM as well.

**REDUCED LEAD TIME** is the aim of the Army's research and development program announced last month by Gen. Arthur G. Trudeau, Chief of Army R&D. The new regulation will cut lead time by beginning production engineering early in the development cycle, by using standard parts in R&D equipment, and reducing the testing period without detracting from weapon or reliability. The Army regulation is designated AR705-5.

**THE BATTLE HAS BEEN JOINED** between the packaged hi-fi manufacturers and the hi-fi component producers, brought on by the temporary confusion over stereo. Up till a few months ago the component people were firmly established through their previous half-dozen years of vigorous selling, but their hold now is not quite as secure because of the sudden emphasis on stereo and consequent de-emphasis of hi-fidelity. In the stereo field it is not being emphasized nearly enough that the highest quality components are still extremely important. It is either stereo—or not stereo. Little attention is being given to whether it is "good" stereo.

## "MASER" RESEARCH

Complex laboratory equipment is measuring the magnetic field being applied to a MASER crystal at Sylvania Research Labs. Crystal emits stored energy to amplify weak signals received by radar antenna.





**MORE AND MORE ENGINEERS**, particularly those in middle management positions, are being urged to participate in local political activities. The trend is a reaction to the stepped-up political spadework being done by the labor unions. A very strong movement is gathering force in the management and executive circles to bring more management-minded individuals into political discussions.

**AUTOMATIC MAIL SORTERS** are being explored by the Post Office Dept. Last month two R&D contracts were awarded; one to Aerojet General Corp. for mechanical parcel post sorting system, and another to Food Machinery & Chemical Corp., for R&D on equipment to automatically sort mail which does not come in letter or parcel post sizes. The proposed system would handle approximately 100 thousand to 300 thousand parcels a day with about 75% being sorted completely automatically.

**THE FCC** has a tartar on its hands in the great numbers of illegal VHF boosters around the country. The best estimates place the number at between 1000 and 1500. The number of sets serviced by the boosters then must represent a very significant political force. The members of the commission vary widely in their views on how to deal with the problem. For the moment no action is being taken but two distinct possibilities exist. The first would be to force the VHF boosters to UHF translators; the other would be to license the boosters as they exist, with the degree of control that the commission would impose determined after careful study. But time is on the side of the booster operators. Where enough people are affected, the decision must certainly go to the booster operators.

**THE "HOT CHASSIS" PROBLEM** is up for renewed attention, with two methods being seriously considered. The "more obvious" way is to employ a 3-conductor supply cord and a 3-blade attachment plug cap with the grounding conductor cord and the grounding blade of the cap connected to the cabinet. The second, and more favored method, is to make use of the polarity provision built into modern 120 v. 2-blade outlet receptacles and connect the chassis of the receiver to that conductor of the supply cord which connects to the blade of the cap corresponding to the grounded or neutral side of the power supply circuit—that is, the wide blade of the attachment plug cap. Definite action on the problem was urged to the Winter general meeting of the AIEE by engineers of GE and Underwriters Laboratory, Inc. They emphasize that several million direct-connected TV receivers with metal cabinets are presently in use in the U. S. and a failure of insulation or spacing in these receivers presents a very serious shock hazard condition. (EI, Sept. '57, p. 53.)

**AN ORBITAL POST OFFICE** that will speed up mail to all parts of the world is being worked on at RCA.

### **ENGINEERING EDUCATION**

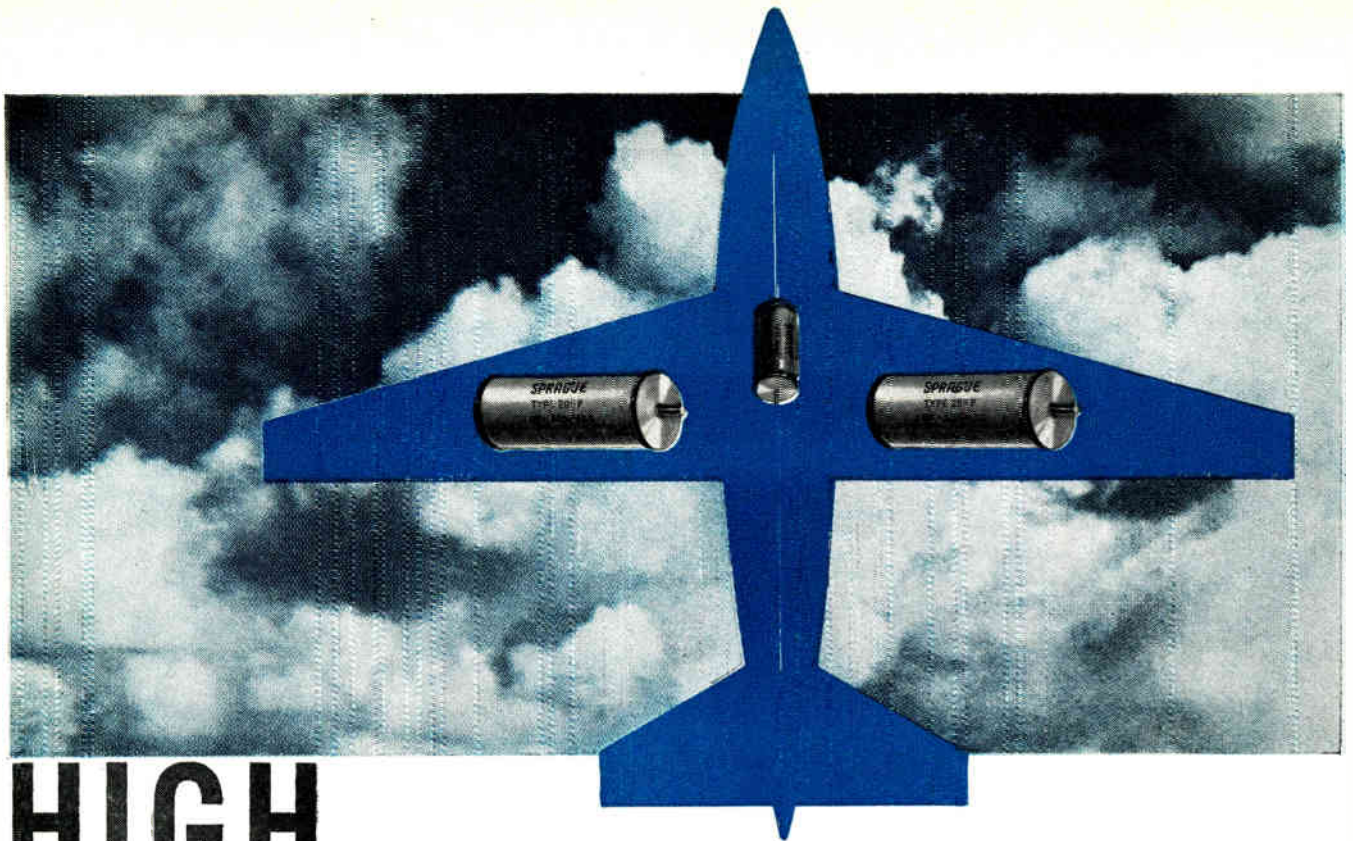
**TWO-YEAR TECHNICAL INSTITUTES** to prepare young people for positions in support of professional scientists and engineers are being urged vigorously by the American Society for Engineering Education. "Wide recognition of this type of higher education, distinguished from four year engineering courses and from vocational programs," the society says, "is important for the future welfare of the nation—both in the interest of national defense and developing the national economy." The society is particularly concerned over the confusion in the public's mind between vocational programs and the high-level training necessary for an engineering technician. A program to resolve this misunderstanding is sorely needed. The published report of the ASEE study due for completion early this year, will call for a substantial increase in this type of education.

### **SYNTHETIC CRYSTALS**

R. A. Sullivan (l), of Western Electric and R. A. Laudise, Bell Telephone Labs are shown behind the top of a high pressure autoclave used in growing synthetic quartz crystals at WE's Merrimack Valley works, North Andover, Mass. The large crystal was grown in the large autoclave. Smaller crystal was used in early research.







# HIGH VOLTAGE, GLASS-ENCASED DIFILM® VITAMIN Q® CAPACITORS

New leakproof dual dielectric design meets severe life tests  
... withstands high altitude applications

HIGH-ALTITUDE and HIGH-VOLTAGE capacitor applications in airborne electronic equipment are simplified with Sprague's new Type 205P Difilm Vitamin Q capacitors! These glass-encased, dual-dielectric capacitors are specifically designed to minimize corona problems.

In addition to their use in airborne equipment, Type 205P capacitors also find application in high-voltage ground equipment, including power supplies for transmitters, induction heating equipment, and electro-static precipitators...as well as in coupling and bypass applications in various industrial electronic control devices and allied equipment.

Ruggedness and dependability are built right into

these capacitors. Special, heavy-walled tempered glass housings encase the capacitor sections. A new end-seal design and a sealing technique eliminate the plague of impregnant leaks associated with other glass-encased capacitors. The dual dielectric used in Type 205P units results in capacitors with the best electrical properties of both polyester plastic film and the highest grade kraft condenser tissue. The outstanding electrical properties of Vitamin Q, Sprague's exclusive inert synthetic impregnant, are well known.

Type 205P capacitors are available in standard catalog ratings up to 10,000 volts for both 85°C and 125°C ambient temperatures; higher voltage designs are furnished to meet your special application needs.

*For complete technical data, write for Engineering Bulletin No. 2312 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.*



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CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS  
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# As We Go To Press...

## Atlas Is First Step To 'Relay' Satellites

The orbiting communications relay inside the Atlas missile now circling the earth is a first step toward "courier" satellites for military communications.

The communications payload provided by the Army consists primarily of transmitting, receiving, and recording equipment which are designed to receive, store, or relay messages from ground stations. When in range of these stations the orbiting relay can receive and transmit seven written messages and one voice message at one time.

To obtain stored messages from the communications relay in the Atlas, a ground station triggers off the relay transmitter by electronic command. As long as the satellite courier is in range the ground station can also transmit its own message for relay to another station. Messages can be relayed from one station to another without storage.

The project, including the launching and the communications payload provided by the Army, was conducted under the auspices of the Advanced Research Projects Agency directed by Roy W. Johnson. It is called Project Score; (Signal Communications by Orbiting Relay Equipment). The Army's contribution was developed by the Army Signal Corps in cooperation with the Astro-Electronics Products Division of RCA, and other firms.

The orbiting communications relay was installed inside the Atlas, using the missile itself as the carrier. The relay consists primarily of two transmitters, two receivers, and two recorders using erasable loops of magnetic tape.

## ULTRASONIC WELDER



Sheets of dissimilar metals are welded continuously with this developmental Westinghouse ultrasonic seam welder. There is no surface preparation prior to welding.

## "Simple Design Is Key To Reliability"—Hull

"Simple design," EIA President David R. Hull told the recent Symposium on Reliability & Quality Control in Philadelphia, "is my approach to the problem of reliability." "Gadgetitis," in military electronics as well as consumer products is contributing to unreliability.

Hull said that "some courage is needed both in the military services and among equipment manufacturers to overcome a psychological roadblock to realistic design." The services need courage to resist the "insistent pressure" from many quarters "to 'do something' fast whenever the United States seems to be lagging in the international armament race," he explained. Industry needs courage "to resist ill-advised military developments which cannot succeed and which usually end in damaging the reputation of the contractor."

## Cold Cathode Tubes Return In New Role

A joint announcement by Tung-Sol Electric and the Army Signal Corps Labs. last month disclosed a revolutionary new type of tube design, based on a cold cathode, which is expected to lead to tubes that outlast the equipment in which they operate.

Cold cathode tubes have been operating continuously for 14,000 hours without any depreciation in emission. They are expected to find wide use in equipment such as trans-Atlantic cables, satellites and computers where reliability is a must.

The cold cathode tubes are similar in appearance to conventional tubes but have no heaters. They



Test adjustments are being made to cold cathode tubes by Dr. Dobischek, Signal Corps scientist who discovered these new tubes

are instant-starting—but are not presently self starting. However, several methods for starting these tubes are known, including one which requires no extra effort on the part of the equipment operator.

The cathode surface is magnesium oxide, applied in the same manner as conventional heater tubes. Standard tube parts have been adapted in their construction. Normal tube manufacturing equipment may be used for production.

These tubes offer the advantages of less cathode power for operation, quick starting, very long life

*Continued on page 10*



## NEW LANDING SYSTEM

Complete control of this B-47 is in the hands of the new automatic electronic all-weather landing-system developed by Bell Aircraft Corp. and housed in trailer at left.



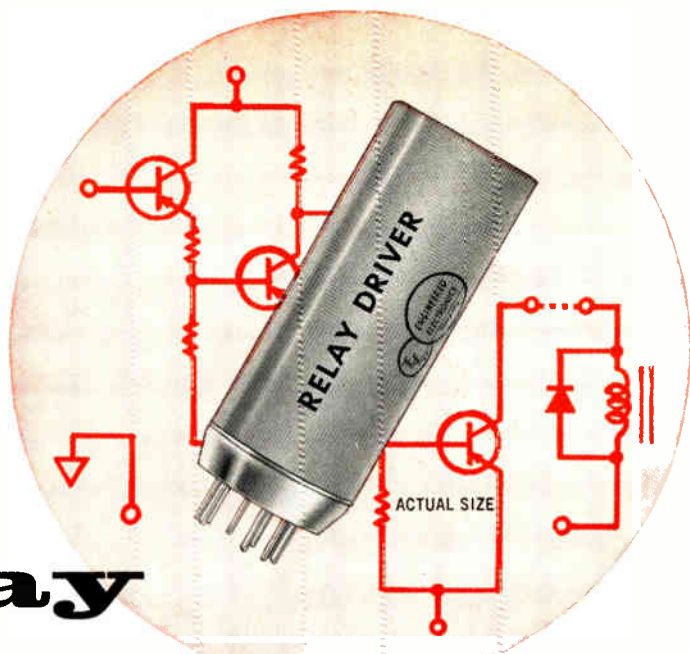
# NEW

## EECO T-Series

### Transistorized

# Relay

# Driver



... Drives 400 ma relay with as little as 50  $\mu$ a input current!

**T**HIS latest addition to the EECO T-Series family of compatible transistorized plug-in circuits provides sufficient power to operate most of the general-purpose relays available today. The T-120 Relay Driver circuit contains three germanium transistors: two driver transistors (one of which is provided with a Birtcher Radiator) and one power transistor (30-volt rating). The unit inserts into a standard 9-pin miniature tube socket and can be operated directly from the T-Series digital units (Flip-Flop, One Shot, Multivibrator, or Squaring circuits).

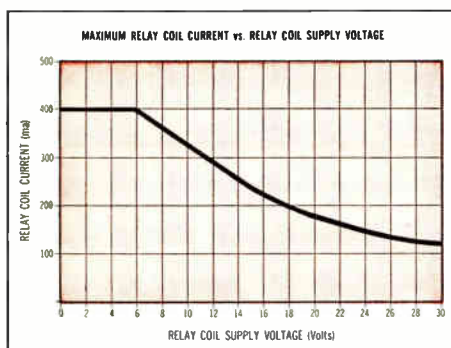
Output current of the EECO T-120 Relay Driver is naturally dependent on the supply voltage requirements of the relay coil. (See

Current vs. Voltage curve at left.) An input current of as little as 50  $\mu$ a will serve to drive any relay with current-voltage requirements falling within the curve.

The T-120 Relay Driver features the same conservative engineering design and high quality of components that are offered throughout the entire family of T-Series digital plug-in circuits. All

units are especially well suited for use in compact digital systems and equipment requiring a high degree of accuracy and dependability.

The entire T-Series family of circuits is now optionally available in encapsulated models, designated as the TE-Series. Encapsulation adds approximately 1/10th ounce to the total weight of each unit.



#### ELECTRICAL SPECIFICATIONS

##### INPUT

Signal Frequency Range: 0-1 kc (for 400 ma resistive load). Max. frequency with relay load depends on relay capabilities.

DC Signal Level to Actuate Relay: -11 V nominal.

DC Signal Level to Release Relay: -3 V nominal.

Input Current: 50  $\mu$ a minimum.

##### OUTPUT

Maximum output current available is dependent on relay voltage used. See curve at left.

Absolute maximum output current: 400 ma.

Relay Driver must be protected against reverse surge voltages generated by relay. This may be accomplished by diode clamping across relay.

##### POWER REQUIRED

B+ +12 V  $\pm$ 10% at 5 ma.

B- -12 V  $\pm$ 10% at 20 ma to 30 ma, depending on load.

Relay Coil Supply Voltage: -30 V absolute max.

##### PHYSICAL SPECIFICATIONS

(Applicable to entire T-Series family.)

Body: 7/8-inch diameter.

Seated Height: 2-3/16 inches, maximum.

Over-all Height: 2-7/16 inches, maximum.

Mounting: On 1-inch centers, minimum.

(51 circuits can be mounted on 3 1/2" x 19" panel.)

Weight: Approximately 1 ounce. (Encapsulation increases weight by only 1/10th ounce.)

Temperature Range: -45°C to +65°C.

##### OTHER CIRCUITS

In addition to the T-120 Relay Driver, the complete family of digital circuits includes:

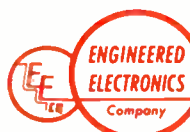
- FLIP-FLOPS
- ONE SHOT
- SQUARING AMPLIFIERS
- EMITTER FOLLOWERS PNP and NPN
- DC "AND" GATES
- DC "OR" GATES
- PULSE "AND" GATES
- PULSE "OR" GATES
- MULTIVIBRATOR
- PULSE AMPLIFIERS
- SHIFT REGISTER LOGIC
- LINEAR AMPLIFIERS
- RESET GENERATOR

as well as Blocking Oscillator, Crystal Oscillator, etc.

##### COMING SOON

Watch for details on our forthcoming series of plug-in TRANSISTORIZED DECADES miniaturized to approximately 1" x 1-5/16" x 3-1/16"!

Write today on your company letterhead for our complete EECO Transistorized Circuit Catalog No. TR-758A.



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(a subsidiary of Electronic Engineering Company of California)

506 East First Street • Santa Ana, California

P.S.— See all of our new products, including Relay Drivers, Minisig Indicators, and Transistorized Decades, at the IRE Show, New York City, March 23-26, Booth 3838.



# Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period February-March that are of special interest to electronic engineers

- Feb. 1-6: Winter General Meeting, AIEE-Technical Operations Dept.; Hotel Statler, New York, N. Y.
- Feb. 2-4: 7th Regional Tech. Conf. & Trade Show, IRE, University of New Mexico, Albuquerque, N. M.
- Feb. 2-7: Committee Week, ASTM; Penn-Sheraton Hotel, Pittsburgh, Pa.
- Feb. 3-5: 14th SPI Reinforced Plastics Div. Conf., SPI; Edgewater Beach Hotel, Chicago, Ill.
- Feb. 5-8: 1959 San Francisco High Fidelity Music Show, Institute of High Fidelity Manufacturers, Inc.; Cow Palace, San Francisco, Calif.
- Feb. 6: Regional Conference, Society of Technical Writers and Editors—Chicago Chapter; Chicago, Ill.
- Feb. 12-13: Transistor & Solid State Circuits Conf., IRE, AIEE, & University of Pennsylvania; Univ. of Penna., Phila., Pa.
- Feb. 12-13: Electronics Conference, AIEE, IRE, ISA; Engineering Society Bldg., Cleveland, Ohio.
- Feb. 14: Meeting on Short Range Navigational Aids; International Aviation Bldg., Montreal, Canada.
- Feb. 15-19: Annual Meeting-Metallurgical Society Functions, AIME; St. Francis Hotel, San Francisco, Calif.
- Feb. 16-19: West Coast Convention, Audio Engineering Society; Los Angeles, Calif.
- Feb. 16-23: 1959 Los Angeles High Fidelity Music Show, Institute of High Fidelity Mfg., Inc.; Biltmore Hotel, Los Angeles, Calif.
- Feb. 17: Annual Education Seminar, Assoc. of Elect. Parts and Equip. Mfg. Inc.; Tam O'Shanter Country Club, Niles, Ill.
- Feb. 17: Meeting, The Radio Club of America; Benjamin Franklin Auditorium, New York, N. Y.
- Feb. 17-20: Annual Western Conference, Audio Engineering Society; Hotel Biltmore, Los Angeles, Calif.
- Feb. 19: Conf. on Ammonium Persulfate Etching, Western Assoc. of Circuit Manufacturers; Rodger Young Aud., Los Angeles, Calif.
- Feb. 19-21: Winter Meeting, National Society of Professional Engineers; Dinkler-Tutweiler Hotel, Birmingham, Ala.
- Feb. 23-26: Symp. on Thermophysical Properties, ASME; Purdue Univ., Lafayette, Ind.
- Feb. 24-25: State Presidents Conference, National Association of Broadcasters; Washington, D. C.
- Feb. 26-27: 15th Annual National Wiring Sales Conference, Nat'l Wiring Bureau, Edison Electrical Institute, Nat'l Electrical Contractors Assoc.; Jung Hotel, New Orleans, La.
- Feb. 26: 1959 Engineering Exposition, Balboa Park, San Diego, Calif.
- Mar. 2-4: Electronics Conference, American Management Assoc.; Statler Hilton Hotel, New York, N. Y.
- Mar. 1-3: Southeastern Regional Conference, Nat'l Assoc. of Music Merchants; Dinkler-Plaza Hotel, Atlanta, Ga.
- Mar. 2-6: Western Joint Computer Conf., IRE, AIEE, Assoc. for Computing Machinery; Fairmount Hotel, San Francisco, Calif.
- Mar. 5-6: Flight Propulsion Meeting, IAS; Hotel Carter, Cleveland, Ohio.
- Mar. 5-7: Western Age Conference, Domestic Trade Dept., Los Angeles Chamber of Commerce; Los Angeles, Calif.
- Mar. 6-7: Meeting, American Physical Society; Univ. of Texas, Austin, Tex.
- Mar. 8-11: Gas Turbine Power Conf. and Exhibit, ASME; Netherlands-Hilton Hotel, Cincinnati, Ohio.
- Mar. 8-12: Aviation Conference, ASME; Statler Hilton Hotel, Los Angeles, Calif.
- Mar. 10: Annual Meeting & Election of Officers, Assoc. of Electronic Parts & Equipment Mfgs. Assoc.; Como Inn, Chicago, Ill.
- Mar. 11-12: Iron & Steel Instrumentation Conference, ISA; Pick-Roosevelt Hotel, Pittsburgh, Pa.
- Mar. 15-18: 37th Annual Convention & Broadcast Engineering Conf., National Assoc. of Broadcasters; Chicago, Ill.
- Mar. 16-20: 11th Western Metal Exposition and Conference, American Society for Metals; Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.
- Mar. 17: Annual Meeting, Broadcast Pioneers; Conrad Hilton Hotel, Chicago, Ill.

#### Abbreviations:

- ACM: Association for Computing Machinery  
 AIEE: American Inst. of Electrical Engrs.  
 AIME: American Institute of Mining & Metallurgical Engineers  
 ASME: American Society for Mechanical Engineers  
 ASTM: American Society for Testing Material  
 EIA: Electronic Industries Assoc.  
 IAS: Institute of Aeronautical Sciences  
 IRE: Institute of Radio Engineers  
 ISA: Instrument Society of America  
 SMPTE: Society of Motion Picture & TV Engineers  
 SPI: Society of Plastics Industry  
 WCEMA: West Coast Electronic Manufacturers Assoc.

## RELAY MANUFACTURING



Extra-sensitive relays are assembled in these air-tight, dust-proof enclosures at Phillips Control Corporation, Joliet, Ill.

## First Army Technical Net Hails Its 1st Anniv.

The First Army MARS SSB Technical Net celebrating its first anniversary, was organized to disseminate technical knowledge by radio communication. Outstanding specialists in the electronics field are invited to give talks. Net members, who are licensed radio amateurs, call in from various parts of the northeastern United States and conduct a forum by radio. The net meets each Wednesday evening at 9 PM EST on 4030 kc. upper sideband.

### SOME HIGHLIGHTS OF 1959

- Mar. 23-26: National Convention, IRE; Waldorf Astoria (Hdqts), New York Coliseum (Radio Engr'g Show), New York, N. Y.
- April 5-10: 5th Nuclear Congress, Institute of Aeronautical Sciences, Coordinated by EJC, ISA, ASME, IRE; Municipal Auditorium, Cleveland, Ohio.
- May 6-8: Electronic Components Conference, WCEMA, IRE, EIA, AIEE; Benjamin Franklin Hotel, Phila., Pa.
- May 18-20: Electronic Parts Distributors Show, Assoc. of Electronic Parts & Equipment Mfg., Inc.; Conrad Hilton Hotel, Chicago, Ill.
- Aug. 18-21: WESCON, West Coast Electronic Mfgs. Assoc. & 7th Region IRE; San Francisco, Calif.
- Oct. 12-14: Nat'l Electronics Conf., IRE, AIEE, EIA, SMPTE; Hotel Sherman, Chicago, Ill.
- Nov. 9-11: Radio Fall Meeting, IRE EIA; Syracuse, N. Y.
- Nov. 30-Dec. 1: Eastern Joint Computer Conf., IRE (PGEC), AIEE, ACM; Hotel Statler, Boston, Mass.

## ELECTRONIC SHORTS

► The McDonnell Aircraft Company of St. Louis won the competition for a new Fleet all-weather fighter with its F4H-1, which as yet, bears no popular name. It was cited as the airplane which best meets the Fleet requirement for an all-weather air defense fighter. It carries a radar operator in addition to the pilot, and is powered by two J-79 turbojet engines. The addition of the radar operator and the fact that the plane is powered by two engines became decisive factors in the choice as a result of data developed from operational experience with all-weather fighters in the Fleet during the period in which the two aircraft were under development.

► The National Aeronautics and Space Administration has selected Rocketdyne, Canoga Park, California, as the source for design and development of a rocket engine in the one to one and one-half million pound thrust class. Six companies submitted proposals in the NASA competition for the large rocket engine project. The selection of Rocketdyne, according to T. Keith Glennan, NASA Administrator, was based on a careful assessment of the technical value of the proposal, and of the facilities, experience and other qualifications of the company.

► Purchase of 39 basic scan conversion systems to provide "daylight" displays of long range radar information for air traffic control was announced today by James T. Pyle, Administrator of Civil Aeronautics. The \$5,729,116 contract was awarded to the Admiral Corporation of Chicago. It marked the first procurement of scan conversion equipment to be manufactured according to CAA specifications. Previous procurement of scan conversion equipment for use in airport traffic control towers and air route traffic control centers was off-the-shelf equipment.

► So that the Postal Service may increase its ability to handle greatly increased volumes of parcel post more rapidly and at a lower unit cost, the Aerojet-General Corporation of Azusa, California, has been given a contract for the development, design, construction, and installation of a highly mechanized parcel post sorting system. The contract calls for an operational analysis of the procedures for handling of parcel post, the design and construction of an automatic sorting machine, and the installation of the system in a major post office.

► A new, electronically-controlled system which will completely stabilize generation of electrical power at constant frequencies and thus solve a major existing problem in everything from jet aircraft to utility power plants has been developed by The Siegler Corp.'s Hallamore Electronics Co. division, located in Anaheim, California. Basic patents recently were issued on the revolutionary new product known as a variable speed constant frequency alternator and the first engineering model has just successfully passed the "proof-of-principle" test, according to John G. Brooks, Siegler president. With the completion of this significant test, steps already are underway to develop full-sized units of various sizes for flight and field testing, he said.

► A follow-on contract to produce radar beacons for United Kingdom's long-range missile program has been awarded to the Avion division of ACF Industries, Incorporated. The contract is for an undisclosed number of the beacons which will be used in missile test firings to extend the tracking range of ground radar.

► A special television system that will permit astronomers on the ground to aim and focus a telescope suspended from a balloon fifteen miles above the earth is being developed by RCA scientists. The system is being prepared for a Princeton University experiment sponsored by the National Science Foundation and the Office of Naval Research. The television equipment, comprising a specially designed slow-scanning airborne camera and transmitter as well as a ground monitoring system, is to be used in high-altitude solar observation.

► Minneapolis-Honeywell Regulator Company has entered the medium-scale computer field with a new transistorized system "so flexible it can do data-processing and scientific computation simultaneously at lightning speed," according to Paul B. Wishart, Honeywell President. The system, Honeywell 800, establishes several "firsts," the most important being a new ability of its small, powerful central processor to independently perform more than one job at a time. This ability, called "automatic parallel processing," is combined with a building-block expansion principle of design.

## As We Go To Press (cont.)

### Cold Cathode Tubes (Cont)

and no heater failure problems. But they do have disadvantages. A minimum voltage of 300 volts is required; the present tubes are not self starting and they are slightly more complex internally. However, they are about equal in cost, noise level and some other characteristic to conventional heater type tubes.

Development of a cold cathode electron gun for use in cathode ray tubes, and in klystrons, traveling wave tubes and the like is well underway using the same principles as above. These CRT's combined with other cold cathode tubes and transistors should give us reliability plus in the near future.

### Army Missile School Growth Is Spectacular

Over 7,500 Army missilemen will graduate this year from the Army Ordnance Guided Missile School, Huntsville, Ala.

The huge training center, the Army's only school devoted entirely to guided missile training, is the educational adjunct of the vast rocket and missile installation at the Redstone Arsenal. The "Space Academy" is training students from all branches of the U. S. armed forces and from 11 allied nations.

The school has doubled in size and stature during the past year and is still expanding.

Faculty, staff and permanent administrative and maintenance personnel now number 2,076, up from 1,165 a year ago.

Its payroll is \$15,775,000 for the fiscal year ending on June 30th, up from \$9,140,000 last year. In fiscal 1960, it is expected to top \$27,000,000.

More than 5,000 students were graduated last year, bringing its "alumni" to 12,725 trained in six years of operation.

Graduates in 1959 should approximate 7,500, an increase of about 50 per cent.

Civilian employees at the school increased last year from 197 to 340.

The curriculum was expanded during the past year from 23 courses to 47, to accommodate more Army and allied students as well as hundreds of Air Force students sent for ballistic missile training.

More News on Page 9



**Holland**—General Transistor International Corp., wholly owned subsidiary of General Transistor Corp., will provide technical assistance to Van Der Heem, N.V., The Hague, in the manufacture of a full line of npn and pnp germanium alloyed junction and diffused base transistors. The agreement provides for on-the-job training of Van Der Heem engineers and for the supply of information by General Transistor International on items not yet in production and on new technical developments as they become available.

**Canada**—A. P. H. Barclay has been elected Director of the Canadian Region by the IRE Board of Directors. Mr. Barclay is General Manager, Engineering and Manufacturing, Professional Equipment Div., Philips Electronics Industries Ltd., Toronto, Ontario. There are over 2,400 IRE members in the Canadian region.

**Mexico**—The fourth edition of the Mexican National Industrial Directory, sponsored by the Confederation of Industrial Manufacturers of Mexico, is being published by Rolland Publications, Vallarta 21-2nd floor, Mexico City 4, Mexico. It will contain a classification of all important Mexican firms and the products they offer, of individuals engaged in the import and export business and banking activities. It will include hotels, insurance companies, daily newspapers, trade papers and magazines.

**Denmark**—Bruel & Kjaer, Naerum, has set up a new marketing agency, B & K Instruments, Inc., to handle their line in the U. S. Headquarters is at 3044 West 106th St., Cleveland, Ohio. Bruel & Kjaer manufactures high quality sound, vibration and strain instrument systems.

**Export controls**—Changes in regulations governing exports of U. S. goods, published in Current Export Bulletin No. 808, ease controls over some commodities and tighten others.

Specified types of transistors and laboratory-type high vacuum pump stations are among the items deleted from the positive list. Added to the list are silicon and germanium crystal growing equipment, wires and electrodes and other specified types of transistors.

Items not on the list may be shipped to most countries under general license GRO without prior application to the Bureau of Foreign Commerce, U. S. Dept. of Commerce. Individual export licenses continue to be required for shipment to Hong Kong, Macao, the communist-controlled area of Viet-Nam and all countries in the European Soviet bloc except Poland. Most items on the positive list must be supported by import certificates when destined for Austria, Belgian Congo, Belgium, Denmark, France, Federal Republic of Germany, Western Sectors of Berlin, Greece, Hong Kong, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Turkey and the United Kingdom. All items on the positive list require export licenses except for shipment to Canada.

**Venezuela**—Texas Instruments Incorporated will provide electrical control and automatic programming equipment for an oil well lease processing unit to be located on Lake Maracaibo. Expected to be completed by the second quarter of 1959, the equipment will handle 40 well completions producing an estimated 100,000 barrels of oil per day. The \$100,000 plus contract was awarded by J. Ray McDermott Corp., representing the Venezuelan Sun Oil Co.

**United Kingdom**—British scientist Ralph Brewer of Wembley, Middlesex, is the first non-American to receive the award for the best technical paper at the National Symposium on Reliability and Quality Control. The paper, presented last year in Washington, D. C., describes a 5-year tube reliability improvement program undertaken by his group which resulted



Ralph Brewer

in improvement factors in some areas as high as 50 to 1. Brewer is a member of the senior scientific staff of the research laboratories, The General Electric Company, Ltd.

**India**—A committee of six authorities in engineering teaching, headed by Dr. W. E. Stirton, Vice President of the Univ. of Michigan, have been named by the American Society for Engineering Education to study plans for a new engineering school at Kanpur. Under a contract with the U. S. International Cooperation Administration, they will visit existing universities and colleges in Roorkee, Chandigarh, Delhi, Calcutta, Kharagpur, Tatanagar, Poona, Bombay, Bangalore and Madras.

**Cuba**—Francisco Fernandez, Havana, will be the Cuban representative for Wyco Metal Products Co., North Hollywood, Calif., manufacturers of chassis and cabinets.

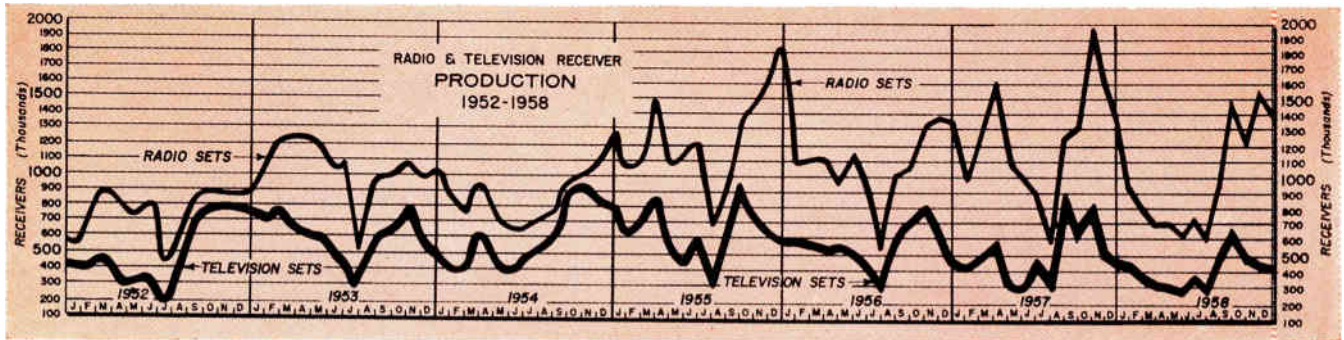
**Canada**—Both U. S. and foreign tubes are checked in a new universal tube tester being produced by Stark Electronic Instruments Ltd., Ajax, Ont. Permanently wired foreign base type sockets are installed as well as the full quota of American sockets. Tubes are checked by the patented Stark/Hickok method of dynamic mutual conductance.

#### GERMANY:

Entire range of bank functions of Dresdner Bank, Hamburg, Germany, is now being handled by their new Remington Rand Univac Computer. The "new" Univac uses solid-state devices and a new programming system, Flow-Matic coding, which uses words instead of math symbols.







#### GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in December, 1958.

Amplifiers	387,514
Amplifiers, servo	1,041,710
Antennas, systems, assemblies	62,944
Batteries, dry	1,949,422
Cable assemblies	40,212
Cable, electronic	25,689
Cable, telephone	158,489
Calibrator sets, frequency	52,397
Cells, solar	500,000
Computer, analog	442,700
Computer, flight director	578,500
Computer spares, accessories, components	48,290
Crystal units	27,603
Diodes, variable capacitance microwave	99,150
Direction finder sets	144,347
Earphones	28,969
Filter, band pass	27,314
Filter, radio interference	40,468
Generator, pulse	63,228
Indicator, coupler antenna	67,986
Kit, modification	30,257
Lead, test	61,959
Loudspeakers, dynamic	43,270
Meters, volt	69,208
Microphone, dynamic	35,435
Monitor, telegraph	1,462,551
Multiplexer	80,551
Power supplies	84,987
Radar sets, accessories & components	4,140,872

Radio sets	72,645
Receiver, radio	1,119,927
Receiver-transmitters	250,476
Receiving-transmitting sets, telemetric data	283,000
Recorders-reproducers & accessories	367,590
Relay, armature	28,264
Research & development	4,076,996
Resistors	28,031
Sextant, electronic	898,911
Spectrophotometer, infrared	143,072
SSB equipment	1,426,535
Switchboard equipment	34,852
Switch, pressure	43,330
Switch, rotary	65,135
Switch, toggle	160,233
Switching units, antenna	38,690
System, telemetry	48,730
Teletypewriter, radio	1,997,879
Test sets, radar	65,000
Transducers	68,381
Transistors	25,302
Transmitters, rate gyro	81,778
Transmitter-receivers, tape	12,267
Transmitter, SSB	25,878
Transmitters, syncro	198,117
Transmitters, telemetry	83,880
Transponders	495,445
Tube, cathode ray	75,544
Tube, electron	2,457,720
Tube, klystron	388,530
Tube, Magnetron	672,445
Tube, thyratron	41,665
Wire	484,415

Last month the monthly contract awards were omitted due to statistical round-up. In answer to our readers requests, the November awards are listed on page 160.

#### TRANSISTOR SALES

	1958 Sales (units)	1958 Sales (dollars)
January	2,955,247	\$6,704,383
February	3,106,708	6,806,562
March	2,976,843	6,795,427
April	2,856,234	7,025,547
May	2,999,198	7,250,824
June	3,558,094	8,232,343
July	2,631,894	6,598,762
August	4,226,616	9,975,935
September	5,076,443	10,811,412
October	5,594,856	13,461,847
November	5,440,981	12,441,759
<b>TOTAL</b>	<b>41,423,114</b>	<b>\$96,133,811</b>

#### TUBE SALES

	TV Units	Receiving Units
January	621,910	26,805,000
February	556,136	29,661,000
March	634,779	28,548,000
April	590,357	32,582,000
May	560,559	36,540,000
June	725,846	36,270,000
July	549,817	30,795,000
August	713,458	30,456,000
September	891,803	40,061,000
October	969,501	41,540,000
November	789,283	35,640,000
<b>TOTAL</b>	<b>7,603,449</b>	<b>368,862,000</b>

—Electronic Industries Association

#### FCC NOTES

The FCC has more than 2,100,000 current authorizations in the radio field alone. This is in addition to existing grants for telegraph and telephone wire and cable systems.

Its radio permits and licenses increased by about 200,000 during 1958. The present total represents the use of approximately 1,500,000 transmitters, which is 250,000 more than 1957.

##### Safety and Special Radio Services

The 40 groups in these services account for some 465,000 authorizations covering more than 1,400,000 fixed and mobile transmitters.

Over 300,000 of these transmitters are operated by public bodies in connection with safeguarding life and property. Police departments have 167,000 transmitters; fire departments 60,000; forestry conservation agencies 34,000; highway maintenance

28,000, and special emergency over 13,000. During the year a service was added for local governments.

Marine safety and navigation is furthered by 80,000 transmitters, of which number over 75,000 are on ships. Some 3,700 U S. vessels have radar installations and shore-based radar is helping boats enter and leave certain harbors.

Aviation operations are facilitated by over 81,000 transmitters, 60,000 of which are on aircraft.

Land transportation is aided by 342,000 transmitters. Over 100,000 of these are employed for taxicab dispatching; over 65,000 for railroad operation; 38,000 for auto trucking; 2,700 for passenger buses, and 9,000 for automobile emergency aid.

Private industry harnesses nearly 420,000 transmitters to a variety of activities. Separate services for manufacturers, business, and telephone maintenance have just been established.

Amateur radio stations represent the use of about 185,000 transmitters.

Radio usage by individual citizens, mostly

for localized personal services, now accounts for 125,000 transmitters.

##### Common Carrier Services

Common carriers are expanding their use of radio for point-to-point telephone and telegraph communication, both domestic and international; also television relay, and rural radio and public land mobile services.

The nation's telephones are approaching 70,000,000. The great majority are now dial operated. About 250,000,000 telephone calls are made daily.

One-way signaling systems for "paging" customers are on the increase.

Public telephone service to passengers on aircraft in flight is under test.

The nation's telegraph system handles about 150,000,000 messages a year. Its Eastern microwave system is being extended to Chicago, and links to St Louis, Kansas City, Detroit and Cleveland are in prospect. More telegraph customers are receiving facsimile service in different forms in connection with their business operations.



# PHILCO

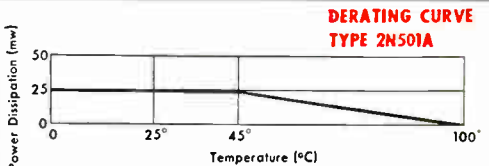
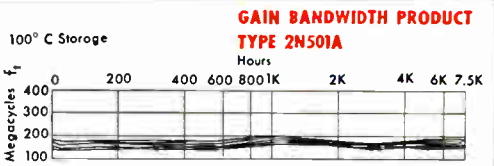
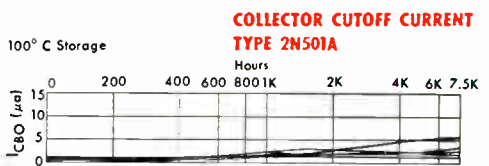
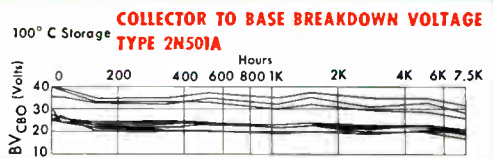
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## deliver outstanding switching performance



2N501A



High frequency, high gain Transistor offers excellent stability and operating efficiency in extensive environmental testing

Modern advances in electronics necessitate highest possible temperature performance from germanium transistors. Philco 2N501A transistors are designed for switching speeds of less than 18 milli-microseconds rise time, 12 m $\mu$ sec. storage time and 10 m $\mu$ sec. fall time . . . AND STORAGE TEMPERATURES UP TO 100° C. (see curve at right for derating factor). In extensive life tests (see graphs at right) these transistors exhibit excellent parameter stability at 7500 hours.

Philco's long and successful experience with electrochemical techniques and automatic transistor production, assures precise control of micro alloy diffused-base transistor performance. Philco know-how pays off for you . . . in outstanding uniformity and reliability of all transistors produced at Transistor Center, U.S.A.

Make Philco your prime source for all Transistor information.

Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. EI 259

\*Trademark Philco Corporation for Micro Alloy Diffused-base Transistor.

# PHILCO CORPORATION

## LANSDALE TUBE COMPANY DIVISION

### LANSDALE, PENNSYLVANIA

Circle 11 on Inquiry Card, page 117

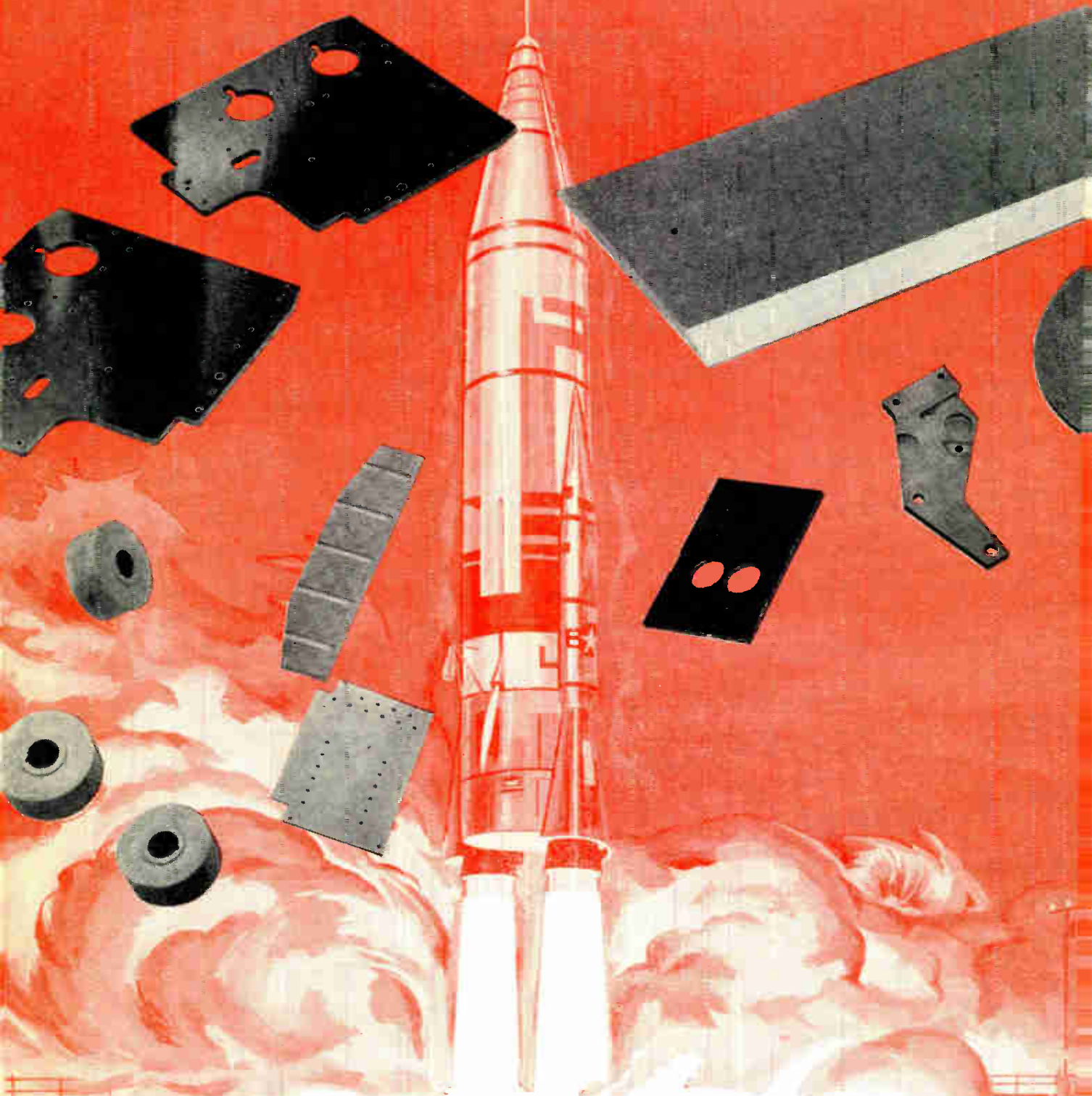




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- |   |  |
|---|--|
| ALBUQUERQUE, N. M.<br>Plasticrafts, Inc.  | LOS ANGELES, CALIF.<br>Conroy & Knowlton, Inc.<br>Leed Insulator Corp.<br>Tri-State Supply Co. |
| ARLINGTON, VA.<br>Milton H. Brooks & Son  | LOUISVILLE, KY.<br>C. Lee Cook Co.   |
| ATLANTA, GA.<br>Southeastern Plastics Sales Co.   | MEMPHIS, TENN.<br>Norrell, Inc.  |
| BRISTOL, VA.<br>Williams Co.  | MIAMI, FLA.<br>Commercial Plastic &<br>Sup. Corp. of Fla.                                      |
| BUFFALO, N. Y.<br>Curbell, Inc.   | MILWAUKEE, WISC.<br>General Plastics, Inc.   |
| CHICAGO, ILL.<br>Colonial Kolonite Co.<br>Tingstol Co.  | NASHVILLE, TENN.<br>Plastic Fabricator Co.   |
| CINCINNATI, OHIO<br>Aqua Sportsman Inc.<br>Durham Mfg. Co.  | NEW ORLEANS, LA.<br>Prager, Inc.   |
| CLEVELAND, OHIO<br>Jaco Products Co.  | NEW YORK, N. Y.<br>Commercial Plastics & Sup. Co.<br>Frank Products<br>Thomas J. Long, Inc.    |
| COLORADO SPRINGS, COLO.<br>Empire Plastics  | OZONE PARK, N. Y.<br>Comco Plastics  |
| COLUMBUS, OHIO<br>Dayton Plastics, Inc.   | PHILADELPHIA, PA.<br>Laminated Materials   |
| DAYTON, OHIO<br>Dayton Plastics, Inc.   | PITTSBURGH, PA.<br>Earl B. Beach Co.   |
| DENVER, COLO.<br>Plasticrafts, Inc.   | POMONA, CALIF.<br>Plastic Stamping, Inc.   |
| EAST RUTHERFORD, N. J.<br>Insulating Fabricators, Inc.  | ROCHESTER, N. Y.<br>General Circuits, Inc.   |
| EL CAJON, CALIF.<br>Dutton Mfg. Co.   | ST. LOUIS, MO.<br>Harris Mfg. Co.  |
| FORT WORTH, TEXAS<br>Plastelite Engineering Co.<br>Service Engineers, Inc.<br>Standard Parts & Equip. Corp. | ST. PAUL, MINN.<br>Plastics, Inc.  |
| GIBSONVILLE, N. C.<br>Engineered Plastics, Inc.   | SAN DIEGO, CALIF.<br>Ridout & Co.  |
| GRAND RAPIDS, MICH.<br>Novel Products   | SAN FRANCISCO, CALIF.<br>Laminated Fabricators<br>Tri-State Supply Corp.                       |
| HOUSTON, TEXAS<br>Houston Gasket & Packing<br>F. H. Maloney Co.<br>Replacement Parts Co.                    | SEATTLE, WASH.<br>Tri-State Supply Corp.   |
| HUNTINGTON, W. VA.<br>O'Neill Industrial Plastics, Inc.   | TAMPA, FLA.<br>Manatee Corp.   |
| INDIANAPOLIS, IND.<br>Automatic Machinery Co., Inc.   | UNIONVILLE, CONN.<br>Fabricon Corp.  |
| JACKSONVILLE, FLA.<br>St. John's Fry. & Mch. Co., Inc.  | WATERTOWN, MASS.<br>Insulating Fabricators of N. E.  |
| KANSAS CITY, MO.<br>Brooks Beatty Co.   | WEST ALLIS, WISC.<br>Colonial Kolonite Co.   |

# Electronic Industries' News Briefs

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

## EAST

**RADIATION, INC.**, has formed a new Washington research group headed by John Crone, formerly chief of the Physical Sciences Laboratory of the National Security Agency. It will be located in the Guardian Federal Bldg. in Silver Spring, Md.

**RCA's ASTRO-ELECTRIC PRODUCTS DIV.**, Princeton, N. J., developed the special radio system used by the communications relay inside the Atlas satellite.

**WESTINGHOUSE ELECTRIC CORP.**, East Pittsburgh Div., has created a new Power Control and Communications Department within the division. V. B. Baker will be manager of the new department.

**STROMBERG-CARLSON**, San Diego, has installed an S-C 4010 High-Speed Microfilm Recorder at the Naval Proving Ground, Dahlgren, Va. The system is capable of recording up to 15,000 characters or 10,000 graph plotting points per second.

**GENERAL ELECTRIC CO.** dedicated its new replacement tube plant in Augusta, Ga. The plant is manufacturing the "Black-Day-lite" tube.

**BENDIX AVIATION CORP.** delivered a G-15 digital computer to the Naval Research Laboratory for use in underwater acoustic studies.

**MILITARY PRODUCTS DIV.**, IBM received a subcontract for the design of an ultrahigh speed computer for SAC's world-wide electronic control system.

**INTERNATIONAL TELEPHONE & TELEGRAPH CORP.** has developed a miniature, airborne radar receiver that produces a picture 20 times brighter than the average home television set. It will do away with the need for hoods presently used on aircraft radar.

**MISSILE SYSTEM DIV.** is the new name for Republic Aviation Corporation's Guided Missiles Div. It reflects more clearly the areas of work in which the 7-year-old division is engaged.

**NATIONAL VULCANIZED FIBRE CO.** and **PARSONS PAPER CO.** have approved a plan under which National will acquire the business and assets of the New England paper company.

**KAHLE ENGINEERING CO.** has acquired the Lamp and Tube Equipment Department of Alfred Hofmann & Co.

**JERROLD ELECTRONICS CORP.** foresees an intensive drive by legitimate services to extend TV reception into fringe area communities, now that the economic and technical threat of unauthorized boosters has been removed by recent FCC rulings.

**MARTIN CO.'s** engineers at its Baltimore Materials Laboratory are obtaining extremely accurate records of microscope creep-strain tests with a 16 mm camera set-up that records the progress of the tests at elevated temperatures.

**SYNTRON CO.** is now operating a completely new silicon rectifier plant, the most modern facility of its type at 263 Lexington Ave., Homer City, Pa.

**JOHN BECK ASSOCIATES**, sales promotion, will be located at 421 Haddon Ave., Haddonfield, N. J. The founder, John C. Beck, was formerly an executive with RCA Victor.

**SANDERS ASSOCIATES, INC.** has been awarded a \$1.4-million Navy contract for the production of classified anti-submarine warfare "Sonobuoys."

**SPECIAL PRODUCTS DIV., I-T-E CIRCUIT BREAKER CO.** has been awarded a contract, approximately \$5-million, for all antennas of a new military communications system in NATO countries of Europe.

**RADIATION RESEARCH CORP.** is now producing thin films of tritiated titanium on stainless steel or molybdenum.

**THE TABET MFG. CO.**, Norfolk, Va. will manufacture its rotary wafer switch in a second plant now under construction in that city. Operation and production facilities will be doubled.

**ARTHUR V. PETERSON ASSOCIATES** has been formed by the nuclear engineer and administrator of that name. He was formerly of AMF Atomics. The new firm will provide atomic energy consultation to industrial management. Address: Bridge Square, Westport, Conn.

## MID-WEST

**KESTER SOLDER CO.**, the first manufacturer of flux-core solder for the infant electrical industry, celebrated its 60th anniversary in January.

**SPERRY GYROSCOPE CO.** received a contract for almost \$3-million for radar sets from the Air Materiel Command. The contract is for APN-59 radar sets and auxiliary equipment.

**SEMICONDUCTOR DIV., HOFFMAN ELECTRONICS CORP.** is working on two new production contracts totaling \$791,000 for solar energy converters. Contracts were awarded by the U. S. Signal Corps and Space Technology Labs.

**SEISMOGRAPH SERVICE CORP.**, Tulsa, Okla. is now completing arrangements for the installation of a four-station Lorac network at Cape Canaveral, Fla., for use in positioning missile-launching ships.

**TEXAS INSTRUMENTS INCORPORATED** and **METALS & CONTROLS CORP.** have agreed in principal to a merger of the latter into TI.

**SPERRY UTAH ENGINEERING LABORATORY** has received Army contracts for continued development and manufacture of the Sergeant, surface-to-surface tactical missile, totaling approximately \$22-million.

**PHELPS DODGE COPPER PRODUCTS CORP.** opened a new district office at 621 17th St., Denver, Colo. Mr. K. F. Packard will be the District Manager.

**MOTOROLA INC.** recently introduced a compatible stereo sound system in television.

**P. R. MALLORY & CO. INC.** verified the reliability of its tantalum capacitors with the successful completion of an 18,000 hour life test.

**LITTON INDUSTRIES' TRIAD TRANSFORMER CORP.** sales warehouse in Huntington, Ind. moved to 305 So. Briant St.

**COLLINS RADIO CO.** was selected by McDonnell Aircraft Co. to develop complete electronic instrumentation for the "Man-In-Space Program" to be designated Project Mercury.

## WEST

**CANNON ELECTRIC CO.** recently presented its 100-millionth Cannon plug to Donald Douglas, Jr., President of the Douglas Aircraft Co. in commemoration of Douglas's decision in 1933 to use the plugs to facilitate production and maintenance of planes. The \$100-million industry developed largely as a result of this decision.

**LOCKHEED MISSILE SYSTEMS DIV.** has purchased a 154-acre parcel of the Holthouse ranch next to its main plant at Sunnyvale, Calif., for "possible future expansion."

**MOTOROLA'S WESTERN MILITARY ELECTRONICS CENTER** has formed a Solid State Electronics Dept. It will provide an immediate capability for the development and manufacture of microwave ferrite materials.

**STORM PRODUCTS CO.** has moved to larger quarters at 2251 Federal Ave., West Los Angeles, sizeably increasing its floor space and providing additional warehousing facilities for its electronic wire, cable and tubing business.

**LING ELECTRONICS, INC.**, will manufacture high-power sonar transmitting equipment for the U. S. Navy under a contract with Raytheon Co.

**MICROTRAN CO., INC.** opened its West Coast warehouse, situated at 1485 Bayshore Blvd., San Francisco, Calif. Phone: SU 7-8700.

**ROBERTSHAW-FULTON CONTROLS CO.'s AERONAUTICAL AND INSTRUMENT DIV.** produced 13 of the airborne components of the Atlas satellite.

**POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.** opened a Southern California sales office. The office located at 2639 La Cienega Blvd., Los Angeles 34, will be headed by Lyle Jevons.

**THE NATIONAL CASH REGISTER CO., ELECTRONICS DIV.** recently conducted a seminar on new military system developments and digital computer techniques for government scientific agencies and military services.

**HUGHES AIRCRAFT CO.** boosted its 1958 sales to half a billion dollars in 1958. The increase was helped by the introduction of four new systems geared to defense projects.

**ENGINEERED MAGNETICS DIV., GULTON INDUSTRIES, INC.** has developed a new low level DC amplifier that will permit the use of one instrument instead of many. The unit eliminates the need to amplify each signal separately. Completely transistorized it is designated Model EM-2000A.

**BJ ELECTRONICS, BORG-WARNER CORP.** received a new Signal Corp contract for additional high performance radio frequency test sets.

**NORTHROP CORP.** is the new name for Northrop Aircraft, Inc. **NORAIR** is the new name for the company's Northrop Div. at Hawthorne, Calif.

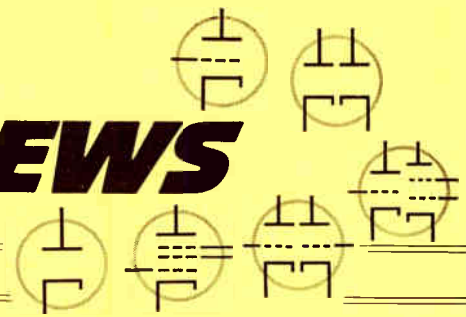
**CONSOLIDATED ELECTRODYNAMICS CORP.** has established a marketing research department within its marketing division. Richard N. Schuck will serve as director.

**HOFFMAN LABORATORIES DIV., Hoffman Electronics Corp.**, were awarded contracts for approximately \$1½ million to manufacture the "Sonobuoy" anti-submarine device. The contract calls for several thousand units with production scheduled to start in mid-summer.

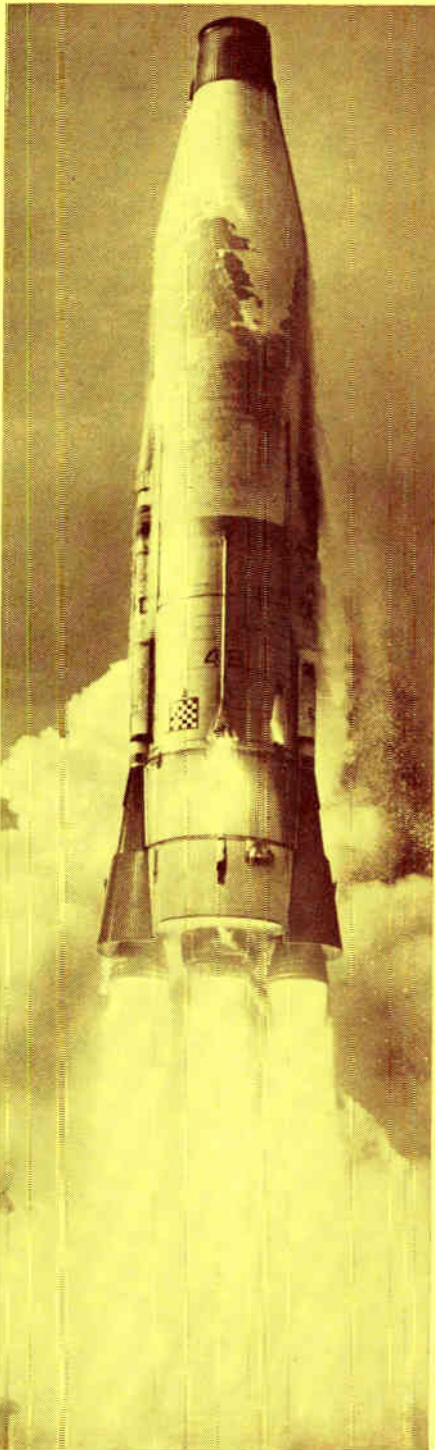


# TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY



## Five-Star 6829's Help Guide Atlas ICBMs to Target 6,325 Miles Distant And into Earth-Circling Orbit!



High reliability of General Electric's 6829 twin triode was a factor in the historic full-range test flight of Convair's U.S. Air Force Atlas missile November 28—the nose-cone dropping well within the target area.

Ground radio-command guidance for the range shot used 6829's both in computer sockets, and for general-purpose triode functions such as cathode-follower, coincidence, pulse-generator or amplifier, and gating.

In the Atlas satellite shot, Type 6829 was used for many ground-base sockets because of its dependability. DC and pulse life tests of hundreds of 6829's show 1,350,000 tube hours with no defectives.

With high perveance,  $\mu$ , and transconductance, plus uniform, controlled cut-off, the 6829 is a military tube having wide usefulness. Ask any General Electric tube office on the next page for circuit applications!

## Six 7077 Ceramic Triodes Used in RF Stage of Collins ARC-52 Military Communications System

Low noise, high gain, exceptionally small size—these qualities of General Electric's 7077 were responsible for Collins Radio Company's choice

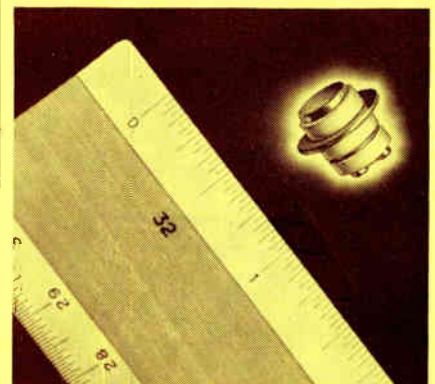
of the tube for RF amplifier and mixer sockets in their new military airborne communications equipment.

Now in production, Collins' advanced system meets the needs of the newest, fastest planes because of its communications range, compact size, and ability to stand up in hard service. The tough metal-ceramic construction of Type 7077 contributes to the ARC-52's ruggedness.

## New 5-Star 6688 Amplifier Pentode Features High $G_m$ -to-Cap. Ratio!

Developed for use in broad-band IF amplifiers, General Electric's new high-reliability 6688 has a transconductance of 480 micromhos per microfarad of tube capacitance ( $G_m$  over  $2\pi \sqrt{C_{in} \times C_{out}}$ ), or approximately twice that of Type 5654/6AK5. Double the gain bandwidth product of the 5654 may therefore be anticipated from the new tube.

Also the frame-grid design of the new 6688 makes possible a very high  $G_m$ -to-cathode-current ratio. This helps produce an exceptionally low-noise grid-cathode structure. See next page for information on the performance of General Electric's 6688 when the tube is triode-connected!



This actual-size picture of the G-E 7077 shows the triode's small dimensions—only .41" long by .48" wide. Extreme compactness was one reason Collins specified Type 7077.



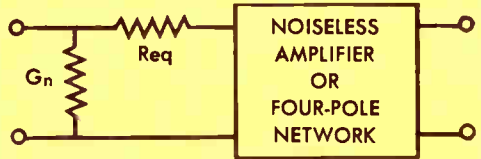
**Tear off and keep this sheet for reference. It contains useful tube-application data.**

# New Parameters Help Pinpoint Tube RF Noise Characteristics!

**Designer's Choice of Correct Type Made Easier  
by Curves That Show  $R_{eq}$  and  $G_n$   
as Functions of Tube Operating Frequency!**

The curves at right enable the circuit designer to analyze, in advance, the noise characteristics of a triode at different frequencies of operation. Type 6688, triode-connected, has been chosen for this example.

The equivalent parameters employed— $R_{eq}$  and  $G_n$ —are based on recent work\* on the specification of tubes at high frequencies. The fundamental circuit is:



( $R_{eq}$  is the equivalent series shot-noise resistance.  $G_n$  is the equivalent shunt noise conductance.)

The value  $R_{eq}$  already is familiar as the term for shot-noise resistance, and describes the relative amount of shot-noise voltage present in the tube.  $G_n$  is a comparatively new term.  $G_n$  may be assumed to be equal to five times transit-time conductance, a familiar value.

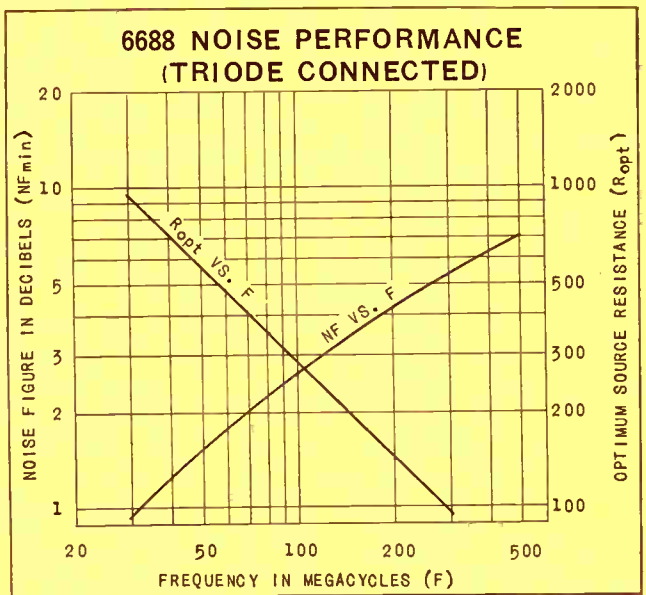
$R_{eq}$  is essentially constant over a tube's useful frequency range, while  $G_n$  varies directly with frequency squared. In the light of these facts, simple equations can be written for minimum noise figure and optimum source resistance:

$$NF_{min} = 1 + 2 \frac{f_x}{f_0} \sqrt{R_{eq} G_n} \quad R_{opt} = \frac{f_0}{f_x} \sqrt{\frac{R_{eq}}{G_n}}$$

—where  $f_x$  is frequency at which noise figure and optimum source resistance are desired, and  $f_0$  is frequency at which the value of  $G_n$  has been measured.

At lower right are values of  $R_{eq}$  and  $G_n$ , as measured on commercially available samples, for most of the popular high-frequency tube types. From these values, the noise characteristics of any type listed can easily be determined and charted. Ask any General Electric receiving-tube office listed below for additional facts!

\* Rothe, H., and Dahlke, W., "Theory of Noisy Fourpoles", PROCEEDINGS OF THE I.R.E., Vol. 44 (June, 1956) pp 811-818.



**MEASURED VALUES OF  $R_{eq}$  AND  $G_n$**

Tube type	$R_{eq}$ (ohms)	$G_n$ at 90 mc (micromhos)
<b>Military and Industrial:</b>		
6201	600	320
6688	120	1160
7077	350	140
<b>Entertainment:</b>		
6AM4	260	600
6AN4	250	550
6BC4	260	540
6BC8	600	320
6BK7-A	240	520
6BN4	420	390
6BQ7-A	435	290
6BZ7	490	350
6CE5	650	1200
2CY5	525	640
PC86	170	710

NOTE: pentodes are connected as triodes.

**For further information, phone nearest office of the G-E Receiving Tube Department below:**

**EASTERN REGION**  
200 Main Avenue, Clifton, New Jersey  
Phones: (Clifton) GRegory 3-6387  
(N.Y.C.) Wlconsin 7-4065, 6, 7, 8

**CENTRAL REGION**  
3800 North Milwaukee Avenue  
Chicago 41, Illinois  
Phone: SPring 7-1600

**WESTERN REGION**  
11840 West Olympic Boulevard  
Los Angeles 64, California  
Phones: GRanite 9-7765; BRadshaw 2-8566

*Progress Is Our Most Important Product*





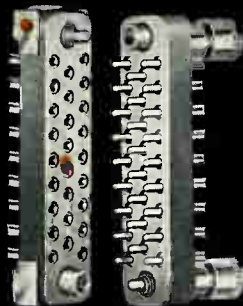


**“better than we expected!”**

**SMI-C Subminiature Series\*  
Precision Connectors**

When our connectors meet your specifications perfectly . . . well that's all part of our job. But when they exceed requirements, we drop all modesty and do a little shouting. This was the case with our new SMI-C Connector Series, causing one of our leading customers to exclaim "Better than we expected!" These are the newest members of the family of over 150 reliable types of U. S. COMPONENT connectors, products of a close liaison between application engineers and our design team. Read all about it . . .

- **STAINLESS STEEL REINFORCING RETAINER** provided under each screwlocking element removes all torque stresses from molded bodies, avoiding breakage.
- **POSITIVE RE-ENTRANCY OF MALE PINS** assured each time by flanged guide female contact.
- **SELF-ALIGNMENT ACTION** assisted by provision of wider countersink on upper end of contact.
- **IDEAL FOR CRITICAL ENVIRONMENTAL CONDITIONS** and extremes of military applications.
- **7-11-14-20-26-34 contacts.** Other configurations upon request.



**U. S. COMPONENTS, INC.**

associated with U. S. Tool & Mfg. Co. Inc.

454 East 148th Street, New York 55, N. Y. • CYPRESS 2-6525

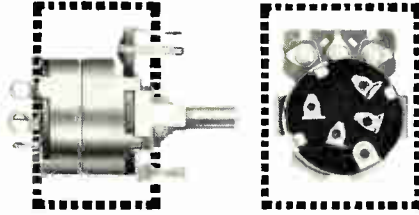


Pat. #2,761,108 and additional Patents Pending.

# WHEN IT COMES TO MINIATURE CONTROLS...

## CHECK THE OVERALL SIZE...

including switch, if needed. For practical space-saving ability, Stackpole miniature "F" Controls lead the way — only 0.637" in diameter behind the panel for the entire length of *both* control and switch.



Photos show side and rear views of a Stackpole F Control with 2-pole switch. Dotted lines indicate behind-panel space occupied by a conventional "miniature" control.

Notice how Stackpole's small switch size perfectly complements the miniature control . . . saves precious chassis space where it's needed the most.

## FEEL and HEAR THE SWITCH ACTION...



for the tease-proof, positive "feel" and audible "click" only a true snap-action switch provides. "B"-Series switches used on "F" Controls have the same time-proven mechanism as larger Stackpole control switches. They're U.L. Inspected for 1 amp. @ 125v ac-dc; 4 amps @ 25v dc.

## CHECK THE COMPLETENESS OF BOTH CONTROL and SWITCH LINES

Printed wiring, wire-wrap, or standard lug terminals as well as fold-tab or threaded bushing mountings are available on all Stackpole miniature "F" controls. *Both* SPST and DPST switches can be supplied.



# STACKPOLE

miniature "F"-series

# VARIABLE RESISTORS

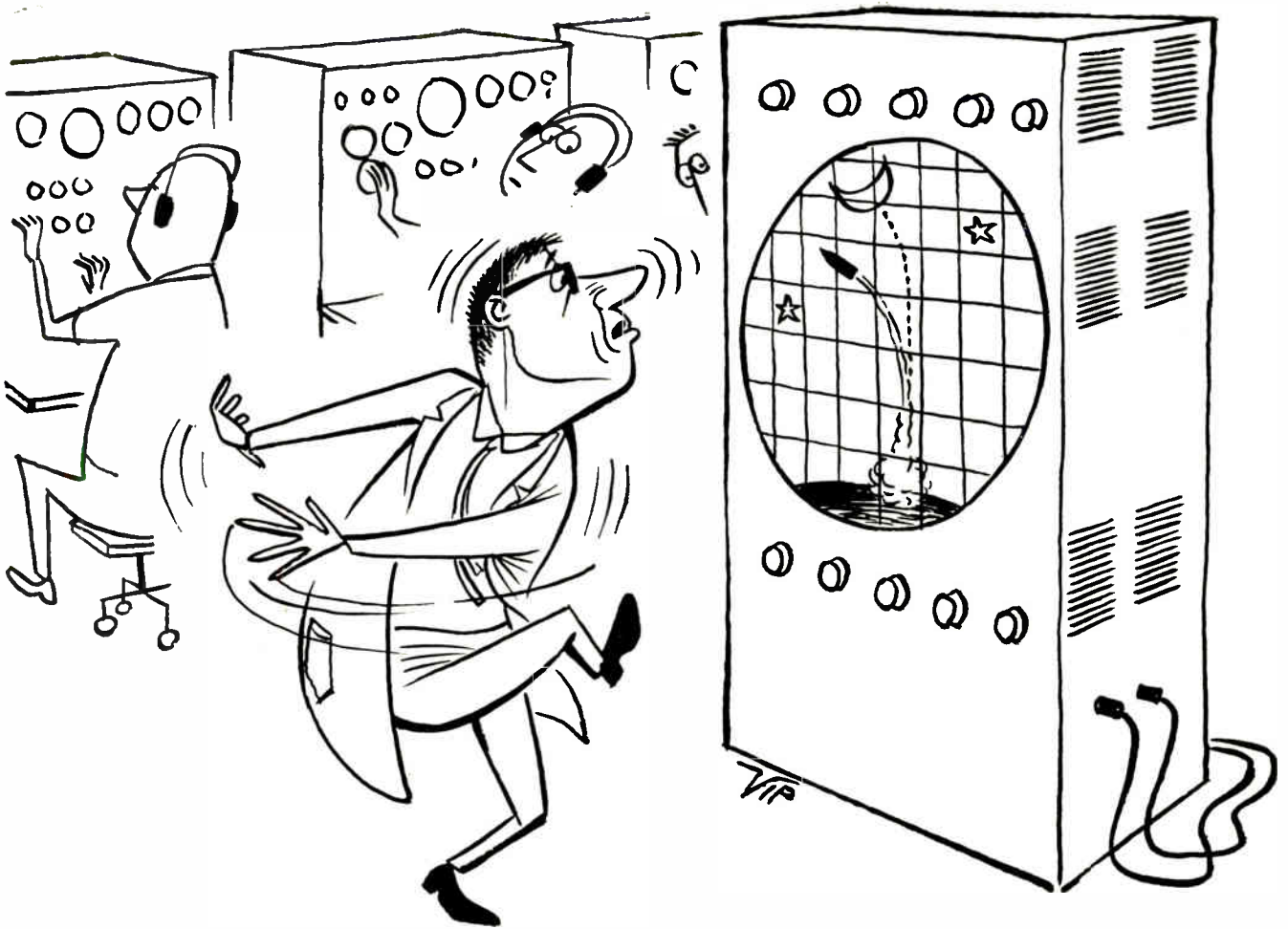
Electronic Components Division

**STACKPOLE CARBON COMPANY, St. Marys, Pa.**

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

FIXED & VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • IRON CORES • CERAMIC MAGNETS  
 FIXED COMPOSITION CAPACITORS • CERAMAG® FERROMAGNETIC CORES  
 HUNDREDS OF CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.





## Missile Guidance—*Body English*

*Contortions of the human body* have not, as yet, proven themselves acceptable means for overcoming component failures in missile guidance systems. While you may be able to “will” a golf ball into a cup, no one has ever “willed” a missile back on course. We at Hughes Products feel that missile component reliability can take a more scientific form. The tight quality control procedures at Hughes Products insure you component reliability that can be counted upon, even under the most severe environmental conditions.

On the following three right-hand pages you will find specific examples of reliable Hughes Products components—Gold Bonded Germanium

Diodes, TONOTRON\* storage tubes, and High Frequency Crystal Filters.

In addition to these, other Hughes Products devices which provide you with this “built-in” reliability include: Special-purpose oscilloscopes...Rotary Switches...Thermal Relays...MEMOTRON® and TYPOTRON® display storage tubes...Diodes, Transistors and Rectifiers with uniform performance...and Industrial Systems which automate a complete and integrated line of machine tools.

\*Trademark of H.A.C.

*For additional information regarding any component or system please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.*

*Creating a new world with ELECTRONICS*

**HUGHES PRODUCTS**

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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS



## Solve Tough Molding Problems with *Teflon*\* & **KEL-F**†

Our specialty is precision molding where close tolerances, intricate shapes, and where thin wall sections are involved. Garlock's United States Gasket Plastics Division has the personnel, the facilities, the unequalled experience in handling tough fluorocarbon plastics.

Guarantee yourself the best parts, and the right price—ask for a quote on any molding problem concerning **TEFLON T.F.E.** and **KEL-F**. Call us, too, for fluorocarbon sheets, discs, tape, rods, tubing, bars, and cylinders from the world's largest and most complete stock.

**U**  
**S**  
**G** **United States Gasket**

For Prompt Service, contact one of our 30 sales offices and warehouses in the U.S. and Canada, or write The Garlock Packing Company, Palmyra, New York.

\*DuPont Trademark for T.F.E.-fluorocarbon resin  
†M.M.&M. Trademark

*Plastics Division of*  
**GARLOCK**



## Tele-Tips

**ELECTRO-NICKS** on the blackboard of time—a ramble through our file of "Must Run" items that somehow just never made it during the past year.

For instance—

A peak of creativity can be expected in about 15 years, with another Dark Age to follow by 2055 A.D., says a Univ. of Michigan researcher. He checked back to 600 B.C., and found that creative peaks occurred every 164 years, inevitably. Both U.S. and Russian science, he says, will take the dip.

Pennsylvania with its new Rem-Rand Univac is the first state to establish an electronic data processing center for all its departments and agencies.

At ITT Labs, engineers are designing an "atomic" clock that will vary less than 3 secs. in 1,000 years.

Nearly half of the business failures in the U.S. during 1958 were caused by inadequate sales. (This sounds like a joke, but it isn't. It's a pitch by an outfit that checks the credit of potential customers.)

Recession times play tricks on top management. Last year, business staggered through its shakiest period since the war and top executives were called on for their most herculean efforts—yet received least in the way of increases. In fact, the average top exec received no increase at all during 1958.

The average man is more likely to be disabled for three months before age 65 than he is to die before retirement age. Nearly 33% of men reaching 35 will be disabled for at least 3 months before age 65, and 10% or more of those disabled will be permanently disabled.

"Avigation" is not only technically correct, it is the only proper word to describe navigation in the  
(Continued on page 26)





# GOLD BONDED

## HUGHES GERMANIUM DIODES

*first of all for reliability.*

Typical performance levels: @ 25°C. unless otherwise stated

	Forward Current @ +1V (mA min.)	Inverse Current @ Specified Voltage ( $\mu$ A max.)	Maximum Inverse Voltage (Volts)
1N270	200	100 @ -50V	100
1N276	40	100 @ -50V 100 @ -10V*	60
1N277	100	250 @ -50V* 75 @ -10V*	125

\*Measured @ 75°C.

*For additional information write: Hughes Products,  
Marketing Dept.—Semiconductors, International  
Airport Station, Los Angeles 45, California.*

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance... vibration resistance... thermal stability... electrical stability.

*Creating a new world with ELECTRONICS*

**HUGHES PRODUCTS**

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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS



**Another Tinnerman Original...**

## Nut-in-a-cage eliminates welding or staking... **SPEED GRIPS®** hold themselves on panels!

Wherever you require a heavy-duty, multi-thread, self-retaining fastener, a Tinnerman SPEED GRIP Nut Retainer answers the need, holds down assembly costs.

SPEED GRIPS snap into place... some into panel holes... others over panel edges. No special tools or skills required. Spring-steel fingers grip the panel, yet let the nut float to compensate for normal panel-hole misalignment. Welding, staking and clinching are eliminated. SPEED GRIPS can even be applied after panels have been finished, avoiding paint-clogged threads.

SPEED GRIPS are available in a wide range of sizes and types, including front-mounting nut and bolt retainers for hard-to-reach or blind locations.

See your Sweet's Product Design File, section 8-T for data on these and other SPEED NUT

Brand Fasteners. Your Tinnerman representative has complete information and samples. If he isn't listed under "Fasteners" in your Yellow Pages, write to:

**TINNERMAN PRODUCTS, INC.**  
Dept. 12 • P.O. Box 6688 • Cleveland 1, Ohio

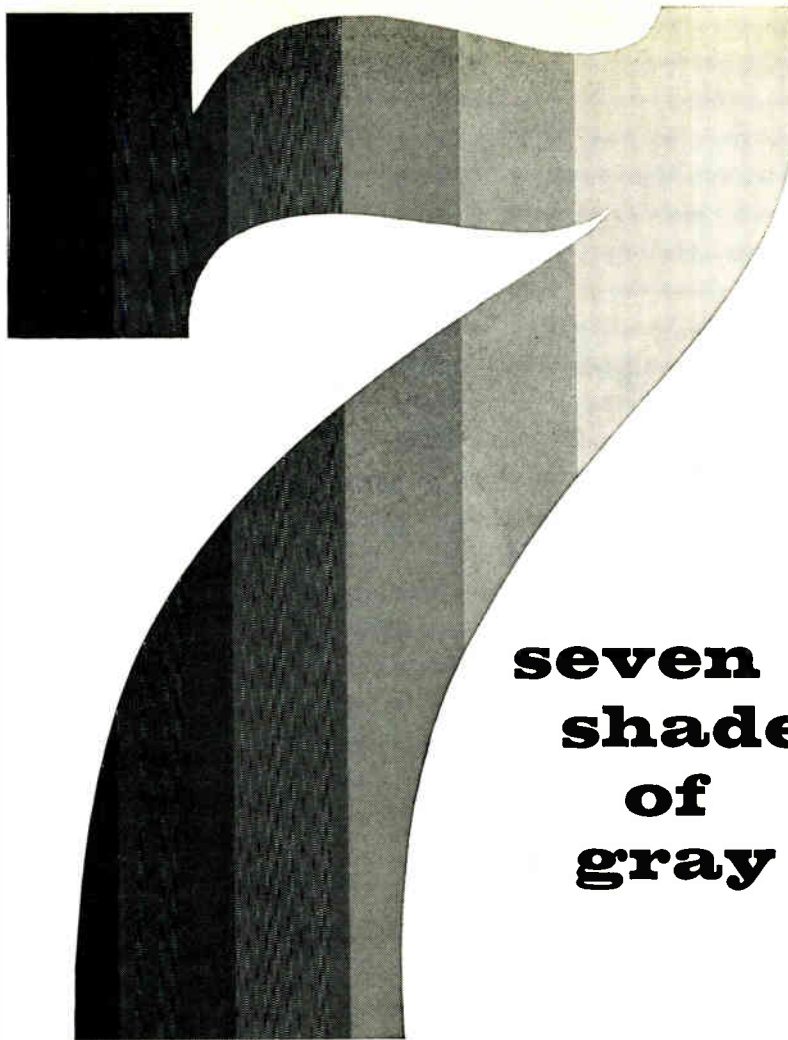
**TINNERMAN**

*Speed Nuts®*



FASTEST THING IN FASTENINGS®



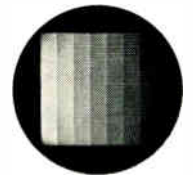


## seven shades of gray

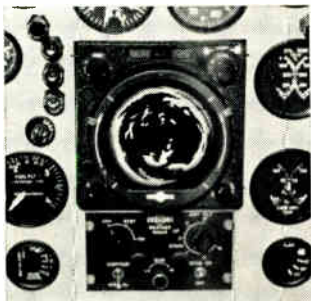
### with the Hughes TONOTRON\* Storage Tube

Able to present as many as seven shades of gray, the Hughes TONOTRON\* cathode-ray storage tube now provides you with high-fidelity picture reproduction.

In addition, the Hughes TONOTRON\* tube features high picture brightness (in excess of 1500 foot lamberts with full half-tone range) and controllable persistence.



Other Hughes electron tubes include the MEMOTRON® storage tube, the TYPOTRON® storage tube, and a family of microwave tubes. With a wide variety of reliable tubes designed to meet your strictest requirements, Hughes continues to maintain leadership in the field of storage and microwave tubes.



Typical installation in a commercial aircraft.

**Collins Airborne Weather Radar System** WP-101 incorporates the Hughes Type 7033 Magnetic Deflection TONOTRON\* tube. This system provides the pilot with a continuous high-fidelity picture of weather conditions within a radius of 150 miles. Ground mapping—a secondary function—shows the location of cities, lakes, rivers, mountains, and shorelines, and dangerous obstacles. *Even in direct sunlight, no viewing hood is required.*

*For additional information regarding any of the Hughes electron tubes please write: Hughes Products, Marketing Dept.—ELECTRON TUBES, International Airport Station, Los Angeles 45, California.*

\*TRADE-MARK OF H. A. C.

*Creating a new world with ELECTRONICS*

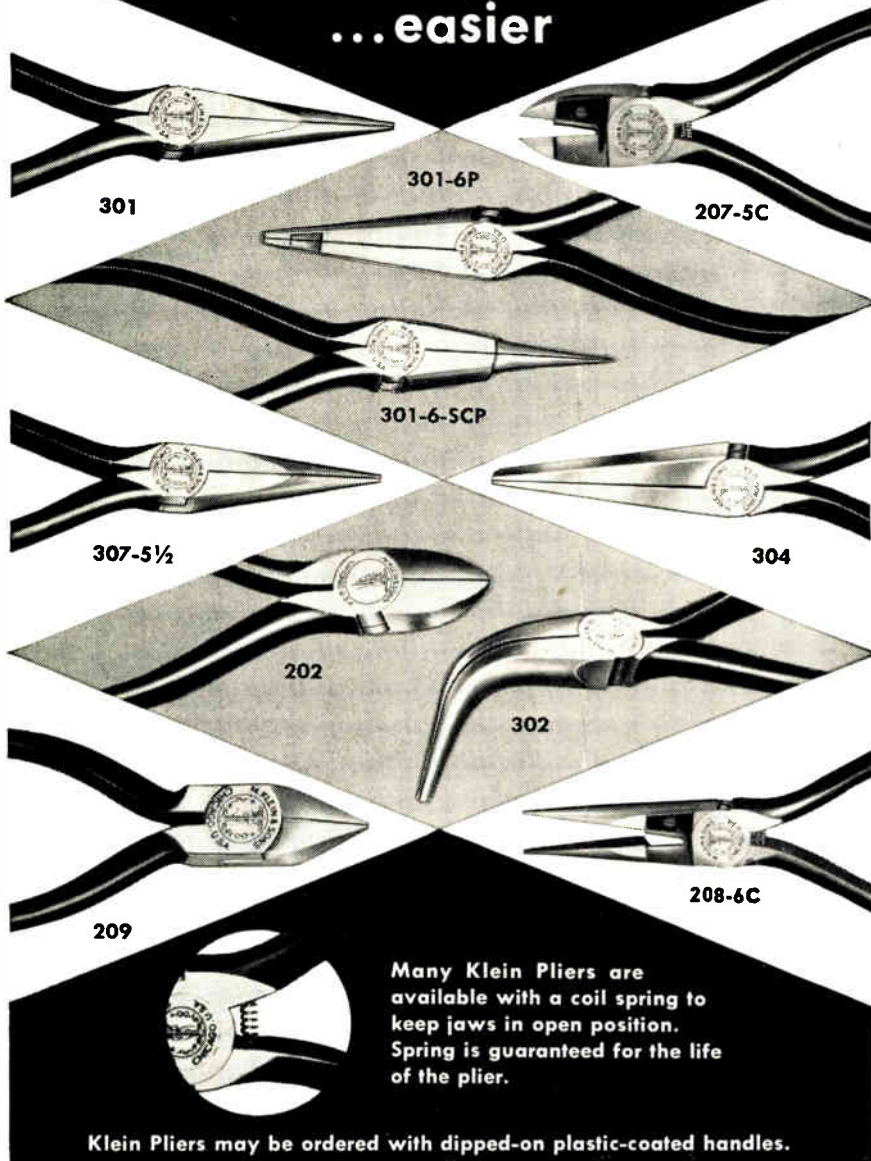
**HUGHES PRODUCTS**

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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

# KLEIN PLIERS

make wiring faster  
...easier



Many Klein Pliers are available with a coil spring to keep jaws in open position. Spring is guaranteed for the life of the plier.

Klein Pliers may be ordered with dipped-on plastic-coated handles.

There's a lot to like in Klein Pliers. There is a size and style for every job, even the toughest wiring assembly. All are made of finest alloy

steel, individually tempered and tested. They are backed by the Klein name, serving industry for more than 100 years.



Write for the new Klein Catalog 101A listing the complete line of Klein pliers including over 20 pliers recently developed

ASK YOUR SUPPLIER

Foreign Distributor: International Standard Electric Corp., New York



**Mathias KLEIN & Sons**  
Established 1857 Chicago, Ill., U.S.A.  
7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

## Tele-Tips

(Continued from page 22)

air. The first book by that name, "Electronic Avigation," by ITT's P. C. Sandretto, is just off the press.

The electronic industries' contribution to rock-and-roll—the short short cathode ray tube.

For those not up on Space Talk, Republic Aviation has a little 18-page dictionary of out-of-this-world terms heard around the launching pad. Items like auntie, bird, brain, dog-house, pick-up and zip fuel.

San Diego, Calif., engineer Dr. Charles H. Graves will next month run out the first model of his electric auto, the Charles Town-About, a 2-door coupe with a speed of 58 mph and range of 77 miles without recharging. Charging is done at any 110-v. outlet. Power is supplied by two 2½-hp. electric motors located at the rear wheels.

In 1958 the highest temperature ever recorded on or around this old planet of ours was reported by a Weather Bureau balloon 13 miles above the South Pole. It read -135.4°F.

Avco has designed a super loud-speaker system to vibration-check the nose cones for Titan and Minuteman missiles. Noise output is 163 db, enough to split the eardrum.

These trade shows are becoming truly gigantic affairs. Here's the number of people that were involved in the last Aircraft Electrical Soc. Display: 500 exhibitors, 100 volunteer workers, 20 concession workers, 18 auditorium workers, 2 telephone men, 4 telephone operators, 3 secretaries, 6 parking attendants, 11 typists, 10 decorators, 10 truck drivers, 9 hostesses, 6 ushers, 3 directors, 1 attorney, 5 electricians, 6 guards, 6 aud mgrs, 1 printer, 2 florists, 2 sign painters, 1 fireproofers, 1 porter, 1 maid.





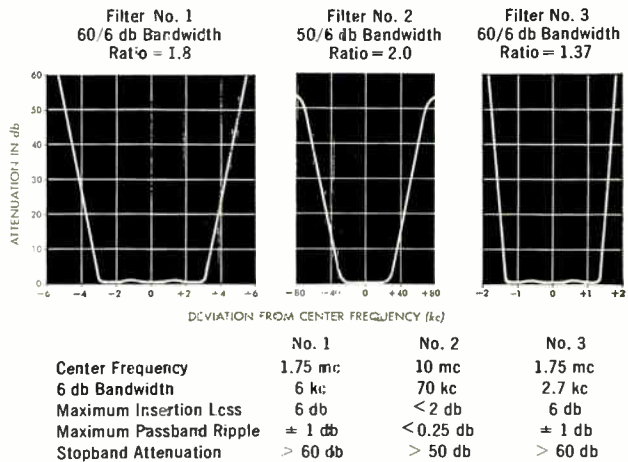
## precision performance levels set by Hughes Crystal Filters

Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

### SPECIFIC PERFORMANCE CHARACTERISTICS FOR TYPICAL FILTERS



For further information please write HUGHES PRODUCTS, Crystal Filters, International Airport Station, Los Angeles 45, Calif.

Creating a new world with *ELECTRONICS*

**HUGHES PRODUCTS**

© 1959. HUGHES AIRCRAFT COMPANY

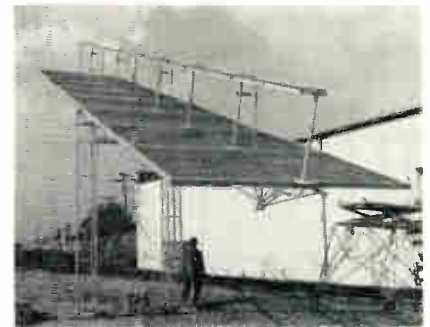
SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS



**"MOON BUILDING"**

Living quarters, research labs and maintenance shops for space ships could be housed in this unusual "moon" building designed by Wonder Building Corp. of America, Chicago, Ill.

# Snapshots of the Electronic Industries



**SPACE-PROBE TEETER-TOTTER**

Telemetry antennas for Project Vanguard, over 50 ft. in length, are scanned across the heavens by this teeter-totter mechanism supplied by E-Z Way Towers Inc., Tampa, Fla.

**TRAINING NAVY MISSILEMEN**

Lockheed instructor (right) watches as Navy missilemen assemble instrumentation wiring for Polaris test vehicle at Lockheed Missile Systems Division's Sunnyvale, Calif. plant.

**TRUCKERS TELEVISION (below)**

Ten TV monitors in new operations office of Yale Transport Corp.'s N.Y.C. office provide constant surveillance of 43 truck bays.







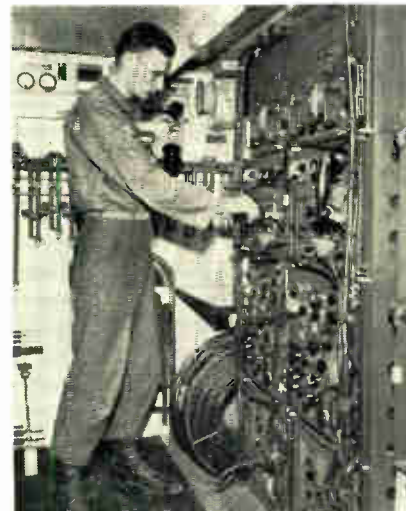
**OVERSEAS VISITORS**

Japanese industrialists are shown B & H Instrument Co.'s Jetcal Analyzer by B & H pres. J. S. Howell in the course of their 6-week tour of American manufacturing plants



**MOON LINK**

Contact with the moon probe will be made by the unique "Microlock" receiver manufactured by Siegler Corp's Hallamore Electronics Div. and shown at lower right.



**MOBILE CENTER**

The Army's airborne communications center is demonstrated at Ft. Monmouth. New center gives Army commanders better control over widely dispersed troops in atomic war.

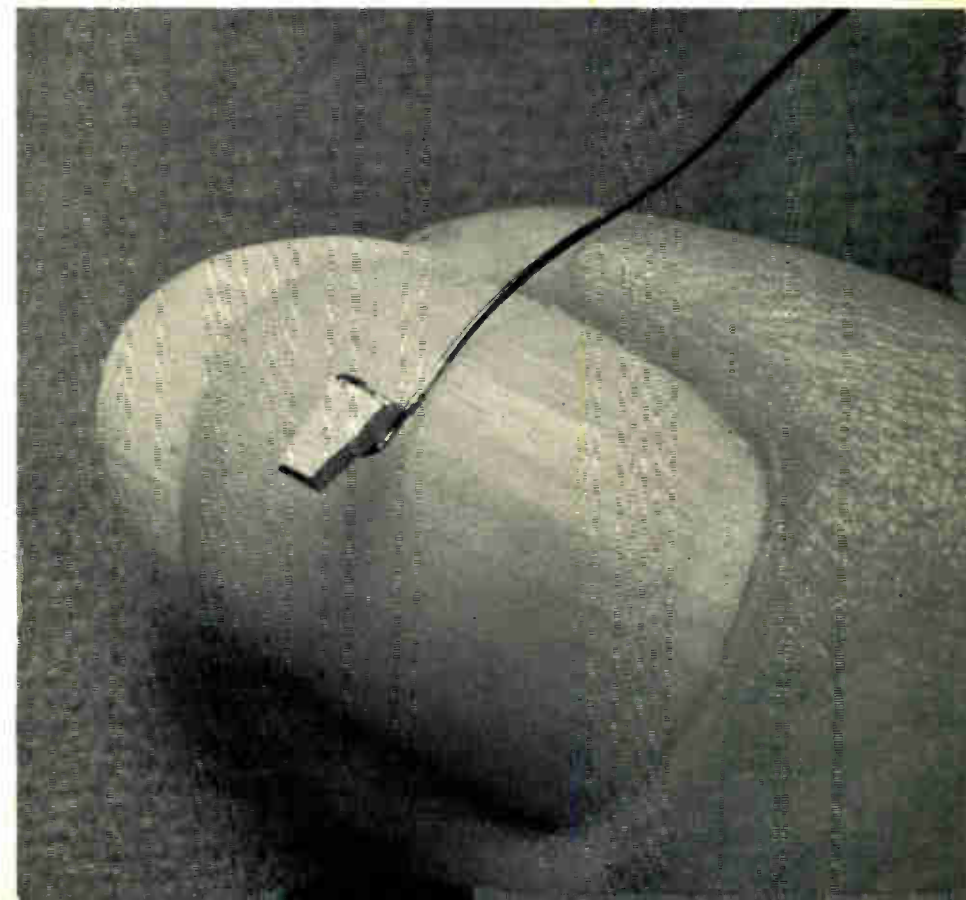


**FOR ALL-WEATHER GYROS**

Sperry Gyroscope technician demonstrates new gyro flotation fluid (l) that remains a liquid at sub-zero temperatures where conventional fluid (r) freezes

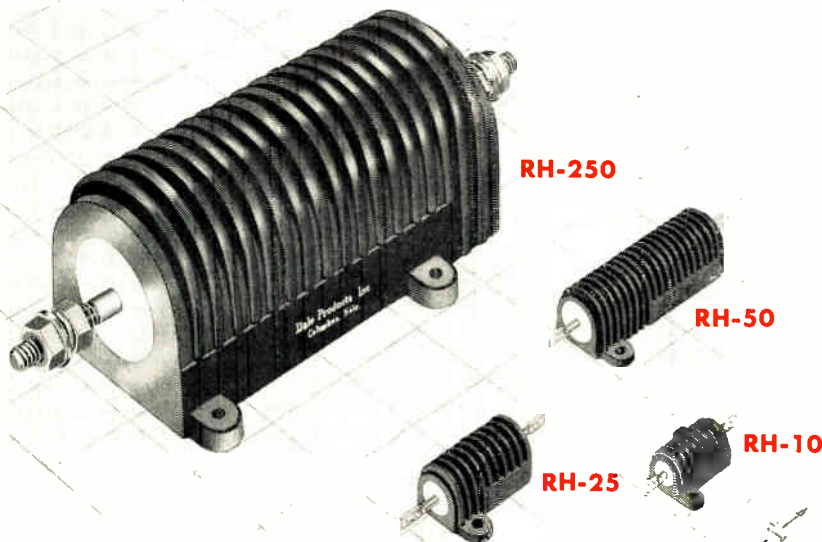
**NEUTRON "DETECTOR"**

This world's smallest neutron detector, developed by Westinghouse atomic scientists, probes inside reactor to map neutron flow paths, the most basic data for reactor design





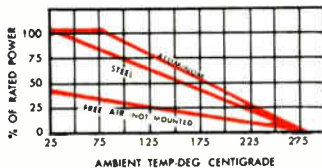
... for Complete Reliability Under Severe Environmental Conditions



## TYPE RH POWER RESISTORS

Wire Wound, Precision, Miniature, Ruggedized

TYPICAL DERATING CURVE



### JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

**DALE  
PRODUCTS  
INC.**

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COLUMBUS, NEBRASKA

Designed for the specific application of high power requirements, coupled with precision tolerance. Mounts on chassis for maximum heat dissipation. Operates under severe environmental conditions as outlined in specifications below.

- Rated at 10, 25, 50 and 250 watts.
- Resistance range from 0.1 ohm to 175K ohms, depending on type.
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%.

**TEMPERATURE COEFFICIENT:** Within  $\pm 0.00002/\text{degree C.}$

**COMPLETE PROTECTION:** 100% impervious to moisture and salt spray.

**WELDED CONSTRUCTION:** Complete welded construction from terminal to terminal.

**RUGGED HOUSING:** Sealed in silicone, inserted in radiator finned aluminum housing.

**SMALLEST IN SIZE:** 7/16 x 3/4 to 3 x 4-1/2 inches.

**MILITARY SPECIFICATIONS:** Surpasses applicable paragraphs of MIL-R-18546B.

Write for Bulletin R-21

## Books

### Sample-Data Control Systems

By Eliahu I. Jury. Published 1958 by John Wiley & Sons, 440 Fourth Ave., New York 16. 453 pages. Price \$16.00.

This book provides the first real source of knowledge with successful treatment and industrial problems related to the basic theory of sample-data control systems in particular, and circuits, networks, computers and system engineering in general.

Augmented with extensive examples and problems, the book describes the theory through a general approach to mixed digital-analog linear systems and a thorough discussion of the Z-transform method which can be applied to a wide variety of fields.

Problems arising in feedback control systems are solved and discussed by means of applications of digital computers. General Applications of the Z-transform method and the operational solution of linear difference equations are enumerated and clarified.

### How to Design and Specify Printed Circuit

Published 1958 by The Institute of Printed Circuits, 27 E. Monroe St., Chicago 3, Ill. 92 pages. Price \$5.00.

This comprehensive technical manual reports on the consensus of experiences and skills of the leading manufacturers of printed circuits. The book is a practical guide for the design engineers, purchasing executives, and the appliance, automotive, electrical manufacturing, and electronic industries.

The book presents a general technical explanation and the sequence in adapting electrical and electronic wiring circuits to a single or co-planar printed wiring connecting structure.

The new book also contains recommendations for tolerances which have been prepared by the Institute of Printed Circuits.

### Electronics of Microwave Tubes

By W. J. Kleen. Published 1958 by Academic Press Inc., Publishers, 111 Fifth Ave., New York 3. 349 pages. Price \$9.00.

The author explains, both qualitatively and quantitatively, the effects governing the operation of those microwave tubes now used in telecommunications. The material is presented in such a form as to be suitable for the reader with the physical and mathematical background of a postgraduate student.

Because in the microwave region it is difficult to separate tubes from the circuit, certain chapters have been added dealing with tubes and circuits and the properties of resonant circuits and delay lines used as tube elements.



# Books

## The Algebra of Electronics

By Chester H. Page. Published 1958 by E. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 250 pages. price \$8.75.

Presented here are the tools one needs for an intelligent understanding of electronics, from a fundamental review of principles to many alternate solutions covering common problems in the field of circuit theory and design.

The needs of a non-mathematical reader are carefully recognized, with many graphs and tables included to explain results at a glance. For the mathematically ambitious, and the more experienced, equations presenting more than one approach to a problem can be derived.

The author covers practical methods of solving simultaneous equations, develops elementary fourier waveform analysis, and shows the effects of frequency selectivity, modulation, and distortion. Tubes, transistors, and power supplies are analyzed.

## Mathematical Programming

By Nyles V. Reinfeld and William R. Vogel. Published 1958 by Prentiss-Hall Inc., Publishers, 70 Fifth Ave., New York 11. 274 pages. Price \$8.00.

This new text has been designed to bring what formerly had been considered a mathematician's tool, down to the level of training the average industrial manager.

Timely comprehensive and practical, it is alive with examples from industry, enabling the layman to better understand the problems of management as well as parallel problems.

## Properties and Applications of Transistors (in French)

By J. P. Vasseur. Published 1958 by Societe Francaise de Documentation Electronique, 12 Rue Carducci, Paris 19<sup>e</sup>, France. 479 pages. Price \$12.50.

This work sets out in detail the properties of transistors with a view to their use in circuits. It is written for engineers or students interested in this branch of electronics and can be used as an introduction to the subject or for more advanced study.

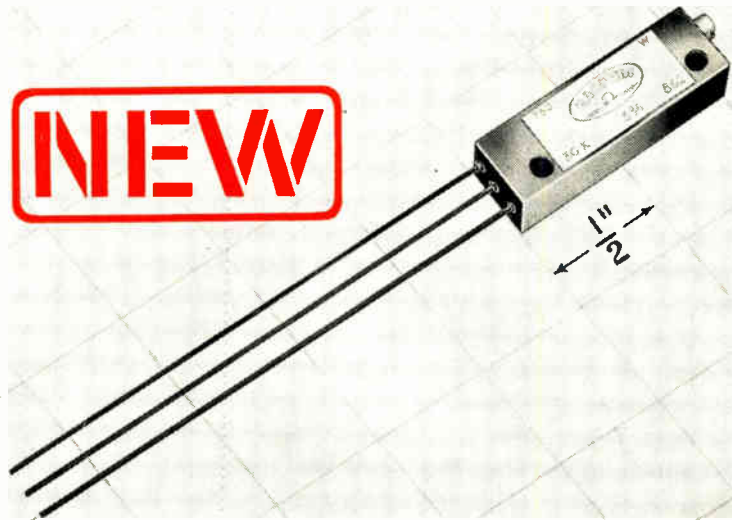
The author has adopted the essentially practical point of view of the technician, whose interest is not restricted to purely theoretical developments, but who wishes to understand and analyze the physical phenomena concerned in circuitry. In this spirit, the fundamental characteristics and properties of transistors and basic circuits are closely examined.

Many numerical examples are set out in the usual orders of magnitude of all the quantities considered, the best methods of measurement of which are discussed.



...for Complete Reliability Under Severe Environmental Conditions

**NEW**



## TYPE 750 TRIMMER POTENTIOMETERS

Super-Miniature, Wire Wound, Precision

The 750 trimmer, with a completely sealed case and welded construction, offers outstanding performance and stability.

It has a space saving design for advanced electronic circuits where it's mandatory to meet demanding conditions of miniaturization, reliability, precision and severe operating conditions.

Two terminal styles available: 750W—with leads extending from end of case; 750WP—with leads extending from bottom of case for printed circuits.

- Rated at 2 watts, up to 70° C. ambient.
- Resistance range from 100 ohms to 30K ohms.
- Standard tolerance:  $\pm 5\%$ , closer tolerance available.

**OPERATING TEMPERATURE RANGE:** -55° C. to 175° C.

**SUPER-MINIATURE SIZE:** .180 x .300 x 1.00 inch.

**RESOLUTION:** .1% to 1%, depending on resistance.

**SHAFT TORQUE:** 5 inch, ounces max.

**BACKLASH:** 10° maximum.

**SCREW ADJUSTMENT:** 18 turns, nominal.

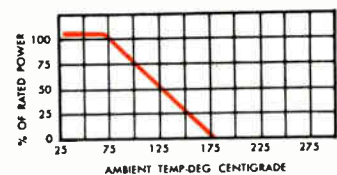
**MOUNTING:** Individually or in stacked assemblies with standard 2-56 screws.

**SAFETY CLUTCH:** Clutch arrangement on movable wiper contact prevents breakage due to over-excursion.

**WEIGHT:** 1.8 grams.

**MILITARY SPECIFICATIONS:** Surpass applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL E 5272A and MIL-STD 202A.

### TYPICAL DERATING CURVE



### JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

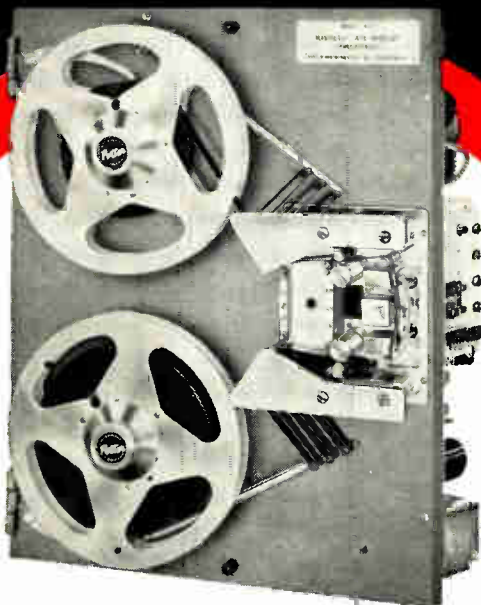
Just outline your specific situation.

Write for Bulletin R-41

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New Speed...Versatility...Reliability...



## TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

### • Check these new standards of reliability and performance

- Completely transistorized for maximum reliability
- Trouble free brushless motors
- Over 50,000 passes of tape without signal degradation
- Linear servo system
- Life expectancy of pinchroll mechanism: over 100,000,000 operations
- Skew  $\pm 3 \mu\text{sec}$   $\frac{1}{2}$ " tape, center clock at 100 i.p.s.
- Vacuum loop buffer
- Continuous flutter free cycling 0 to 200 cps
- Normal speed up to 100 i.p.s.
- Rewind or search speed constant at 300 i.p.s.
- Six speeds forward or reverse up to 150 i.p.s.
- Better than 3 milliseconds start, 1.5 millisecond stop
- Front panel accessibility
- In line threading
- End of tape and tape break sensing
- All functions remotely controllable
- Tape widths to  $\frac{1}{4}$ "

The 906 is usually supplied with the Potter 921 transistorized Record-Playback Amplifier, a unit that features:

- |                        |   |
|------------------------|---|
| Pulse or level outputs | Manual, relay, or electronic function switching |
| Output gating          | Dual read-write operation                       |
| 1 i.p.s. to 150 i.p.s. |   |

Potter also manufactures a complete line of Perforated Tape Readers, High Speed Printers and Record-Playback Heads.

Contact your Potter representative or call  
or write direct for further information.



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Engineering Quality

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Overbrook 1-3200

Potter has career opportunities for qualified engineers who  
like a challenge, and the freedom to meet it.

## Letters

to the Editor

### Zener Diodes In Heater Circuits

Editor, ELECTRONIC INDUSTRIES:

This comment is in reference to the article, "Zener Diodes Stabilize Tube Heater Voltages," by Perry L. Toback, which appeared in the December issue.

The author of the article neglected one important factor which should always be considered in any reliable design, namely, the use of the equipment under "field" conditions.

The basic regulator consists of a shunt combination of vacuum tube heater load and diode back-biased in the Zener region, separated from the unregulated source by a series current-limiting resistor. The value of resistance is chosen from the nominal unregulated voltage and the total load current resulting from a given operating current for the diode.

However, should the equipment be in field use and should faulty operation develop, it is conceivable that in the troubleshooting procedure it may be informative to remove the tube or tubes whose heater(s) are being regulated *with the equipment on*. This would impose a current burden on the Zener diode far in excess of the design value, which would probably be highly detrimental, if not catastrophic.

Of course, this factor may be taken into consideration in the design, but it greatly limits the number of tube heaters being regulated by a given circuit. Then again, the circuit configuration given in the article with no design modifications is suitable in those cases where it is definitely known that under no circumstances will the tube(s) in question be removed from the circuit with the unit powered.

I. J. Nissman

Electronic Engineer

Loral Electronics Corp.  
825 Bronx River Ave.  
New York 72

### 'Inexpensive Output Stage'

Editor, ELECTRONIC INDUSTRIES:

I have just read the article entitled "An Inexpensive Ultra-linear Output Stage," by I. F. Barditch. I think Mr. Barditch has an excellent idea in using cathode-followers to supply a controllable amount of signal to the output tube screen grids. However, the circuit configuration he has shown is wasteful of power.

A reasonable value of plate-to-plate load resistance for 6V6 tubes is 10,000 ohms. If we now shunt this load with the series combination of two 10,000 ohm pots, the net load seen by

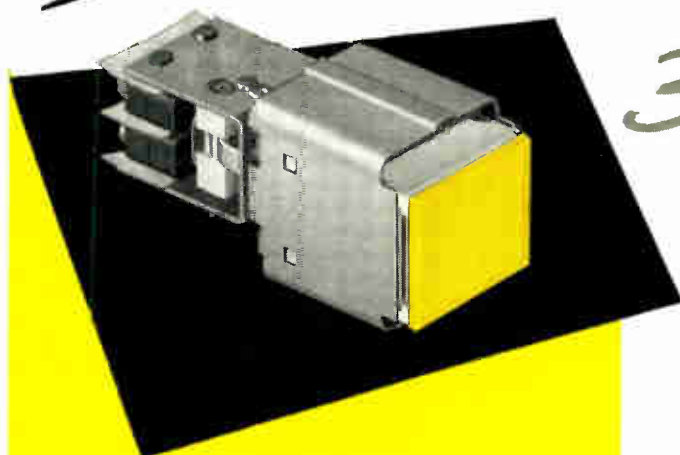
(Continued on page 34)



*New* **ELECTRO SNAP**

**"PUSH-ON, PUSH-OFF"**  
ALTERNATE ACTION  
**LIGHTED PANEL SWITCH**

**3** units in **1** compact mounting;  
use singly or in "stacked" arrangement



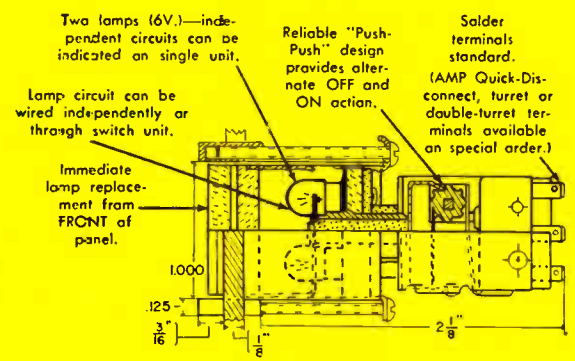
The compact, modular design of this new Electro-Snap "Push-Push" alternate-action, panel-mounted switch combines a two-piece, color-coded button, pilot light and switching unit in one space-saving component. Two or more units may be "stacked" side-by-side in one panel slot. This eliminates congestion while achieving greater operating efficiency and quality appearance than where separate button, light and switch units are used.

**Wide range of configurations permits almost unlimited application for control and indicating operations.**

Almost unlimited operating and indicating conditions can be provided for sequencing, movement-limit, start-and-stop and similar applications on missile, electronic and industrial controls through variation of:

- circuit arrangements of switch and pilot lights
- colored lights for color monitoring
- colored push-buttons for color coding

For full application details and specifications contact your local representative or write for data on Standard (C6 Series) Electro-Snap "Push-Push" Panel Switches.



**STANDARD MODELS (C6-Series)**  
Lighted Push-Button Panel Switches

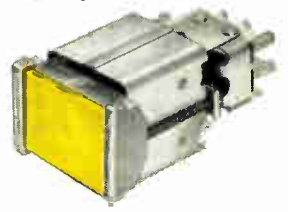
Standard models furnished with two-piece colored button, two 6V. lamps, two basic switches (E4-103) with solder terminals.  
C6-53—[shown above]—"Push-Push", alternate action.  
C6-52—Momentary action with over-centering device, positive feel.  
C6-51—Momentary action.  
Model C6-50 — for pilot light duty only. Consists of 2-piece colored button and lamp unit with two 6V. lamps. (No switching mechanism).  
• 2-piece color-coded button; 5 colors available.  
• Barriers ordered separately — to meet panel requirements.  
• 28V. lamps available on special order.

**BASIC SWITCH OPERATING CHARACTERISTICS**

Contact Arrangement	.....	D.P.D.T.
Travel	.....	3/32 Approx.
Contact Pressure	.....	60 Grams
Contact Gap	.....	.020 Max.
Temp. Range	.....	-65° F to +180° F.
Current Rating	.....	.5A @ 125/250 V.A.C.
	4A Res @ 30 V.D.C.	2.5A Ind @ 30 V.D.C.

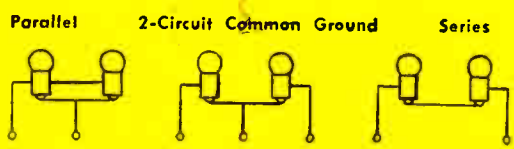
**MOMENTARY-CONTACT PUSH-BUTTON PANEL SWITCH**

This momentary-contact, lighted push-button panel switch (C6 Series) has the same space-and-cost-saving features as the "Push-on Push-off" switch above. It is available in various configurations to permit application to a wide range of indicating and switching operations.

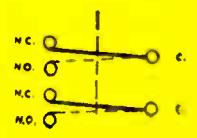


For details, write for "Bulletin CB"

- Complete push-button switch unit or pilot-light assembly can be supplied in any of the three following circuit arrangements. (solder terminals on lamp assembly).



- The double-pole, double-throw switching unit may be wired normally-open or normally-closed.



**ELECTROSNAP CORPORATION**

4244 West Lake Street, Chicago 24, Illinois  
Telephone VA 6-3100 TWX No. CG-1400

Sealectro



Pat. Pend.

## SUB-MINIATURE R. F. CABLE CONNECTORS



Type 3000 Cable Plug



Type 3001 Cable Jack



Type 3002 Bulkhead Receptacle



Type 3003 Bulkhead Jack



Type 3004 Cable Feedthru



Type 3005 Right-Angle Plug

# REVOLUTIONARY

because...

- **EASE OF ASSEMBLY:**  
In factory, shop, lab, field. No special tools required.
- **INCREASED PULL-OUT RESISTANCE:**  
Cable-clamping construction withstands over 20-lb. strain.
- **CAPTIVATED CONTACTS:**  
Insure proper engagement with mating parts.  
Especially important with short cable lengths.

The result of a decade and a half of intense specialization, "ConheX" connectors set brand new standards. Yes, *revolutionary* is the word.

In 50-ohm impedance size as shown, including the *unique* right-angle plug. 75- and 95-ohm sizes to follow. Designed for use with latest MIL sub-miniature cables. Suitable for use at microwave frequencies. Interchangeable with but *superior* to existing connectors of corresponding types.

Parts of machined brass except for female contacts of heat-treated beryllium copper. Genuine gold plating (not just gold flash) over copper. Insulators of Teflon.

**JUST TRY "CONHEX"!** Write for literature. If you are a design or specification engineer, write on business letterhead for free sample. Make your own comparisons and tests. And let us quote!

\*TM reg. pend.



Sealectro CORPORATION

610 FAYETTE AVE. • MAMARONECK, N. Y.

## Letters

to the Editor

(Continued from page 32)

the tubes will be reduced to 6600 ohms, causing a slight decrease in output power at a given distortion level. Of this power, one third will be dissipated in the pots, leaving something less than two thirds of the original power capability of the amplifier to be delivered to the speaker.

This situation could be remedied very easily by increasing the resistance of the signal take-off pots to 50,000 or 100,000 ohms. Since the input capacitive loading of a cathode-follower is practically negligible at audio frequencies, this should cause no loss of frequency response nor undesirable phase-shift.

Roger Dorr

Radiation Laboratory,  
Univ. of California,  
P. O. Box 808,  
Livermore, Calif.

## IBM Computer Speeds Ordnance Operations

An IBM 650 Tape RAMAC electronic data processing system, is expediting inventory and stock accounting operations at the Anns-ton Ordnance Depot-Ordnance supply center for major Army, Navy, and Air Force bases in the South-east.

The computer edits issues for authorization, availability, out-of-stock status, sufficient funds cited control status, stock position, computation of financial data for inventory accounting, updates records at the time of each transaction and prepares output records as required on punched cards, magnetic tape or printed listings. It is processing an average of 5500 daily supply transactions.

## COMPUTING TOOL SALES



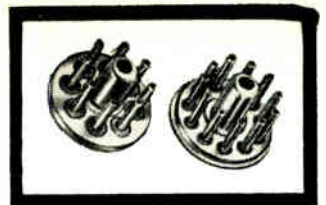
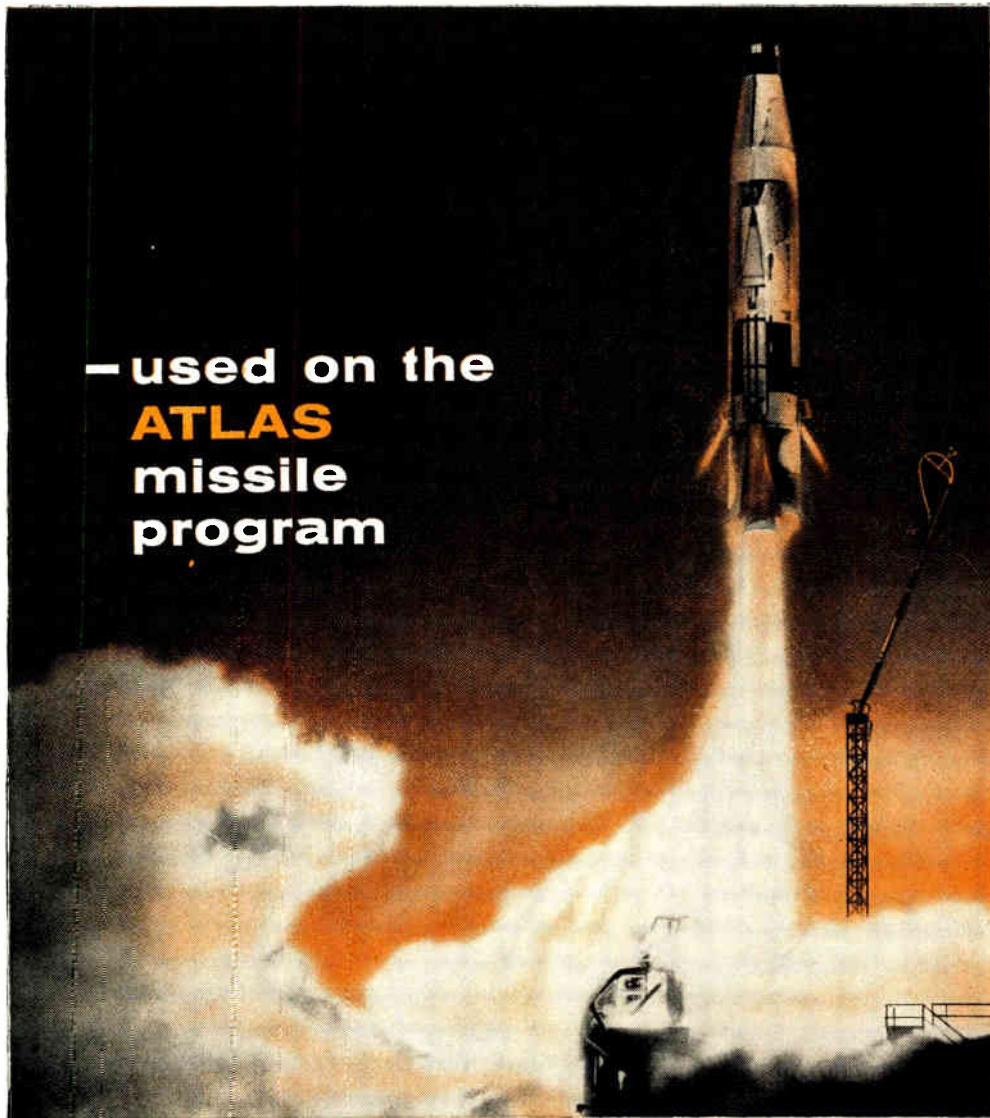
At Stanley Tools, Div. of The Stanley Works of New Britain this new IBM 350 RAMAC has been installed to expedite order writing, billing, inventory control and payroll.



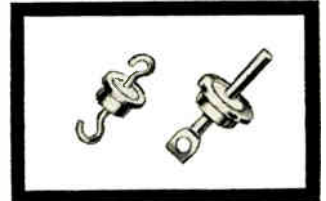
## Meeting tough specifications is our business

E-I supplies the hermetically sealed terminals and headers used in the Atlas Intercontinental Ballistic Missile Program. The complete E-I line of standard glass-to-metal seals offers engineers widest possible design latitude . . . includes super-rugged compression seals, miniature closures and standardized color-coded terminals. When specifications call for hermetic seals, ask an E-I sales engineer for a recommendation on your requirements. In most cases, an economical E-I *standard* seal will meet your specifications. If your application is unusual, custom components can be supplied.

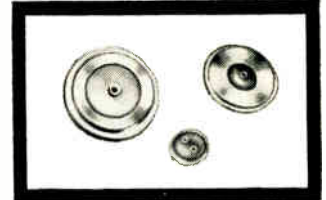
# GLASS-TO-METAL SEALS by E-I



Plug-in Connectors



Single Lead Terminals



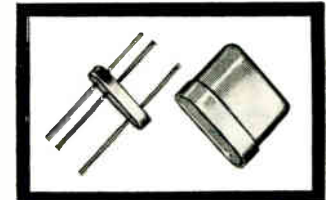
End Seals for Tubular Components



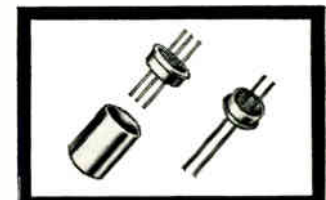
Multiple Headers



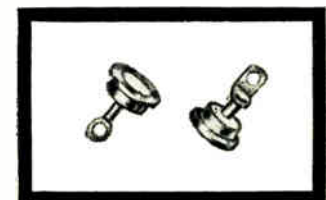
Threaded End Seals



Transistor Closures



Miniature Closures



Color Coded Terminals



Call or write for latest catalog containing complete engineering information and helpful installation data.

**ELECTRICAL INDUSTRIES**  
A Division of Philips Electronics Inc Murray Hill, New Jersey

Patented in Canada, No. 523,390; in United Kingdom, No. 734,583; licensed in U.S. under Patent No. 2561520

# Twist It 'til It Snaps and It Still

## WON'T

## LEAK



The new improved Fusite V-24 Glass is so solidly fused to the stainless pins that 180° twisting won't break the bond between glass and metal.

Here is the line of hermetic terminals that is so resistant to both mechanical and thermal shock that terminals require no special nursing in application. Weld them, solder them, treat 'em rough—your assembly will remain hermetic, free of cracks under Statiflux testing.

Only V-24 Glass developed and smelted here in our own plant can produce terminals that give you such latitude in your production operation.

Wide variety of combinations of size, flange treatments, pin types and placement.

Write Dept. G-1 today stating your application and we'll send appropriate samples for your own testing.

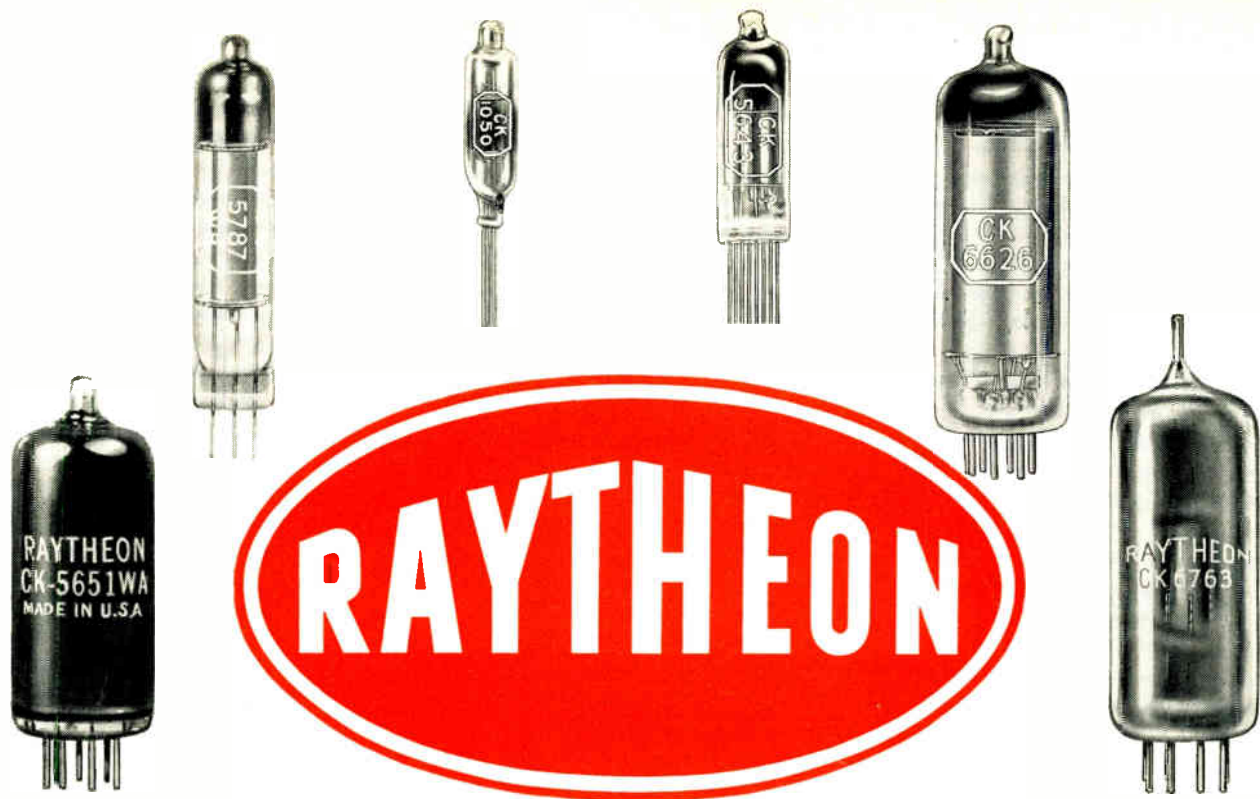


THE **FUSITE** CORPORATION

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# GAS FILLED TUBES

**VOLTAGE REFERENCE • VOLTAGE REGULATOR • COLD CATHODE RECTIFIER**  
for Military and Industrial Applications

These Raytheon Tubes are designed, constructed and tested for severe military environment, including temperature ratings to 165°C, and shock and vibration resistance.

Raytheon custom designed gas filled tubes are backed by over thirty years of design, development and production experience. It will pay you to get in touch with Raytheon for gas filled tubes that meet your specific needs.

### RAYTHEON GAS FILLED TUBES

VOLTAGE REGULATOR TUBES			
<b>OA2, OA2WA, CK6626</b>	Miniature	150 volts,	5 to 30mA
<b>OB2, OB2WA, CK6627</b>	Miniature	108 volts,	5 to 30mA
<b>CK5787WA</b>	Submin.	98 volts,	5 to 25mA
<b>CK6542</b>	Submin.	150 volts,	5 to 25mA
VOLTAGE REFERENCE TUBES			
<b>CK5651, CK5651WA</b>	Miniature	85 volts,	1.5 to 3.5mA
<b>CK5783WA</b>	Submin.	85 volts,	1.5 to 3.5mA
<b>CK6213</b>	Submin.	130 volts,	1 to 2.5mA
RADIAC TUBES			
Raytheon offers Corona Voltage Regulator Tubes for higher voltages in a wide range of ratings; also a variety of Radiation Counter Tubes.			

COLD CATHODE RECTIFIERS			
<b>CK5517</b>	Miniature	PIV = 2800	$I_o = 12mA$
<b>CK6174</b>	Miniature	PIV = 2800	$I_o = 3mA$
<b>CK6659 (CK1042)</b>	Submin.	PIV = 2800	$I_o = 8mA$
<b>CK6763</b>	Miniature	PIV = 2800	$I_o = 12mA$ (Ruggedized)
THYRATRONS			
<b>RK61</b>	Submin.	For control receivers in model aircraft, boats, etc.	
<b>CK1054</b>	Submin.		
<b>CK5643</b>	Submin.	For general purpose military use	
LIGHT INDICATOR			
<b>CK1050</b>	Submin.	Low drain, grid controlled indicator for semiconductor circuitry.	



## INDUSTRIAL TUBE DIVISION

Reliable Miniature and Subminiature Tubes • Voltage Reference Tubes • Voltage Regulator Tubes • Rectifiers • Nucleonic Tubes

Newton, Mass.: . . . . . 55 Chapel St., Bldg. 4-7500  
 New York: . . . . . 589 Fifth Ave., Plaza 9-3900  
 Chicago: 9501 Grand Ave., Franklin Park, National 5-4000  
 Los Angeles: 5236 Santa Monica Blvd., Normandie 5-4221

# Industry News

J. R. McPhee is now Administrative Vice President at Telechrome Manufacturing Corp. He was formerly Assistant to the Vice President—Planning at Sanders Assoc., Inc.

C. P. Baxter, formerly Vice President & General Manager, RCA Television, has formed Charles P. Baxter Associates, Management Consultants, Box 109, Drexel Hill, Penna.

A. Van Gordon, former Plant Manager of the DeJur-Amsco Corp., is now General Manager of the Anton Electronic Laboratories Inc.

F. M. Folsom, former President of RCA and present Chairman of the RCA Board Executive Committee has been elected a Director of Crown Cork and Seal Co., Inc. He is a permanent representative to the International Atomic Energy Agency.



F. M. Folsom



J. A. Montllor

J. A. Montllor has been appointed Vice President of Essex Electronics Co. He was formerly Chief Engineer of the Company, and will retain that title. He has been associated with Allen B. Cardwell Co.

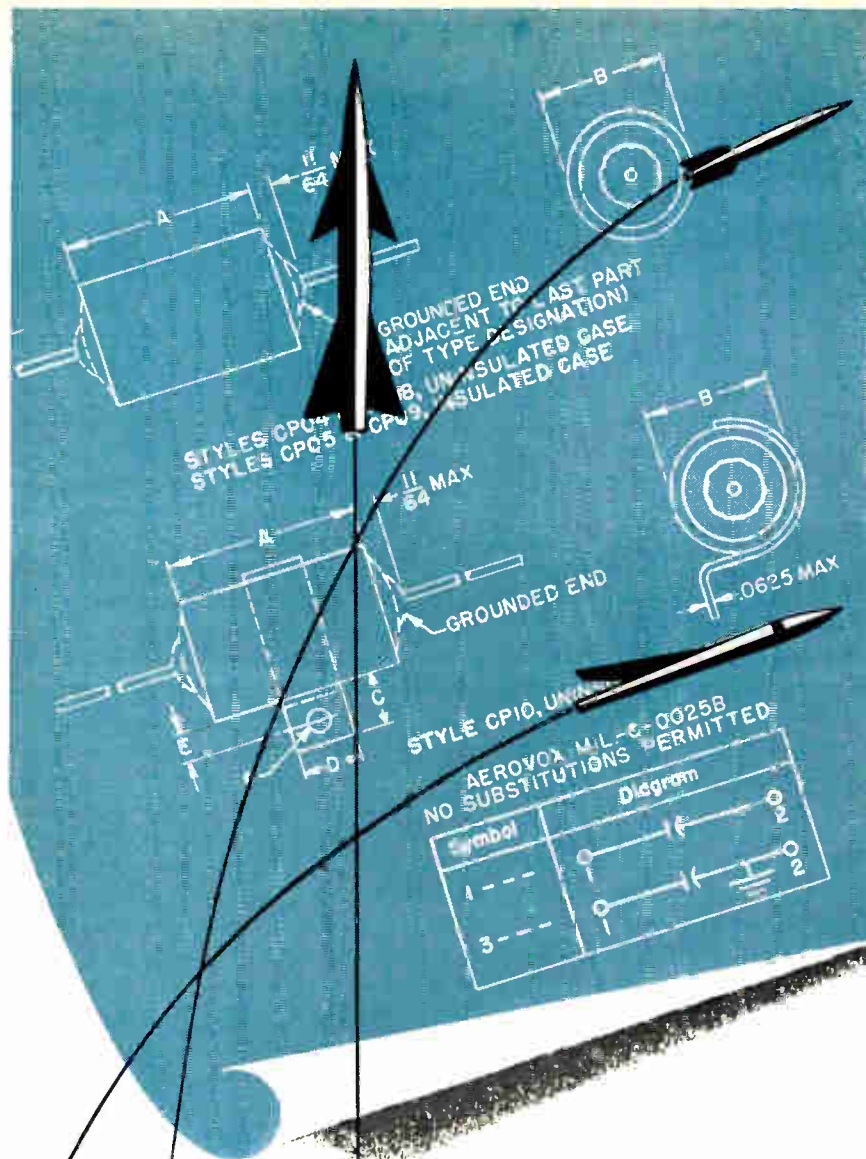
G. W. DeSousa has become Vice President in Charge of Marketing for the Semi-conductor Division, Hoffman Electronics Corp.

J. G. Copelin has been elected as a Vice President and Comptroller of International Telephone and Telegraph Corp. He had been Vice President and Comptroller of an IT&T subsidiary, International Standard Electric Corp.

M. E. Potter is Special Accounts Sales Manager, Duplicating Products Division, Minnesota Mining & Manufacturing Co.

W. J. Flanagan is now Director of Material at Pacific Automation Products, Inc. He was formerly General Purchasing Agent at Convair Astronautics Division.

(Continued on page 46)



## FIRST FROM TO BLUE PRINT BLUE SKY...

One source for your MIL-C-0025B (USAF) capacitors for all airborne electronic equipments and missile applications.

For details and expert technical assistance on all MIL Type capacitors write or wire Applications Engineering Department...

**AEROVOX CORPORATION**  
NEW BEDFORD, MASSACHUSETTS





"Now you get  
laboratory performance  
out in the field"

## WIDE RANGE HETERODYNE FREQUENCY METER

### *Divco-Wayne Electronics Model 1021 Heterodyne Frequency Meter Advantages*

- Broadest RF Spectrum:**  
125KC to 1000MC . . . a range normally requiring three separate meters.
- Accuracy:**  
.005% overall frequency.
- RF output:**  
100 microvolts on all calibrated fundamentals.  
50 microvolts on all calibrated harmonics.
- Field or laboratory operation:**  
Ruggedly built for battery or 115/230 volt 50-450 cps power supply . . . for operation in field or lab.
- Calibration data:**  
Accurate calibration data supplied for 5000 dial readings . . . allowing unskilled operators to make accurate measurements.
- Temperature conditioned:**  
Each meter conditioned in Tenney environment chamber at temperature extremes for conditions under which it will actually operate.
- Low cost:**  
Priced below many meters with narrow RF spectrums.

The Divco-Wayne Electronics 1021 frequency meter works equally well in the laboratory or out in the field. It's the only wide range meter covering the entire range of 125KC to 1000MC. Widely used in missile work, radar, communications, or for any laboratory work in frequency determination or as a signal source. Fully illustrated and described in new bulletin DW-102. For your free copy, write Divco-Wayne Electronics, 9701 Reading Road, Cincinnati 15, Ohio.



A Division of the Divco-Wayne Corporation  
**DESIGNERS • ENGINEERS • MANUFACTURERS**  
Custom-built precision mechanical, electro-mechanical and electronic equipment for industry and defense.

# NPN

.....

## switching transistors

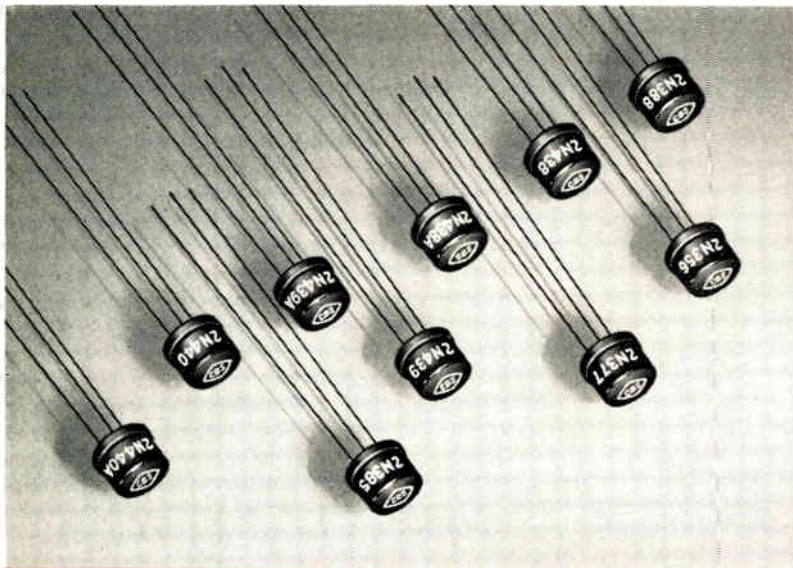
# PROVE MORE RELIABLE

.....

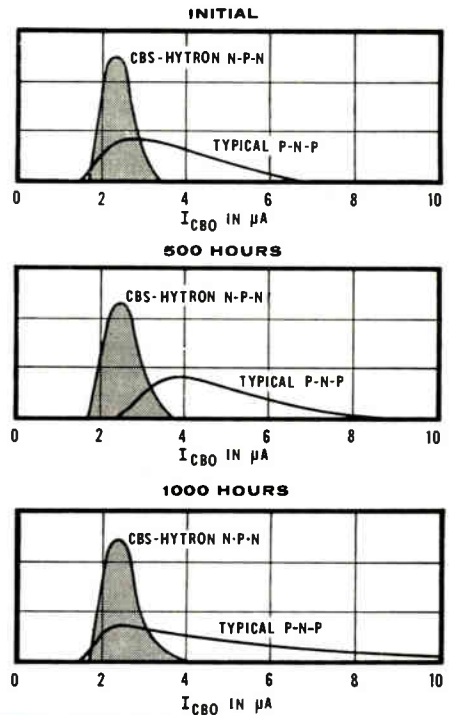
## than PNP

Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS-Hytron NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

The superiority of CBS-Hytron NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching . . . high voltage . . . low cutoff current . . . and low saturation resistance . . . in a welded JETEC TO-9 package.



**Comparative Life Tests  
NPN vs. PNP Switching Transistors.**



**CBS-Hytron NPN Switching Transistors**

Type	Minimum $BV_{CBO}$ (Volts)	Dissipation @ 25°C (Milliwatts)	Minimum $h_{FE}$ @ $I_C$ (Ma)		Typical $f_{ab}$ (Megacycles)	Application
<b>2N356</b>	20	100	20	100	3	Core Driver
<b>2N377</b>	25	150	20	200	6	Core Driver
<b>2N385</b>	25	150	20	200	6	Core Driver
<b>2N388</b>	25	150	30	200	8	Core Driver
<b>2N438</b>	30	100	20	50	4	Logic Circuit
<b>2N438A</b>	30	150	20	50	4	Logic Circuit
<b>2N439</b>	30	100	30	50	8	Logic Circuit
<b>2N439A</b>	30	150	30	50	8	Logic Circuit
<b>2N440</b>	30	100	40	50	12	Logic Circuit
<b>2N440A</b>	30	150	40	50	12	Logic Circuit

Operating and storage temperature,  $T_j = -55$  to  $+85^\circ\text{C}$

A comprehensive line of these reliable CBS-Hytron NPN high-speed switching transistors is available now in production quantities. Check the table. Order types you need . . . or write for Bulletin E-293-302 giving complete data...today.

*More reliable products through Advanced-Engineering*

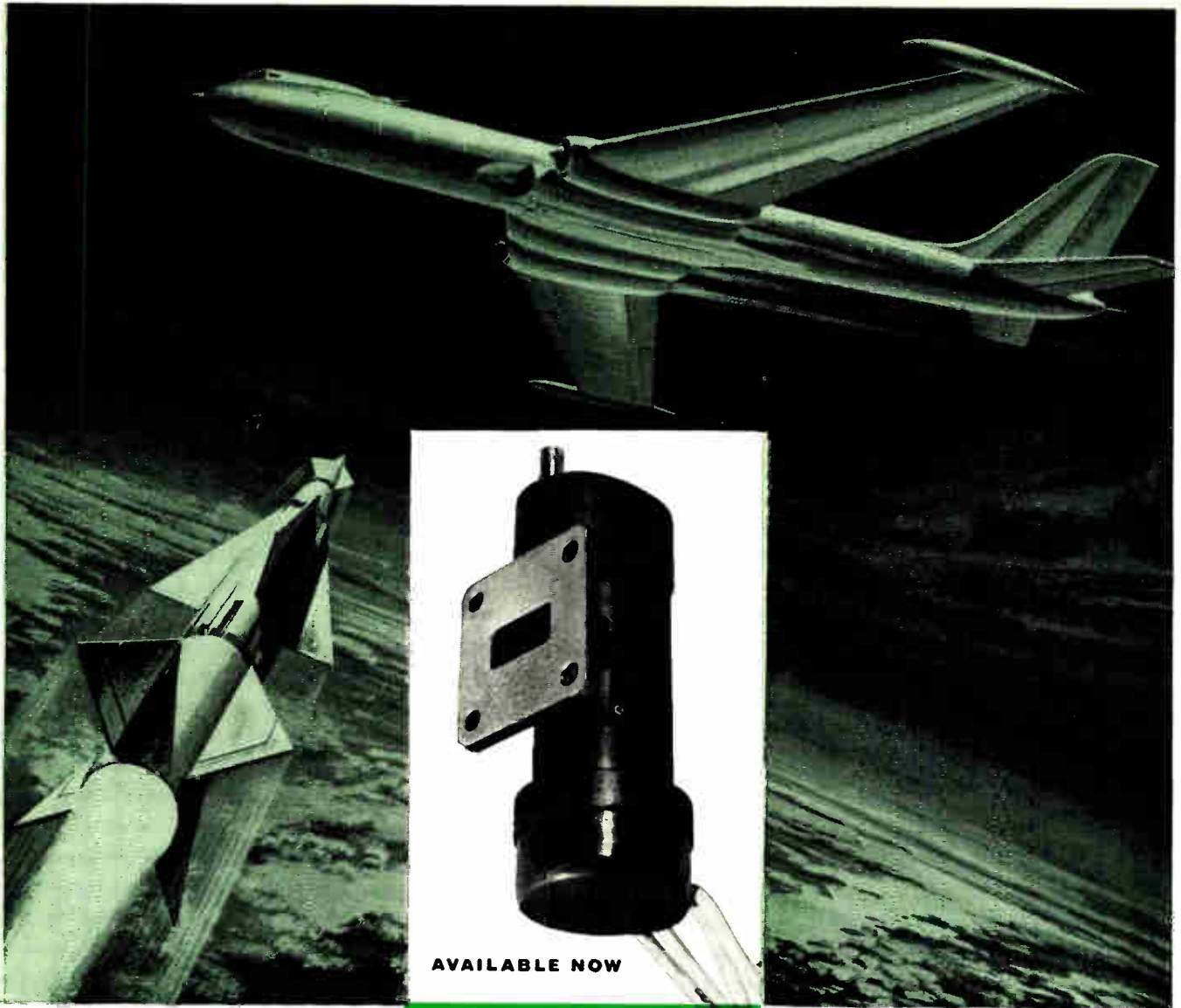


## semiconductors

**CBS-HYTRON, Semiconductor Operations**  
A Division of Columbia Broadcasting System, Inc.

**Sales Offices:** Lowell, Mass., 900 Chelmsford St., Glenview 4-0446 • Newark, N. J., 32 Green St., Market 3-5832 • Melrose Park, Ill., 1990 N. Mannheim Rd., ESTebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., Raymond 3-9081





AVAILABLE NOW

Sperry's new **SRU-216** broad band klystron

has 2,000-mc tuning range combined with frequency stability under severe shock and vibration

- Requires less than 15 watts total power
- Non-axial motion of tuning shaft
- Low tuning torque

This new Sperry Klystron features superior electronic characteristics yet is so rugged it can withstand the severe environments encountered in missile and jet radar applications.

The SRU-216 not only has an extremely wide mechanical tuning range of 2,000 mc but also offers a very wide electronic tuning range from 60 to 100 mc. Frequency remains stable even under severe pressure, vibration and shock environments.

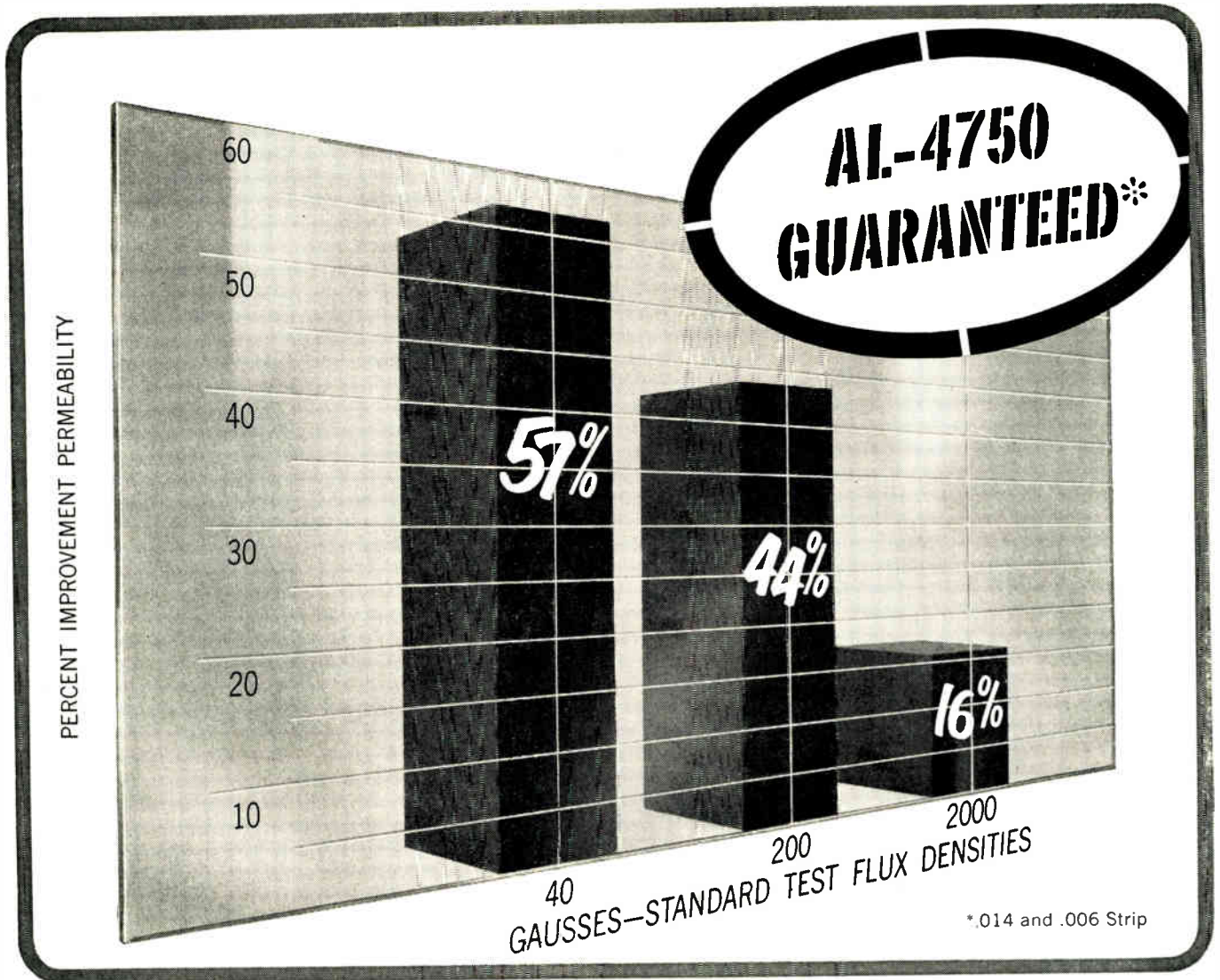
PERFORMANCE	
Frequency Range.....	15.0 to 17.0 kmc
Power Output.....	15 mw (min.) from 15.0-15.7 kmc
	20 mw (min.) from 15.7-17.0 kmc
Frequency Stability Units:	
Vibration.....	2.0 mc (max.) at 10 g's, 40-500 cps
Low Pressure.....	4.0 mc (max.) at 70 mm Hg
Shock.....	11.7 mc (max.) at 70 g's for 0.3 ms, 3 axes
Temperature Coefficient.....	5 mc/°C (max.)

This new tube makes for easier system design. Low power consumption means smaller associated equipment . . . air cooling is not required. Potted base eliminates need for pressurization. Design provides more linear frequency-to-turns ratio over tuning range. The optional four locations of the shaft with respect to waveguide flange gives designers extra flexibility. Write for more information on this new Sperry Klystron.



**SPERRY ELECTRONIC TUBE DIVISION, SPERRY RAND CORPORATION, GAINESVILLE, FLORIDA**  
 Address all Inquiries: Gainesville, Florida, or Sperry Gyroscope Offices in Brooklyn · Cleveland · Seattle · San Francisco · Los Angeles · New Orleans · Boston · Baltimore · Philadelphia

**Experience—the added alloy in A-L Stainless, Electrical and Tool Steels**



## **GUARANTEED PERMEABILITY... and at higher values than old average values in AL-4750**

AL-4750 nickel-iron strip now has higher permeability values than ever before . . . and the new, higher values are guaranteed. For example, using the standard flux density test, at 40 induction gaussses, AL-4750 now has 57% higher permeability than in the past. And permeability values are guaranteed.

This guaranteed permeability means greater consistency and better predictability for magnetic core performance . . . permits careful, high performance design.

The improvement in AL-4750 didn't just happen. It is the result of Allegheny's electrical alloy research and production program in nickel-bearing steels. A similar improvement has been made in AL Moly Permalloy.

WSW 7269

And research is continuing on silicon steels including AL's famous Silectron (grain oriented silicon steel), as well as on other magnetic alloys.

Another service of Allegheny Ludlum includes complete facilities for the fabrication and heat treatment of laminations. Years of experience in AL's lamination department means that Allegheny Ludlum has encountered and solved most problems common to core materials. This practical know-how is available to all. Call us 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-14.*

## **ALLEGHENY LUDLUM** STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17  
Export distribution, Laminations: AD. AURIEMA, NYC 4





*Now... from Clevite!*



**CLEVITE GOLD BONDED DIODES FOR**

# **MECHANICAL RELIABILITY**

**New manufacturing techniques  
increase ruggedness for rough  
service applications.**

Designed to withstand severe conditions of shock and vibration, the new Clevite ruggedized diode offers, in addition to the well known electrical advantages of gold-bonded diodes, a new high in mechanical strength.

For installation with automatic assembly equipment, for missiles, or other applications in which high values of acceleration are encountered, for all your diode needs, specify Clevite

Clevite data on request.

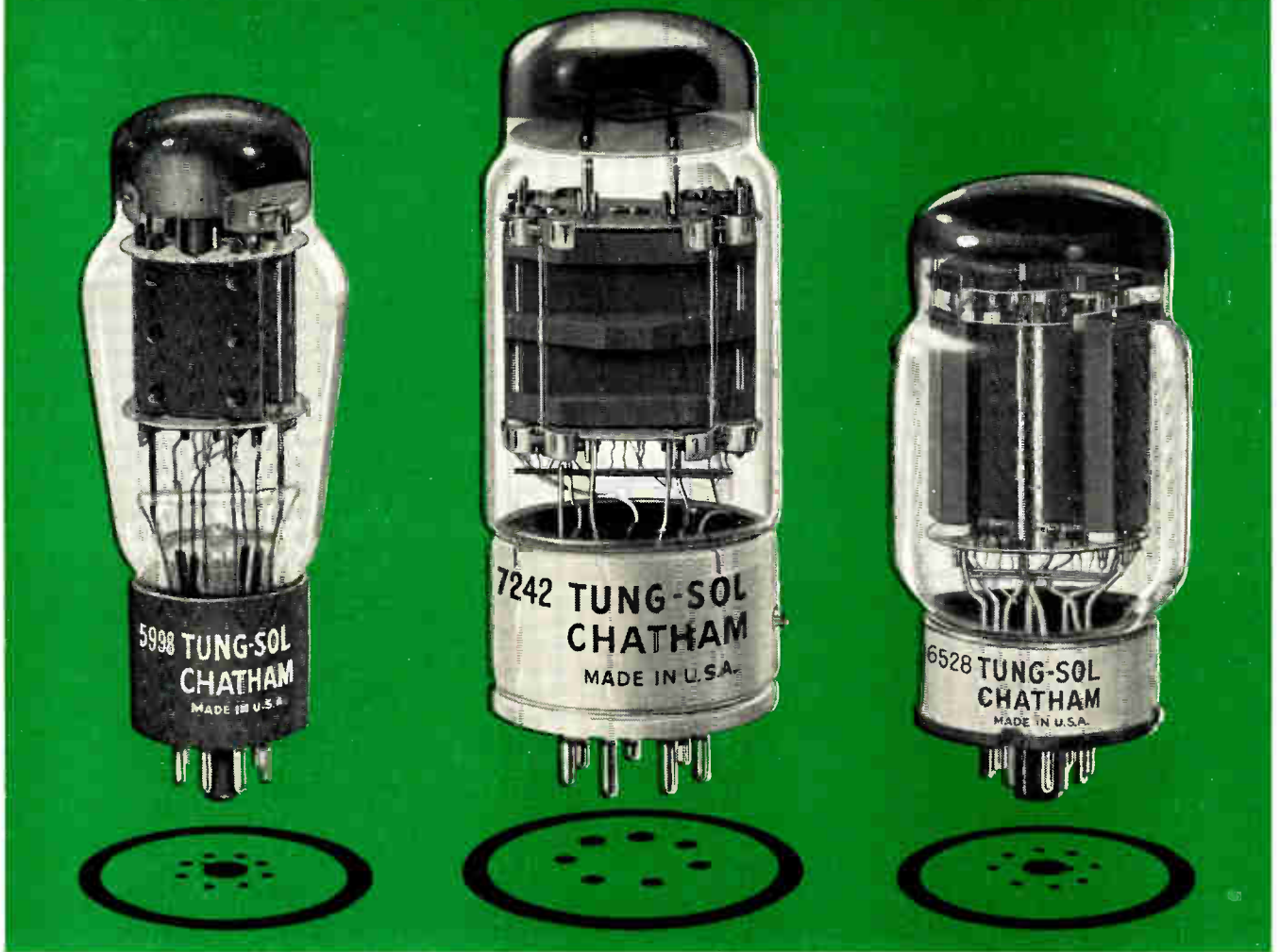
A DIVISION OF



**OTHER CLEVITE DIVISIONS:**  
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**CLEVITE**  
**TRANSISTOR PRODUCTS**  
241 Crescent St., Waltham 54, Mass. TWInbrook 4-9330

*First family of power triodes made specifically for series regulation!*



## Tung-Sol/Chatham power triode family covers every series regulator need!

Now designers can specify a premium quality Tung-Sol/Chatham tube for all series regulator sockets. Tung-Sol/Chatham's family of power triodes—the first designed and produced specially for series regulator service—meets all design requirements and assures maximum reliability and life at all times.

Types include the new 100 Watters, 7241 and 7242, medium mu or low mu-high current. 12 or 26 Volt

heater versions available on most types. All embody sturdy construction features that contribute to overall ruggedness and long hours of heavy-duty operation.

Compare the ratings below against your particular application! If you desire complete data sheets . . . or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

TYPICAL VALUES

	Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
5998	200 ma	80 v	45 v	20 v
7242	400	65	70	10
7241	600	80	70	13

PERTINENT CHARACTERISTICS PER TUBE

	Max. Plate Current	Max. Plate Voltage	MU	Gm
5998	280	275	6.5	28,000 umhos
7242	600	400	9.0	74,000 umhos
7241	900	400	9.0	111,000 umhos

TUBE TYPES BY PLATE DISSIPATION RATINGS

Total Plate Dissipation	26 to 30 W	60 W	100 W
Low Mu	6AS7G, 6082	6336A	7241
	6080WA, 7105	6394A	
Medium Mu	5998	6528	7242

 **TUNG-SOL®**



## MULTIVERTER CONVERTS "BEEP" TO NUMERAL

The MULTIVERTER is the first solid state, high-speed digital  $\leftrightarrow$  analog conversion system accurate to .01%. It is also the first converter to solve various complicated arithmetic problems, including square root, during the process of conversion. A typical MULTIVERTER application is its use in converting analog data received from the orbiting "Explorer." Information telemetered from the satellite and recorded on magnetic tape is converted to numbers by the MULTIVERTER and fed into a digital computer. The result: usable and accurate new knowledge of outer space.

## Satellite "Interpreter"

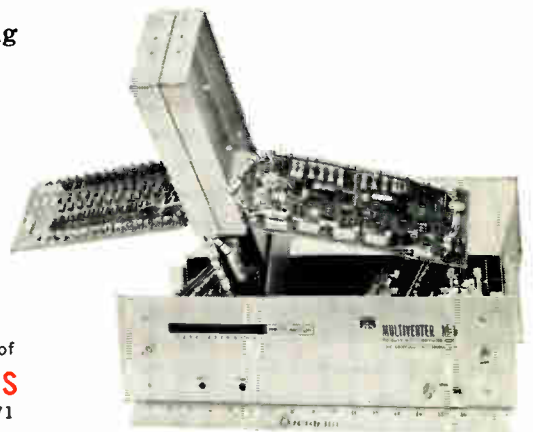
### ENGINEERING BEYOND THE EXPECTED

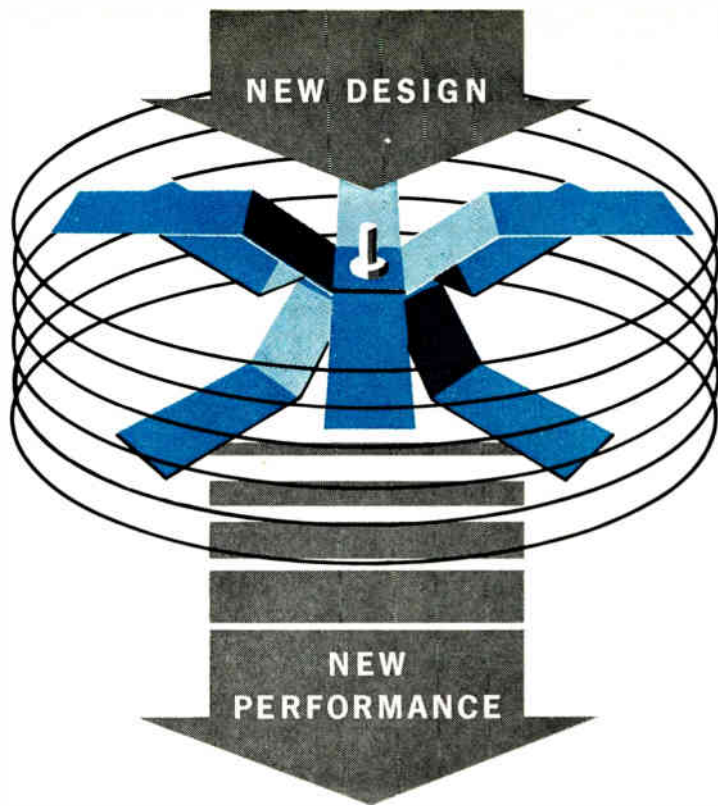
The need for highly accurate measurement in an accelerating technology called for a solid state converter with an accuracy of .01% and a speed of four microseconds per bit. The MULTIVERTER and related accessories resulted. One immediate application has been the interconnection of Packard Bell's TRICE, the first incremental differential analyzer to operate in real time, with various analog systems. Other applications include Missile Impact Prediction, Coordinate Conversion, Orbit Prediction and Solid State Automatic Checkout Systems.

Packard Bell Computer Corp., a subsidiary of

**PACKARD BELL ELECTRONICS**

12333 W. Olympic Blvd., Los Angeles 64, Calif., BR 2-2171





... a completely new pressure pickup family

Inside the stainless steel housings of CEC's new unbonded strain-gage pickups is a completely new sensing element. This is the "interleaved" spring ... compactly constructed with two four-legged springs and two sets of windings intermeshed within a stainless steel ring. Movement of the pickup diaphragm causes extension of one set of windings and relaxation of the other. The change in resistance results in an electrical output directly proportional to displacement. With this element, all members of the "4-320" family offer these outstanding specifications:

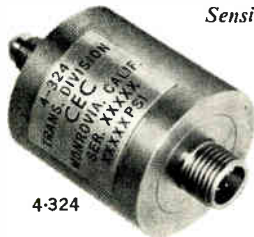


4-322A



4-323 MC

*Linearity and Hysteresis:* 1% of full scale  
*Zero Shift:* 0.01% of full scale per degree F  
*Sensitivity Shift:* 0.01% of full scale per degree F



4-324

Type 4-322A measures differential pressures from  $\pm 7.5$  to  $\pm 50$  psi. Gage and absolute measurements are made with the 4-323MC in ranges up to 2000 psi and with the 4-324 in ranges to 5000 psi. For complete details, call your nearest CEC sales and service office, or write for Bulletin CEC 1617-X4.

Transducer Division



CONSOLIDATED ELECTRODYNAMICS / 300 n. sierra madre villa, pasadena, california

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

## Industry News

(Continued from page 38)

C. K. Fennel has joined Texas Instruments Incorporated as Manager of Marketing Techniques. He was formerly manager of Sales Education and Training at GE's apparatus sales division.

S. Norris, President and Chairman of the Board of the Nuclear Corp. of America, Inc., has been appointed Consultant to the Director of the Electronics Division, Business and Defense Services Administration, U. S. Dept. of Commerce.

G. A. Franco is now Manager of the Radio Communication Laboratory in Stromberg-Carlson's Research and Advanced Development Division.



G. A. Franco



M. Katz

M. Katz will join Astron Corp. as Head of the tantalum operation. He was Vice President and Chief Engineer of Minitronics Corp. which was recently purchased by Astron.

C. D. Bacon has been promoted to Western Regional Sales Manager, Brush Instruments, a division of Cleveite Corp. He has been associated with Minneapolis-Honeywell and with Bourns Labs.

W. H. Stewart is now Philadelphia District Manager, Burroughs Corp. ElectroData Division.

D. A. Thomas has been elected Vice President and General Manager, Industrial and Automation Div., Radio Corporation of America. He was formerly Chairman of the Board and President of the Babb Co.

The newly created corporate office, Manager of Electronic Requirements, Martin Co., will be filled by J. M. Pearce, former Vice President and General Manager at Hoover Electronics Co.

M. E. Christiansen is the new General Sales Manager at Mallory Battery Co. He was formerly Assistant General Sales Manager.

(Continued on page 164)



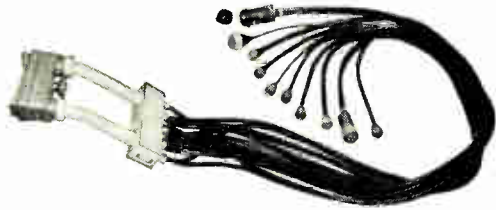
# Cable assemblies by BENDIX

*Specialized designs for the most exacting requirements*

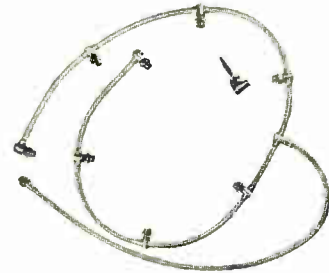
The versatility of design and reliability of performance offered by Bendix\* Cable Assemblies result from over a quarter century of precision manufacturing in this field. Our outstanding research and design facilities are avail-

able for custom designing cable assemblies to meet your specialized requirements on each installation. Cable assemblies shown are typical Scintilla Division developments in cabling for aircraft, electronic and missile applications.

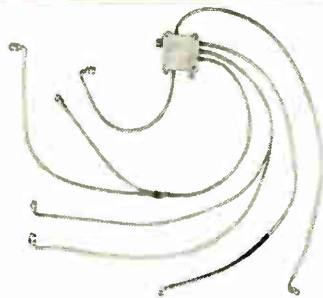
\*REG. U. S. PAT. OFF.



**MISSILE CONTROL CABLE:** This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.



**THERMOCOUPLE HARNESS:** Flexible, completely sealed and suitable for continuous operation in ambient temperatures of  $-65^{\circ}\text{F}$  to  $1500^{\circ}\text{F}$ . Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.



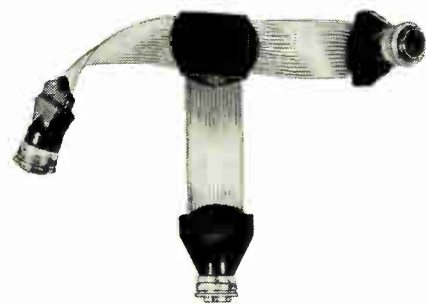
**CONTROL HARNESS:** This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.



**FUEL CELL CABLE:** Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.



**HEAVY DUTY CABLE:** Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



**RIBBON CABLE:** Ribbon type cable terminated to both standard MS or Bendix Pygmy® connectors. Advantages offered by this type of wiring include durability, performance, lightness, plus minimum space requirements.

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

**SCINTILLA DIVISION**  
SIDNEY, NEW YORK



# SQUEEZING

# HIGH POWER

# INTO

# small packages



Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment — unequalled in compactness, ruggedness and dependability.

## TELEMETERING TRANSMITTERS

FM/FM or PDM/FM Crystal Controlled  
215 to 260 Megacycles

SUB-CARRIER OSCILLATOR.  
Model 800C — 1.5" x 1.9" x 2.45"

Model 1472



4" x 1.5" x 2.7"  
2 Watts

Model 1463



5 1/32" x 3 1/16" x 4"  
15 to 30 Watts

Model 1462



6" x 4 1/4" x 3 3/4"  
50 to 80 Watts

Model 1466A



6.5" x 4" x 3.25" RF Amplifier  
2 watts in — 100 watts out



Deviation stability  $\pm 1\%$   
of band width. Deviation  
linearity less than 1% of  
band width under all con-  
ditions measured from a  
straight line drawn be-  
tween end points.

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# TELECHROME

MANUFACTURING CORP.

FOR MESSAGES FROM OUTER SPACE

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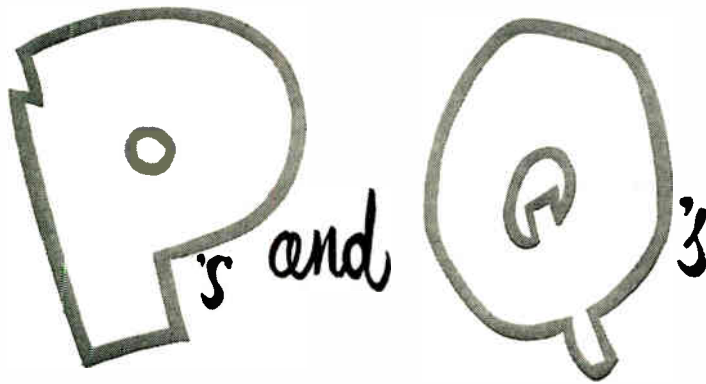
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Midwest Engineering Division — 106 W. St. Charles Rd.,  
Lombard, Ill., Mayfair 7-6026

Western Engineering Division — 13535 Victory Blvd.,  
Van Nuys, Calif., Glendale 2-7479



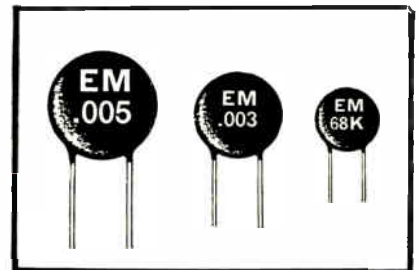
remember your...



call on **El-Menco** for capacitors  
 ... with proved **P**erformance and **Q**uality!

## CERAMIC DISC CAPACITORS with TEST-PROVED RELIABILITY!

In the field of capacitors, the name of El-Menco stands head and shoulders above all others. Its ceramic disc capacitors dominate in quality . . . in performance . . . in creative engineering . . . are unmatched for high Q value, high insulation resistance, high dielectric strength.



WRITE TO EL-MENCO for latest bulletin and samples on Ceramic Disc Capacitors . . . the Mighty Midgets with EXTRA Ruggedness and Stamina. Superior Features of El-Menco Ceramic Disc Capacitors . . .

- Working V.D.C. 500 . . . available also in 1,000 working volts and 2,000 test volts D.C. per E.I.A. specs. RS-165.

- Wax impregnated with low-loss phenolic coating.
- Flat design assures reduced self-inductance.
- Insulation resistance far exceeds the 10,000 megohm minimum requirements.
- Available with straight leads 1/4" minimum. Or manufactured with crimped leads for printed circuit applications.

### MIGHTY MIDGETS BY EL-MENCO INCLUDE:

- El-Menco TC—Temperature Compensating—for resonant circuit application.
- El-Menco TS—Temperature Stable—designed for applications where a minimum capacitance change with temperature is required.
- El-Menco SS—Semi-Stable—general purpose with stability.
- El-Menco GP—General Purpose—for bypassing, coupling or filtering applications . . . space saving, provide high capacity in relation to size.

EL-MENCO CERAMIC DISC CAPACITORS MEET OR EXCEED E.I.A. SPECS. RS-198.

LOOK TO THE LEADER . . . LOOK TO EL-MENCO . . . for capacitors to serve all your needs. Investigate, too, El Menco Dur-Mica Capacitors, the longest-living capacitors ever made.



## THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT  
 Manufacturers of El-Menco Capacitors

- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.  
 Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

# TANK TACTICS

*on teletypewriter tape*



**Capable of reception at speeds of 750 words a minute, new Kleinschmidt unit is world's fastest message printer and code puncher**

A major breakthrough in mechanical printing! Developed in cooperation with the U.S. Army Signal Corps, this new super-speed teletypewriter is ten times faster than "standard" equipment, five times faster than normal conversation. In future commercial use it could speed operations such as the

transmission of telegrams, stock market quotations, and weather reports. It has important applications in the field of integrated data processing. In recognition of its quality, Kleinschmidt equipment is manufactured for the U.S. Army under the Reduced Inspection Quality Assurance Plan.

# KLEINSCHMIDT

**DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS**  
Pioneer in teleprinted communications systems and equipment since 1911



# New

## ALLEN-BRADLEY Power Ferrites for Audio Frequencies (400 to 15,000 cps)

With the development of these two new power ferrites, it is now possible for you to gain the advantages of high-efficiency operation at the lower frequencies. These new ferrites are available in a wide range of shapes and sizes. A-B engineers will be glad to assist you in the application of these new ferrites.

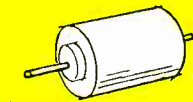


### Typical Applications for Allen-Bradley Power Ferrites

**W-07**

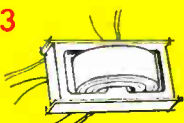


HF Fluorescent Lighting  
Ballast

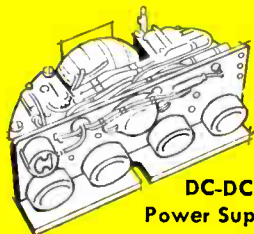


Motor

**R-03**



Transistor DC Power  
Supply Transformer



DC-DC  
Power Supply

**W-07** NEW POWER FERRITE with maximum flux density in excess of 5000 gauss — Here's an A-B ferrite that opens new fields for the use of ferrites in continuous power applications at frequencies between 400 and 15,000 cps — where even special laminated iron alloys are impractical. And its lower material costs bring tremendous savings in high-frequency fluorescent lighting ballasts, power transformers, motors, and high-frequency converters.

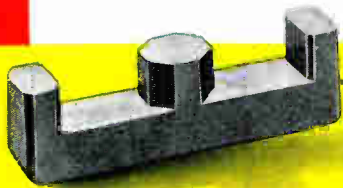
**R-03** NEW POWER FERRITE has rectangular hysteresis loop — The many unique properties of this R-03 ferrite offer unusual opportunities for designing intermediate frequency magnetic amplifiers, static switching devices, transistorized inverters, and power supplies. At operation above 500 cps, the cost and weight of this new ferrite is less than one half that of square loop, metallic tape wound cores . . . and core losses are much less. In addition, the extreme squareness of the hysteresis loop minimizes transient spikes which can damage transistors.

Allen-Bradley Co., 222 W. Greenfield Ave.  
Milwaukee 4, Wis.

In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

## ALLEN-BRADLEY Electronic Components

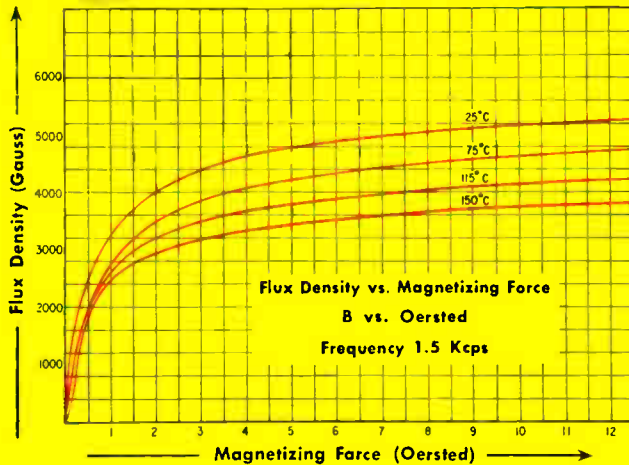
# New Allen-Bradley Power Ferrites Open New Design Horizons



**W-07**



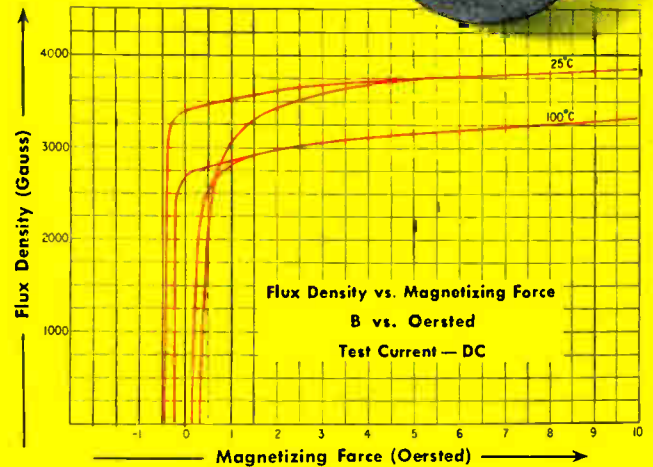
**R-03**



**W-07 MAGNETIZATION CURVES** show the extremely high flux density available. Also, it reveals that the maximum flux density does not decrease appreciably in increasing temperature. Technical Bulletin 5655 has complete specifications—send for your copy.

TABLE OF MAGNETIC PROPERTIES (TOROIDAL)

Property	Symbol	Unit	Nominal Value	Test Current
Sat. Flux Density @ 10 Oersted	$B_s$	Gauss	5,200	1.5 Kcps
Residual Mag.	$B_r$	Gauss	1,000	1.5 Kcps
Coercive Force	$H_c$	Oersted	.24	1.5 Kcps
Initial Permeability	$\mu_0$	—	1,300	1.5 Kcps
Maximum Permeability	$\mu_{max}$	—	4,000	1.5 Kcps
Curie Point	CP	+ °C	280	—



**R-03 HYSTERESIS LOOPS** show the high flux density provided with low levels of drive. The reduction in area with temperature shows that the loss per cycle is less at higher temperatures. For complete specifications, write for Technical Bulletin 5658.

TABLE OF MAGNETIC PROPERTIES (TOROIDAL)

Property	Symbol	Unit	Nominal Value	Test Current
Sat. Flux Density @ 10 Oersted	$B_s$	Gauss	3,900	D.C.
Residual Mag.	$B_r$	Gauss	3,360	D.C.
Coercive Force	$H_c$	Oersted	.37	D.C.
Initial Permeability	$\mu_0$	—	325	1.5 Kcps
Maximum Permeability	$\mu_{max}$	—	3,500	1.5 Kcps
Maximum Differential Permeability $\left(\frac{\Delta B}{\Delta H}\right)_{B=0}$	$\mu_d$	—	40,000	D.C.
Switching Time @ $2.5 H_c$	$t_s$	$\mu$ sec	2.9	—
Curie Point	CP	+ °C	315	—

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1-59-E

**ALLEN-BRADLEY**  
**ELECTRONIC COMPONENTS**

QUALITY



# Next month

## ELECTRONIC INDUSTRIES

"Where the engineer comes first"

will include as outstanding technically important "first-run" features:



SEMICONDUCTORS

### TRANSISTOR INTERCHANGEABILITY CHART

The results of another editorial research project aimed at producing greater technological values for EI engineer readers. Using EIA type numbers as a base, this chart will tell what type numbers are interchangeable electrically and who manufactures them.



### TODAY'S ELECTRONIC ENGINEER

How much are engineers paid? What kind and how many cars do they own? How much life insurance has he got? How many have pension plans? What's the value of his home . . . his personal holdings? Our recent exclusive survey provides the answers to these questions and we present it to you herewith by age groups and by regions. We are so proud of this study that we used it as a cover theme.



COMMUNICATIONS

### IONOSPHERIC REFLECTION INTERFERENCE

Ground to air communications systems, radar or other radio links with directional antennae that point skyward are subject to two main sources of interference propagated via the ionosphere. Learn the causes and cures.

### THE 47th NATIONAL IRE CONVENTION

Technical papers . . . new products . . . important contributions to the industry . . . special events of the show . . . all this and more will be presented for your information. If you're coming to the show, you can use this

report as your guide to the most outstanding features. If you can't make it this year—your perusal of this special feature will give you all the highlights.

### Plus all our other regular departments

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events,

EI Totals, Snapshots of the Electronic Industries, EI International, News Briefs, Tefe-Tips, Books, Rep News, International Electronic Sources, Personals, Industry News and New Products.

### COMING SOON—THERMOELECTRICITY

There is a continuing scientific effort to develop practical means for converting heat energy into usable electrical power. One of our current editorial research projects

is to list, summarize and define the present state of this art. Data being compiled now will shortly be ready for press. Watch for this valuable reference information.

### Watch for these coming issues.

\* JUNE

17th Annual Directory & All-Reference Handbook

\* AUGUST

WESCON Convention

\* NOVEMBER

Microwave issue.

By **LEANG P. YEH**  
Fellow Engineer  
Westinghouse Electric Corp.  
Baltimore, Maryland

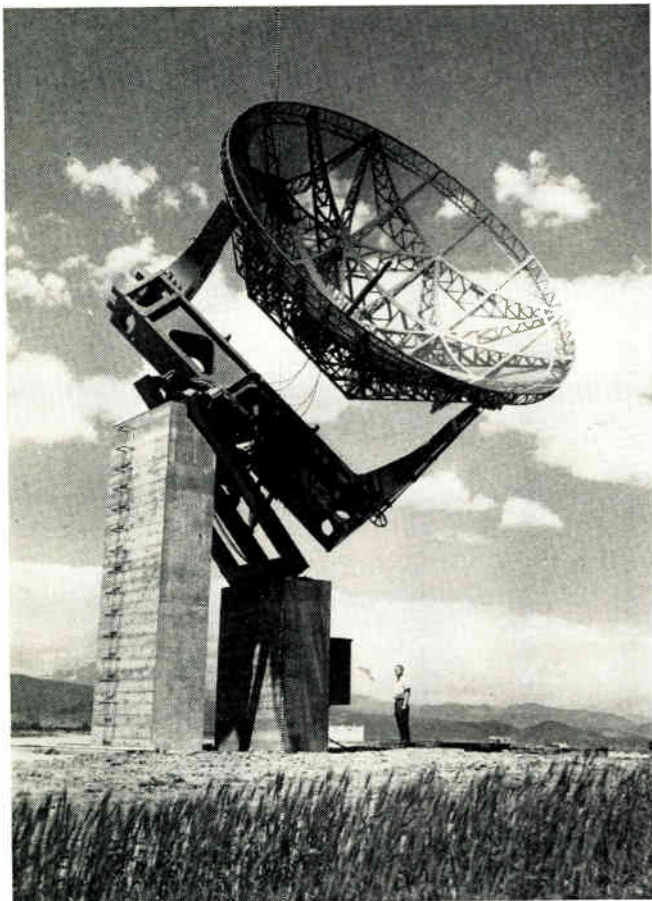
*System Designing . . .*

# Communicating in Space

*This young and controversial art is discussed from the overall and performance points of view. Known techniques and experimental data are analyzed, in hopes that a more realistic approach to the problem can be made.*

## Part One of Two Parts

A radio telescope at National Bureau of Standards, Boulder, Colo. It is one of those used during the recent IGY to listen to the sun.



**M**UCH has been written about space communications recently.<sup>1-4</sup> This article is not intended to indorse or criticize any of these views.

### *Free Space Loss*

At the present state of the art it seems that only line-of-sight transmission is feasible for space communications. For line-of-sight transmission in free space (a region free of all objects that might absorb or reflect energy), the relation of received power  $P_r$  to transmitted power  $P_t$ , between two isotropic antennas (which is defined as an antenna with a gain of unity), if treated by the direct ray theory, may be represented by:

$$\frac{P_r}{P_t} = \left( \frac{\lambda}{4\pi d} \right)^2 = \left( \frac{c}{4\pi d f} \right)^2 \quad (1)$$

where  $\lambda$  = wavelength =  $c/f$

$f$  = frequency

$c$  = velocity of light =  $3 \times 10^{10}$  cm/sec  $\cong 10^9$  ft/sec

$d$  = path length

Eq. 1 is usually called the free space loss. Expressed in db basis:

$$\text{Free space loss} = L_{FS} = -36.6 + 20 \log_{10} d_{mi} + 20 \log_{10} f_{mc} \quad (2)$$

where  $d_{mi}$  = transmission path length in statute miles

$f_{mc}$  = frequency in megacycles per second

The simple picture of line-of-sight transmission in free space between a transmitter and a receiver has been shown in Eq. 1 to involve only a direct path.



This may be fairly true in the case of space-to-space communications.

For space-to-earth or earth-to-space communications, the presence of earth's surface and atmosphere modifies the simple picture in a rather complex manner. Firstly, the direct path becomes slightly curved due to refraction and secondly, there are many indirect paths due to reflections from the earth's surface.

As long as the change in refractive index is linear with height, the net effect of refraction is the same as if the radio waves continued to travel in a straight line but over an earth with modified radius. For U.S. standard atmosphere, the modified radius is 4/3 times the true radius of the earth. The factor 4/3 is called the effective earth radius factor.

To simplify the analysis, it is usually assumed that only two paths are present. Due to two-path transmission the resultant signal is subject to both amplitude and phase change. Besides, the carrier frequency has a Doppler shift; the resultant signal has a lobe structure when the space vehicle is moving toward or away from the earth. Such lobe structure is sometimes called the interference pattern.

### Doppler Shift

The Doppler shift  $f_d$  depends on the carrier frequency  $f$  and the relative velocity  $v$  between the transmitter and receiver. The maximum value may be expressed as:

$$f_d = \frac{fv}{c} \quad (3)$$

where  $c$  = velocity of light.

Eq. 3 is plotted in Fig. 1. For 1000 MC and a relative velocity of 20,000 mph, the maximum Doppler

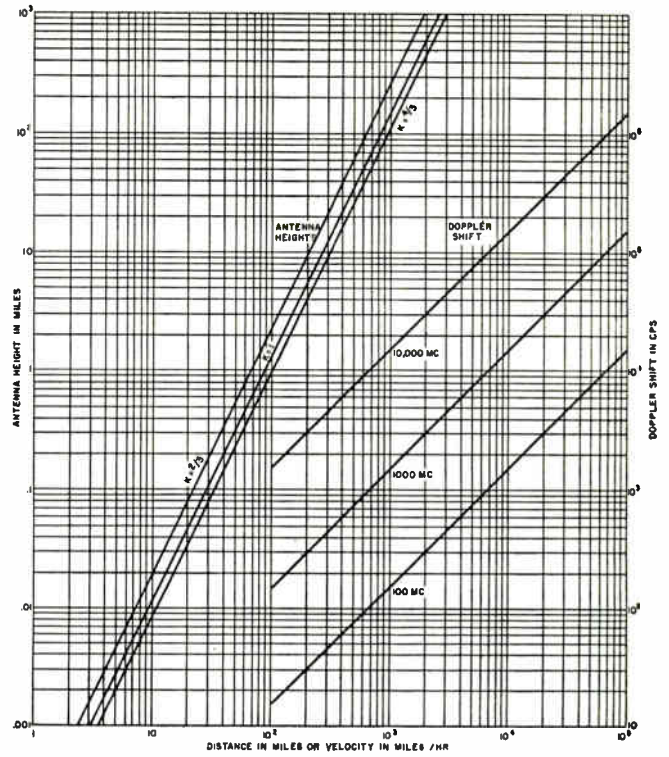
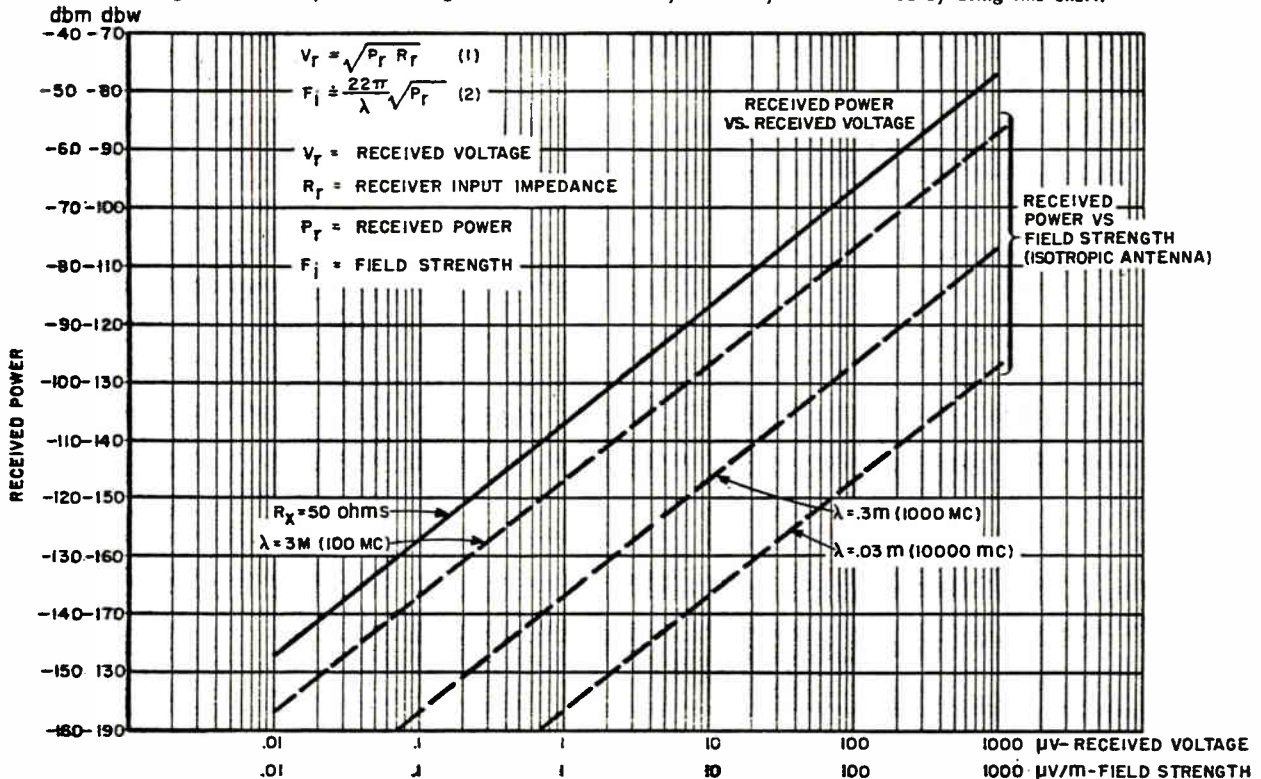


Fig. 1: Max. value of Doppler shift is obtained with this chart.

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of this article can be obtained by writing on company letterhead to  
The Editor  
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

Fig. 2: Received power & voltage and the field intensity can easily be determined by using this chart.



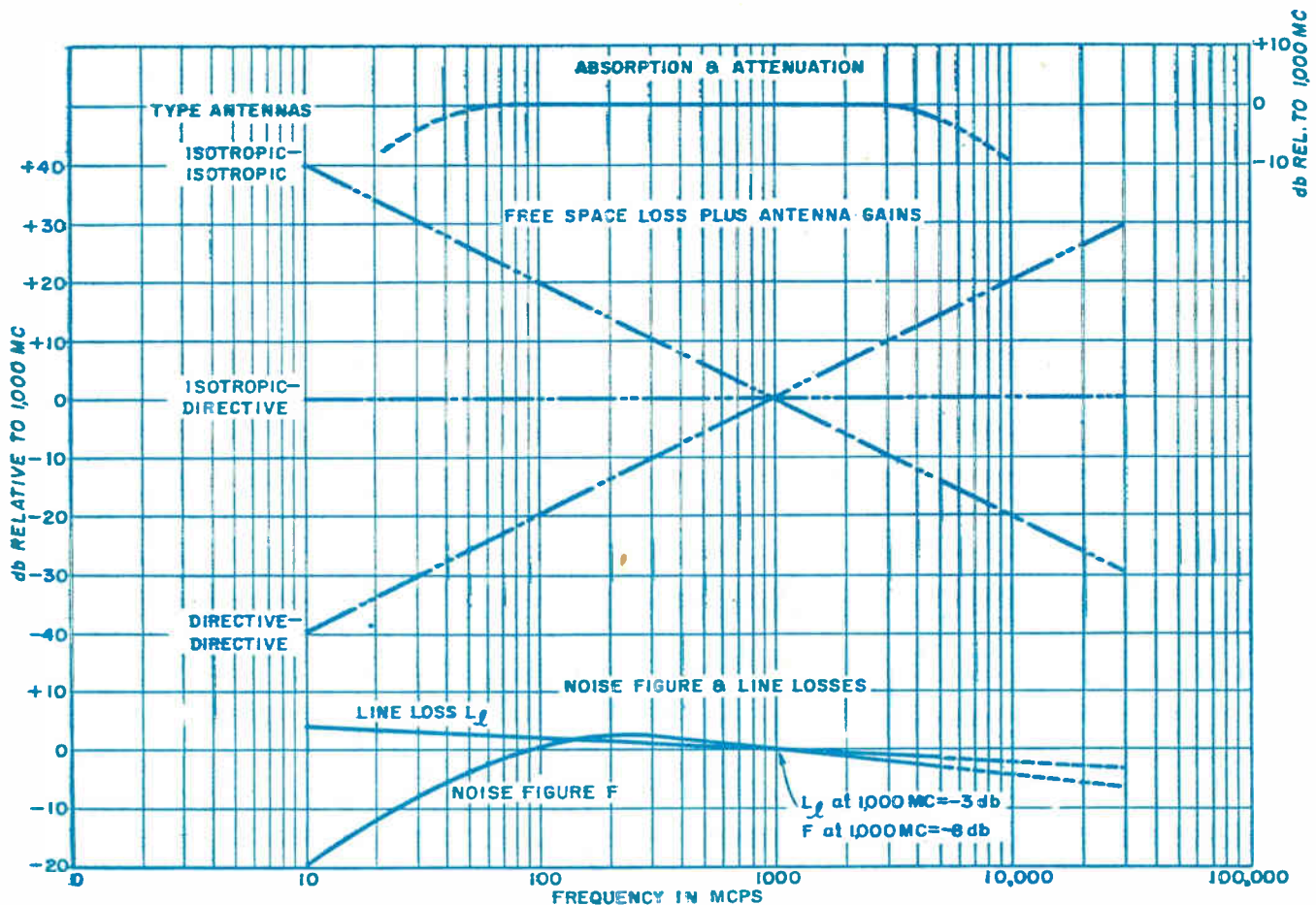


Fig. 3: Plot of parameter variations facilitates determination of optimum frequency to be used.

## Space Communications (Continued)

shift may be as high as 30 KC. Although smaller Doppler shift has been successfully compensated by several practical schemes, such high shift may be a serious problem. The lobe structure can be reduced by the appropriate design of the directivities of both transmitting and receiving antennas.

The received power  $P_r$  is usually expressed in watts, or in db relative to 1 watt (dbw), or in db relative to 1 milliwatt (dbm). Sometimes the received voltage  $V_r$  is required. This can be easily obtained if the input impedance  $R_r$  to the receiver is known:

$$P_r = \frac{V_r^2}{R_r} \text{ or } V_r = \sqrt{P_r R_r} \quad (4)$$

Another very popular expression for received signal is the so-called field intensity or strength expressed in microvolts/meter. This should not be confused with the received voltage in microvolts, although one is related to the other.

Conventionally, the field strength is either referred to the signal received by the isotropic antenna or by a dipole. In such cases,

$$F_i \cong \frac{22\pi}{\lambda} \sqrt{P_r} \text{ volts/meter for isotropic antenna} \quad (5)$$

$$\cong \frac{17\pi}{\lambda} \sqrt{P_r} \text{ volts/meter for a dipole} \quad (6)$$

Eqs. 4 and 6 are plotted in Fig. 2.

### System Calculations

In any communication system the minimum usable carrier-to-total noise power ratio or sometimes called the "Threshold," is of utmost importance. This ratio will determine whether or not the input signal can be detected in the presence of noise associated with the receiver input including the antenna system. This is the first limitation on the system performance.

As seen from later discussion, in the frequency ranges considered feasible for space communications, the thermal noise of the receiver predominates at isolated locations where the terminals are likely to be located. This discussion is limited to thermal noise only.

The minimum usable carrier-to-noise power ratio depends on the modulation techniques used. For practical system design, a value of 15 db seems to be

**Table 1**  
**OPTIMUM FREQUENCY**

Antenna System	One-Way		Two-Way
	Communication	Radar	Passive Relay, or Radar
Isotropic-Isotropic	40- 100 MC	—	—
Isotropic-Directive	100- 300 MC	—	—
Directive-Directive	2000-4000 MC	2000-4000 MC	2000-4000 MC



an average acceptable figure. Furthermore, the carrier-to-noise power ratio used hereafter will mean the rms carrier to rms thermal noise power unless otherwise stated.

The carrier-to-noise power ratio C/N for one way communication or radar may be expressed as:

$$C/N = 10 \log_{10} P_t + G_t - L_{FS} + G_r - L_f - L - 10 \log_{10} F + 204 - 10 \log_{10} B_{if} \quad (7)$$

where

C/N = carrier-to-noise power ratio in db

$L_{FS}$  = free space loss =  $20 \log_{10} \left( \frac{\lambda}{4\pi d} \right)$  in db

$G_t$  = transmitter antenna power gain in db

$G_r$  = receiver antenna power gain in db

$L_f$  = fading allowance in db

$L$  = line losses in db = 3 db at 1000 MC

$10 \log_{10} P_t$  = transmitter power in dbw

$F$  = effective receiver noise figure = 9 (8 db) at 1000 MC

$K$  = Boltzmann's constant =  $1.38 \times 10^{-23}$  joules/°K

$T$  = 290°K (ambient temperature at the Earth's surface; it will be higher in space, depending on distance from the sun).

$KT$  = -204 dbw per cycle

$B_{if}$  = Receiver i.f. bandwidth in CPS

Eq. 7 may be extended to become a passive relay or two-way radar equation:

$$C/N = 10 \log_{10} P_t + 2G_t - 2L_{FS} + G_B - L_f - L - 10 \log_{10} F + 204 - 10 \log_{10} B_{if} \quad (8)$$

where  $G_t$  = effective power gain of passive reflector or echo cross section

$$= 10 \log_{10} \frac{4\pi A_b}{\lambda^2} \text{ in db}$$

$A_b$  = effective area of passive reflector or echo cross section.

Since  $G_t$ ,  $G_b$ ,  $L_{FS}$ ,  $L$  and  $F$  are varying with the carrier frequency together with the fact that low h-f and high uhf are subject to reflection absorption and attenuation, a plot of all these parameters together will facilitate the determination of the optimum frequency to be used.

Variations of individual parameters vs. frequency are shown in Fig. 3 and combination of all of them vs. frequency is shown in Fig. 4. All values are plotted as db relative to 1000 MC. From Fig. 4, the optimum frequencies in Table 1 may be obtained.

### Fading Allowances

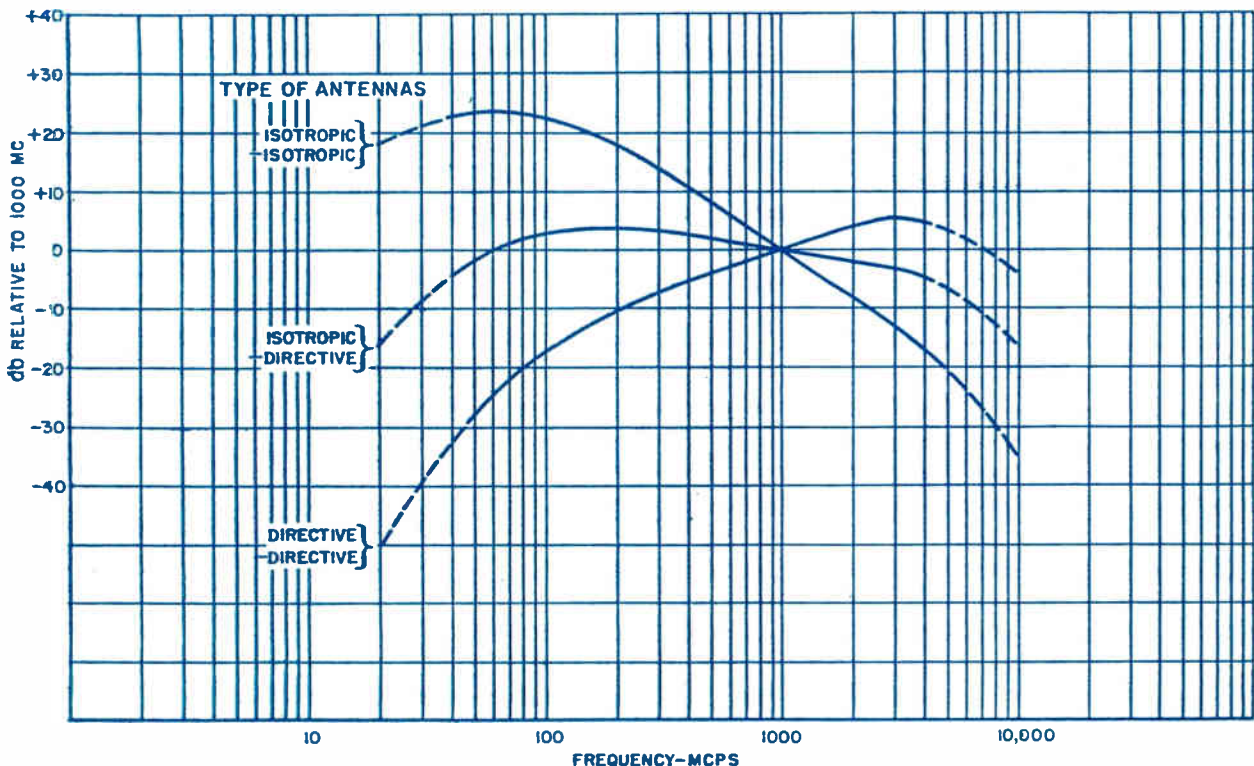
Of all the parameters mentioned in Eqs. 7 and 8, the fading allowance is as yet to be established. Although long term measuring data are lacking, an examination of the experimental results from some of the moon echo experiments and the recent radio observation of the earth satellites has arrived at a tentatively recommended value to be used for system design.

A summary of some of the moon echo experiments<sup>5-11</sup> is shown in Table 2. Calculated receiver sensitivity and received signal in Table 2 are obtained by using Eq. 8: Furthermore, the reflection factor of the moon's surface is calculated from the average measured received signal in some cases.

Some conclusions may be drawn from these moon echo experiments:

(a) For CW and long pulse signals, the reflection factor of the moon was found to vary from 0.07

Fig. 4: The optimum frequencies in Table 1 may be obtained from this plot of carrier-to-noise ratio vs. frequency.



# Space Communications

(Continued)

to 0.26. For very short pulses, considerable reductions of the reflection factor ( $10^{-2}$  or  $10^{-3}$  reduction) were observed. Except for very short pulses, the reflection factor of the moon's surface may be taken to be 0.1-0.2.

(b) A circuit loss of 250 db between isotropic radiation and collector for 100 MC and 6 db increase of loss per octave of frequency may be used for future moon echo system design.

(c) Since the angle subtended by the moon on the earth is about  $\frac{1}{2}^\circ$ , any antenna beamwidth smaller than  $\frac{1}{2}^\circ$  may reduce the effective echo area. For parabolic antennas, this requirement will limit the antenna gain to about 50 db (antenna with aperture of about 100 wavelengths).

(d) The moon echoes are subject to fading continuously at both slow and fast rates. Fadings of 20 db or more have been observed.

Radio observation of the earth satellites also indicate fading of the signal. One of the experimental results<sup>12</sup> is shown in Table 3.

From the moon echo study and the radio observation of the satellites two types of fading were usually reported. One, with a period of seconds, is believed due to the moon's libration for moon echoes, and due to the spinning of the satellite for satellite observa-

**Table 2**  
MOON ECHO EXPERIMENTS

Investigator	Mofenson <sup>5</sup> De Witt <sup>6</sup>	Kerr <sup>7</sup>	Sulzer <sup>8</sup>	Trexler <sup>9</sup>	Yaplee <sup>10</sup>	Fricker <sup>11</sup>					
							Frequency	MC	111.5	20	418
Peak power	kw	3	70	—	1200	—	2300	—	—	—	—
Pulse width	sec	$\frac{1}{4}$	$\frac{1}{4}$	—	$10 \times 10^{-6}$	—	$2 \times 10^{-6}$	—	—	—	—
P. R. F.	pps	$\frac{1}{4}$	—	—	10	—	250	—	—	—	—
Ave. power	kw	—	—	20	—	0.1	—	—	—	—	40
Rec. Ant. Gain	db	24	20	30	40	40	51	—	—	—	36
Trans. Ant. Gain	db	24	20	21	40	40	51	—	—	—	21
Rec. B. W.	cps	57	70	$10^3$	$10^5$	$3 \times 10^3$	$35 \times 10^4$	—	—	—	50
Rec. Noise Fig.	db	7	20	4	4	4	8	—	—	—	6
KT##	dbw	-204	-204	-204	-204	-204	-204	—	—	—	-204
Rec. Sen.	dbw	-179	-166	-170	-150	-165	-141	—	—	—	-181

**CALCULATED RECEIVED SIGNAL**

Refl. factor		0.18	0.15	0.26	.0018#	0.18	0.00028#	0.07#
Echo area*	sq mi	$6 \times 10^5$	$5 \times 10^5$	$8 \times 10^5$	$6 \times 10^3$	$6 \times 10^5$	975	$25 \times 10^3$
Moon Area gain	db	+124	+109	+137	+110	+130	+124	+136
Ant. Sys. gain	db	+48	+40	+51	+80	+80	+102	+57
F. S. L. (L <sub>FS</sub> )	db	-372	-342	-394	-382	-382	-428	-394
Trans. pwr. (P <sub>t</sub> )	dbw	+35	+48	+43	+60	+20	+64	+46
Rec. pwr. (P <sub>r</sub> )	dbw	-165	-145	-163	-132	-152	-138	-155
Circuit loss**	db	-248	-233	-257	-272	-252	-304	-258

**MEASURED RECEIVED SIGNAL**

Max. rec. sig.	dbw	-159	-146	-160	—	—	—	-148
Ave. rec. sig.	dbw	—	—	—	-132	-152	-138	-155
Min. rec. sig.	dbw	-177	—	—	—	—	—	-166

\* echo area of moon = projected area of moon  $\times$  reflection factor  
=  $3.48 \times 10^6$  sq. mi.  $\times$  reflection factor

\*\* circuit loss is the total transmission loss of the two-way radar system between an isotropic radiator and collector.

# reflection factor calculated from measured received signal.

##  $K = 1.38 \times 10^{-23}$  joules/ $^\circ$ K;  $T = 290^\circ$ K.

tion. Libration is an apparent oscillation of the moon's face as seen from a point of the earth—arrives from the diurnal rotation of the observer on the earth and from variations in the moon's orbit. Satellite spinning causes the rotation of the radiation patterns of the aerials and the change of polarization of the transmitted signals.

Another, with a period of about an hour, is believed due to the Faraday effect (the plane of polarization of the radio waves is rotated as they traverse the ionosphere in the presence of the earth's magnetic field).

Atmospheric refraction in both the troposphere and ionosphere and the lobe structure of the signal due to two path transmission may also have some bearing on the fading of the received signal. Prac-

(Continued on page 159)

**Table 3**

**RADIO OBSERVATION OF THE SATELLITE**

Type Observation	Signal Measurement		
Satellite	Sputnik #1		
Investigator	Brice <sup>12</sup>		
Frequency	MC	20,005	40,002
Trans. Power	w	1	1
Path Distance	mi	150/300	150/300
Trans. Ant.	ft	4-rod	4-rod
Rec. Ant.	ft	dipole	dipole
Rec. Sensitivity	dbw	-162	-137
Rec. Ant. Gain	db	+2*	+2*
Free Space Loss	db	-107/-113	-113/-119
Trans. Power	dbw	0	0
Line Loss	db	-1*	-1*
Calculated Rec. Power	dbw	-106/-112	-114/-120
Measured Rec. Power	dbw	-95/-132	-112/-137

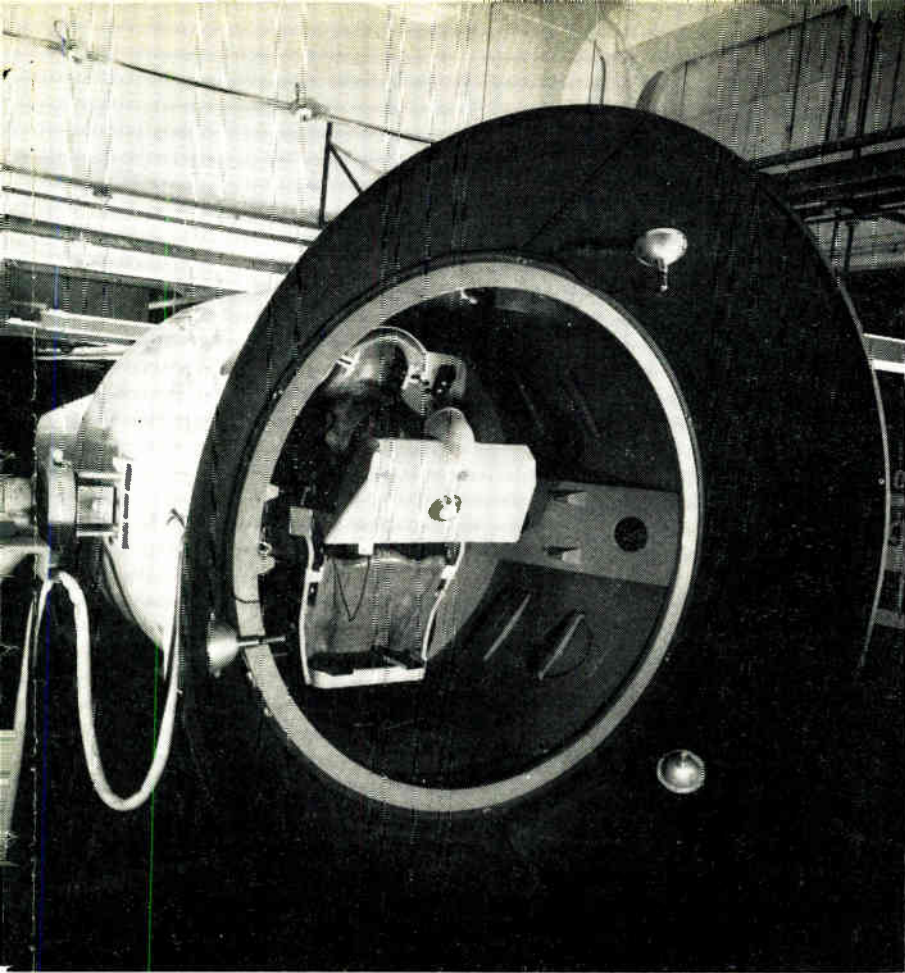
\* Estimated.

**Table 4**

**CORRECTION FOR OTHER FREQUENCIES**

Group	Antenna System	Distance Only	Power Only
I	Isotropic-Isotropic	multiplied by $1000/f_{MC}$	multiplied by $(f_{MC})^2/1000$
II	Directive-Isotropic	No	No
III	Directive-Directive	multiplied by $f_{MC}/1000$	multiplied by $1000^2/f_{MC}$

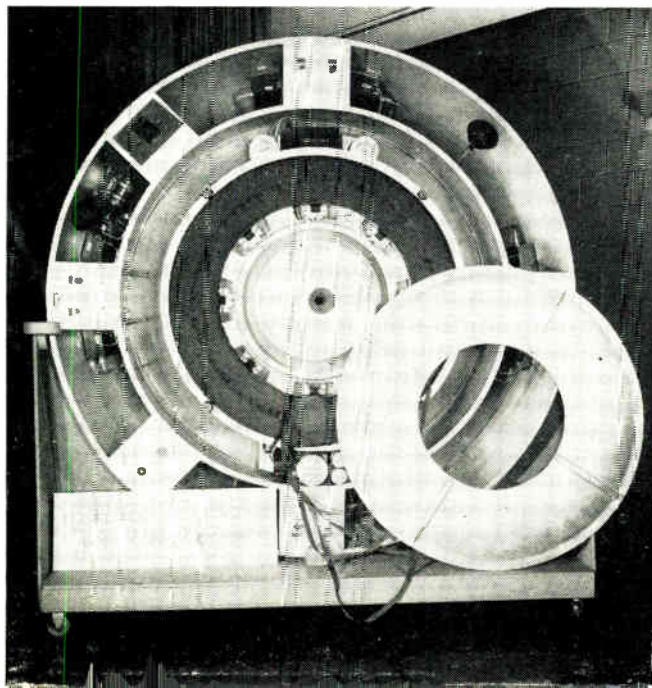




Open end view of satellite capsule designed to withstand up to 10 g's. Form moulded occupant's seat is shown with the instrument panel in front of it. Flared portion packed with instruments shown in picture below fits into open end.

## Design for "Man-in-Space"

Flared portion of space capsule with parachute cover removed showing how it is packed. Mounted around the periphery are instruments, a balloon antenna, sofar bombs, and a cutter for severing chute lines on impact.



Pilot's panel showing optical periscope at top, suit & cabin pressure gauge upper left, angled mirror for TV surveillance clock showing lapsed time; at left again are 2 of the 3 oxygen supply gauges, accelerometer measuring roll, pitch & yaw, and altimeter. To the right and below the mirror are eye and hand perception tests. In corner at right are fuel gauges

THE United States last month pinned its hopes of placing a man in space on the McDonnell Aircraft Co., St. Louis, Mo. McDonnell was selected by the National Aeronautics and Space Administration (NASA) over 11 competing companies to build a dozen or more satellite capsules to put man in orbit around the earth.

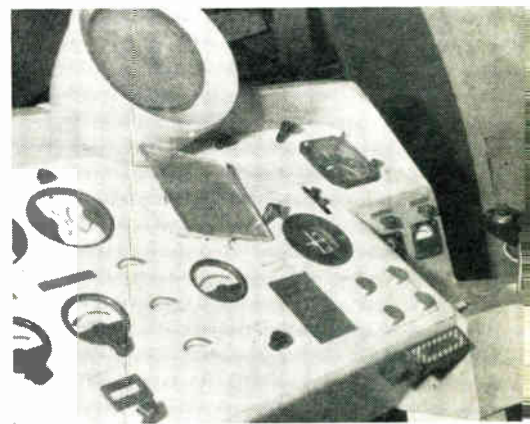
While the amount of money involved—\$15 million—was not significant by present weapons systems costs, the prestige involved in the award is tremendous.

In brief, the contract calls for a man-carrying capsule, weighing between 2,000 and 3,000 lbs, to be launched by a Convair Atlas-D missile booster and guided into a circular orbit between 100 and 150 mi. up.

The capsule will include 2-way communication equipment, telemetering, radio command system and guidance. Collins Radio has been tabbed by McDonnell to supply the electronic instrumentation and Minneapolis-Honeywell the guidance mechanisms.

NASA's confidence that the job can be done now, at the present state of the various arts involved, is based on extensive investigation carried out by a number of other firms under earlier NASA research contracts. Prominent in this research was the General Electric Co.'s Missile and Space Vehicle Dept., Phila., Pa., which last year designed and built a complete space capsule for NASA that included instrumentation, communication, retro rocket and parachute for recovery. The plans and technical data for all components of the GE capsule were delivered to NASA to become part of the pack-

*(Continued on page 154)*



*In planning for outer space flights of up to 80,000 mph, first and foremost is the requirement for highly reliable and accurate high speed automatic control systems. The additional environmental problems that remain to be solved include exposure to cosmic radiation, meteorites, temperature and high acceleration rates.*

# Some Survival Aspects of Space Travel

**By A. M. MAYO,**

*Chief, Equipment Safety Research Eng'g,  
Douglas Aircraft Co., Inc.  
El Segundo, Calif.*

**I**N a space craft as in aircraft the overall objectives must command first attention. Survival problems resulting from space environment will, however, be so severe that a larger percentage of total space craft design time is likely to be spent in their solution than in airborne craft.

Aside from short trips around the Moon or nearby space excursions, it seems likely that the trips, even to planets in our own solar system, would involve a

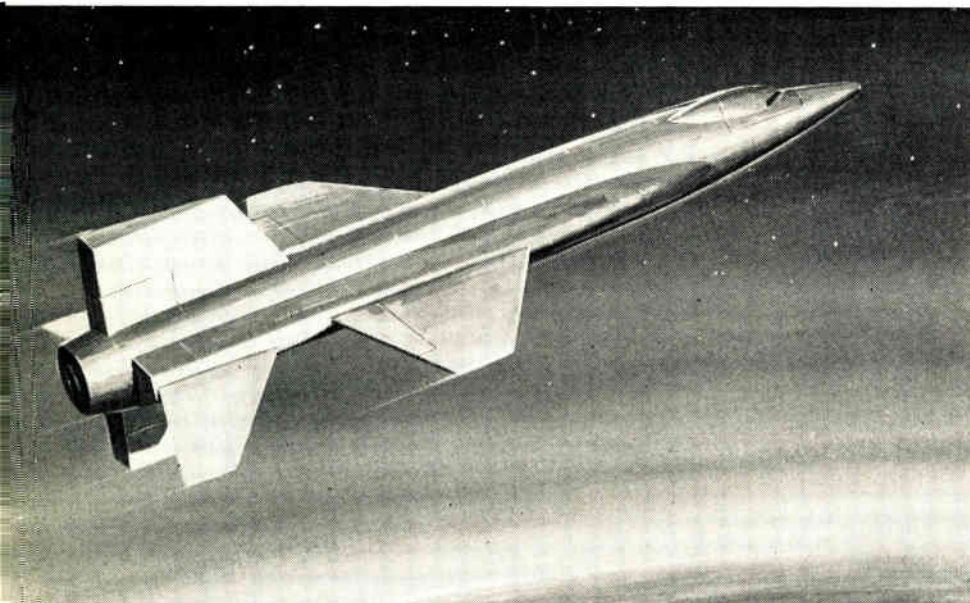
substantial period of time. A trip around the Sun in fact has been a commonly proposed method of reaching the sister planets in our own solar system.

The design of crew compartments will be dictated by the requirements of human operators not significantly different in basic physical and mental capabilities from those of the pilots of present aircraft, or for that matter the cave man whose primary means of travel were his own legs. The radical differences in speed from walking to the probable speed of the space craft point up some of the survival aspects.

The need for information to be gathered from very great distance to provide time for a human crew member to think and act is emphasized in Fig. 1. It is evident from the distance involved that survival will increasingly depend on the reliability and accuracy of high speed automatic control systems.

Automatic controls will be needed as greatly for actuation of safety equipment and environmental control of the crew quarters as in control of the craft and its propulsion and power systems.

A major problem will be that of suitably linking the human operator to his "automatic" systems. As in every man-machine system de-





cision making control must be retained for the human brain. An intermediate computer can undoubtedly be used to link sensed information to both "automatic" systems and display for the operator.

Hermetically sealed crew quarters to provide a livable earth environment in space will be a prime survival requirement. The time of flight will tend to be sufficiently great that total regenerative air, water and food cycles are likely to be the only practical answer to this survival problem.

Suitable control of air pressure and composition might be approached by a combination of stored materials possibly in a solid chemical state together with a system which can reconvert CO<sub>2</sub> and other excreted body gases to their original state. The immediate possibility of utilizing sunlight and the action of chlorophyll in green plant life has occurred to many people. Another possibility in which more precise control and less uncertainty with respect to health problems of living algae or other plants might grow out of intensified research in the area of synthetic photosynthesis. Here again the need to provide reliable automatic controls with suitable standby systems can hardly be overemphasized.

### Secondary Living Organisms

The reconversion of liquid and food waste products to useful nutrients of a psychologically satisfactory nature might also be approached by the use of secondary living organisms in the same manner as in nature. Here again, the desire for a system subject to more positive control and greater overall reliability might well dictate the expenditure of great effort to provide a regenerative chemical cycle not dependent on the art of keeping biological specimens healthy, happy and productive.

The evident need to protect against loss of vital materials through a leak or from structural damage will undoubtedly dictate the considerations of extensive compartmentation and automatically controlled air locks as a means of isolating damaged compartments. Pressure suited emergency crew members may be able to then effect repairs and return damaged compartments to use, after a minimum loss of vital gases.

Such compartmentation and repair facilities might be emphasized by considerations of the possible effects of meteor showers.

Newer estimates by Whipple and others indicate an increase over past data in the probable numbers of meteor particles of potentially dangerous size. In addition to compartmentation, it is also likely that added emphasis in the design of the structure and skin will be needed to provide penetration resistance to meteors of a larger size than previously considered statistically important. The large amount of kinetic energy per unit mass of meteor particles indicates that an explosive type of impact with a surface is likely. Accordingly Whipple has suggested a relatively thin outer or buffer skin to effect that explosion. The smaller particles could then be absorbed by a larger mass of primary material. Self-sealing substances on the inner skin surface might also help to reduce the importance of the smaller penetrating

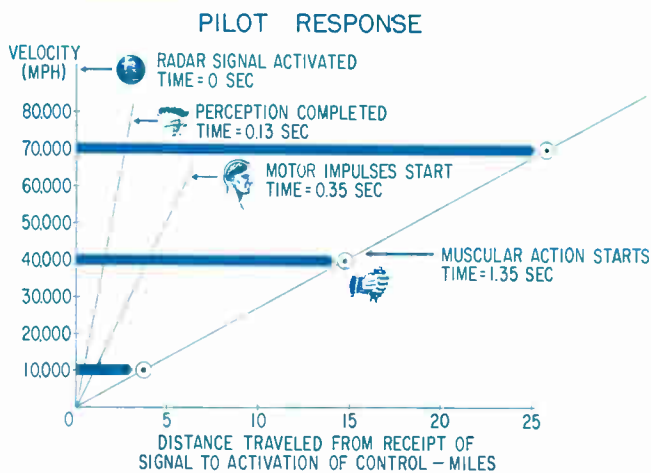


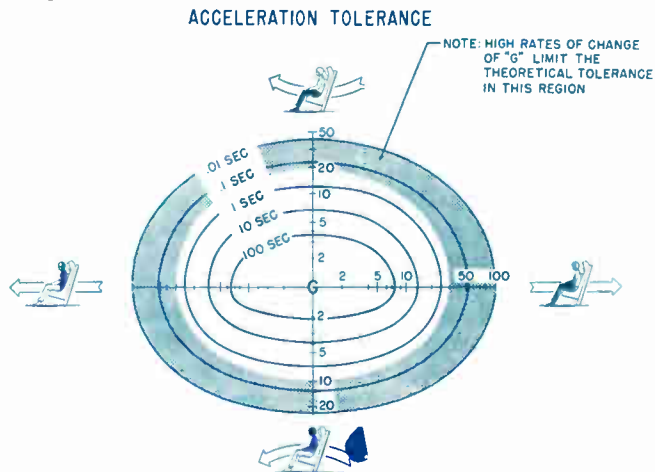
Fig. 1: Time intervals between perception and action

meteors. A rapidly applicable mechanical seal might also be needed to seal larger holes quickly.

### Temperature Control

Temperature control will undoubtedly require much specialized attention. For free space flight it is likely that large heat radiating surfaces will be needed. Waste heat from powered equipment could be transferred to these surfaces by an intermediate fluid. The resulting radiant refrigeration system would then be roughly comparable in intermediate stages to some present low temperature refrigeration systems. Similar surfaces could be used to collect solar heat and by reverse cycle operation provide energy to the chemical and mechanized systems during periods when large amounts of power are not being dissipated within the craft. The orientation of the radiation surfaces with respect to the sun would determine whether they added or removed heat from system. For free space travel there is then a rather direct though complex engineering approach to the problem of temperature control. During re-entry in a craft not utilizing retro thrust or contained fuel to dissipate its high kinetic and potential energy, much aerodynamic and thermodynamic study will be needed. The craft would need to operate long enough in the thin outer boundaries of the atmosphere with a high

Fig. 2: Human tolerance to acceleration as function of time



## Space Travel (Continued)

enough surface temperature to allow these very large amounts of energy to be dissipated entirely by radiation and molecular rebound.

### Acceleration

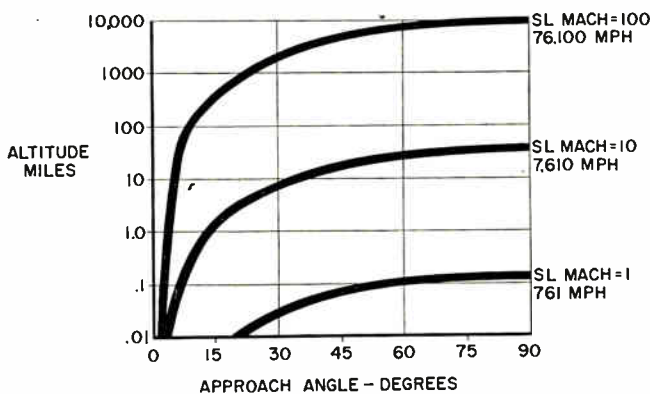
A substantial amount of data with respect to human tolerance to acceleration as a function of time and acceleration (Fig. 2) and an increasing understanding of the effects of rate of change of acceleration on the human body are available. It should then be possible to configure a space craft such that the accelerations encountered under controlled take off conditions need not be a serious survival problem.

The relative lack of knowledge as to the exact psychological and resulting physiological problems of the gravity free or weightless state of free space flight probably should not cause excessive concern. The engineer should be able to provide nearly any specified value of artificial weight by rotating the craft about its own center of gravity. The configuration, of course, would need to be such that the resulting cabin spaces would be oriented in a usable direction with respect to such rotation. Considerable inconveniences might be expected if the normal ceiling of the compartment were to be oriented such that it were usable only as a floor.

### Solar Radiation

The problems of surviving the effects of a wide variety of solar and cosmic radiation are still not

Fig. 3: Approach angle varies with altitude and speed



thoroughly defined. Physicists and biologists are confident that shielding against the lower energy solar radiations will not be too difficult. No practical approach utilizing a reasonable weight of shielding or deflecting material has yet been advanced to protect against the effects of very high energy cosmic particles. With the ionizing paths of such particles still increasing after penetrating a foot of solid lead, mass shielding does not appear practical.

Proposed methods of generating a sufficiently extensive and powerful electromagnetic force field indicate an even less promising approach. Practical methods of utilizing the reduced secondary emission effect of low atomic weight materials in shielding still remain to be advanced. This avenue may, though,

prove interesting. The inherent capability of a complex biological organism to tolerate and/or repair damage along the paths of penetration of individual cosmic particles on a statistical basis appears to be the only present practical reason for hope. Available physical and biological data are not extensive enough for categorical statements that tolerance to the cosmic radiations, existing in space, is practical, for extended times. On the other hand, competent physicists and biologists are showing considerable optimism on the basis of the data available.

### Escape Potential

Careful consideration must be given to a proper balance of the fundamental moral, morale and economic factors to provide escape equipment justifiably on the basis of the total purpose of the craft involved. Certain of the space craft escape requirements are merely extensions of those which need to be met in aircraft. Others are unique and a function of space itself. In order to outline some of the problems involved, it might be well to consider three phases of space flight. These are: (1) Take-off through an atmosphere and against gravity, (2) Free space flight and (3) Landing involving re-entry through an atmosphere.

During the initial part of the take-off phase, failure of the control system or a major power plant malfunction could impose escape requirements not too radically different from those of a high performance aircraft. The requirement to separate cleanly a suitably stabilized section and to provide controlled deceleration to solve the primary "G" time tolerance of the crew would not materially differ from that of a very high performance aircraft. A separate crew section of high structural and environmental integrity might also aid in the solution of problems pertaining to fire, power plant malfunction and structural failure during the take-off phase. Such a device if properly isolated might even be useful in certain types of explosions where the build-up of pressure might be slow and the initial violence limited. A number of different types of acceleration control devices varying from a winged escape vehicle to parachute decelerated systems or combinations of both suggest possible solutions to this portion of the problem.

As the craft moves into free space and power is no longer needed to maintain velocity, a new set of problems and requirements present themselves. Many of these problems are concerned with providing an adequate human environment and are just as real a safety consideration during normal flight as in a properly configured escape section. Since both the "Mother" craft and any escape device will continue to travel indefinitely at constant velocity in space, it is evident that the average time for rescue after separation must be assumed to be relatively large. Additionally the problem of sending distress and rescue messages and that of providing directions to rescue forces would not only be of paramount importance, but in all probability will present a problem not at all easily solved. The basic unfriendliness of the free space environment coupled with the prob-



able substantial times of waiting for rescue dictate the need for adequate air, water and food provisions. These problems in themselves might well determine a minimum practical size for the free space escape vehicle. The case of a crew successfully separating itself from a dangerously damaged "Mother" craft only to be lost in space to starve or die from exhaustion of environmental control facilities would be a not at all unlikely situation if very careful consideration is not given to the need for adequate emergency communication, locating and rescue procedures.

During the re-entry and landing phases of flight, the hazards of possible instability and induced accelerations from air drag would be added to the environmental problem. Additionally if it were neces-

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sary to re-enter an atmosphere without retro-thrust equipment, the escape craft must have suitable aerodynamic and heat resisting characteristics. Both the extreme kinetic energy of high velocity and the high potential energy of gravitational attraction must be dissipated as radiant heat or molecular rebound. This presents a problem of allowing a very high surface temperature for a relatively prolonged period of time. It further requires an aerodynamic and drag configuration capable of precisely controlling a craft

within the fringes of a relatively thin atmosphere until sufficient slow down is effected and energy dissipated. The deceleration problem is further emphasized by Fig. 3 which shows minimum distances vs. speed and angles that are required for survival as a function of available deceleration and time data. For example, if a man were travelling at Mach 1 in a 90° sea level dive, his physical tolerance to acceleration for the required time would make it necessary to utilize approximately .12 miles of distance to slow him down without killing him. Similarly if he were travelling toward the earth at Mach 100, or approximately 76,000 miles per hour, a distance of the order of magnitude of 10,000 miles would be required to slow him down within his acceleration tolerance limit.

In order to achieve satisfactory performance and economic compromise without sacrificing the escape potential, it appears evident that major use must be made of portions of normal crew stations in order that excessive penalty to the overall craft will not make impractical the provisions of escape capability. The requirements for extended times of survival coupled with the temperature aerodynamic and acceleration problems of re-entry indicate that the size of any useful separable portion of a large space craft would need also to be rather large to allow the provisions necessary for survival.

Original manuscript published in "Journal of Aviation Medicine," Oct. 1957, Vol. 28, pp. 498-503. From Space Travel—A symposium.

## PROBLEM CLINIC

### Measuring The Temperature of Moving Workpieces

An eastern manufacturer is faced with this problem:

**Problem:** To measure the internal temperature of large steel billets and other workpieces in the range of 1000°F to 2300°F while the workpiece is being heated under high temperature gradient (large temperature differential between furnace and workpiece). Problem is frequently complicated by fact that workpiece is continuously in motion.

**Purpose:** To permit better utilization of existing and projected heating methods by increasing the accuracy of temperature determination.

**Conditions:** Recently developed heating methods now in use permit fast, reasonably accurate heat processing by empirically setting heat input and exposure time, or by arbitrarily setting control in-

strumentation to read a surface temperature estimated to correspond to the desired internal temperature.

Such variables as varying emissivity and surface coating of scale prevent accurate detection of temperature by radiation pyrometer, while workpiece motion and high heating rates make use of thermocouples impractical.

Device needed should provide indicator and control signal either of internal temperature or of integration of surface and internal temperatures. It would probably depend on a characteristic of the material which changes predictably with temperature, such as the magnetic properties or permeability to or refraction of atomic radiation.

Workpieces may be round, square, rectangular or other regu-

lar shape in cross-section, and may move at rates between 20 and 500 fpm. They may be of any material, although most pressing needs are first for steel, then for other metals. Device might also be used on strip and tubing, but the problem is not as critical as in the case of the larger, solid shapes.

The internal temperature reader should find a tremendous market among manufacturers and users of the most advanced types of heat processing equipment.

Firms or individuals offering solutions to this problem are invited to contact "The Problem Clinic," Electronic Industries, 56th & Chestnut Sts., Phila. 39. Letters will be forwarded to the manufacturer.

*If you specify wire for high temperature use in the electronic field, then you should know all the facts about wire which are given here. Information about the latest types of conductor material, insulation, and methods of applying insulation to the conductor are included to aid you in selecting the right wire for your particular use.*

# High Temperature Wire & Cable



**By F. X. BUSCHMAN**

*Vice Pres. of Operations  
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**T**HE shields usually used on the types of wire covered in this discussion are braids or servings.

A braided shield consists of a basket weave of single or multiple ends of wire. The diameter increase is between 4 and 5 times the diameter of a single end of wire. The coverage is a theoretical percentage and is calculated from a formula.

The braid angle is the angle between a wire in the braid and the axis of the wire being shielded, keeping the same coverage. A 30° braid angle is considered normal for shielding.

A served shield consists of a single helical wrap of wires around the insulation to give the desired degree of coverage. The shield is usually served with a left hand lay. A served shield increases the diameter of the wire by twice the diameter of a single end used in the shield. To offset the advantage of reduced diameter, a served shield will buckle when the wire is bent and must be covered with an outer jacket. If used as the shield for a coaxial cable, the served shield may generate noise when the cable is flexed. This can be overcome by applying a semi-conducting layer to the primary insulation.

## *Cabling*

Cabling consists of taking a number of wires or groups of wires and making them into a bundle. The wires may be cabled on a planetary cabler, bunched or laid in parallel. Special cases would be flat cables which could be either ribbon braids with conductors in the braid pockets, or cases where the individual wires are laid parallel and sealed together at the point of contact.

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## **Part Two of Two Parts**

The most common type of cabling is concentric, made up using a planetary cabler. Here, the various layers have opposite directions of lay in the same manner as a concentric conductor. Planetary cabling produces a round firm cable. Cables may also have subsequent operations such as shielding or jacketing.

**Fig. 9: High temperature cable is available in large sizes. The 42 conductor cable uses a special Teflon fiber braid.**





## Jacketing

Jacketing is the process of putting an outer covering over a primary conductor, shield or cable. The jacket can serve one or more of the following functions:

1. As a binder to hold the members of the cable together and in place.
2. Mechanical protection for the cable members from abrasion and mechanical damage.
3. Moisture protection.
4. Protection from chemicals and solvents.
5. Electrical—to prevent shields from coming in contact with grounded objects.

The common types of jackets are:

- A. Braided jackets—cotton, synthetic fibers (particularly nylon), glass. This type of jacket may be impregnated or lacquered with materials such as nylon, acetate, Teflon, Kel-F elastomers and others.
- B. Extruded jackets—The common materials are nylon, polyvinyl chloride, Teflon, Kel-F, 100-X.
- C. Taped jackets—Teflon, silicone rubber.

### High Temperature Hook-up Wire

In the past several years needs have arisen, particularly in military and commercial electronic applications for hook-up wires in which the product must survive and operate under a severe range of environmental conditions. Among these are operation over a temperature range from 250°C to -90°C with minimum change in dielectric constant and power factor, and with resistance to attack by many corrosive chemicals and compounds. In addition, the pressing need for miniaturization in military and commercial electronics requires the use of hookup wires of low weight, small diameter (the same voltage ratings), and possessing the ability to be soldered and terminated in extremely close quarters without damage to the insulating medium.

An examination of Table 2 listing insulating properties will show three plastic materials which possess, in varying degrees, some or all of the above requirements. These plastic insulating mediums are Teflon,\* Kel-F,\*\* and silicones. In addition, there are several materials as shown on the table which are frequently used in fibrous form such as asbestos and glass, which possess a few of the desired properties for high temperature application.

There are five military specifications covering hook-up or control wires within the temperature ranges discussed in this paper. Mil-W-16878C (Navy) is used by the services and by many electronic firms specifying test and environmental conditions for high temperature hook-up wire. The Type E and Type EE specify Teflon insulation, while Type F and Type FF of the same specification are insulated with silicone rubber.

Mil-W-7139A, Mil-C-25038 and Mil-W-8777A specify lead and control wires under varying conditions for aircraft and air frame applications. Common insulating mediums are Teflon, silicones and fibreglass in varying combinations to meet the individual applicable requirements.

Synopsis of government wire specifications may be found on page 91 of the December, 1958, issue of ELECTRONIC INDUSTRIES.—Ed.



Fig. 10: Test chamber controls temperatures from -73° C to 177° C. It is being set-up for -65° C wire bend tests.

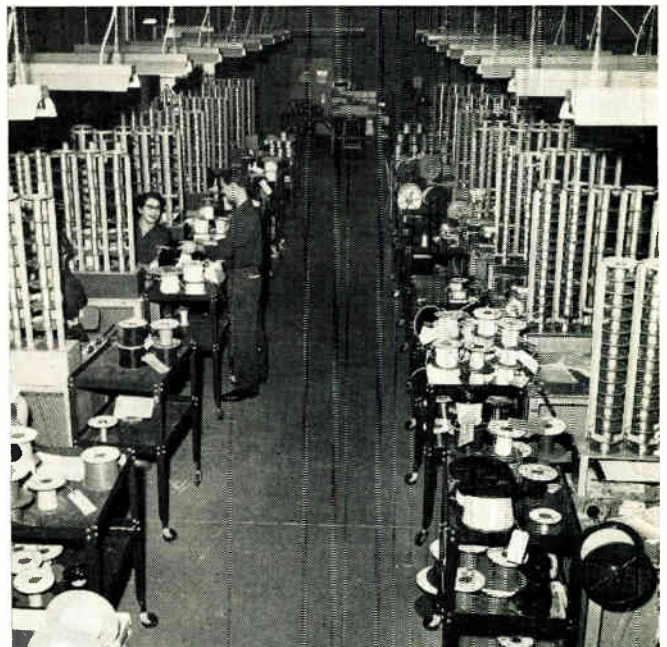
It will be anticipated that as the high temperature wires for electronic uses are increasingly adapted, that the end commercial specifications will approximate those of Mil-W-16878C (Navy).

Wire made in conformance to Mil-W-16878C, Types E and EE, therefore, is insulated with Teflon. Teflon has a dielectric constant of 2.1, a volume resistivity greater than  $10^{15}$  ohms/cm, good flexibility, "O" moisture absorption and is inert to nearly all materials except molten alkaline materials and fluorine at high temperatures.

Teflon is applied to hook-up wire by three methods: Wrapping with tape; extrusion and dip coating.

There are 3 Teflon tapes currently available. The first tape commercially sold was a "skived" tape in which the tape was shaved from pre-molded and cured billets of Teflon. Tape is also available that is extruded and then calendered down to a thickness of 3 to 4 mils, suitable for wire wrapping. A cast Teflon tape is also made which is used on wire but

Fig. 11: An overall view of a Rewind and Inspection Department



# High Temperature Wire

(Concluded)

more commonly used in film applications for capacitors, etc.

The wrapping of Teflon on wire is accomplished by two methods. One consists of applying the tape cylindrically to the conductor, building up as many as 9 or 10 layers over any individual segment of the conductor, thereby insuring a uniform dielectric strength and a uniform wall thickness and longer dielectric lengths. This product, known as Flexolon, is done with a patented process held by the Tensolite Insulated Wire Company. The other method of wrapping wire with Teflon is by spiralling the tape helically around the conductor using sufficient over lays to achieve the desired wall thickness and dielectric strength. In this method it is common to have 3 or 4 layers of tape over any point on the conductor.

Teflon not possessing a melt index, as is common with many thermoplastic materials, cannot be extruded on conventional screw type extrusion equipment. The extrusion of Teflon is accomplished by preforming a fine Teflon powder completely saturated with an extrusion aid in a ram type extruder. With this equipment, the preform is inserted into a cylinder and a moving piston forces the Teflon powder to flow around the conductor which travels through the center of the preform and into a die. The wire and insulating material then progress through a series of high temperature ovens where first the extrusion aid (highly volatile) is removed and then the Teflon sintered and fused. The preform density and pressures in extrusion are extremely critical in this operation. Of the methods of insulating conductors with Teflon, the extrusion process, because of the necessity for highly controlled conditions, offers the shortest average dielectric lengths. Table 3 below lists comparative properties of the three methods of insulating with Teflon described above.

Dip coating is accomplished by passing a conductor successively through an aqueous dispersion of Teflon and sintering and fusing. This is the method commonly employed in producing magnet wire. Recent developments in improvements of Teflon dispersions have enabled the building of substantial wall thick-

nesses so that a low voltage hook-up wire of extreme flexibility and minimum diameter may be obtained using this method.

## Conductor Material

With the exception of magnet wire, the commonly used conductor in Teflon insulated wire is silver plated copper. Silver plated copper is employed to prevent oxidation of the copper at the elevated temperatures required to sinter and fuse Teflon, and also as a subsequent aid in soldering and terminating the final wire. Tin is undesirable as a protective coating for the copper, since at the high fusion temperatures of Teflon tin melts and flows, lumping severely on the surface of the copper.

Until recent months, the copper employed most commonly was Electrolytic Tough Pitch. It is this writer's opinion, however, that the use of oxygen free copper provides an additional safety factor in the processing and usage of Teflon insulated wire because of the freedom from possible embrittlement of the copper when subjected to high temperatures.

Nickel plated copper conductors are also used. The most recent issue of Mil-W-16878C (Navy) includes the use of nickel plated conductors as an alternate to silver. The Army Ballistic Missiles Agency has requested the use of this type of conductor in all wire entering army ballistic missiles. With either silver or nickel plating, the general requirement is for a minimum of 40 microns of plate over the copper.

Silicones are used in producing Types F and FF wire to Mil-W-16878C (Navy). Silicone has a slightly higher dielectric constant than Teflon and is not resistant to those materials shown in Table 2.

Silicones are applied to wire either by wrapping with tape or by extrusion. In extrusion the conventional type equipment employed in rubber type insulations is used. Curing is accomplished by either continuous vulcanization, CV or by hot air vulcanization, HAV. Continuous vulcanization employs the use of steam as a heating medium, and the other method from the name implies curing with heated air. The conductor normally employed with silicone insulated wire is bare copper or tinned copper conductors. Silicone is limited in some applications due to its low tear strength and abrasion resistance.

In both Teflon and silicone insulated wires, the conductors normally used are stranded filaments generally in conformance with the common strandings shown.

Both Teflon and silicone insulated wires are also available in any or all of the cable forms described in the section under "Secondary Operations." Considerable progress has been made in formulating methods of processing for these high temperature materials to evolve elaborately designed cables for control work, etc.

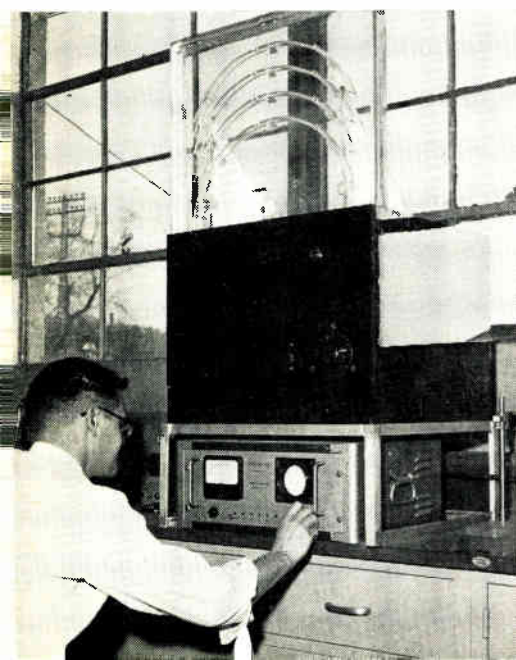


Fig. 12: A corona test unit used in determining the initiation and extinction voltage of corona for coax cables

Table 3—Comparison of Qualities

	Cylindrical Wrap Flexolon	Extruded	Spiral Wrap
Average Dielectric Lengths	Longest	Shortest	Intermediate
Average Dielectric Strength	Highest	Lowest	Highest
Flexibility	Highest	Intermediate	Intermediate
Abrasion Resistance	Intermediate	Highest	Lowest



The temperature limit of thermistors as sensing elements is now at 15°F or 9°K. above the absolute zero point and only 5°K above the boiling point of liquid helium. Their ultimate reliability is still being investigated but first reports are encouraging.

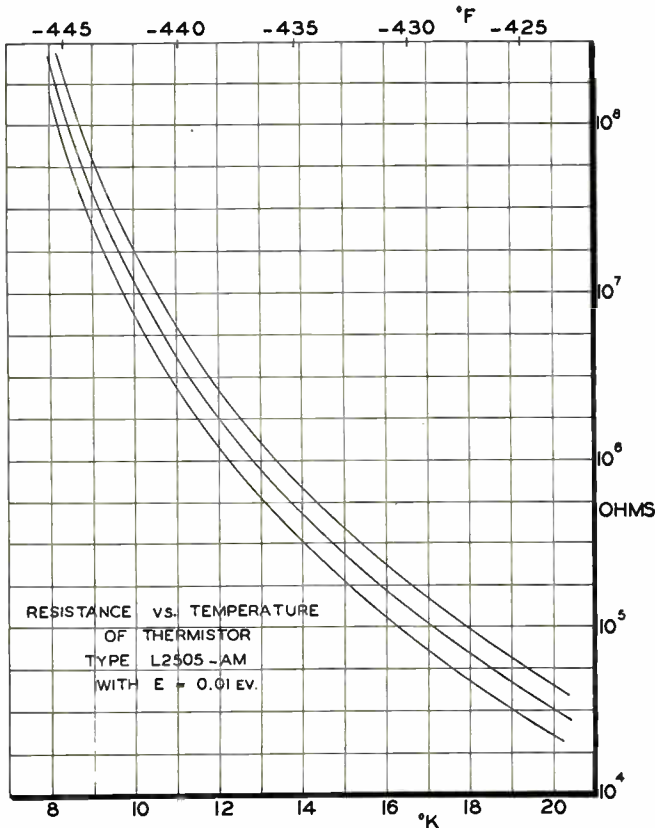
# Thermistor Sensing Elements

## For -445°F.

By Dr. H. B. SACHSE & G. W. VOLLMER

Keystone Carbon Co.,  
St. Mary's, Pa.

Fig. 1: Resistance vs. temperature of thermistor, type L2505-AM, with  $E=0.01$  electron volts.



IN three preceding articles<sup>1, 2, 3</sup> we described the properties of thermistors which can be used as temperature sensing elements down to the boiling point of liquid hydrogen ( $-422.9^\circ\text{F}$ ). The various technical activities in the low temperature field which have stimulated the development of these new thermistor types were briefly discussed and the special advantages of replacing other, conventional low temperature thermometers by thermistors were explained.

Thermistors, since they are made from semiconducting materials, increase their resistance with falling temperature. Therefore their leads can be made either very thin or very long and still be negligible in resistance, a feature which is most attractive for remote measurement or control and applications requiring small heat transfer from the object to other parts of the instrumentation. The sensing element itself can also be kept very small in size which results in fast response and favorable ratio of absorbed energy from the heat source to the product electrical signal.

The major obstacle in developing thermistors for very low temperatures was their exponential resistance increase with falling temperature. Commercial thermistors are made from materials with activation energy from .25 to .60 ev, resulting in resistance values above  $10^8$  ohms in liquid oxygen. A great step was made in the direction of lower resistance values when thermistors with activation energy of .09-.11 were developed. Their resistance value in liquid nitrogen ( $-320.4^\circ\text{F}$ ) was 60-300 K-ohm depending upon the chosen resistance and resistance vs. temperature slope. (Continued on following page.)

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# Thermistor Sensing Elements

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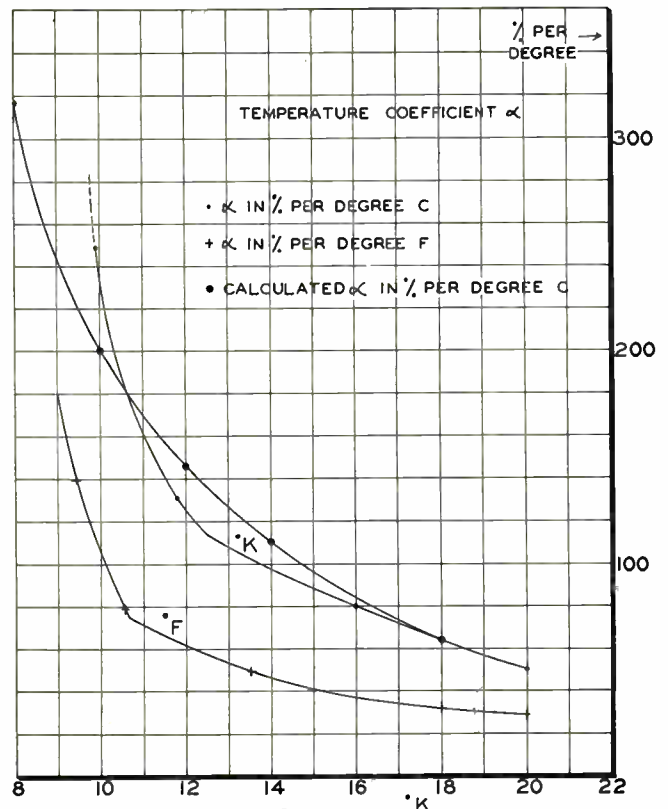
Fig. 2: High values are obtained below the boiling point of liquid hydrogen

The fast growing low temperature electronic field soon called for much lower operating temperatures, thus stimulating the development of thermistor materials with an activation energy of .02-.03 ev. Soon after these new thermistors, which were applicable down to the boiling point of liquid hydrogen, became commercially available, the challenge for still lower temperature limits was presented by an increasing number of applications. The efforts to meet this challenge have brought first results. The temperature limit of thermistors as sensing element is now at approximately  $-445^{\circ}\text{F}$ , corresponding to approximately  $15^{\circ}\text{F}$  ( $9^{\circ}\text{K}$ ) above the absolute zero point and only  $5^{\circ}\text{K}$  above the boiling point of liquid helium. The units made for these purposes are disks of .250-in. diameter and .050-in. thickness with lead wires made according to specifications.

The resistance vs. temperature curve for these thermistors is shown in Fig. 1. Its values are calculated with the formula

$$\log r_t = \log r_H + \frac{E(20.4 - T) \cdot 11500}{20.4 \cdot T \cdot 2.303 \cdot 1}$$

using the measured resistance in liquid hydrogen and the activation energy in the temperature range of boiling hydrogen .010 ev. At  $9^{\circ}\text{K}$  ( $443^{\circ}\text{F}$ ) a resistance value of  $40 \pm 15$  megohm is observed which is still within the scope of a commercial bridge measurement if a sensitive null indicator is used. The given tolerance of  $\pm 15$  megohm at  $9^{\circ}\text{K}$  is rather arbitrary. It specifies the spread of individual units of this type and must be considered as an economical compromise. The reproducibility of individual units is much better and they can therefore be calibrated to a higher



accuracy. Further investigations to determine their ultimate reliability are in progress.

Since the temperature coefficient increases with  $1/T^2$ , very high values are obtained below the boiling point of liquid hydrogen as shown in Fig. 2.

The authors wish to thank Keystone Carbon Company for granting permission to publish this information.

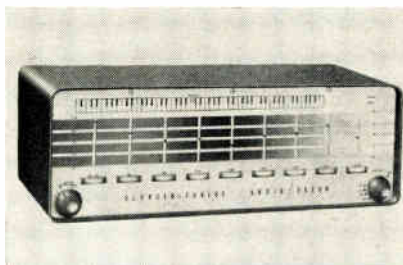
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# Audio Baton

A NEW, low cost instrument that enables control to an infinite degree, any sound in the entire audio range, was introduced by Blonder-Tongue Labs., Inc. of Newark, N. J.

The Audio Baton, Model B-9, provides a tone control for each of the nine octaves in the sound spectrum. The range extends from 20 to 20,000 CPS, and the controls allow the user to amplify or reduce any sound in any octave. For example, it is known that a kettle drum's sound occurs between the frequencies of 80 and 160 CPS. Suppose you were listening to a musi-



The Audio Baton can amplify or attenuate desired audio frequencies

cal composition in which there were drums and every other instrument being played. With the Audio Baton, you can accentuate the drums and diminish other instruments. Conversely, if you wanted to reduce the drum sound, you would reduce the tone controls in that range.

The Audio Baton is useful for eliminating many forms of distortion in systems and for an infinite number of compensation settings. Since record surface noise occurs at some point in the audio spectrum, it is possible to reduce the sound in that particular range by turning its respective tone control knob down to as far as  $-14$  db. This will eliminate the surface noise and allow the music to be heard without distortion.

It is not only useful in high fidelity music reproduction, but also for public address systems. Reducing the level of the proper octave control virtually eliminates feedback. By the same token, the speaker's voice can be made clearer by adjusting several control knobs.



For Computers and Controls . . .

# Unity-Gain Amplifiers Improve Operation

Because high-gain feedback amplifiers are often required for flexibility and precision, the reliability and economy of the cathode follower must be sacrificed. Two unity-gain amplifiers offering significant improvements are presented.

By **GARETH M. DAVIDSON**  
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R. N. Brady

**F**EEDBACK-TYPE amplifiers are often used for isolation purposes in analog computers and control systems. One of the most common circuits of this type is the ordinary cathode follower which has the important virtue of basic simplicity.

However, because of certain inherent shortcomings of the cathode follower, it is often necessary to use high-gain feedback amplifiers to achieve the required flexibility and precision. The reliability and economy of the cathode follower are thereby sacrificed.

This article presents two different isolation amplifier circuits which retain the desirable characteristic of using only one vacuum tube envelope, while at the same time offering certain significant improvements in operation over the conventional cathode follower.

## Cathode Follower Amplifier

The common cathode follower amplifier, Fig. 1, possesses a number of useful properties. Among these

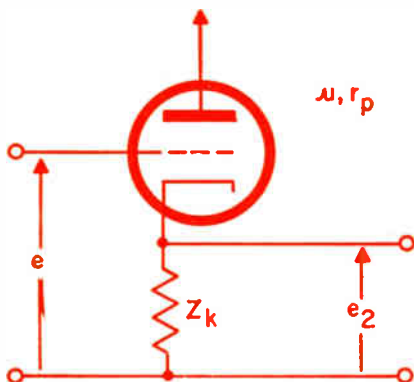


Fig. 1: Conventional cathode follower circuit actually offers a slight attenuation to input signal.

are low effective input capacitance, high input resistance, low output impedance, low nonlinear distortion, and the fact that one side of both the input and output signals is at ground potential.

The above description indicates that this type of amplifier is a very useful coupling device to be used between a high impedance source and a low impedance load. While such is the case, a simple analysis of the circuit indicates that it has some limitations when used for certain applications, as in computing circuits. These include departure from exact unity gain and restriction on the lowest value of output impedance which can be obtained.

Ordinary methods of circuit analysis show for the cathode follower of Fig. 1.

$$K = \frac{e_2}{e_1} = \frac{\mu Z_k}{r_p + (\mu + 1) Z_k} \quad (1)$$

It is seen that as the load impedance,  $Z_k$  is made very large with respect to  $r_p$ , the gain,  $K$ , approaches  $\frac{\mu}{\mu + 1}$  as a limiting value. Normally, the values of  $\mu$ ,  $r_p$ , and  $Z_k$  are such as to yield a gain in the neighborhood of 0.9. Thus, it is seen that the conventional cathode follower circuit actually offers a slight attenuation to the input signal. This attenuation will vary from tube to tube due to variations in  $\mu$  and  $r_p$ . In

# Unity-Gain Amplifiers (Continued)

certain applications it would be desirable to be able to trim this variable gain to a value of exactly unity.

With reference to Eq. 1, if the load impedance  $Z_k$  is made equal to  $\frac{r_p}{\mu + 1}$  then the gain becomes equal to  $K = \frac{1}{2} \frac{\mu}{(\mu + 1)}$ . This means that the output impedance of the cathode follower circuit of Fig. 1 is given by:

$$Z_o = \frac{r_p}{1 + \mu} \quad (2)$$

Normally, values of  $r_p$  and  $\mu$  are such as to yield a value of  $Z_o$  within the range of 100-1000 ohms. It should be realized, however, that this is the output impedance only of the cathode follower proper. The impedance offered by any series coupling capacitor would add directly to this value to yield the total effective output impedance.

At low audio frequencies the effect of the coupling capacitor tends to become quite large. Thus, for a capacitance of  $1 \mu\text{f}$  at a frequency of 60 cps, a series impedance of  $j 2650$  ohms is added to that of the cathode follower output. Hence, two of the important limitations of the conventional cathode follower may be seen. These are departure of nominal gain from a value of unity, and the possibility of a rather high output impedance.

### Operational Amplifier

In an effort to overcome the above limitations, this article proposes using a cathode follower in conjunction with an operational amplifier.

A diagram of a typical operational amplifier is shown in Fig. 2. Among its distinguishing characteristics are its high input resistance, low input capacitance, and low output impedance. Although high, the input resistance of an operational amplifier is somewhat lower than the cathode follower and the output impedance is slightly higher. The gain stability of the operational amplifier is comparable to that of the cathode follower.

Also of importance, is the fact that the gain of an operational amplifier may be adjusted exactly to a desired value, and phase shift through the amplifier may be adjusted by the feedback elements. These are desirable features which are not found in the cathode follower.

In addition, as will be shown in the following derivation, the effective series impedance contributed by

Fig. 2: Gain of an operational amplifier may be adjusted exactly to a desired value, and phase shift adjusted by the feedback elements.

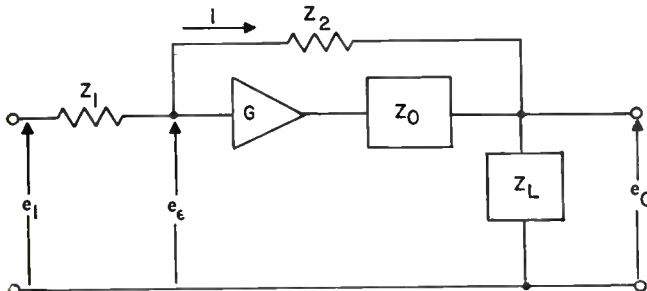


Fig. 3 (below): A composite circuit, with cathode follower input, designed to overcome limitations of common cathode follower.

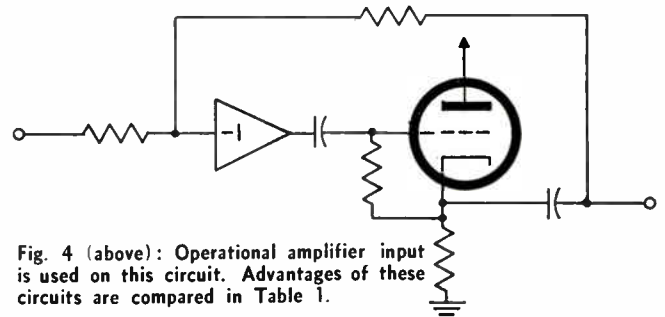
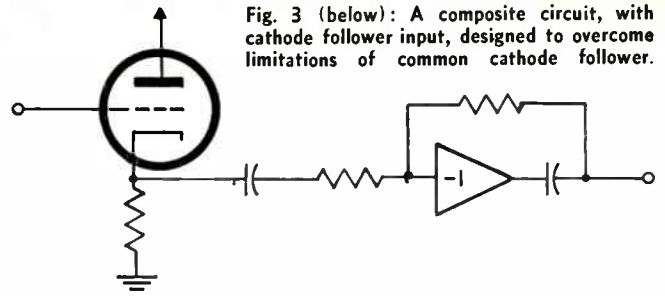


Fig. 4 (above): Operational amplifier input is used on this circuit. Advantages of these circuits are compared in Table 1.

the output coupling capacitor is reduced by a significant factor because of the feedback connections. Another feature is that by a simple capacitance trimming of the input feedback element, the overall high-frequency bandwidth can be extended beyond that which is normally obtained in a cathode follower.

Consider the operational amplifier of Fig. 2. For the case where the current drawn by the load impedance  $Z_L$  is neglected, the gain from input to output is given by<sup>1</sup>:

$$\frac{e_o}{e_i} = \frac{Z_2}{Z_1} \times \frac{1}{1 + \frac{Z_1 + Z_2}{Z_1} \times \frac{1}{G}}$$

### Appreciable Load Impedance

Let us now take the case where the effect of the load impedance is considered to be appreciable. The mathematical steps are as follows:

$$i = \frac{e_i - e_o}{Z_1 + Z_2} \quad (1)$$

$$e_\epsilon = e_i - i Z_1 \quad (2)$$

Substituting 1 in 2,

$$e_\epsilon = e_i - \frac{Z_1}{Z_1 + Z_2} (e_i - e_o) \quad (3)$$

$$e_o = -e_\epsilon \times \frac{G Z_L}{Z_o + Z_L} \quad (4)$$

Since the Gain  $G$ , must be negative for stable operation.

$$e_\epsilon = -e_o \frac{(Z_o + Z_L)}{G Z_L} \quad (5)$$

Equate 5 and 3

$$-e_o \frac{(Z_o + Z_L)}{G Z_L} = e_i - \frac{Z_1}{Z_1 + Z_2} (e_i - e_o) \quad (6)$$

1. Millman & Taub, *Pulse & Digital Circuits*, McGraw-Hill Book Co., New York, 1956. Chapter 1.



$$\frac{e_0}{e_1} = - \frac{Z_2}{\frac{Z_0 + Z_L}{G Z_L} (Z_1 + Z_2) + Z_1} \quad (7)$$

$$\frac{e_0}{e_1} = - \frac{G \frac{Z_2}{Z_1 + Z_2}}{1 + \frac{Z_1}{Z_1 + Z_2}} \times \frac{Z_L}{\frac{Z_0}{Z_1 G} + Z_L} \quad (8)$$

$$= - \frac{Z_2}{Z_1} \times \frac{1}{1 + \frac{Z_1 + Z_2}{Z_1} \times \frac{1}{G}} \times \frac{Z_L}{1 + \frac{Z_1 G}{Z_1 + Z_2} + Z_L} \quad (9)$$

The first two factors of Eq. 9 are recognized as the previously mentioned closed loop gain with no load. The third factor represents the loading effect caused by the impedance  $Z_L$ .

The circuit in Fig. 2, when used as an amplifier with a gain of  $-1$ , ( $Z_1 = Z_2$ ), in conjunction with a

Fig. 5 (below): Actual circuit of composite shown in Fig. 3. Extremely high input impedance of the cathode follower is preserved.

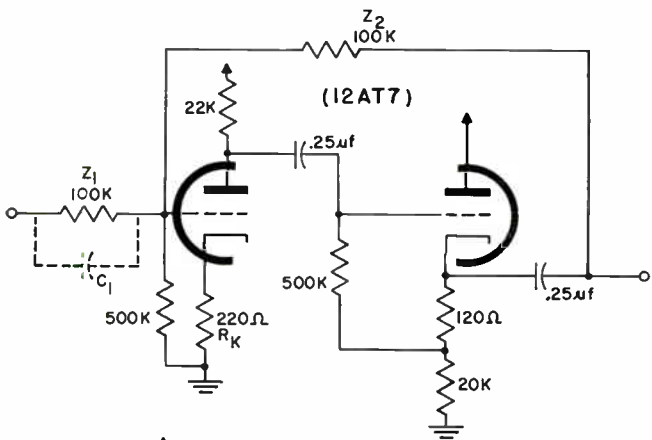
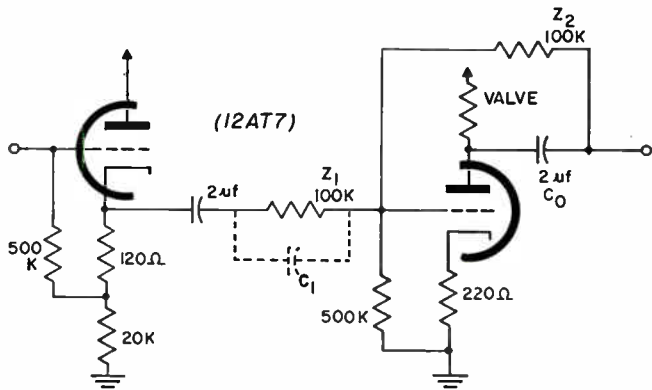


Fig. 6 (above): When input device is an operational amplifier, input impedance is essentially equal to  $Z_1$ .

Fig. 7 (left): Measured characteristics of this normal cathode follower circuit are shown in Table 2.

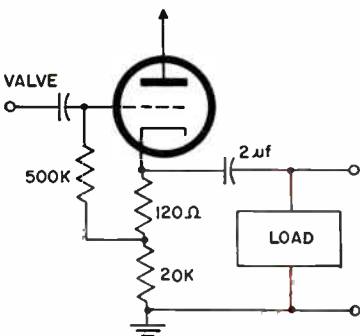


Table 1

Isolation Amplifier Advantages

Cathode Follower Input	Operational Amplifier Input
Very high input resistance	Moderately high input resistance
Low input capacitance	Very low input capacitance
Low output impedance including coupling condenser	Very low output impedance including coupling condenser
Gain can be trimmed to unity	Gain can be trimmed to unity
Phase shift can be trimmed to zero at a given frequency	Phase shift can be trimmed to zero at a given frequency
Fairly wide bandwidth	Very broad bandwidth can be obtained by adjusting feedback elements

cathode follower, offers a number of improvements in operation over a single cathode follower.

It is seen from Eq. 9 that the output impedance of the circuit of Fig. 2 is equal to

$$\frac{Z_0}{1 + \frac{Z_1}{Z_1 + Z_2} G}$$

where  $Z_0$  is the output impedance of the open-loop amplifier. Since the output coupling capacitor is normally a part of  $Z_0$ , its impedance when seen at the output terminal is also divided by the factor

$$\left(1 + \frac{Z_1}{Z_1 + Z_2} G\right)$$

Composite Circuits

Figs. 3 and 4 indicate the composite circuits which have been developed to overcome the limitations of the common cathode follower. The advantages and features of each of these two circuits are shown in Table 1.

Figs. 5 and 6 indicate the two actual circuits showing all component values used in making laboratory measurements.

In Fig. 5, the extremely high input impedance of the cathode follower is preserved by using it as the input device. The output impedance of this circuit is slightly higher than the common cathode follower. However, the effect of the impedance of the coupling capacitor  $C_0$  on the input impedance is reduced by the feedback factor of the operational amplifier. The overall circuit gain may be adjusted to unity by trimming the values of  $Z_1$  or  $Z_2$  with shunt resistance.

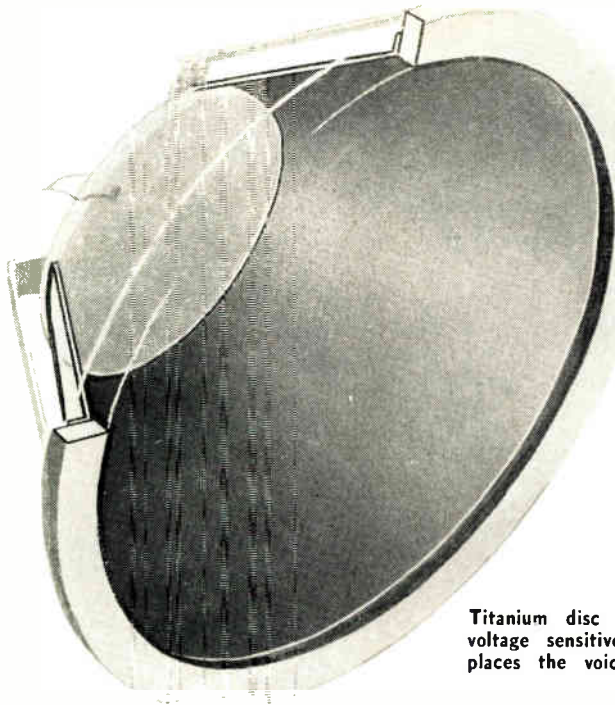
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Table 2

Circuit of	$R_{in}$	$C_{in}$	Cutoff Frequency		$Z_0$ at 10 kc
			Low w/10 k Load	High	
Fig. 5	25 meg	2 μμf	6 cps	1.8 mc	930 Ω
Fig. 6	100 K	Stray Wiring	6 cps	10.0 mc	19 Ω*
Fig. 7	25 meg	2 μμf	48 cps	1.4 mc	230 Ω

\* Can be further lowered by bypassing  $R_k$ .

# What's New . . .



Titanium disc sandwiched between voltage sensitive ceramic discs replaces the voice coil and magnet.

**L**OW cost, lightweight loudspeakers are promised by a new development in electrostrictive ceramics made at Mullenbach Div. of Electric Machinery Mfg. Co., Los Angeles, Calif. The ceramics would replace the voice coil and eliminate the need for heavy magnets.

The ceramics, compounds of barium titanate, are baked in the form

of thin discs, a few thousandths of an inch thick. They respond to minute and rapid fluctuations in electrostatic fields, contracting radially with increases in the applied field. Bonded to a larger titanium disc, they produce a cupping action that in turn drives a speaker cone. The ceramic-metal-ceramic sandwich disc is riveted to the speaker

frame at the hub, and the rim of the disc assembly is glued to the floating apex of the speaker cone.

Since the breakdown voltage for the ceramic is 1500 to 3000 v, no modification is needed in the radio circuitry. Each disc may be connected, for example, to a plate circuit in an audio push-pull amplifier. In one experimental loudspeaker built by Mullenbach, the ceramic wafers are 1 in. in dia. and the metal disc is 1½ in. in dia. A titanium diaphragm 0.006 in. thick is used.

Besides the speaker drives, the ceramics are being developed for compact metering manometers, non-magnetic switches for sensitive recording devices, and rapid acting relays for computer circuitry. Stacked in parallel hookup, the ceramics can be used as actuators to produce pressure peaks as high as 30,000 lbs. per square inch.

## "Ceramic" Voice Coil



## Electronic Nerve Cells

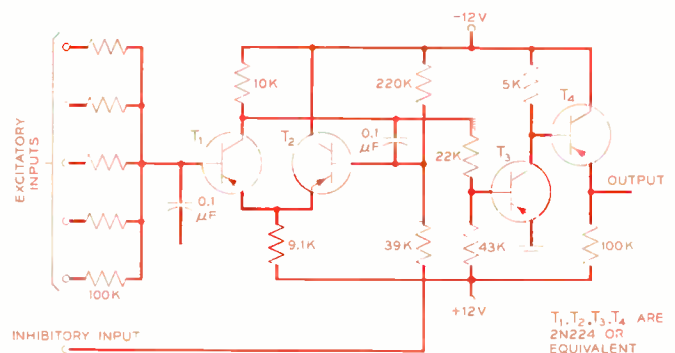
**A**N electronic circuit that simulates some functions of the individual biological nerve cell, or neuron, has been developed at Bell Telephone Laboratories. The scientists are interested in dis-

covering how visual and auditory nerves function and how their signals are interpreted by the brain.

The gross function of the nerve cell—transmission of electrical

**Left:** Network of electronic nerve cells simulates some functions of nerves in the eye. Mutual inhibition of cells in an array has been demonstrated.

**Right:** Circuit simulates some functions of individual biological nerve cell.





# 26 Section Filter Network

R. F. interference and noise pulses in a special radar relay switch have been eliminated by Astron Corp., East Newark, N. J., with a complex network of filters.

The radar relay switch when activated, produced noise which seriously interfered with the normal functioning of the equipment. Detailed screen room studies and analysis of the source and nature of the noise signals indicated both conducted and radiated noise, and

Sealed unit has metal-to-glass terminals



that the solution was individual filtering of each contact of the network, plus line filtering.

The network required 26 filters built into a single enclosure. The design of each filter section was

pulses in response to stimuli, and only to those stimuli that meet certain conditions—has been simulated. The cells have been combined into groups that simulate simple functions of the eye. Similar experiments with ear models are being started.

The neuron circuit fires electrical pulses of standard amplitude and duration, just as a biological cell usually does. If the circuit is driven by a constant stimulus, simulating receptor cells as in the eye or ear, trains of pulses are emitted. A higher intensity of excitation increases the frequency of pulsing; and when the neuron is excited continuously, the frequency of pulses can be made to decrease with time, exhibiting ac-

(Continued on page 86)

Right: Filter network has 26 separately designed filters, cuts r-f interference-noise pulses. Unit is sealed in epoxy.

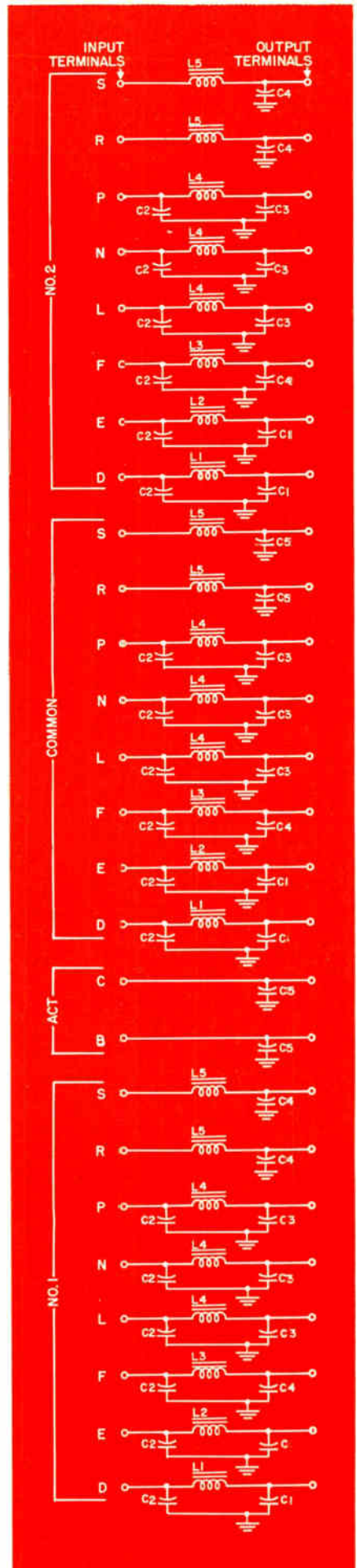
carried out separately, considering the noise spectrum, voltage and current rating, available space, and the avoidance of resonance effects. For capacitance, Astron's paper and mylar dielectric condensers were used. When warranted, a special "feed-through" construction was used on the capacitors. Ceramics capacitors were also used. Inductors were either powdered iron core, pie-wound solenoids, or molybdenum permalloy core toroids. Experimental results sometimes indicated the necessity of internal shielding between circuits.

Location of components, orientation of fields, and placement of ground connections, of crucial importance in noise filtering, were all carefully considered.

After completion of the unit, the capacitors were impregnated and the whole enclosure filled with a thermosetting epoxy to reduce moisture problems and impart extreme rigidity. Terminals used were the metal-to-glass compression type, insuring a perfect hermetic seal.

High standards of hermetic sealing, high altitude operation, minimum weight, extended life and compliance with military environmental requirements were observed, and the units were subjected after assembly to 100% test procedures for dielectric breakdown, insulation resistance, capacitance, inductance, resistance, elevated temperature, shock, and vibration to reduce field failure rate to a minimum.

The high voltage filter, itself hermetically sealed, is within the hermetically sealed switch enclosure. This eliminates Corona problems at high altitudes and reduces the required size and weight. Filters of this type, although primarily designed for airborne applications are versatile and sturdy enough to fit many other functions of noise reduction.



*Evaluating and analyzing the circuit losses inherent in  
stabilized resistance-capacitance coupled transistor amplifiers,  
with particular emphasis on the bias circuits  
and their effect on the preceding stage.*

# Circuit Losses in

**By H. K. COOPER,**

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2900 W. 36th St.,  
Chicago 32, Ill.*

**P**ROPER bias circuit design will stabilize the transistor operating point against variations of the ambient temperature or parameters due to transistor interchangeability.

Fig. 1 shows a typical bias network for the common emitter configuration.  $R_e$  should be as large as tolerable, perhaps 20 times greater than the emitter to base diode resistance.

$R_1$  and  $R_2$  should be as small as tolerable without undue signal loss. The effects of this will be discussed later.

The equivalent input circuit of Fig. 2 clearly indicates the circuit losses found in a stable optimized circuit.

Since our analysis is restricted to audio frequencies we can assume that  $C_c$  is so large that its reactance may be neglected.

It should be borne in mind that the currents we are discussing are A.C. signal currents.

It can be then be seen that the equivalent circuit becomes a current divider where  $r_b$  and  $r_e$  are the transistor device parameters and are inherent in the transistor characteristics. The values of  $r_b$  and  $r_e$  are usually small compared with the bias elements and most of the current will divide through them.

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The Editor  
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For our purpose we will assume the value of  $r_e$  is insignificant with respect to the other circuit constants and therefor its effect can be neglected.

Let us start with the derivation of the input impedance equation. Assuming an un-bypassed  $R_e$ , from Fig. 2 we obtain,

$$Z_{11} = \frac{R_A R_B}{R_A + R_B} \quad (1)$$

where  $Z_{11}$  = Input impedance and  $\beta$  = common emitter short circuit current gain

$$R_A = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_B = r_b + \beta R_e$$

substituting  $R_A$  and  $R_B$  into Eq. 1,

$$Z_{11} = \frac{(R_1)(R_2)(r_b + \beta R_e)}{R_1 + R_2} \quad (2)$$

$$\frac{R_1 R_2}{R_1 + R_2} + r_b + \beta R_e$$

simplifying Eq. 2, we obtain,

$$Z_{11} = \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \quad (3)$$

Before the circuit currents may be evaluated, we must resolve the input circuit into equivalent networks so that their effects may be evaluated. Fig. 3 shows the three networks to be evaluated.

Fig. 3a shows the shunting effect of  $R_2$ ,  $R_e$ ,  $\beta$ , and  $r_b$  upon  $R_1$  and in the following manner  $i_1$  may be calculated. The shunting elements shall be  $R_s$ ,  $R_s'$ , and  $R_s''$ .

$$i_1 = i_{11} - \frac{i_{11} R_1}{R_1 + R_s} \quad (4)$$

An analysis of Fig. 3a shows,

$$R_s = \frac{R_2 r_b + R_2 \beta R_e}{R_2 + r_b + \beta R_e} \quad (5)$$

substituting Eq. 5 into Eq. 4, we obtain,

$$i_1 = i_{11} - \frac{(i_{11})(R_1)}{R_1 + \left( \frac{R_2 r_b + R_2 \beta R_e}{R_2 + r_b + \beta R_e} \right)} \quad (6)$$

Similarly, if we analyze Fig. 3b for  $i_2$  we find



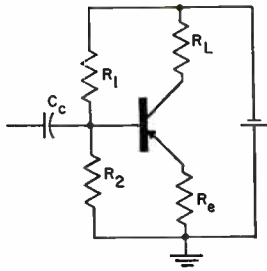


Fig. 1: typical transistor bias network

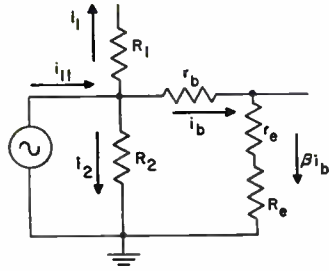


Fig. 2: Equiv. circuit with circuit currents

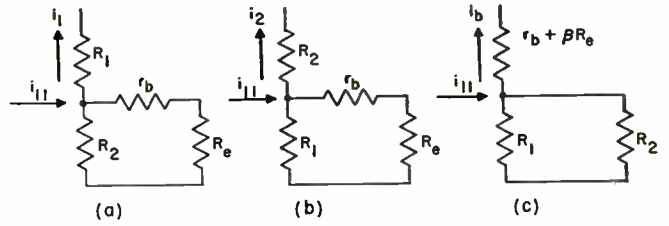


Fig. 3: Equivalent input networks

# the Transistor AF Amplifier

$$i_2 = i_{11} - \frac{(i_{11})(R_2)}{R_s' + R_2} \quad (7)$$

where,

$$R_s' = \frac{R_1 r_b + R_1 \beta R_e}{R_1 + r_b + \beta R_e} \quad (8)$$

substituting Eq. 8 into Eq. 7 we can now solve for  $i_2$ .

$$i_2 = i_{11} - \frac{(i_{11})(R_2)}{R_2 + \left( \frac{R_1 r_b + R_1 \beta R_e}{R_1 + r_b + \beta R_e} \right)} \quad (9)$$

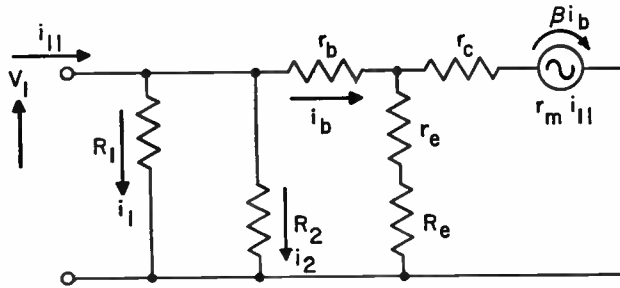


Fig. 4: Common emitter equivalent "T" configuration including bias elements

Fig. 3c is now analyzed to solve for  $i_b$ .

$$i_b = i_{11} - \frac{i_{11}(r_b + \beta R_e)}{R_s'' + r_b + \beta R_e} \quad (10)$$

where,

$$R_s'' = \frac{R_1 R_2}{R_1 + R_2} \quad (11)$$

and substituting Eq. 11 into Eq. 10,

$$i_b = i_{11} - \frac{i_{11}(r_b + \beta R_e)}{r_b + \beta R_e + \left( \frac{R_1 R_2}{R_1 + R_2} \right)} \quad (12)$$

With the aid of Fig. 4, The Common Emitter equivalent "T" configuration the input circuit current equation may be written.

$$i_{11} = i_1 + i_2 + i_b + \beta i_b - i_c \quad (13)$$

where,

$$i_c \cong i_e \cong \beta i_b \quad (14)$$

substituting Eq. 14 into Eq. 13.

$$i_{11} = i_1 + i_2 + i_b + \beta i_b - \beta i_b \quad (15)$$

$$i_{11} = i_1 + i_2 + i_b \quad (16)$$

We have now eliminated the effects of  $r_e$  from the circuit equations. This has been done because it is a relatively insignificant value.

The results of Eqs. 6, 9, and 12 may now be substituted into Eq. 16 and the circuit currents may be verified as follows:

$$i_{11} = \left[ i_{11} - \frac{(i_{11})(R_1)}{R_1 + \left( \frac{R_2 r_b + R_2 \beta R_e}{R_2 + C_b + \beta R_e} \right)} \right] + \left[ i_{11} - \frac{(i_{11})(R_2)}{R_2 + \left( \frac{R_1 r_b + R_1 \beta R_e}{R_1 + r_b + \beta R_e} \right)} \right] + \left[ i_{11} - \frac{i_{11}(r_b + \beta R_e)}{r_b + \beta R_e + \left( \frac{R_1 R_2}{R_1 + R_2} \right)} \right] \quad (17)$$

## Output Loss

From Fig. 5 we see that in multistage transistor amplifiers, the input impedance of stage 2 becomes part of the output impedance of stage 1. Thus, it is important to consider the effect of stage 2 input impedance upon stage 1 output impedance.

Fig. 6a shows a typical RC coupled transistor amplifier with its extremely simplified equivalent circuit in Fig. 6b.

We assume a large value of  $C_c$  so that its reactance may be sufficiently small to be neglected from the equivalent circuit.

From Fig. 2, Eq. 3 was derived and expresses the input impedance as follows:

$$Z_{11} = \frac{R_1 R_2 r_b + r_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \quad (3)$$

From Fig. 6b the circuit currents may now be evaluated.

$$i_L = i_c = \frac{i_e R_L}{R_L + Z_{11}} \quad (18)$$

Substituting Eq. 3 into Eq. 18

$$i_L = i_c - \frac{i_e R_L}{R_L + \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e}} \quad (19)$$

# Circuit Losses

(Continued)

In a similar manner the magnitude of  $i_{11}$  may be calculated.

$$i_{11} = i_c - \frac{i_c Z_{11}}{Z_{11} + R_L} \quad (20)$$

Substituting Eq. 3 into Eq. 20

$$i_{11} = i_c - \frac{(i_c) \left( \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \right)}{R_L + \left( \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \right)} \quad (21)$$

Further analysis shows the current equation to be,

$$i_c = i_L + i_{11} \quad (22)$$

Substituting Eqs. 19 and 21 into 22 we obtain,

$$i_c = \left[ (i_c) - \frac{i_c R_L}{R_L + \left( \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \right)} \right] + \left[ (i_c) - \frac{(i_c) \left( \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \right)}{R_L + \left( \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \right)} \right] \quad (23)$$

The following examples will show how the equations are to be used in the circuit analysis.

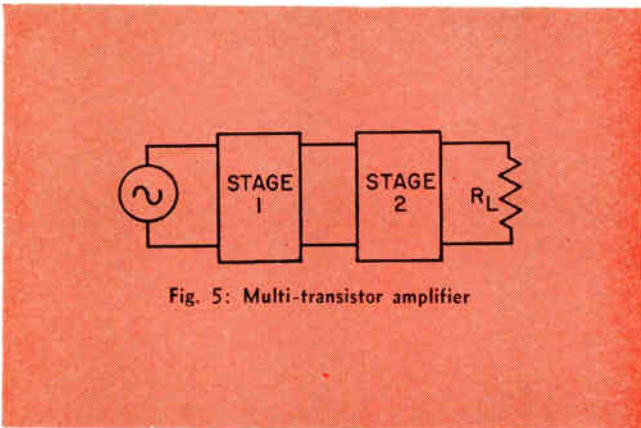


Fig. 5: Multi-transistor amplifier

## Example 1 (Output Circuit Loss)

Consider Fig. 7.

The problem is to determine the output circuit loss through the collector load resistor of Transistor 1. Remember that the currents to be calculated are ac signal currents and the effects of  $C_c$  are to be neglected. We also assume an un-bypassed  $R_e$ .

Given:  $i_b = 10 \mu\text{A}$        $R_2 = 47 \text{ K}$        $\beta T_1 = 100$   
 $R_1 = 68 \text{ K}$        $R_e = 330$        $\beta T_2 = 100$

from Eq. 14,

$$\begin{aligned} i_c &= \beta i_b \\ i_c &= (100) (10) \times 10^{-6} \\ i_c &= 1 \text{ mA.} \cong i_c \end{aligned} \quad (14)$$

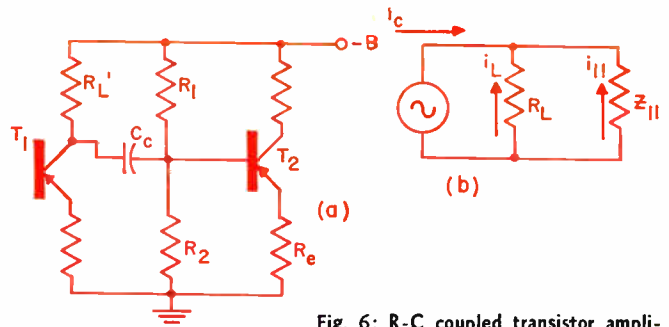


Fig. 6: R-C coupled transistor amplifier with simplified equivalent circuit

From Eq. 3, we may determine the input impedance of the second transistor stage.

$$\begin{aligned} Z_{11} &= \frac{R_1 R_2 r_b + R_1 R_2 \beta R_e}{R_1 R_2 + R_1 r_b + R_2 r_b + \beta R_1 R_e + \beta R_2 R_e} \\ Z_{11} &= \frac{(68) (47) (1) \times 10^3 + (68) (47) (100) (330) \times 10^6}{10^3 [ (68) (47) + (68) (1) + (47) (1) + (100) (68) (330) + (100) (47) (330) ]} \\ Z_{11} &= 15 \text{ K.} \end{aligned} \quad (3)$$

Eqs. 18 and 20 may now be used to find  $i_L$  and  $i_{11}$ .

$$\begin{aligned} i_L &= i_c - \frac{i_c R_L}{R_L + Z_{11}} \\ i_L &= 1 \times 10^{-3} - \frac{(1) (2) \times 10^3 \times 10^{-3}}{(2 + 15) \times 10^3} \end{aligned} \quad (18)$$

$$i_L = (1 - .1175) \times 10^{-3}$$

$$i_L = .8825 \text{ mA.}$$

$$i_{11} = i_c - \frac{(i_c) (Z_{11})}{Z_{11} + R_L}$$

$$i_{11} = 1 \times 10^{-3} - \frac{(1) (15) \times 10^3 \times 10^{-3}}{(15 + 2) \times 10^3} \quad (20)$$

$$i_{11} = (1 - .8825) \times 10^{-3}$$

$$i_{11} = .1175 \text{ mA.}$$

Substituting  $i_{11}$  and  $i_L$  into Eq. 22 will verify the circuit currents.

$$\begin{aligned} i_c &= i_L + i_{11} \\ 1 \times 10^{-3} &= .8825 \times 10^{-3} + .1175 \times 10^{-3} \\ 1 \times 10^{-3} &= 1 \times 10^{-3} \end{aligned} \quad (22)$$

Close observation of the results obtained in this analysis shows that  $i_{11}$  now becomes the input current to stage 2.

The condition that now exists is described in Fig. 8. Before proceeding with the input circuit losses, it may be of interest to calculate the stage gain. Neglecting the effects of stage 2 and stage 1 and further assuming a matched load, the stage gain may be calculated as follows:

$$\begin{aligned} A &= 20 \log \frac{i_c}{i_b} \\ A &= 20 \log \frac{1000}{10} \times 10^6 \times 10^{-6} \\ A &= 20 \log 100 \\ A &= 40 \text{ db gain} \end{aligned}$$



At this point we may now consider the effects of stage 2. It should be remembered at this time that stage 2 does not represent a matched load to stage 1. The stage gain is now calculated under un-matched conditions using stage 2 as a load.

$$A = 20 \log \frac{117.5 \times 10^{-6}}{10 \times 10^{-6}}$$

$$A = 20 \log 11.75$$

$$A = 21.25 \text{ db gain}$$

The pronounced effect of stage 2 reflecting upon stage 1 is noticed and this condition usually exists when operating under un-matched conditions. Because of the expense involved in providing a matched load it becomes necessary to operate under a mismatched condition.

### Example 2 (Input Circuit Loss)

Eq. 5 is used to calculate  $R_s$ .

$$R_s = \frac{R_2 r_b + R_2 \beta R_e}{R_2 + r_b + \beta R_e}$$

$$R_s = \frac{(47)(1) \times 10^6 + (47)(100)(330) \times 10^3}{47 \times 10^3 + 1 \times 10^3 + (330)(100)} \quad (5)$$

$$R_s = 19.7 \text{ K}$$

$$R_s \cong 20 \text{ K}$$

Substituting  $R_s$  into Eq. 4

$$i_1 = \frac{i_{11} - i_{11} R_1}{R_1 + R_s}$$

$$i_1 = 117.5 \times 10^{-6} - \frac{(117.5)(68) \times 10^3 \times 10^{-6}}{(20 + 68) \times 10^3} \quad (4)$$

$$i_1 = (117.5 - 92) \times 10^{-6}$$

$$i_1 = 25.5 \mu \text{ amp.}$$

$R_s'$  is now evaluated for a solution of  $i_2$ .

$$R_s' = \frac{R_1 r_b + R_1 \beta R_e}{R_1 + r_b + \beta R_e}$$

$$R_s' = \frac{(68)(1) \times 10^6 + (68)(100)(330) \times 10^3}{68 \times 10^3 + 1 \times 10^3 + (330)(100)} \quad (8)$$

$$R_s' = 22.7 \text{ K say,}$$

$$R_s' = 23 \text{ K.}$$

Eq. 7 is now used to solve for  $i_2$ .

$$i_2 = i_{11} - \frac{i_{11} (R_2)}{R_s' + R_2}$$

$$i_2 = 117.5 \times 10^{-6} - \frac{(117.5)(47) \times 10^3 \times 10^{-6}}{(23 + 47) \times 10^3} \quad (7)$$

$$i_2 = (117.5 - 80) \times 10^{-6}$$

$$i_2 = 37.5 \mu \text{ amps.}$$

$R_s''$  is now evaluated by Eq. 11.

$$R_s'' = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_s'' = \frac{(47)(68) \times 10^6}{115 \times 10^3} \quad (11)$$

$$R_s'' = 28 \text{ K.}$$

From Eq. 10,  $i_b$  may be solved from  $R_s''$ .

$$i_b = i_{11} - \frac{i_{11} (r_b + \beta R_e)}{R_s'' + r_b + \beta R_e}$$

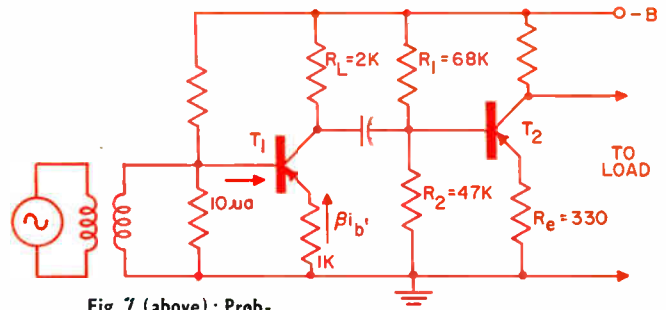


Fig. 7 (above): Problem: What is the output ckt loss through  $R_L$ ?

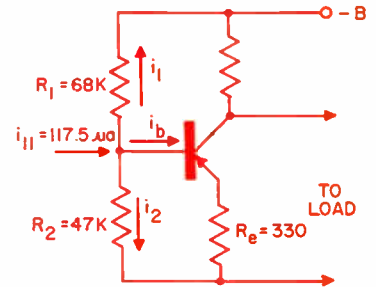


Fig. 8 (right):  $i_{11}$  now becomes the input current to stage 2

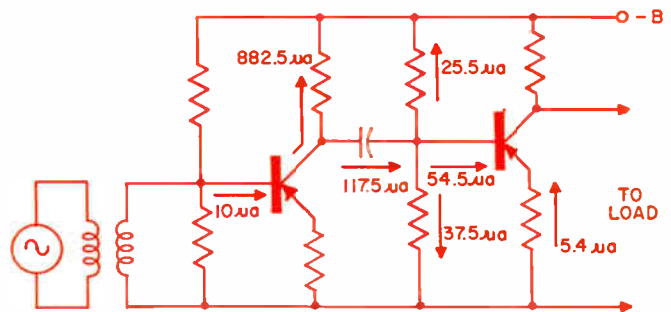


Fig. 9: Summarizing the entire signal distribution

$$i_b = 117.5 \times 10^{-6} - \frac{117.5 [1 \times 10^{-3} + (100)(330)] \times 10^{-6}}{28 \times 10^3 + 1 \times 10^3 + (100)(330)} \quad (10)$$

$$i_b = (117.5 - 63) \times 10^{-6}$$

$$i_b = 54.5 \mu \text{ amps.}$$

$i_e$  may now be calculated from Eq. 14.

$$i_e = \beta i_b$$

$$i_e = (100)(54) \times 10^{-6} \quad (14)$$

$$i_e = 5.4 \text{ ma.}$$

The currents may now be substituted into Eq. 16 to verify that the loop currents are correct.

$$i_{11} = i_1 + i_2 + i_b$$

$$117.5 \times 10^{-6} = (25.5 + 37.5 + 54.5) \times 10^{-6} \quad (15)$$

$$117.5 \times 10^{-6} = 117.5 \times 10^{-6}$$

The entire signal current distribution may now be summarized as in Fig. 9.

Observation of the results obtained indicate that approximately 50% of the available input signal is lost in the bias network. It is important to remember that this is the necessary precaution to assume circuit stability with respect to variations of ambient temperature and provide optimization for transistor interchangeability.

\* \* \*

One of the newest developments in the semiconductor art is the use of the reverse current breakdown characteristics of silicon diodes for voltage regulation. Information about control of the breakdown voltage and the factors which determine how the output voltage changes in response to fluctuations in regulator current is given to aid engineers in understanding the operation and selection of zener diodes.

# Understanding Zener Diodes

By **DR. J. R. MADIGAN,**

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**R**ECENT developments in the semiconductor art have made it feasible to use the reverse breakdown characteristic of silicon diodes for purposes of voltage regulation. In particular the techniques employed in solid state diffusion result in regulators of superior characteristics. The close process control offered by the diffusion method also results in a high degree of uniformity of characteristics.

This article will describe a line of commercially available diffused junction silicon "zener" regulators. The control of the breakdown voltage will be described; the impedance in the breakdown region will be considered; the factors which determine how the

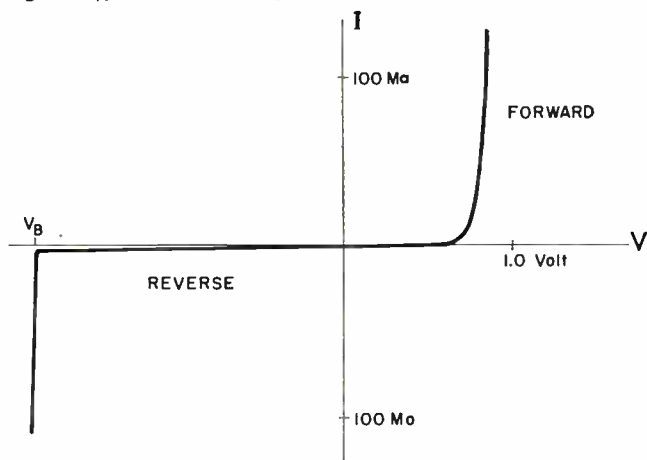
output voltage changes in response to fluctuations in regulator current are reviewed briefly; and the switching speed from the high impedance condition before breakdown to the low impedance condition after breakdown will be discussed.

## Breakdown Voltage

Fig. 1 shows a typical current voltage characteristic of a silicon p-n junction diode. In the forward direction, the diode will start to pass considerable current after the voltage reaches about 0.6 volt. In the reverse direction, the diode will conduct only a very small current until the voltage reaches a value near  $V_B$ , the breakdown voltage. At  $V_B$  the current increases extremely rapidly and the device is said to go into the breakdown region. This breakdown is not destructive and one can cycle into and out of this breakdown condition indefinitely as long as the unit is kept within the thermal limitations.

The breakdown voltage is controlled by two parameters, (1) the resistivity in the more lightly doped or base region of the p-n junction and (2) the gradient in the impurity concentrations in the vicinity of the junction.<sup>1</sup> In alloy diodes the transition from p to n-material is usually abrupt and the "zener voltage" is therefore governed solely by the resistivity of the base material. Resistivity, however, is difficult to control due to the unfavorable separation coefficients of n-type impurities in silicon. It is, therefore, not possible to make high voltage alloy "zener"

Fig. 1: Typical current-voltage characteristic of a silicon p-n diode



CURRENT VOLTAGE CHARACTERISTICS  
of SILICON JUNCTION DIODES

1. H. S. Veloric, M. B. Prince, & M. J. Eder, *J. Appl. Phys.* 27, 895 (1956)



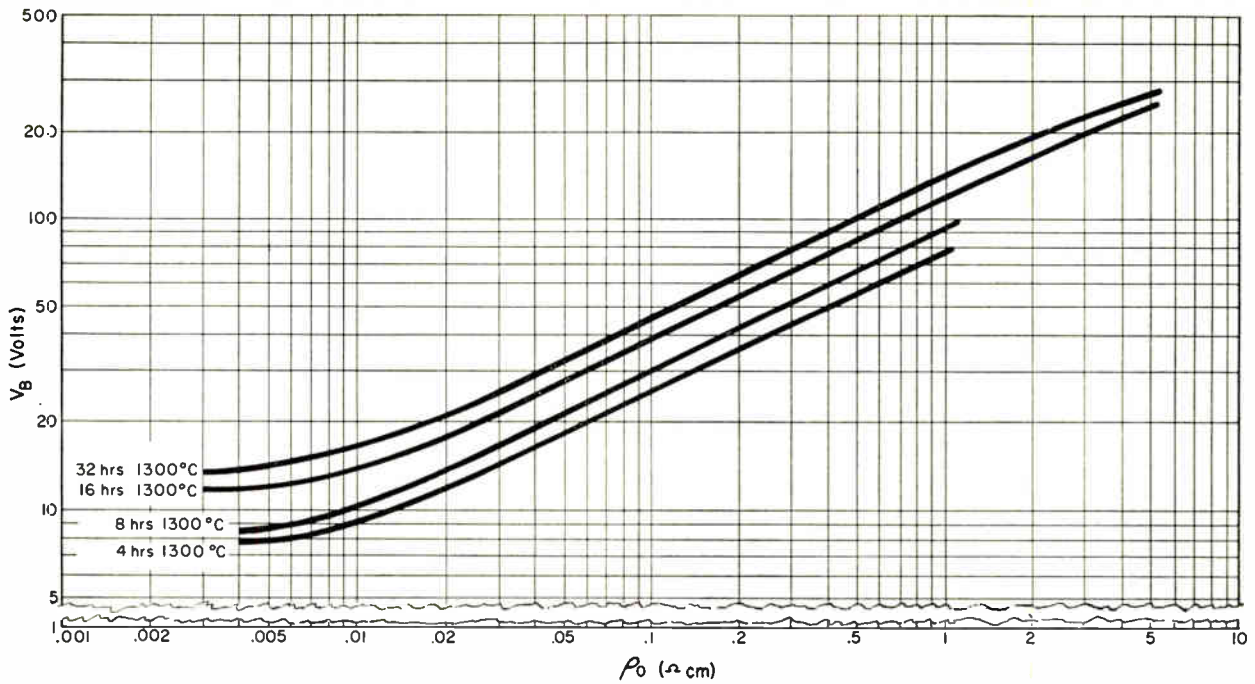


Fig. 2: Breakdown voltage measured at a reverse current of 10 ma. is plotted as a function of base layer resistivity.

diodes with any reasonable yield and alloy junction voltage regulators are usually limited to breakdown voltages below thirty volts.

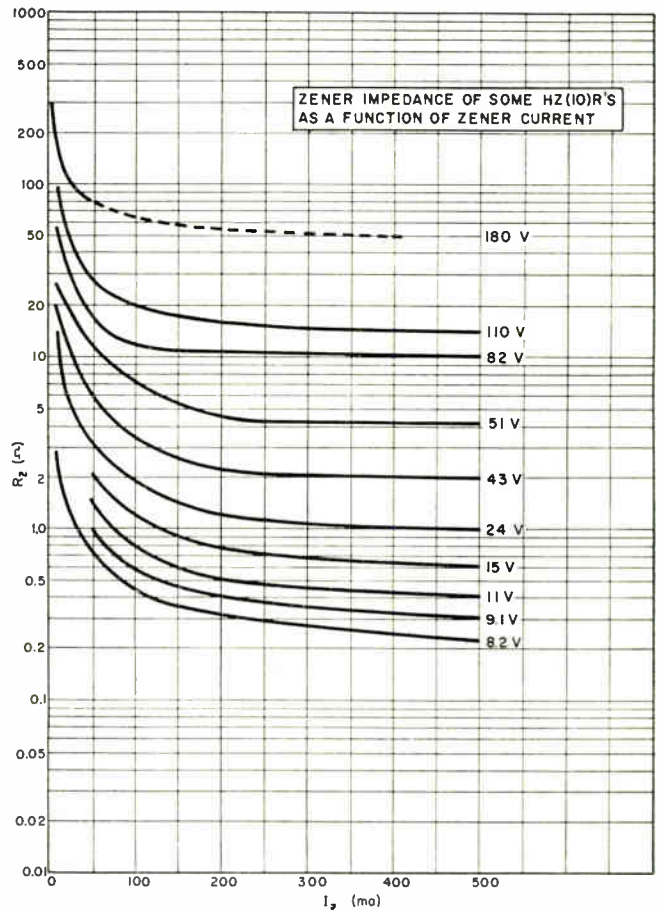
The fundamental process of diffusion in solids automatically produces graded junctions. The impurity gradient at the junction depends on the diffusion program (i.e., diffusion time and temperature) as well as base layer resistivity. In Fig. 2 the breakdown voltage,  $V_B$ , measured at a reverse current of 10 ma. is plotted as a function of base layer resistivity,  $\rho_b$ , for junctions made by diffusing phosphorus into p-type silicon at a fixed diffusion temperature of 1300°C with diffusion time as a parameter. From Fig. 2 it is evident that a given "zener" voltage may be realized from a wide range of base layer resistivities by varying the diffusion time and temperature. The possibility of using boron doped p-type silicon as the base material gives much better control of base layer resistivity with less effort. It, thus, becomes feasible to offer "zener" regulators at any voltage up to 200 volts with a  $\pm 5\%$  tolerance on the specified voltage.

#### Breakdown Resistance

For the diodes under consideration to be used for regulation purposes, the impedance in the breakdown region should be as small as possible. Fig. 3 shows the relation between the resistance in the breakdown region and the breakdown current for some ten watt "zener" regulators with different breakdown voltages. In the case of a reverse biased diode it is only the majority carriers that cause the current flow; thus it is not possible to conductivity modulate the base layer resistivity in the vicinity of the junction. The saturation portion of the zener impedance curves of Fig. 3 should, therefore, be essentially equal to the series resistance of the base layer. For the diodes under consideration the series resistance is about three times the base layer resistivity

but the saturation resistance of the curves in Fig. 3 is typically about ten times greater than this. The reason for this is based on the fact that the avalanche breakdown takes place through pulses of current of

Fig. 3: Breakdown resistance is plotted against breakdown current



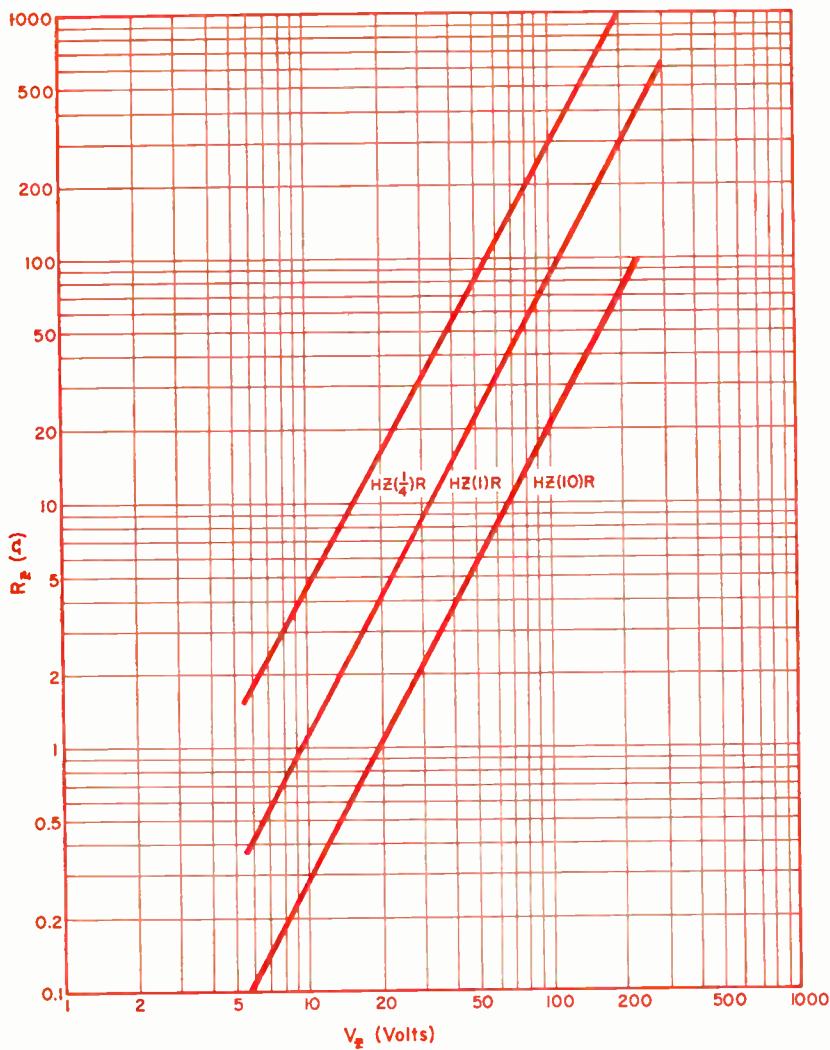
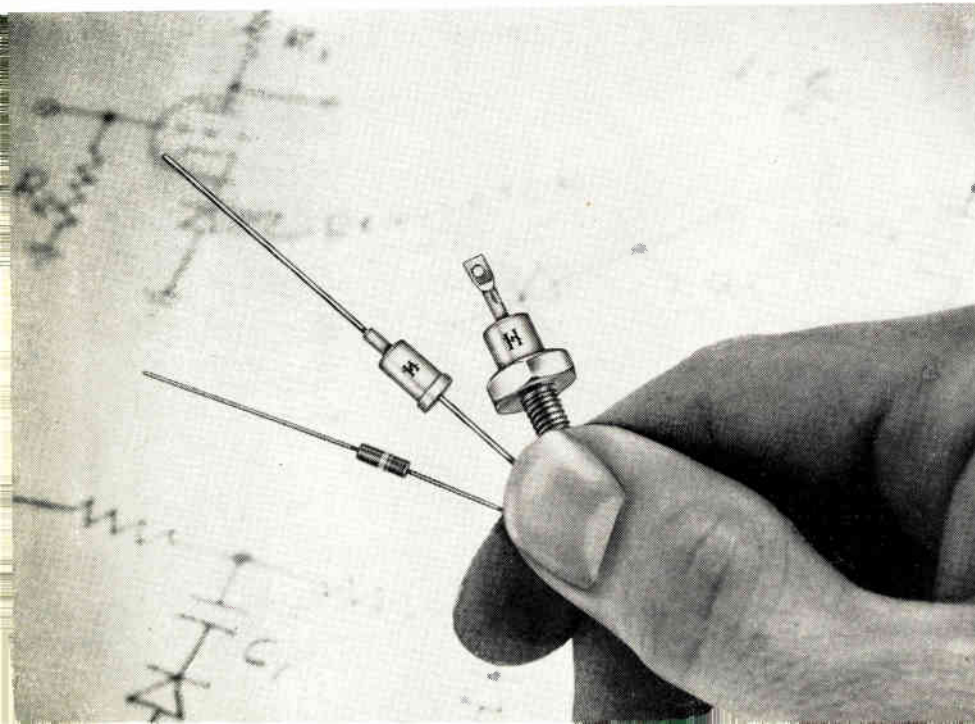


Fig. 4: Dynamic impedance characteristics of regulators at 80% of their rated power

## Understanding Zener Diodes (Continued)

Fig. 5: Three regulator sizes are shown



the order of  $100 \mu\text{a}$  in regions having diameters of the order of one micron.<sup>2</sup> Thus the resistance in the breakdown region is due to the spreading resistances of these avalanche regions in parallel. The spreading resistance is approximately the resistivity divided by the diameter of an avalanche spot. The number of spots is approximately the current divided by  $100 \mu\text{a}$ . Thus, the resistance in the breakdown region,  $R_B$ , is given approximately by the resistivity expressed in ohm-cm divided by the current,  $I_B$ , expressed in amperes.<sup>3</sup> Assuming a diffusion time of 20 hours for the regulators represented in Fig. 3 to enable one to determine the resistivity corresponding to a given  $V_B$  from Fig. 2, it is seen that most of the observed breakdown resistance is accounted for.

Typical dynamic impedance characteristics for the Hoffman line of "zener" regulators measured at 80% of their rated power are shown in Fig. 4. The packages corresponding to the ten, one, and quarter watt diffused junction regulators are shown in Fig. 5. It should be pointed out that the rating of the package is determined by the thermal resistance of the diode in that package. For diffused junction units geometry considerations make the thermal resistance of the regulators typically lower than their alloy junction counterparts. In particular the ten watt regulators have been run continuously at three times their nominal rating when connected to a  $3 \times 5 \times 1/16$  inch aluminum plate and the  $1/4$  watt units at 300 mw. with no degradation of characteristics. The impedances for the one watt and quarter watt regulators are higher than those for the ten watt units simply because they are measured at a lower reverse current level and are not yet in the saturation regions shown in Fig. 3. In addition there is a slight area effect on the impedance since the diameters of the diffused wafers decrease approximately in the ratio 4:3:2 with decreasing power rating.

2. B. Senitzky and J. L. Moll, *Phys. Rev.* 110, 612 (1958)

3. M. B. Prince, paper presented at "International Conference on Solid State Physics," Brussels, June 1958.



### Voltage Regulation

Any type of device intended to regulate voltage must be able to accept a fluctuating input and deliver a reasonably constant output voltage. For instance a variation in supply voltage will change the breakdown current through the regulator diode. The output voltage of the diode then changes due to two effects; (1) the finite zener impedance of the device and (2) self-heating within the diode and the resultant rise in junction temperature which in turn influences the breakdown voltage. For the voltage range depicted in Fig. 4, the temperature coefficient of zener voltage ( $\% \Delta V_z / ^\circ C$ ) is positive (see Fig. 6) and the changes in zener voltage due to finite zener impedance and self-heating are additive. The change in output voltage due to the impedance is simply the product of the impedance and the change in zener current. The change due to self-heating is equal to the product of temperature coefficient expressed in decimal form, the nominal zener voltage, and the change in junction temperature. The change in junction temperature is equal to the thermal resistance of the diode times the change in power dissipated by the unit. The change in power is in turn equal to the nominal zener voltage times the change in current. In Fig. 7 we present the percentage change in regulator voltage as a function of the change in regulator current. The units are ten watt zener regulators which have a thermal resistance of  $5^\circ C / \text{-watt}$  of power dissipated by the diode and are assumed to be initially operating at a ten watt level. The change in output voltage for a given change in current can then be calculated using this data and Figs. 4 & 6. For the voltages indicated then a 100% change in  $I_z$  would be 50 ma. for a 200 volt diode, 100 ma. for a 100 volt diode, 1 amp for a 10 volt diode, etc. The locus of points corresponding to the  $\% \Delta V_z$  for a 100% change in current through these diodes is given by the upper most approximately horizontal line. Following the curves down from left to right one can calculate the change in output voltage of the diode from

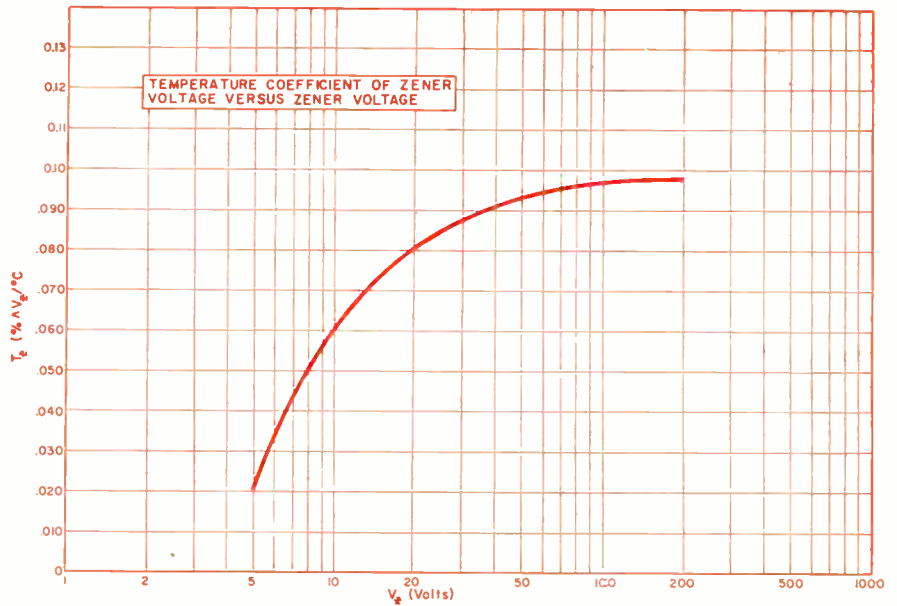


Fig. 6: Temperature coefficient of zener voltage as a function of zener voltage

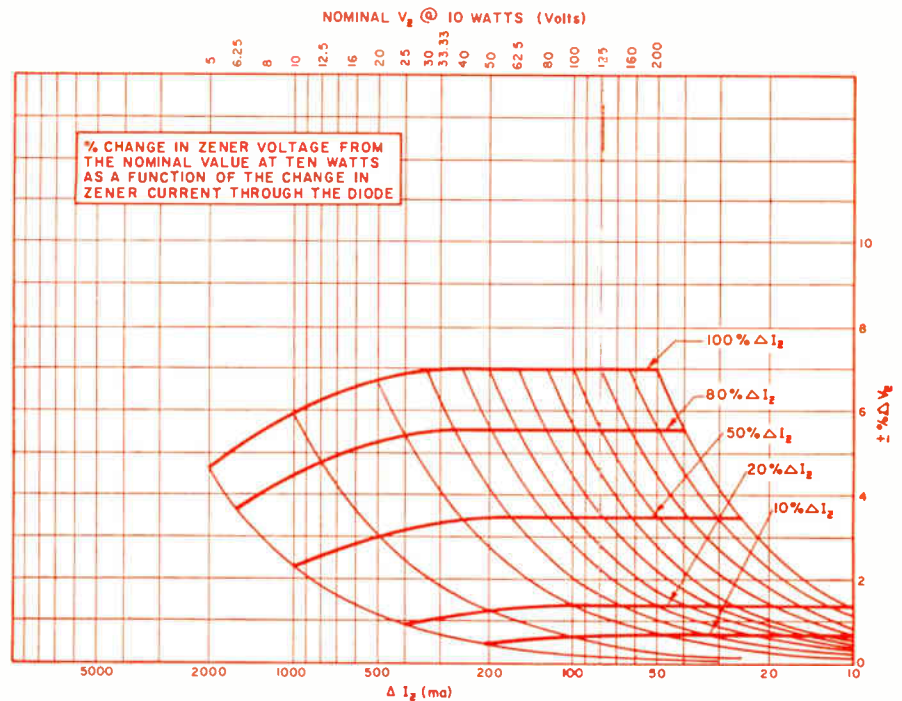


Fig. 7: Percentage change in regulator voltage as a function of regulator current change

its nominal value at the ten watt level for any change in zener current greater than 10 ma. In particular the loci of points corresponding to 80, 50, 20, and 10% changes in  $I_z$  have been sketched in addition to the curve for  $\Delta I_z = 100\%$ .

To improve the degree of regulation one must either reduce the zener impedance or the temperature coefficient or both. In alloy units one must use higher resistivity base material to achieve a given breakdown voltage than with dif-

fused regulators because of the steeper impurity gradient at the junction. Thus for identical geometries the diffused unit will have a lower series resistance and consequently better regulation than an otherwise equivalent alloy unit. Of course, the impedance of the diffused unit may be reduced still further by reducing the thickness of the base layer.

### Effective Temperature Coefficient

The effective temperature coefficient of the regulator voltage may

# Understanding Zener Diodes

(Continued)

be reduced by placing forward biased junctions in series with the reverse biased junction. Since the forward characteristic of a semiconductor diode decreases with increasing temperature and the reverse characteristic, for the voltage range considered, increases with increasing temperature, the total voltage drop across a series combination of a forward and a reverse biased junction will vary more slowly with temperature than the zener voltage for a single reverse biased junction of equivalent voltage. Unfortunately the rate at which the breakdown voltage changes with temperature increases rapidly with increasing breakdown voltage while the rate of change in the forward characteristic remains practically constant and independent of the value of the reverse breakdown voltage of the diode. Figure 8 illustrates this data for some typical diffused junction diodes. As may be seen from the figure, a large number of forward diodes are required to balance one reverse biased diode for the higher values of breakdown voltage. It is therefore not practical to employ this method of temperature compensation for units above ten volts in breakdown voltage.

Before leaving the topic of temperature coefficients it should be pointed out that the name "zener diode" is not really applicable to these units. The zener mechanism

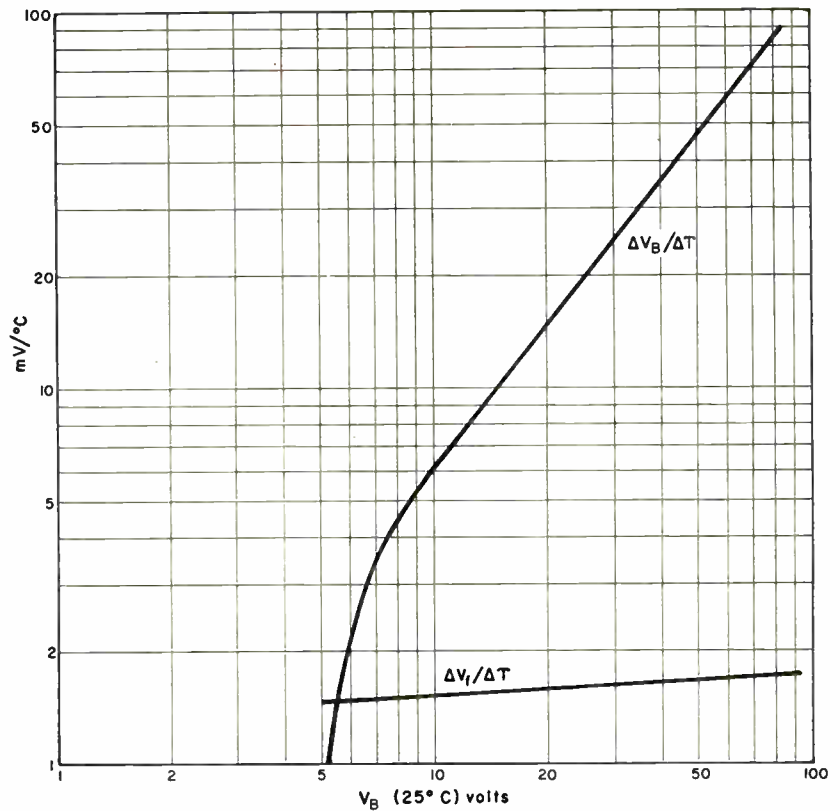
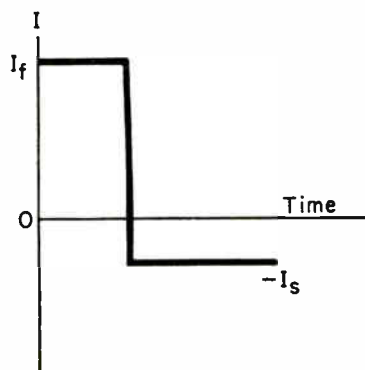


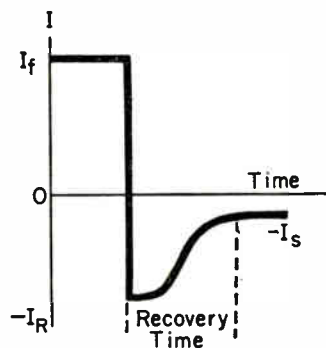
Fig. 8: Change in forward and reverse breakdown characteristics per °C measured at a current of 10 ma. as a function of the reverse breakdown voltage

of breakdown in insulators is due to the internal field emission of electrons from the valence band to the conduction band in the presence of strong electric fields. For higher temperatures the forbidden energy band is reduced in width and thus a lower electric field is needed to cause the zener breakdown. True zener diodes therefore have a negative temperature coefficient of breakdown voltage and this phenomenon occurs in diffused diodes below a breakdown voltage of about 5.4 volts. The characteristics of the diodes we have been

discussing are accounted for by an explanation based on an avalanche mechanism. This is the same phenomenon that takes place in a gaseous discharge. During a mean free path a charge carrier in the high field space charge region will pick up enough energy to cause ionization on collision leading to mobile charge multiplication. At higher temperatures the mobility of charge carriers is reduced and thus higher electric fields are necessary to cause charge carriers in a mean free path to pick up enough energy to cause the multi-

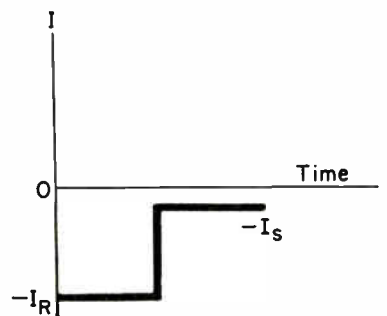


(a) IDEAL FORWARD SWITCHING



(b) ACTUAL FORWARD SWITCHING

Fig. 9: Theoretical and actual zener switching characteristics are illustrated



(c) ZENER SWITCHING



plication or avalanche phenomenon. This effect accounts for the positive temperature coefficient of regulator with breakdown voltages greater than about 5.4 volts. The zener mechanism thus accounts for only a very limited class of regulators, but through a popular misconception has been applied to all such devices. The term should not cause any conceptual difficulty, however, and we will use it in accordance with the common practice.

### Switching Applications

There is one application of Zener regulators which we would like to bring to your attention. In switching applications one attempts to go from a high conductance to a low conductance region as quickly as possible. If one switches from the forward bias to the reverse bias regions, the diode should ideally switch from high forward current,  $I_f$ , to the reverse saturation current,  $-I_s$ , as shown in Fig. 9a.

Actually the reverse current over-shoots the reverse saturation value,  $-I_s$ , and attains a relatively large value  $-I_r$  which persists for a time and then decays to the reverse saturation current. (See Fig. 9b.)

During the forward bias conditions, we force carriers out of the regions where they are in the majority into the regions where they are in the minority (in other words, the forward current is

carried by minority carriers). This has the net effect of altering the minority carrier densities in the n and p-regions of the diode. When the forward bias is removed, the minority carrier densities must return to their normal equilibrium values. This is achieved, at least in part, by the carriers flowing back across the junction and accounts for the large initial value of reverse current. This "relaxation" of the junction typically takes several tenths of a microsecond to several microseconds, depending on the way the diode is made.

If instead of switching about the forward bias condition, one switches about the reverse or avalanche breakdown point the switching time is greatly shortened.<sup>4</sup> When reverse current flows, the current carriers leave the regions where they are in the minority, and move across the junction into regions where they are the majority carriers (i.e., the reverse current is carried by majority carriers). It develops that one cannot alter the majority carrier density for a period of time longer than the dielectric relaxation time. Among other things, this time depends on the resistivity of the sample and for one ohm-cm silicon is of the order of  $10^{-10}$  to  $10^{-11}$  seconds. (Fig. 9c.) The junction could therefore in principle

<sup>4</sup> B. Saltzberg and E. W. Sard *Proc. IRE* 45, 1149 (1957).

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of this article can be obtained by  
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The Editor  
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switch from high to low conductance ten thousand to one hundred thousand times faster about the zener region than about the forward bias region. One objection to such a switching device in the past has been noise associated with the zener knee; however, diffused junction diodes are notably free of this problem. Another point to consider is that desirable switching times are only achieved in the forward direction by severely quenching the material. This is an additional operation which is not required for zener switching and has a deleterious effect on the electrical characteristics, particularly the reverse current.

### Acknowledgments

The zener regulators that are described herein are the results of the labors of many people. In particular the author takes pleasure in acknowledging the great aid of the Device Engineering Section of the Semiconductor Div. of Hoffman Electronic Corp. in obtaining most of the data presented here and in putting this new line of diffused zener regulators into production.

## FAT—For Low-Cost Transistors

**A**N almost completely automated mechanism capable of producing 450 transistors an hour at low cost is now operating at the Lansdale Tube Co. Division of Philco Corp.

One of the early problems attendant upon transistor development was that of mass production—how to produce these wonder-working little giants in quantities to make them readily available for all the roles they fill.

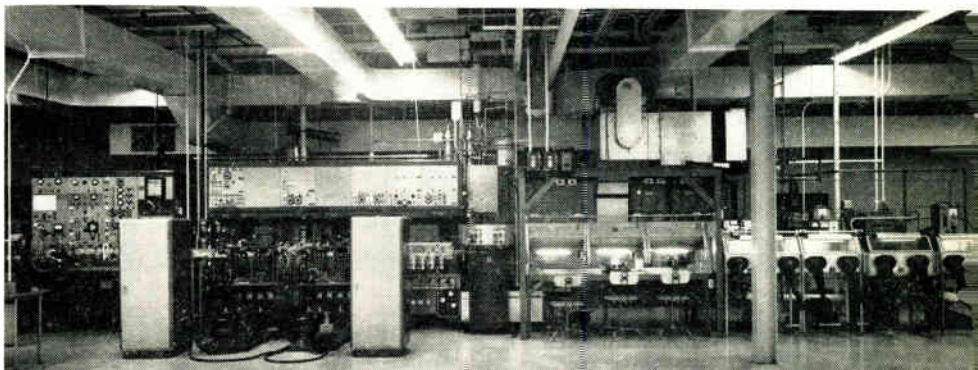
To do this, a whole new kind of equipment had to be designed. It had to be flexible to allow for changes and improvements. It had to be part of a long range mechanization program, so that parallel ef-

fort could continue and machines could be designed to produce transistors while the transistors

themselves were being designed. It had to be capable of transferring the transistors from operation to operation with extreme precision.

(Continued on page 166)

On this relatively short production line, 450 transistors an hour can be produced. Starting at the left: etch-plate controls, whisker attacher, rinse and dry (ultrasonically) machine, tab and lead welder, vacuum oven, tester, and top to stem welder.



**SUCCESS ASSURED**—The Defense Department stated that “communications with manned space vehicles of the future are assured by the success already achieved in this experiment.” The communication relay in the Atlas used the missile itself as the carrier and consists of two 8-watt transmitters, two receivers and two recorders using loops of magnetic tape which may be erased. The orbiting relay in the range of Signal Corps ground stations received and transmitted seven written teletype and one voice messages on 132.45 and 132.905 megacycle frequencies at the same time.

**EXPANDING ECONOMY**—The output of industrial and commercial electronics equipment will follow the trends of the nation's expanding economy. Consumer demand for radio and TV receivers, phonographs and other consumer electronic products is almost certain to recover from the abnormally low levels of last year. Electronics manufacturing is now a major segment of American manufacturing economy, the government agency stated, and since 1939 the industry has increased in output 20-fold compared with the less than 5-fold increase in the Gross National Product.

**SEMICONDUCTORS EXPANSION**—Semiconductor output will continue this year its rapid expansion in part at the expense of the older electron tube industries. Through increased electronic equipment production and the use of many new applications of semiconductors it is estimated there will be a 25% increase in semiconductor production in 1959 to a total value of \$250 million. The outlook, according to the government experts, is that semiconductors (transistors and crystal diodes) have only commenced their development cycle and new applications will provide an expanding market for years to come.

**ALLOCATIONS STUDY**—The President's Special Advisory Committee on Telecommunications which had the objective of improvement of the spectrum's allocations to the government and industry from a broad-range viewpoint has made its report to President Eisenhower but the latter has not yet been made public. Its recommendations were understood to have proposed establishment of a permanent expert committee to continue the survey. It is known that the President took a definite interest in the work of the five-member advisory body as evidenced by several meetings of the group with him in which there was a discussion of the broad situation as to the spectrum. It was anticipated that the President is going to incorporate the major findings by the special advisory committee in one of his messages to Congress.

**1959 TO BE RECORD YEAR**—The electronics industry in 1959 is expected to reach an all-time record high in production of equipment and components, according to a forecast issued by the Business Defense and Services Administration of the U. S. Department of Commerce. Exclusive of research and development expenditures, the estimated factory output of electronic equipment and components is predicted to be around \$7.9 billion or 17% above 1958 which was slightly less than \$7 billion. Most of this increase will be in military electronic equipment production, especially guided missiles, the BDSA division, which is headed by Don Parris, stated.

**MOBILE RADIOTELEPHONE**—Because of its belief that the American people should have the same nationwide telephone service “on the move” in automobiles, or trains or ships or airplanes, the Bell System has asked the FCC to consider in its 25-890 megacycle proceeding the imperative need of the non-broadcast services, including the Bell System, for frequency space in the uhf television portion of the spectrum which is being sparsely used by uhf TV stations. With this inefficient usage, the Bell System and the non-broadcast radio services feel a nationwide public mobile service should be established in this spectrum area. “This untapped market presents an almost unprecedented opportunity” to the electronic industry and the telephone industry, the Bell System stated to the FCC. It was stressed that the Bell System, while providing the basic framework of the system, would stay out of mobile-unit manufacturing.

**SATELLITE COMMUNICATIONS**—The Radio Corporation of America and other electronics companies in cooperation with the U. S. Army Signal Corps Research and Development Laboratory developed and installed the communications system in the giant Atlas satellite which pioneered space communications with its many potentialities of global voice and multiple telegraph signals and the future possible medium of intercontinental television. Besides RCA, which produced the communications components, the other companies participating in the communications system were the Convair-Astronautics Division of General Dynamics (antennas on missile); Radiation, Inc. (ground antennas); RF Laboratories (ground multiplexed telegraph equipment); Potter-Brumfield (special relays), and Eagle-Picher Co. (batteries).

*National Press Building  
Washington 4*

*ROLAND C. DAVIES  
Washington Editor*



# CINCH HINGE CONNECTORS

## PLUG AND SOCKET SHOWING CONTACT ARRANGEMENT

Patent Pending

The top section of the lock fits into a slot in the top of the cap forming a perfect lock which cannot be accidentally opened, as shown below. Lifting up top section releases same prior to unlocking.



**INSURE POSITIVE CONTACT;  
HAVE SIMPLE LOCKING DEVICE,  
EASY RELEASE. MAXIMUM  
NUMBER OF CONTACTS  
IN MINIMUM SPACE**

The plug and socket units of the "H" Series are easily engaged with normal pressure and the lock holds them securely together. Releasing the lock the units separate by the spring action of the contacts. A simple locking device insures positive contact. Wiping contact action keeps contacts clean at all times. Either the plug or socket body fit into the cap. Cable entrance hole can be placed at the one end, or in the top, or both. Cover is finished in black wrinkle and the cable clamps are cadmium plated. Contact tails will take either conventional solder wiring or AMP "78" series Taper Tab receptacles.

Standard units are supplied with general purpose Bakelite insulation and cadmium plated contacts.

For more severe conditions of temperature and humidity we have available glass filled Diallyl-phthalate insulation (Type GDI-30 per Mil. M-19833). Contacts can be supplied with gold plate over silver.

The plug or socket bodies can be ordered from the code numbers listed. The one that is attached to the chassis should have the lock attached. If an insulating liner is required in the cover, suffix L should be added to the Code Number.

The cap is ordered according to the number of contacts required. Then the letter L designating the liner. The letter giving hole size follows. Then the letter indicating the location of the hole; either T for top, or E for end, and if a cable clamp is required, the letter C is added.

For example, if a 50 contact unit is required with cover, having a 3/4" hole in the top with a cable clamp and liner, the code would be 24540-LBTC. The chassis socket would be 24495 and the plug for the cap 24504.

The Cinch "H" series is made in 20 to 100 contacts, in multiples of 10 contacts. (20, 30, 40, etc.)

### Socket with Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24492	20	1.375	1.750
24493	30	1.812	2.187
24494	40	2.250	2.625
24495	50	2.687	3.062
24496	60	3.125	3.500
24497	70	3.562	3.937
24498	80	4.000	4.375
24499	90	4.438	4.812
24500	100	4.875	5.250

### Socket without Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24484	20	1.375	1.750
24485	30	1.812	2.187
24486	40	2.250	2.625
24487	50	2.687	3.062
24488	60	3.125	3.500
24489	70	3.562	3.937
24413	80	4.000	4.375
24490	90	4.438	4.812
24491	100	4.875	5.250

### Plugs without Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24501	20	1.375	1.750
24502	30	1.812	2.187
24503	40	2.250	2.625
24504	50	2.687	3.062
24505	60	3.125	3.500
24506	70	3.562	3.937
24507	80	4.000	4.375
24508	90	4.438	4.812
24509	100	4.875	5.250

### Plug with Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24476	20	1.375	1.750
24477	30	1.812	2.187
24478	40	2.250	2.625
24479	50	2.687	3.062
24480	60	3.125	3.500
24481	70	3.562	3.937
24412	80	4.000	4.375
24482	90	4.438	4.812
24483	100	4.875	5.250

## 50 CONTACT ASSEMBLY WITH CABLE CLAMP



### Caps for Plugs or Sockets without Locks

Code No.	Contacts	Hole Size	Mtg. Ctrs	Overall
24537	20	A or B	1.375	1.750
24538	30	A B or C	1.812	2.187
24539	40	B or C	2.250	2.625
24540	50	B or C	2.687	3.062
24541	60	B C or D	3.125	3.500
24542	70	B C or D	3.562	3.937
24543	80	B C or D	4.000	4.375
24544	90	C D or E	4.437	4.812
24545	100	C D or E	4.875	5.250

### Cap Hole Size

Letter

A  
B  
C  
D  
E

### Cable Clamp Size

Dimension

1/2" dia. Small  
3/4" Small  
13/16 x 1 Medium  
13/16 x 1 1/2 Medium  
13/16 x 1-11/16" Large

### Electrical Rating

	Volts AC RMS	DC
Adjacent Terminals	930	1300
to Ground	1400	2000
Current Rating	4.5 Amperes	
Contact Resistance rated current @	.020 ohms	
Insulation Resistance	1000 megohms	
Capacitance adjacent contacts	.75 MMF	

Components shown  
reduced in size

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; La Puente, California; St. Louis, Missouri



**Cinch**  
ELECTRONIC  
COMPONENTS

## CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Illinois  
Division of United-Carr Fastener Corporation, Boston, Mass.



# SHIELDED CABLES

*designed for*



**STEREO  
HI-FI**



These low capacity cables are especially designed for use as leads between amplifiers, speakers and record changers of Stereo HI-FI units. Standard Two Conductor and Single Conductor cables are available and, where required, modifications of these cables can be developed to satisfy specific requirements.



#### LOW CAPACITY RECORD CHANGER TO AMPLIFIER EXTENSION CABLE

Two Stranded Conductors with clear polyethylene insulation extruded in parallel with a spiral wrapped tinned copper shield and a black extruded plastic jacket. Two styles available, with .030" wall insulation, 24 uuf per foot shield to conductor capacity and .017" wall insulation, 39 uuf per foot shield to conductor capacity.

#### LOW CAPACITY HI-FI AMPLIFIER INTERNAL SIGNAL CABLE

Two Solid Conductors in parallel with red and clear polyethylene insulation and spiral wrapped tinned copper shield with black extruded plastic jacket with 24 uuf per foot shield to conductor capacity.



#### STEREO RECORD CHANGER TO SPEAKER CO-AXIAL SINGLE CONDUCTOR LOW CAPACITY CABLE

Single Stranded Copper Conductors with polyethylene insulation, tinned copper full coverage shield and black or gray plastic insulation. Three styles available with shield to conductor capacities of 28, 31 and 33 uuf per foot respectively.

*For complete specifications for these and other Lenz Wires and Cables write today for the new Lenz Catalog.*



WIRES

and

CABLES

In Business Since 1904

**LENZ ELECTRIC MANUFACTURING CO.**

1751 No. Western Ave., Chicago 47, Ill.

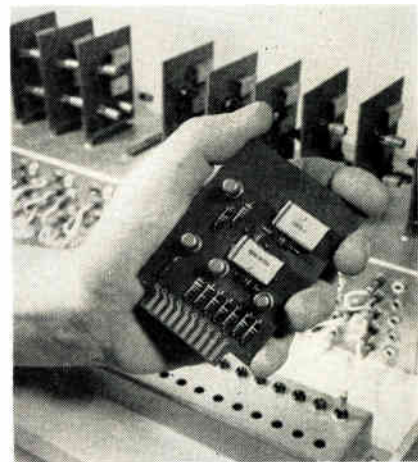
## Electronic Nerve Cell

*(Continued from page 73)*

commodation as a living nerve cell does.

Input excitation must, as in a biological cell, surpass a threshold value, and the cell will integrate two or more input pulses below threshold value to cause firing. A particular input connection can also, while energized, inhibit firing of the neuron by other inputs. Similarly, immediately after firing, the electronic neuron's threshold rises to infinity and for a few milliseconds no input signal can fire the neuron again.

Electronic neurons can be combined with photo-resistive cells to simulate simple functions of nerves in the retina. Some receptors, the "on" receptors, fire only when the light intensity they receive is increasing; "off" receptors fire only when the light is decreasing; and "during" receptors fire while they receive a steady light. Flicker-fusion phenomena have also been produced.



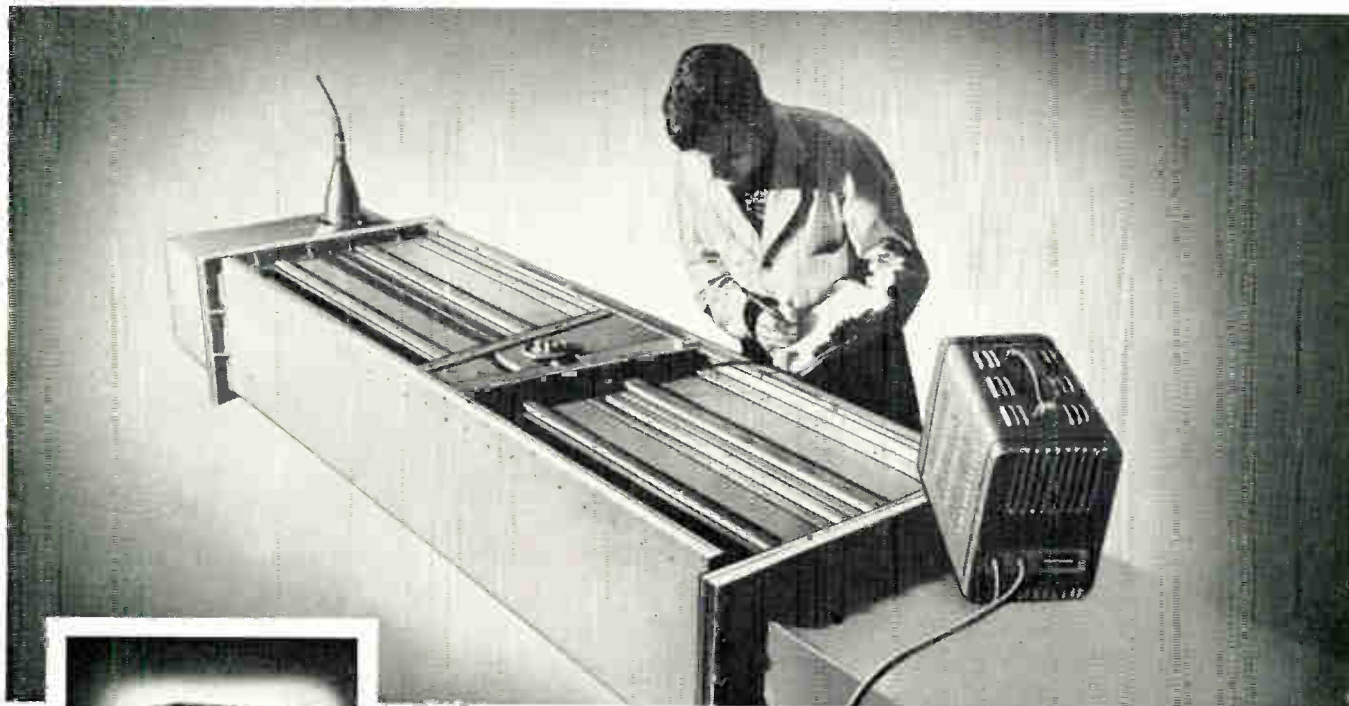
Artificial nerve cell is mounted on a printed-circuit card for assembling into networks that imitate eye and ear functions.

In the human eye, these cause a sequence of flashes to be seen as continuous illumination.

The mutual inhibition of cells in an array has been demonstrated experimentally. Some animals have been observed to possess this arrangement, in which a cell receiving a greater light intensity inhibits the firing of nearby cells that receive less light resulting in local sharpening of image boundary detail.



# I-T-E CAN SUPPLY ALL YOUR LARGE WAVEGUIDE TEST EQUIPMENT



**Slotted lines** are supplied complete with probe and carriage. Residual SWR is less than 1.02:1 over the frequency band. Available in sizes WR770 through WR2300.

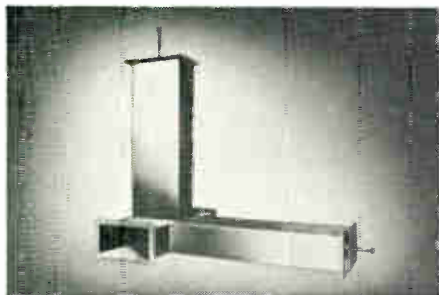


**Folded hybrid tee**

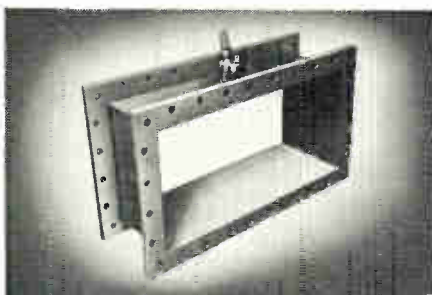
Here are a few examples of the waveguide test equipment and components currently available from I-T-E to meet the testing and operating requirements of multi-megawatt radar and scatter communications systems. This equipment reflects I-T-E's broad experience in all phases of large waveguide design and manufacture.

Take advantage of I-T-E's specialized knowledge of waveguide testing and the precision fabrication capabilities of a specially equipped waveguide shop. Facilities such as these assure you of the highest standards of quality, maximum economy, and excellent delivery—in single or production quantities.

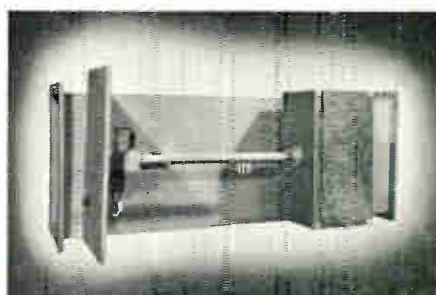
If you have a requirement or problem relating to waveguide test equipment, write I-T-E Special Products Division, 601 E. Erie Ave., Philadelphia 34, Pa. And ask for your copy of free-space wave length vs. guide wave length conversion tables for large waveguide.



**E-H plane tuner**



**Close-loop directional coupler**



**Motorized short circuit section**

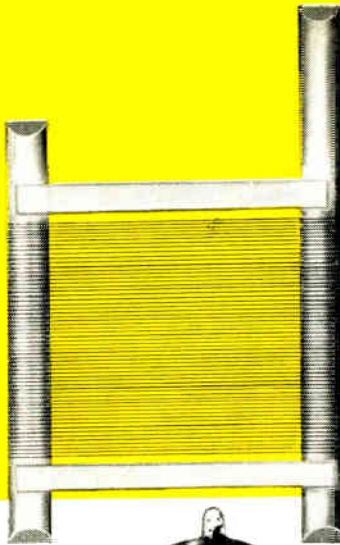


**I-T-E CIRCUIT BREAKER COMPANY**  
Special Products Division • 601 E. Erie Avenue • Philadelphia 34, Pa.

featuring the unique

**Amperex**<sup>®</sup>

**FRAME  
GRID\***



... the world's most modern  
broadband amplifier pentode

## Amperex 6688

a **RELIABLE** premium-quality tube  
for military systems requirements  
and exacting industrial applications

- completely ruggedized construction
- figure of merit of 250 Mc as broadband amplifier
- saves entire stages in IF and video amplifiers
- improves signal-to-noise ratio
- preferred for new equipment design, particularly airborne applications
- long-life cathode



### TYPICAL OPERATION

Plate Supply Voltage	..... 190 volts
Grid Supply Voltage	..... +9 vo'ts
Cathode Bias Resistor	..... 630 ohms
Plate Current	..... 13 ma
Transconductance	..... 16,500 $\mu$ mhos (min. 14,200; max. 18,800)
Amplification Factor	..... 50
Equivalent Noise Resistance	..... 460 ohms
Grid Voltage (rms)	..... 0.5 volt



It's the

### FRAME GRID CONSTRUCTION

that makes the difference!

The frame grid is the closest approach to the ideal "physicist's grid"—the grid with only electrical characteristics but no physical dimensions.

It results in:

- higher transconductance
- tighter  $G_m$  and plate current tolerance
- low transit time
- low capacitances
- lower microphonics
- rugged construction

### Amperex FRAME GRID



The grid-to-cathode spacing tolerance is determined by the carefully controlled diameter of grid support rods (center-less ground) and by frame crossbraces between these rods. Extremely fine grid wire eliminates the "island effect" usually encountered in conventional tubes with equally close grid-to-cathode spacing. Rigid support of fine wires reduces mechanical resonance and microphonics in the grid.

### CONVENTIONAL GRID

Grid-to-cathode spacing tolerance depends on accuracy of grid dimension, obtained by stretching on a mandrel, and on tolerances of holes in top and bottom mica rod supports. Diameter of grid wire must be large enough to be self-supporting.



Other **Amperex** Premium Quality (PQ) frame grid tubes available in production quantities:

5847.....broadband amplifier pentode  
6922.....ruggedized high-gain twin triode

plus other PQ and frame grid tubes for special reliability requirements and exacting industrial applications



ask **Amperex**  
about  
**premium-quality tubes**  
for  
**special reliability requirements**

Semiconductor and Special Purpose Tube Division  
**AMPEREX ELECTRONIC CORP.**  
230 Duffy Avenue, Hicksville, L. I., N. Y.

In Canada: Rogers Electronic Tubes & Components, 116 Vanderhoof Avenue, Toronto 17, Ontario

## Unity Gain Amplifiers

(Continued from page 71)

The phase shift may be adjusted by a shunt capacity trim of  $Z_1$  or  $Z_2$ .

In Fig. 6, the input device is the operational amplifier. Here the input impedance is essentially equal to  $Z_1$  and hence is somewhat lower than that of a cathode follower. However, due to the isolating effect of the impedance  $Z_1$ , the shunt stray capacitance is kept to a minimum. The output impedance including the coupling condenser is unusually low compared to that of the normal cathode follower. Here's how it happens: The output stage is a normal cathode follower. By taking feedback around the cathode follower and the output coupling condenser, the impedance is actually reduced by the amount of the feedback factor. In this manner, the output impedance is lower by at least one order of magnitude over that of the common cathode follower.

Capacity trimming of  $Z_1$  may be used to counteract the effect of phase shift due to stray capacities in various portions of the circuit.

### A REPRINT

of this article can be obtained by  
writing on company letterhead to

The Editor

**ELECTRONIC INDUSTRIES**  
Chestnut & 56th Sts., Phila. 39, Pa.

This results in reduced overall phase shift and serves to greatly increase the amplified bandwidth. As before, the overall gain can be trimmed to exactly unity by adjusting the values of  $Z_1$  and  $Z_2$ .

Measured characteristics of the normal cathode follower, Fig. 7, and the composite circuits of Figs. 5 and 6 as shown in Table 2.

Two circuits have been described which offer improved operation over a normal cathode follower. These new isolation amplifiers have advantages with respect to gain and phase trimming capability, increased bandwidth and reduced output impedance. The choice of circuits to be used depends on which characteristics it is desired to emphasize. ★ ★ ★



*the first real "BREAK" for airborne harnesses*

THE ALL NEW **AMP**

**HELICON**

**CONNECTOR**



**FEATURES**

- helical construction imparts a connection so firm that a special A-MP tool is required to connect and disconnect.
- "o" ring and metal wire-insulation ring make moisture-tight seal
- wiping action cleans pin and socket for assured maximum conductivity
- positive wire-stops prevent over-insertion of stripped conductor

**FEATURES**

- serrations inside barrel assure maximum crimp-contact between barrel and conductor
- inspection ports permit examination of conductors in barrel
- environmental proofing: moisture resistant, corrosion resistant, vibration and shock resistant

Never before has such a unit been available—a reliable, pre-insulated "manufacturing break" for aircraft and missile harnesses. Designed as a quick connect/disconnect for all high-reliability circuits, the all new A-MP HELICON Connector is completely environmental-proofed and fully pre-insulated. Equally important, it requires a special A-MP tool to connect and disconnect, thereby preventing tampering and unintentional breaks in circuits.

The HELICON Connector can be attached to airborne circuit wires with remarkable speed and ease . . . permits multiple connect/disconnects without harm to unit . . . offers the highest reliability.



*This is the product that the Avionics Industry has needed for years. There is nothing else on the market like it. Write for more information.*

**AMP INCORPORATED**

**GENERAL OFFICES: HARRISBURG, PENNSYLVANIA**

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

# New Tech Data

## for Engineers

### Ceramic Design Handbook

A design handbook and manufacturer's catalog describes the mechanical, electrical, and environmental characteristics of Centralab engineered ceramics and contains information on the advantages and disadvantages of various fabricating techniques. Centralab, 900 East Keefe Ave., Milwaukee 1, Wis.

Circle 161 on Inquiry Card, page 117

### Ultrasonic Cleaner

Narda Ultrasonics Corp., Westbury, L. I., N. Y., offers a new data sheet on the Series 5000 Ultrasonic Cleaner. It describes Model G-5001, a 40 KC, 500 w. average output SonBlaster generator, and the G-5002, a 20 KC, 500 w. average output generator. The first is used to energize cleaning tanks and the second operates magnetostrictive transducers for drilling, dip soldering and other high-intensity or high-temperature applications.

Circle 162 on Inquiry Card, page 117

### Electronic Wire

Catalog No. 859 groups wire by type and application. Electrical characteristics and construction details are shown. Listings include microphone and shielded power supply cables, TV camera cables, hi-fi, stereo, and phonograph cables, intercom and sound cables, transmission line cables plus a Conduit Capacity Table. Belden Manufacturing Co., 415 S. Kilpatrick St., Chicago, Ill.

Circle 163 on Inquiry Card, page 117

### Precision Tape Reel

"Precision Reels for Instrumentation Recording," a 4-page, illustrated bulletin, points out the need for a precision tape reel to cope with the increased use in the instrumentation field of wider, thinner-base tapes and larger tape reels. The merits of a new reel designed to meet the critical requirements are discussed. Minnesota Mining and Manufacturing Co., Dept. E8-376,900, Bush St., St. Paul 6, Minn.

Circle 164 on Inquiry Card, page 117

### 2-Way Mobile Gear

The 1959 edition (enlarged) is a catalog of two-way communications parts, kits, chassis, test equipment, and accessories. It features new and improved test equipment, printed circuit repair kits, and information and components needed for split channel conversion. Motorola Communications and Electronics, Inc., Parts Dept. 4910 W. Flournoy St., Chicago, Ill.

Circle 165 on Inquiry Card, page 117

### Thermostats

A 4-page, 2-color bulletin describes the Stemco line of bimetal thermostats, with condensed technical information on operating ranges, electrical ratings, optional mountings, and terminal arrangements. A temperature conversion chart—Centigrade to Fahrenheit & vice versa, from  $-94^{\circ}\text{F}$  to  $+1202^{\circ}\text{F}$ —is included. Stevens Manufacturing Co., Inc., P. O. Box 1007, Mansfield, Ohio.

Circle 166 on Inquiry Card, page 117

### Metal Melting Guide

Bulletin GEA-6113B, from General Electric Co., Schenectady 5, N. Y., tells how to select cast-in immersion heaters, controls, and melting pots for soft-metal melting applications. Melting data is included and a table for determining heater kw-hr requirements for melting solder, tin, and lead. Product data and pricing information for all heating equipment and melting pots is listed.

Circle 167 on Inquiry Card, page 117

### R-F Choke Coil

New r-f choke coil technical data sheet released by Essex Electronics, Berkeley Heights, N. J. contains a detailed description of the electrical parameters for a line of chokes available in a 100,000 to 1 inductance range. The standard line is described by the sheet which lists parameters for 123 different units from 0.1  $\mu\text{h}$  to 10 mh. Logarithmic series is shown as well as the preferred series.

Circle 168 on Inquiry Card, page 117

### Radiation Survey Meters

An 8-page, 2-color, illustrated bulletin, Form 3044B, describes a line of portable radiation survey meters. It includes specifications, performance data, optional accessories, sizes, weights, etc. Victoreen Instrument Co., Instruments Div., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 169 on Inquiry Card, page 117

### Wiring Devices

Pocket-size, illustrated wiring device catalog issued by Eagle Elec. Mfg. Co., Inc., 23-10 Bridge Plaza South, Long Island City, N. Y. covers 3 wire "U" devices, grounding devices, interchange devices, switches, receptacles, combination devices, wall plates, range and dryer receptacles, Eagalok locking devices, fuses, sockets, armored caps and connectors.

Circle 170 on Inquiry Card, page 117

### Resistance Decade Table

Texas Instruments Incorporated, P. O. Box 312, Dallas, Texas, is offering the official decade table for determining standard resistance values of Precision Film Resistors. The table, known as the MIL-Bell decade table, is in accordance with Military Standard 90169 and has been adopted by the American resistor industry in cooperation with the Armed Services Electro-Standards Agency.

Circle 171 on Inquiry Card, page 117

### Potentiometers

A 4-page brochure summarizing key information on TRIMPOT and TRIMIT lead screw actuated potentiometers from Bourns Laboratories, P.O.B. 2112, Riverside, Calif. It features a specification table of available resistances, terminal types, end settings, power ratings, operating temperatures, and dimensions of the more popular models. A cut-a-way drawing illustrates internal construction and design features.

Circle 172 on Inquiry Card, page 117

### Carbon-Graphite

An 8-page brochure serves as an idea book for carbon-graphite applications. Charts and tables provide data on qualities of sceleroscope hardness, density, transverse and compressive strength, oxidizing temperature limitations, performance in sliding contact with bearing metals, thermal conductivity and tensile strength-to-specific gravity. KARAK characteristics and advantages are discussed. Ohio Carbon Co., 12508 Berea Road, Dept. 104, Cleveland 11, Ohio.

Circle 173 on Inquiry Card, page 117

### Phono Needle Wall Chart

A 17½ x 33 in. chart contains a listing of Jensen needles—diamond, sapphire, and durosium—for every brand of cartridge from Astatic to Webster-Chicago and has complete stereo listings. Drawings of needles are included, with a listing of the cartridges they fit. Jensen Industries, Forest Park, Ill.

Circle 174 on Inquiry Card, page 117

### Components-Instruments

Short-form catalog folder, from Burroughs Corp., Electronic Tube Div., P.O.B. 1226, Plainfield, N. J., contains descriptive information and applications data on Burroughs Beam Switching Tubes, Nixie indicator tubes, decade counters, pulse control instruments, optimeters, beamplifiers, visual decoders, and a listing of over 20 items of available literature.

Circle 175 on Inquiry Card, page 117



# NEED PRECISE FREQUENCY CONTROL IN THIS RANGE AND BEYOND?

1  
f (MEGACYCLES)

10

100

1000

10,000

## MANSON

HAS THE LOW-COST SOURCES TO MEET YOUR NEEDS

$$\Delta f/f < 1/10^8$$


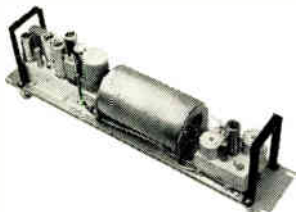
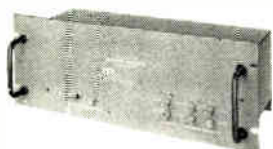
(DRIFT RATE PER DAY DUE TO CRYSTAL AGING)

Plus outstanding stability under all other environmental and circuit conditions:

$\Delta f/f$ due to:	Circuit Noise	parts in 10 <sup>10</sup>
	Ambient Temperature Change	1/10 <sup>8</sup> from 0°C to 50°C
	Vibration & Shock	2/10 <sup>9</sup> per MIL-T-17113
	Change in B+ or Filament Voltage	2/10 <sup>9</sup> for ±20% B+ change or ±10% filament change

Ultra-stable frequency generators for use as reference sources or master oscillators. Unmatched for precision, compactness and low cost, Manson Oscillators and Harmonic Generators meet the highest stability specifications per dollar.

### SPECIFICATIONS

<p><b>1 Megacycle HARMONIC REFERENCE OSCILLATOR</b> Price \$1095.</p>  <p>MODEL RD-110</p>	<p>Complete, self-contained system incorporates ultra-stable crystal oscillator, jitter-free pulse generator, mixer and regulated power . . . . Generates, measures, monitors frequencies at harmonic points to over 1000 Mc . . . . Crystal frequency tunable ±25 cycles without degradation of stability characteristics . . . . counter-type, ultra-linear tuning dial for exceptionally accurate settability and readability.</p>	<p>FREQ. STABILITY: Meets above listed specifications. FREQUENCY: 1 megacycle, tunable ±25 cycles. OUTPUTS: a) Sine Wave, 3 volts rms across 50 ohms; b) Pulse, jitter-free, balanced, ±40 volts peak across 250 ohms. TUNING ACCURACY: 0.1 cps with direct-reading, linear dial; substantially zero-error readability and resettability. HARMONICS: Usable to kilomegacycle region. INPUT: 105/125 V., 60 cps, 100 watts. SIZE: 5¼" H x 19" W x 11¾" D, for rack or bench.</p>
<p><b>1 Megacycle HIGH STABILITY OSCILLATOR</b> Price \$395.</p>  <p>MODEL RD-140</p>	<p>Compact crystal oscillator suitable as a reference source or master oscillator in frequency control systems . . . . non-microphonic design and proportional oven control assure high insensitivity to both vibration and temperature . . . . new packaged version (RD-145) for direct, sub-assembly incorporation in portable or airborne instruments . . . . 2 x 4 x 6 inches, 12 ounces . . . . employs ultra-precise Manson thermostatic oven, substantially meeting RD-140 specs. FREQUENCY DIVIDERS AND MULTIPLIERS available to extend range from 100 kc to 10 mc and above . . . . stability characteristics equal to crystal oscillator. AVAILABLE SOON! Model RD-147, ultra-low-drift oscillator . . . incorporates continuous aging compensation to reduce drift rate to parts in 10<sup>10</sup> per day.</p>	<p>FREQ. STABILITY: Meets above listed specifications. FREQUENCY: 1 megacycle. (Frequencies from 0.8 mc to 1.2 mc available on special modification.) Frequency adjustable more than 6 cycles, allowing ample compensation for crystal aging. Alternate version, Model RD-146, incorporates calibrated trimmer dial on front panel. OUTPUT: Sine wave, 1 volt rms across 1000 ohms. POWER REQUIRED: 250 VDC @ 60 ma; 6.3 VAC @ 1.8A. MOUNTING: For 19" relay rack or bench use. Front panel height, 3½".</p>
<p><b>1000 Megacycle REFERENCE GENERATOR</b> Price \$850.</p>  <p>MODEL RD-170</p>	<p>This precision-built, low cost standard employs crystal synthesizer techniques for high stability, low noise and low spurious signals . . . . Basic unit furnishes outputs of 0.1 kmc and 1 kmc . . . . Optional feature includes harmonic generator utilizing base frequencies to furnish highly stable, usable outputs over a major portion of microwave spectrum . . . . All outputs tunable when used with RD-110. * Model RD-175, L-band generator, output tunable 1.095kmc-1.405kmc in 10-mc steps, meets above listed stability specifications when used with RD-140.</p>	<p>OUTPUT FREQUENCIES: 100 mc and 1000 mc sinusoidal. Tunable ±2.5kc and ±25kc respectively, if used with RD-110. STABILITY: Meets above stability specifications when used with RD-110 or RD-140. OUTPUT POWER: 100 milliwatts at either output. HARMONICS (Model RD-170H): Usable to above 20,000 Mc. INPUT POWER: 250 VDC @ 150 ma reg.; 6.3 VAC @ 4A. SIZE &amp; MOUNTING: 5¼" H x 6¾" D, for 19" rack or bench use.</p>

### For Military Applications. . . . CRYSTAL FREQUENCY SYNTHESIZERS

Manson manufactures the O-406/UR synthesizer and a full line of disciplined incremental and continuous-coverage oscillators, approaching the "black-box" equivalent of a crystal with thousands of selectable frequencies. Ideal for SSB systems, as transmitter exciters or receiver VFO's, ultra-stable frequency generators, FSK exciters and similar applications where exactness, operating convenience and equipment dependability are mandatory.

Standard and developmental models cover the range from 15 kc to 410 mc. Features include stabilities and setting accuracies to 1/10<sup>8</sup> and better; zero-error readability and resettability; ultra-low spurious signals; MIL construction.

Letterhead inquiries invited.



MANSON LABORATORIES  
375 FAIRFIELD AVENUE  
STAMFORD, CONNECTICUT

DAvis 5-1391

Pulse Modulators, High Voltage Power Supplies,  
Communications Instruments and Components,  
Complete Microwave Systems.

### Solvents

Non-toxic, non-explosive, non-combustible, non-inflammable, non-corrosive (no inhibitors) solvents which degrease sensitive mechanical and electrical assemblies without damage to delicate parts are described in a booklet available from E. I. duPont de Nemours & Co., Inc., "Freon" Products Division 521, Wilmington 98, Delaware. The solvents can be recovered and reused without re-inhibiting, and cause minimum swelling of plastics or rubber and without crazing or softening paint, wire coatings or insulation.

Circle 176 on Inquiry Card, page 117

### Phone Dial Equipment

An 8-page, illustrated brochure, describing dial equipment for private radio dispatch and common carrier radio telephone systems, clarifies the similarities and differences between dial signaling on private mobile radio systems and radio telephone systems. Included are: requirements for selective or dial signaling, selective or dial signaling requirements for both private and common carrier systems, equipment required, system operation and Secode dial signaling equipment for use with both automatic and manual telephone exchanges. Secode Corp., 555 Minnesota St., San Francisco 7, Calif.

Circle 177 on Inquiry Card, page 117

### Aluminum R-F Plugs

A complete new line of lightweight r-f Cannon plugs utilizing aluminum shells is described in a new 17-page catalog, ALRF-1. The "ALRF" line of coaxial plugs and the "ALA" line of cable adaptors are described. Comprising the line are the "ALN" and "ALSC" series of r-f plugs, and the "ALA" series of connector-adaptors for joining Foamflex or Raytherm semi-rigid aluminum coaxial cable to standard RG cable. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 178 on Inquiry Card, page 117

### "Stereo Simplified"

A new booklet, available from Sonotone Corp., Electronic Applications Div., Elmsford, N. Y., is an easy-to-follow introduction to stereophonic recording and reproduction. Diagrams and sketches illustrate techniques. It describes the differences between mono and stereo reproduction and offers suggestions on conversion of monaural systems to stereo.

Circle 179 on Inquiry Card, page 117

### Space Talk Guide

A pocket-size, down to earth, glossary of astronomical terms which contains 133 terms used by space scientists and engineers—including technical slang. Republic Aviation Corp., Farmingdale, L. L., New York.

Circle 180 on Inquiry Card, page 117

### Information-Conversion Data

A chart of technical information and conversion data including altitude from -5,000 ft. to 1,800,000 ft. with pressure and temperature equivalents in accordance with ARDC model atmosphere. A Centigrade to Fahrenheit conversion chart from absolute zero to 1,000°C is included. A third chart shows wet bulb and dry bulb with equivalents, relative humidity, and Centigrade - Fahrenheit interchange. Also provided is a table of heat and energy equivalents. Conrad, Inc., Conrad Square, Holland, Michigan.

Circle 181 on Inquiry Card, page 117

### Germanium-Germanium Dioxide

A bulletin describing the physical characteristics and purity standards of germanium and germanium dioxide used in the manufacture of semiconductor devices. It lists the minimum resistivity specifications of electronic-grade germanium measured with a 4-point probe at 25°C, and includes the specifications and chemical characteristics of the finished product. Sylvania Electric Products Inc., Towanda, Penna.

Circle 182 on Inquiry Card, page 117

### Instrumentation

Short Form catalog of Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif., features: time interval meters, EPUT meters, electronic counters gated by applied signal, totalizing counters, preset counter-controllers, readout devices, transducers, general and special purpose test instruments, standard modifications to electronic counters, and special equipment.

Circle 183 on Inquiry Card, page 117

### Analog Computation

George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass., has issued a 4-page folder entitled "The Lightning Empiricist." It contains items of interest and value on applications, techniques, and new or improved components in the field of analog computation.

Circle 184 on Inquiry Card, page 117

### Magnetic Shielding Manual

A 31-page manual considers shielding problems and typical examples of shielding. It contains a glossary of terms, graphs showing B/H curves and curie temperature graph for coatings, saturation point for base metals only using Perfection Anneal-2 cycles, curie temperature graph for base metals without coatings, and saturation curves for dc and ac flux. It also describes the materials used and suggests techniques in the evaluation of magnetic fields. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago, Ill.

Circle 185 on Inquiry Card, page 117

### Adjustable-Speed Drives

A 14-page booklet provides information for selecting adjustable speed equipment. It contains descriptions of three basic systems, performance specifications, outline drawings, dimensional data, and ordering information. Specs include rated HP, output speed, output torque, gear ratios, and ac voltages. Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.

Circle 186 on Inquiry Card, page 117

### Vacuum Spectrum Chart

"High Vacuum Technology and the Space Age," a 6-page brochure, is available from the National Research Corp., 70 Memorial Drive, Cambridge 42, Mass. It includes an 11 in. x 17 in. 3-color Upper Atmosphere Vacuum Spectrum Chart which uses IGY satellite data and information from other literature. It permits rapid determination of atmospheric density, temperature, pressure and mean free path of gas molecules up to an equivalent altitude of 600 miles.

Circle 187 on Inquiry Card, page 117

### Magnetic Circuits

"Applied Magnetics," company publication of Indiana Steel Products Co., Valparaiso, Ind., features a detailed discussion of magnetic circuits in its latest edition. A summary of circuits especially suited for tractive applications which utilize the attractive holding, or repelling forces of permanent magnets is presented.

Circle 188 on Inquiry Card, page 117

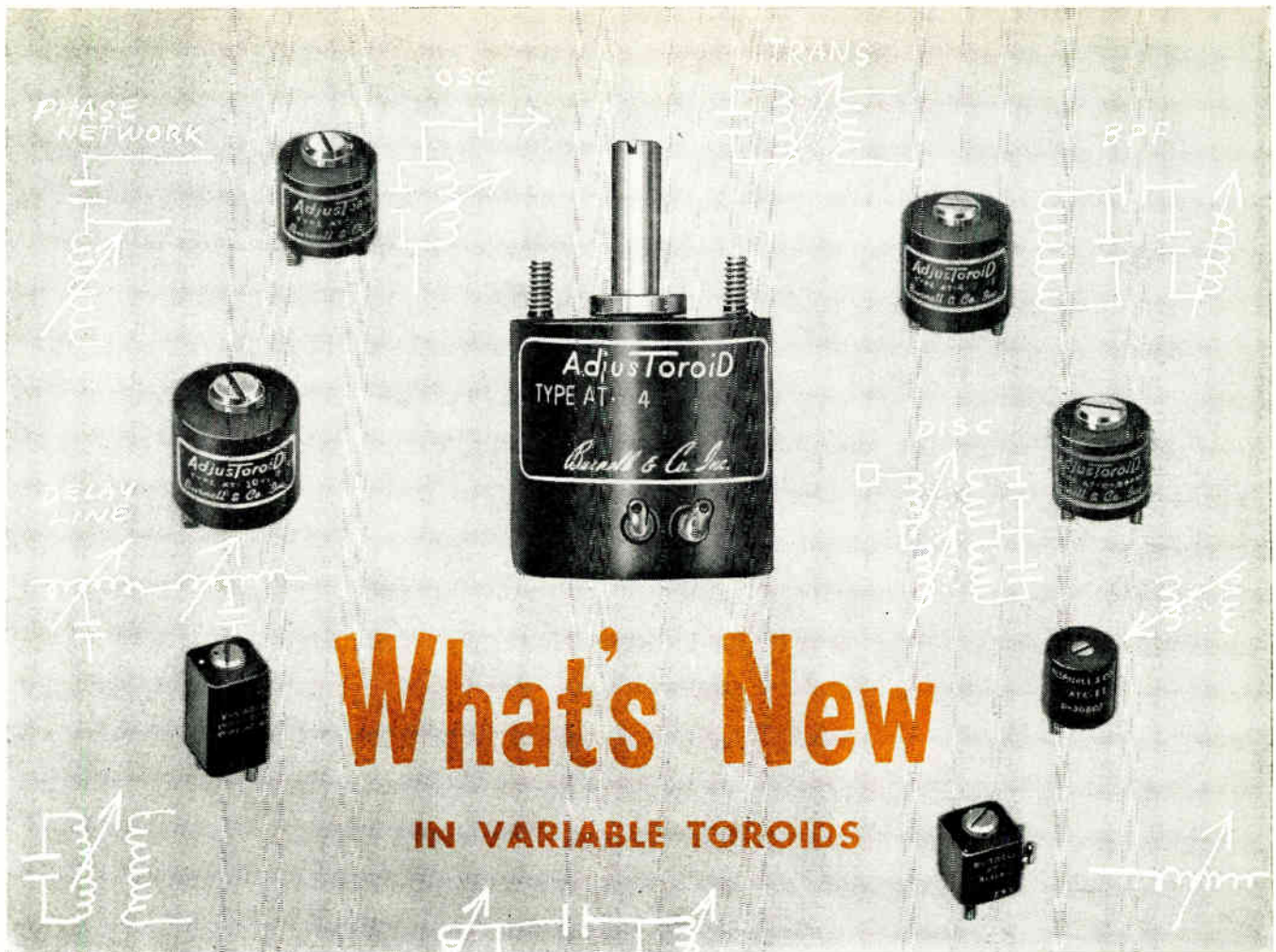
### Fans & Blowers

The 1959 McLean Engineering Laboratories 36 page catalog features packaged fans, blowers, and accessory equipment used in conjunction with the cooling of electronic apparatus. Available by writing to P. O. Box 228, Princeton, N. J.

Circle 189 on Inquiry Card, page 117

(More New Tech Data on page 94)





# What's New

## IN VARIABLE TOROIDS

Burnell Adjustoroids<sup>®</sup> are always new because they are always being designed for newer and broader electronic and mechanical applications.

- NEW** Burnell's complete line of encapsulated Adjustoroids are particularly adaptable to printed circuit use.
- NEW** A screw mount PC type Adjustoroid for greater durability in high acceleration, shock and vibration environments.
- NEW** 'Pot' mounting Adjustoroids for panel mounting and knob adjustment wherever slotted controls are difficult to reach.
- NEW** Continuous internal improvements including adjustment range, Q, size, etc. Burnell Adjustoroid engineers are constantly seeking solutions to space, accessibility and performance problems.

Burnell Adjustoroids and sub-miniature Adjustoroids are supplied hermetically sealed to meet government specifications MIL E 15305A or encapsulated in many sizes and shapes to meet the application. If your Adjustoroid needs can't be met from our stock catalogue, we'll be glad to manufacture to your specifications. For additional information, write for Adjustoroid bulletin.

	Length/ Dia.	Width	Hgt.	Wt.	Useful Freq. Range	Max Q	Max L in hys
AT-0	1 1/16		1"	2 oz	1 kc to 20 kc	10 kc	3 hys
AT-1	1 3/4	1 3/4	1 1/4"	7.25 oz	2 kc to 10 kc	4 kc	15 hys
AT-2	2 3/4	2 3/4	2 1/4"	24 oz	Below 2.5 kc	2.5 kc	125 hys
AT-4	1 1/4		1 1/4"	4 oz	1 kc to 16 kc	6 kc	15 hys
AT-6	1 1/16		1"	2 oz	10 kc to 100 kc	30 kc	.75 hys
AT-10	1 1/4		1 1/4"	4 oz	3 kc to 50 kc	20 kc	.75 hys
*AT-11	4 5/16	4 5/16	3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
*AT-12	4 5/16	4 5/16	3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys
AT-15	3 1/32		1 7/8"	14 oz	Below 5 kc	4 kc	125 hys
AF-51	1 1/4		2"	5 oz	30 cps to 500 cps	120 cps	1000 hys
AF-52	1 1/4		2"	5 oz	50 cps to 1 kc	250 cps	1000 hys
*AF-87	4 5/16	4 5/16	1 1/4"	1.7 oz	90 cps to 2 kc	400 cps	80 hys
*AF-88	4 5/16	4 5/16	1 1/4"	1.7 oz	.16 kc to 4 kc	800 cps	42 hys
†ATE-11	3/4		3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
†ATE-12	3/4		3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys

**Variation:—10%**

\*Special "pot" type sub-miniature Adjustoroids are not available with AT-11, AT-12, AF-87, AF-88.

†Special screw mountings are available with the ATE-11 and ATE-12 in printed circuit applications for "plug in" types. Where vibration and shock are significant considerations, mounting screws serve as terminal connections.

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*Burnell & Co., Inc.*

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

#### EASTERN DIVISION

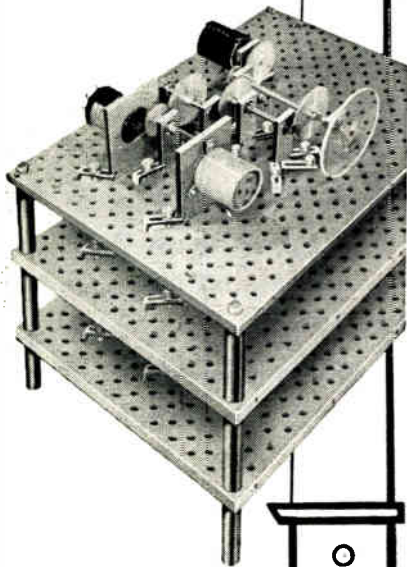
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# SLICE COSTS ON THIS BREADBOARD



Only **SERVOBOARD®** precision assembly kits offer all these outstanding features.

## ECONOMY

Servoboard kits eliminate the usual model shop costs and time lag... right from breadboarding the original schematic to the final prototype. The kit knocks down to be used again and again, reducing part charges on new project budgets.

Production benefits, too. Change orders are made on the breadboard, not on tightly-figured production runs. Every item can be purchased from open stock.

## EASY ASSEMBLY

Extraneous stresses cannot produce spurious effects. Mounting board is absolutely rigid under the weight of all components.

Mounting clamps, each with a captive screw, mate with a tapped board to provide quick, easy assembly from the top; blind fumbling beneath the mounting is eliminated.

## FLEXIBILITY

A wide variety of co-ordinated mechanical components plus hangers to accommodate almost every commercial electronic part provide a multitude of combinations to test your design.

## SPACE SAVING

Not restricted by a grooved board to parallel or right-angle assembly, components may be mounted at any angle. To conserve bench space, mounting boards stack one above the other.

Write today for a complete brochure describing and illustrating these precision assemblies. Request TDS-1100E.

**SERVO CORPORATION OF AMERICA**  
20-20 Jericho Turnpike New Hyde Park, L. I., N. Y.

# New Tech Data

for Engineers

## Thermometer Wire

Brochure on resistance thermometer wire shows graphically resistance vs. temperature from 0° to 500°C with various pure metals and alloys used in thermometry. Included are enamels for wire application from the standard oleoresinous, rated for continuous use to 105°C, up to and including Secon Ceramic Insulation, rated for continuous use to 500°C. Secon Metals Corp., 7 Intervale St., White Plains, N. Y.

Circle 226 on Inquiry Card, page 117

## Switches

Twenty-four-page catalog covers the representative line of precision snap-action and mercury switches manufactured by Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill. Includes data on high-temperature, maintained-contact, explosion-proof, high capacity, proximity, oil-tight, environment-free, and multicircuit types. Has photos, dimensions, electrical ratings, characteristics and application information.

Circle 227 on Inquiry Card, page 117

## Rectifier Handbook

Two-color, 48-page silicon rectifier handbook contains electrical ratings, performance data, and dimensional drawings for every type of silicon rectifier offered by Sarkes Tarzian, Inc., Rectifier Div., Bloomington, Ind. Catalog No. 69 also deals with silicon rectifier theory of operation, manufacture and characteristics, and offers the design engineer help in silicon rectifier application.

Circle 228 on Inquiry Card, page 117

## Silicone Laminate

Continental - Diamond Fibre Corp., Newark, Del., has just issued a 20-page booklet which describes a new economy grade silicone laminate. Material combines high heat resistance, flame, arc and moisture resistances with good electrical and mechanical properties. Complete information is given.

Circle 229 on Inquiry Card, page 117

## Digital Voltmeter

A 2-page data sheet describing the Model 501 Digital Voltmeter is now available from the KIN TEL Div. of Cohu Electronics, Box 623, San Diego 12, Calif. It includes mounting, controls, readout, and specifications.

Circle 230 on Inquiry Card, page 117

## Space Technology

Applied research in space technology, plasma dynamics, and hypersonics is described in a booklet from General Electric Co., Missile and Ordnance Systems Dept., Room 5A, 3198 Chestnut St., Phila., Pa. Included are drawings of a 6 in. dia., 134 ft. long shock tunnel and picture caption summaries of research activity in gas arcs, recombination rates, plasma acceleration, material emissivities, high temperature radiation, and gas-phase chemical reaction.

Circle 231 on Inquiry Card, page 117

## Silicones

Illustrated, 8-page brochure, "Silicones in Missile Design," is a quick reference to missile and rocket applications for silicone rubbers, resins, dielectrics, fluids, greases and compounds. It covers the use of silicones to aid miniaturization and weight reduction. "Silicon News," Dow Corning Corp., Midland, Mich.

Circle 232 on Inquiry Card, page 117

## Capacitors

EFCON (Electronic Fabricators, Inc., 682 Broadway, N. Y.) has published Bulletin AT 101 which gives dimensions and prices of its Polystyrene and Mylar tubular and rectangular capacitors in ±5% capacitance tolerances. Included are descriptions, nomenclature, designations, and electrical characteristics of its precision dielectric film capacitors.

Circle 233 on Inquiry Card, page 117

## Capacitors

"The Ultimate in Reliability" is a 6-page folder describing Ceramic Disc Capacitors manufactured by the Electro Motive Mfg. Co., Inc., Willimantic, Conn. The folder describes type TC, temperature-compensating capacitors, type GP, general purpose capacitors and the type TS, temperature stable capacitors. Also included are standard temperature characteristics and curves on all types.

Circle 234 on Inquiry Card, page 117

## Airborne Weather Radar

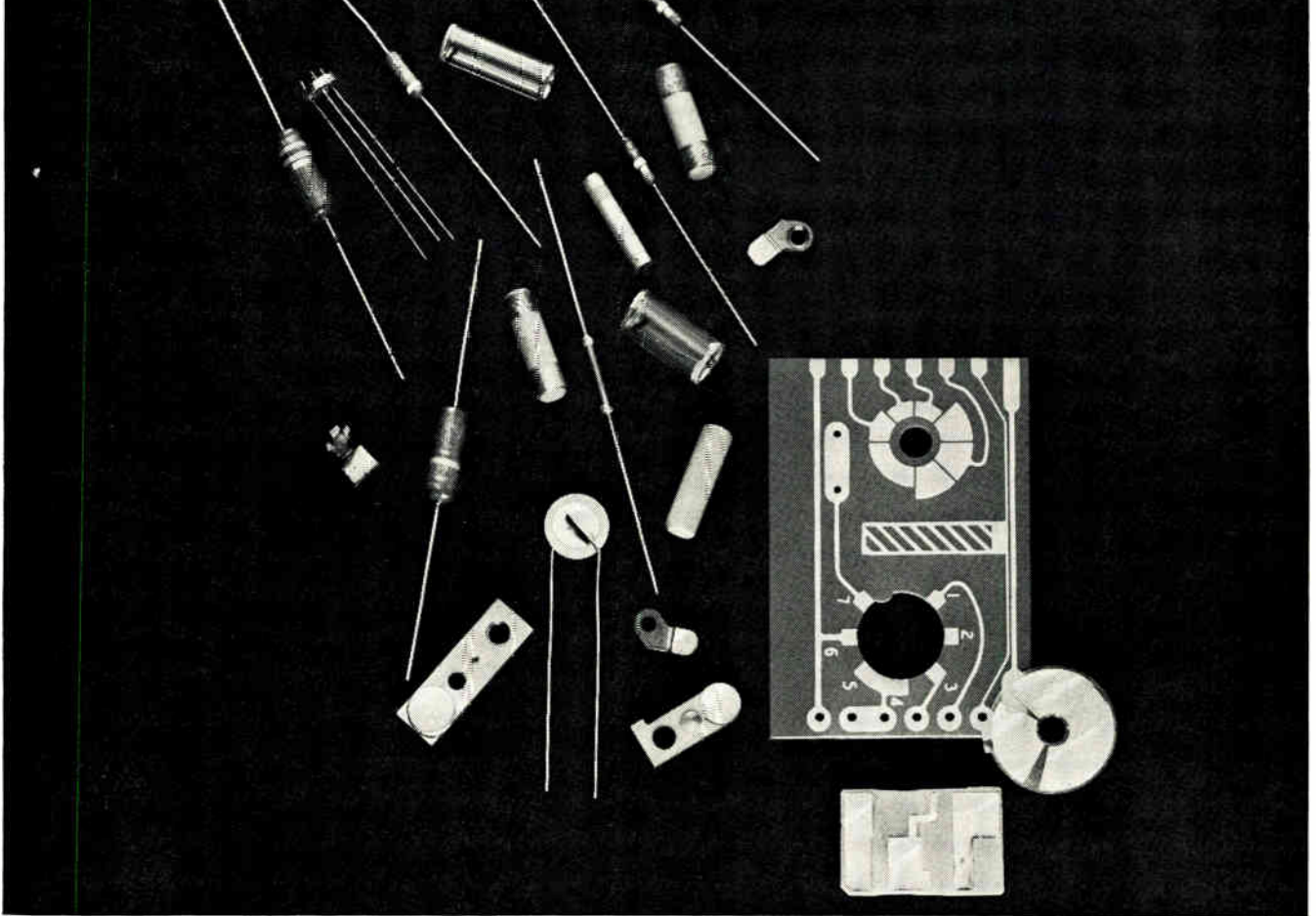
A 12-page, 2-color booklet by Bendix Radio Division, Bendix Aviation Corp., Baltimore 4, Md., describes the RDR-1 Airborne Weather Radar. Included are specifications, system description and advantages, power requirements, and outline drawings of the equipment.

Circle 235 on Inquiry Card, page 117

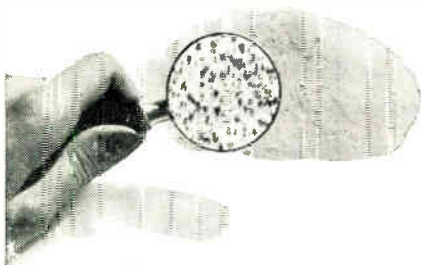
(More Tech Data on page 96)



# SILVER



## Handy & Harman Silver Powder and Flake for Electronic Applications



Among the many forms of silver and silver alloys manufactured by Handy & Harman are:

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice — or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

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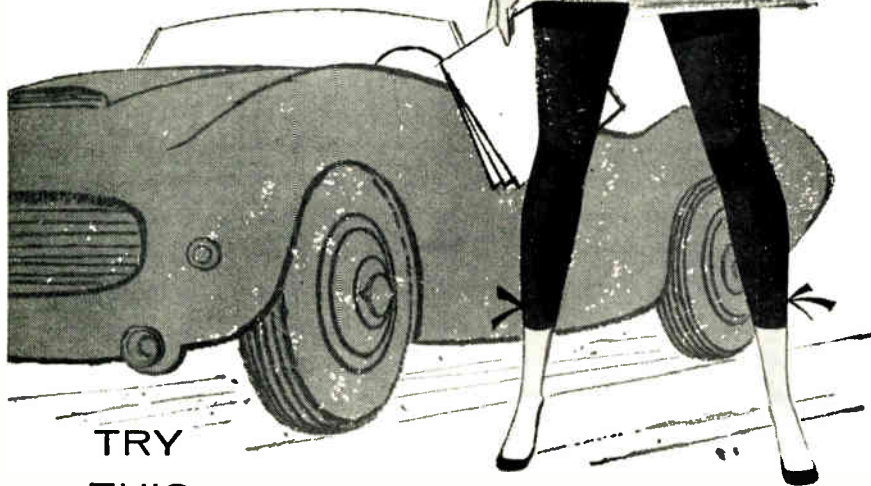
**HANDY & HARMAN**

General Offices: 82 Fulton St., New York 38, N. Y.

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LOOKING  
FOR THE  
**POWER  
TYPE?**



TRY  
THIS  
NUMBER

**PC-2C/220VA**

Advance offers a wide selection of compact, positive-acting, AC or DC relays for power control and power transfer. They can be used in any position, because high gram pressure is maintained by heavy spring tension. Rugged components, careful assembly assure long life.



In addition to PC type relays (specifications below), Advance can also supply PG (general purpose) and PV (very heavy duty) power-type relays, with contact ratings varying from 15 amps to 30 amps.

**SPECIFICATIONS**

- Coil resistance, DC:** From 16 Ohms, at 6 volts, to 4,000 Ohms, at 110 volts.
- Coil resistance, AC:** From 1.6 Ohms at 6 volts, to 2,500 Ohms, at 220 volts.
- Contact arrangement:** From SPST, NO or NC, up to 4PDT.
- Nominal power required, DC:** 2 to 3 watts.
- Nominal power required, AC:** 10 to 12 volt-amperes.
- Contact rating:** 15 amps resistive, 5 amps inductive at 115 volts AC or 26.5 DC.

Available From Leading Distributors

**WRITE FOR COMPLETE DETAILS**

Data sheets are available on the PC series (power control), the PG series (general purpose power transfer), and the PV series (very heavy duty power transfer).



**ADVANCE RELAYS**  
A PRODUCT OF ELECTRONICS DIVISION  
**ELGIN** ELGIN NATIONAL WATCH COMPANY  
Dept. H, 2435 N. Naomi St., Burbank, California



**New Tech Data**

for Engineers

(Continued from page 94)

**Adhesives**

Technical data bulletin, DB-331, describes Isobond 331, an internally catalyzed and flexibilized epoxy adhesive formulation requiring no mixing or metering before use. Included are typical properties of uncured and fully cured Isobond 331 with the test method used; also with directions for use. Isochem Resins Corp., 221 Oak St., Providence, R. I.

Circle 236 on Inquiry Card, page 117

**Desktop Computer**

Data File 340 describes the Model 3400 Desk top analog computer. Includes description of how the computer solves problems, specifications, accessories, and plug-in component selections. Donner Scientific Co., Concord, Calif.

Circle 237 on Inquiry Card, page 117

**Power Supplies**

A 33-page, 2-color catalog, No. 59 from Lambda Electronics Corp., College Point, New York, describes the firm's line of power supplies. It includes descriptions of how the power supplies are made, outline drawings, representative users, and ordering information.

Circle 238 on Inquiry Card, page 117

**Zener Diodes**

Bi-monthly bulletin, December-January issue of International Rectifier Co., El Segundo, Calif., features "The Zero Temperature Coefficient Zener Diode," and "The Influence of Temperature on Silicon Solar Battery Output." Included are "Silicon Diode Low Leakage vs Voltage Ratings" and "Zener Diodes and their Application to Industrial Equipment."

Circle 239 on Inquiry Card, page 117

**Test Point Connectors**

Illustrated, 2-color, 6-page brochure from DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y., gives specifications, outline dimensions and general information on printed circuit test point connectors.

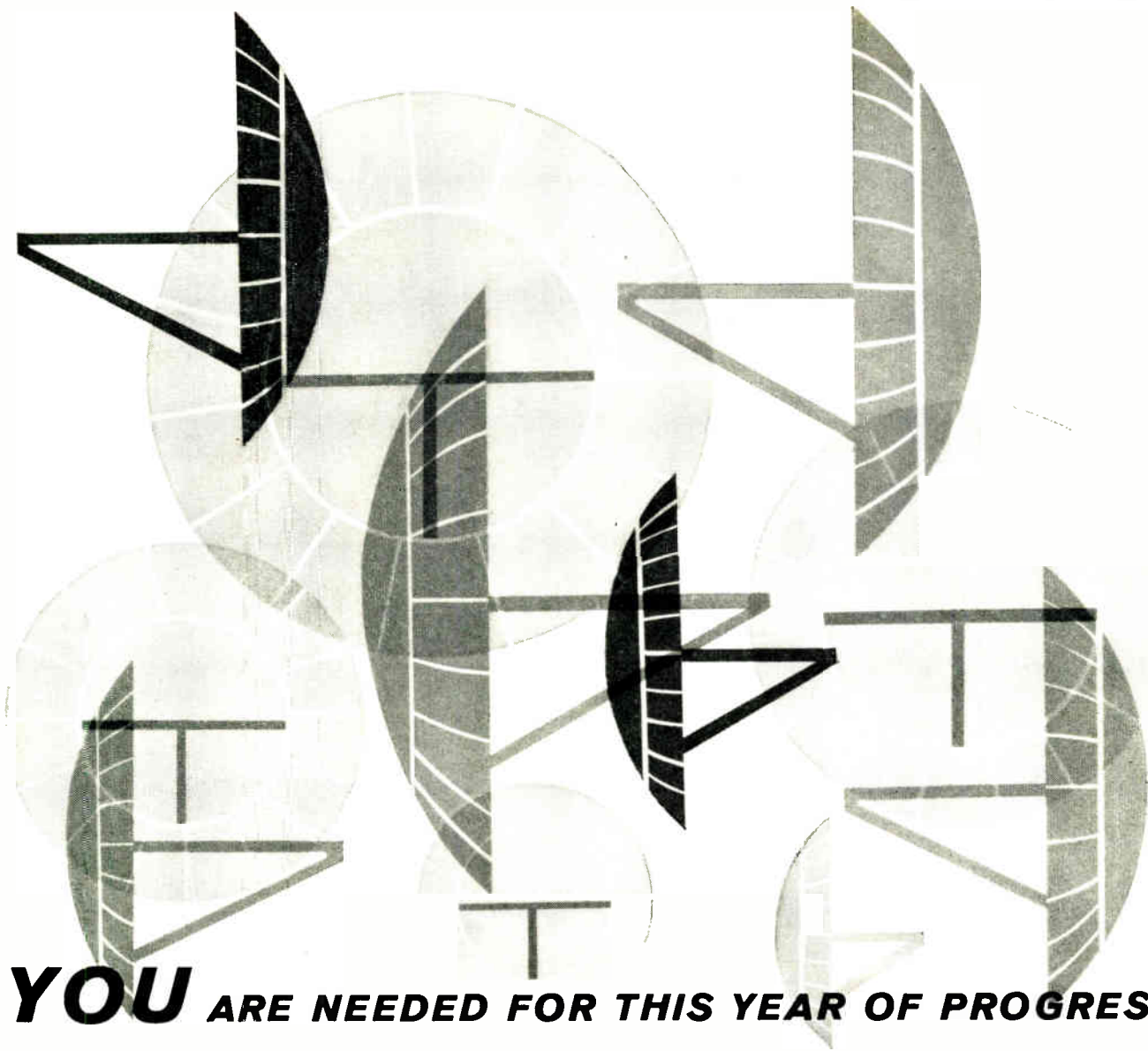
Circle 240 on Inquiry Card, page 117

**Choppers**

"The Contact Modulator," a series of new pamphlets on choppers, replaces Bulletin 103. Part 1, "Why Use Choppers" is available from the Airpax Products Company, Seminole Div., Fort Lauderdale, Florida.

Circle 241 on Inquiry Card, page 117





# **YOU ARE NEEDED FOR THIS YEAR OF PROGRESS**

You are unique. You are a one-of-a-kind man needed to think for a new world of tomorrow. Your greatest gift to progress can be your ability to apply your inherent differences in thought and background to your field of specialty in radio electronics.

To help you think, to help you generate new

ideas, come see THE RADIO ENGINEERING SHOW that requires all 4 floors of New York City's Coliseum. Come hear your choice of more than 200 papers to be given during the CONVENTION. You are needed. Yes, it takes a coliseum to hold this great electronic show. Then, it takes you to have the great thought, the INSPIRATION IN RADIO ELECTRONICS.

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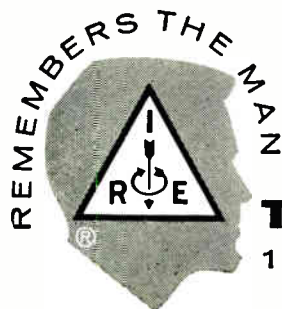
**AND THE RADIO ENGINEERING SHOW**

*Coliseum, New York City*

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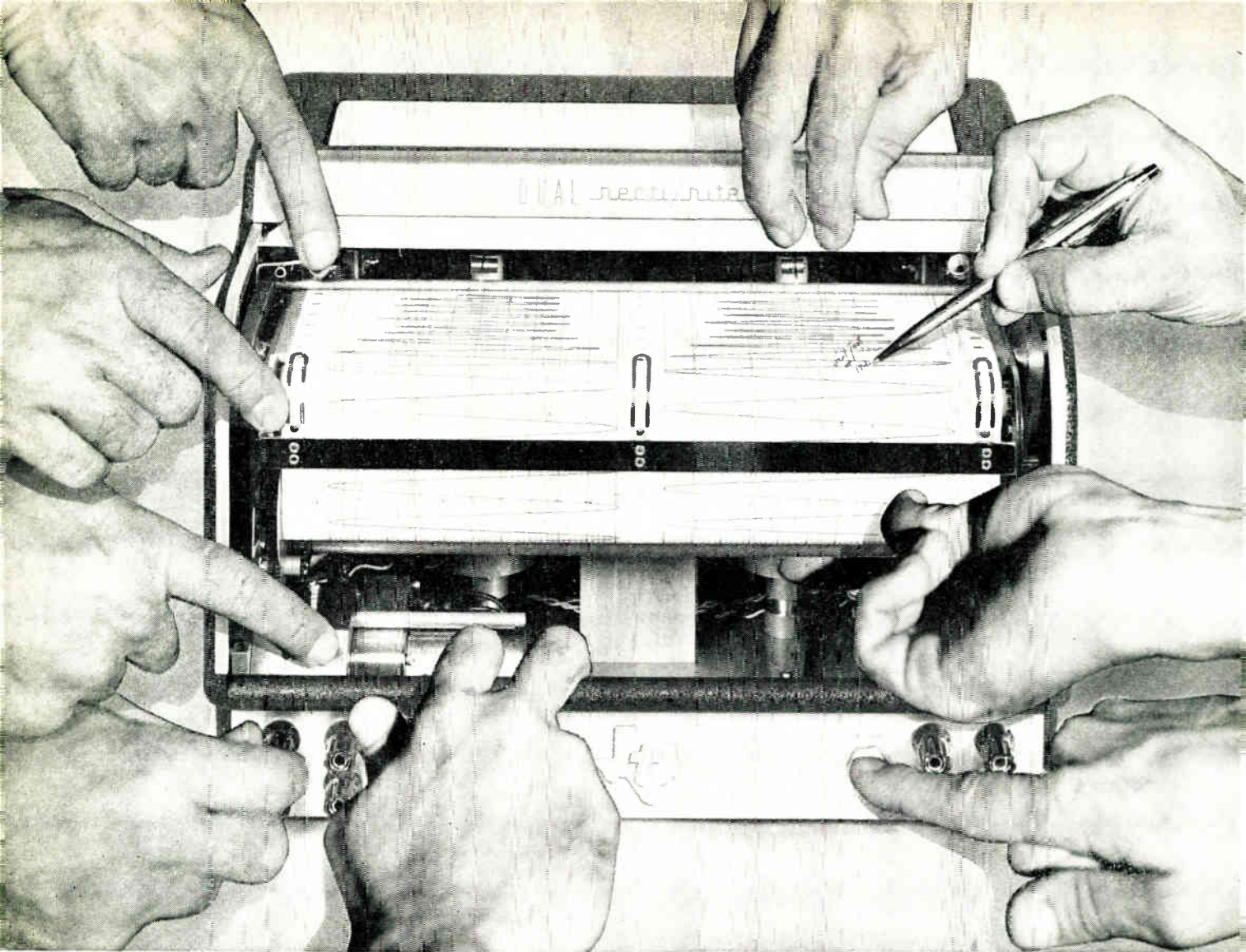
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**THE INSTITUTE OF RADIO ENGINEERS**

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With the greatest ease and speed, you can . . .

1. Raise the transparent, dust-proof door . . .
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10 millivolts to 1000 volts  
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Monitor standard frequencies — 40, 60, 400 cps

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## ANTENNAS, PROPAGATION

**Methods For Increasing The Efficiency Of Simple Wide-Band Shortwave Antennas**, S. I. Nadeneko. "Radiotek," Nov. 1958. 6 pp. Results are given for detailed computation of a wideband shortwave antenna consisting of a horizontal wide-band dipole in a corner reflector. The corner reflector is formed by the surface of the earth and a grid of wires located at an angle with respect to the plane of the earth. It is shown that such an antenna has an efficiency equivalent to an ordinary rhombic antenna, but is more economical and occupies a smaller antenna-field area. (U.S.S.R.)

**The Effect Of The Height Of Antennas On The Received Power For Propagation Under Conditions Of Tropospheric Scattering**, A. E. Tsel'min, L. R. Krauz. "Radiotek", Nov. 1958. 7 pp. An expression is derived for the attenuation function; this expression makes it possible to compute a communication line under conditions of tropospheric scattering for meter wavelengths. The effect of the surface of the earth on the directivity patterns of the antennas is taken into account. Graphs are given for the dependence of the attenuation function on distance and on the heights of the antennas for the case of a square-law dependence of the turbulence on altitude. (U.S.S.R.)

**Considerations Relating To The Analysis Of Fading In The Metric And Decimetric Wavebands**, J. Grobkopf. "Nach. Z." Nov. 1958. 9 pp. More recent theoretical correlation methods for the analysis of fading curves are reported and their application to a number of practical test results from VHF propagation is illustrated. The known theories for scatter propagation are discussed with the aid of measured correlation functions. (Germany.)

**The Horizontal Radiation Patterns of Rhombic Antennas For Receivers in Short-Wave Links**, H. Bohnenstengel, et. al. "Nach. Z." Dec. 1958. 6 pgs. The horizontal radiation patterns of standard rhombic antennas at the transatlantic radio receiving station for short-waves at Eschborn have been measured by means of statistical methods and values for the side lobe level as well as for the backward radiation level at different frequencies have been derived from these measurements. (Germany.)

**Propagation Conditions Between Europe and North-America in The Frequency Band 40 to 52 Mc/s During A Maximum of Sun-Spot Activity**, H. Wisbar. "Nach. Z." Nov. 1958. 5 pp. The transatlantic (USA) reception of

short-waves is compared with the activity of the  $F_2$ -layer and with earth-magnetic disturbances. The evaluation of the test results has lead to the allocation of propagation codes for characterizing the prevailing propagation conditions of the ionosphere close to and in the zone of Aurora. Special statements are made for the path Europe to USA. Various values for the code are discussed. The proposal for scatter tests on the  $F_2$ -layer in the waveband 35-50Mc/s and over distances of 3,000 to 4,000 km is based on various considerations. (Germany.)



## AUDIO

**Self Starting Acoustic Oscillations in Closed Spaces**, D. Barbaro. "Alta. Freq." Oct. 1958. 14 pp. Description is made of the phenomenon known as Larsen Effect which consists in the self starting of acoustic oscillations in a closed space provided with a microphone and a loudspeaker of an amplification plant. A differential equation is given to represent the phenomenon at least in its essential features as recognized on the basis of a discussion. (Italy.)



## CIRCUITS

**Simplified Algebraic Synthesis of Relay Circuits**, Ya I. Mekler. "Avto i Tel." Dec. 1958. 16 pgs. Simplified algebraic synthesis of relay circuits is depicted. The suggested method permits to get structure formulae from switching table directly. The method mentioned is compared with other methods. (U.S.S.R.)

**Generation Of Millimicrosecond Pulses With A High Repetition Frequency**, B. A. Mamyrin. "Radiotek," Nov. 1958. 12 pp. The paper studies a method for generating millimicrosecond pulses with a repetition frequency of the order of a megacycle for amplitudes of the order of hundreds of volts. A method is developed for the engineering design of an oscillator for such pulses; the data is computed for the operating modes of the tubes in the output stages. (U.S.S.R.)

**A Single-Stage Phase-Shift RC Oscillator Using A Transistor**, Ia. K. Trokhimenko. "Radiotek," Nov. 1958. 8 pp. The paper studies the effect of junction-transistor parameters on the operation of a single-stage phase-shift RC oscillator which produces a sinusoidal output voltage. Two basic types of oscillators are treated: a) with shunt resistors, and b) with shunt capacitors. (U.S.S.R.)

## REGULARLY REVIEWED

### AUSTRALIA

AWA Tech. Rev. AWA Technical Review  
Proc. AIRE. Proceedings of the Institution of Radio Engineers

### CANADA

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 Electric Co. Journal  
J. BIRE. Journal of the British Institution of Radio Engineers  
Proc. BIEE. Proceedings of Institution of Electrical Engineers  
Tech. Comm. Technical Communications

### FRANCE

Ann. de Radio. Annales de Radiélectricité  
Bull. Fr. El. Bulletin de la Société Française 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 Über. Archiv der Elektrischen Übertragung  
El Rund. Elektronische Rundschau  
Freq. Frequenz  
Hochfreq. Hochfrequenz-technik und Elektroakustik  
NTF. Nachrichtentechnische Fachberichte  
Nach. Z. Nachrichtentechnische Zeitschrift  
Rundfunk. Rundfunktechnische Mitteilungen  
Vak. Tech. Vakuum-Technik

### POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemekhaniki  
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego  
Roz. Elek. Rozprawy Electrotechniczne

### USSR

Avto. i Tel. Avtomatika i Telemekhanika  
Radio. Radio  
Radiotek. Radiotekhnika  
Rad. i Elek. Radiotekhnika i Elektronika  
Iz. Acad. Bulletin of Academy of Sciences, USSR.

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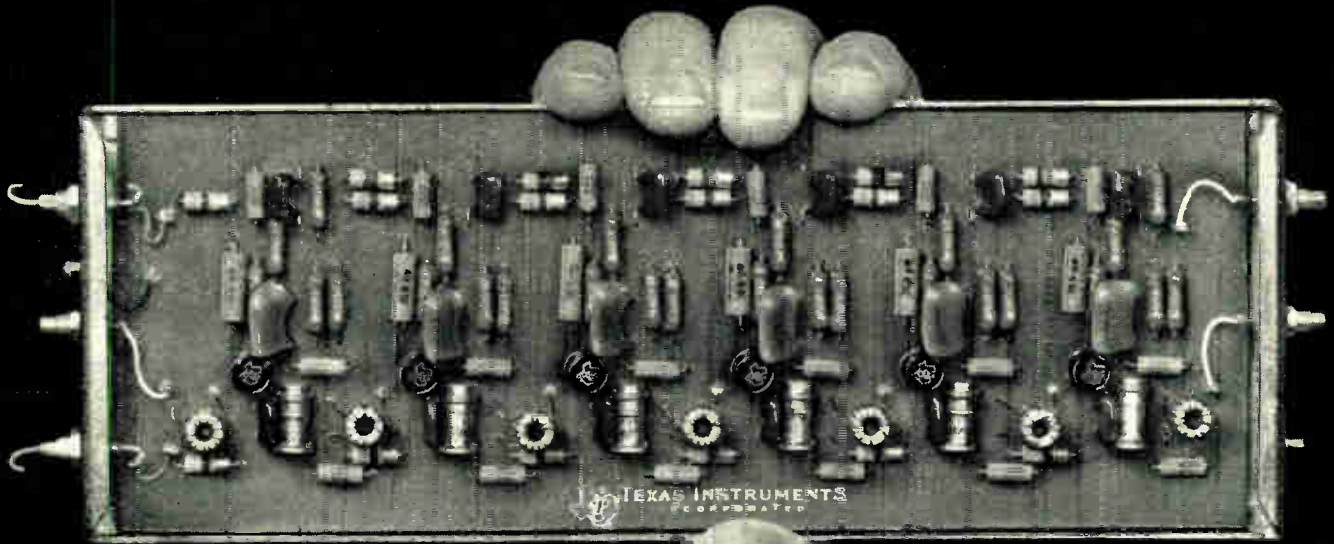
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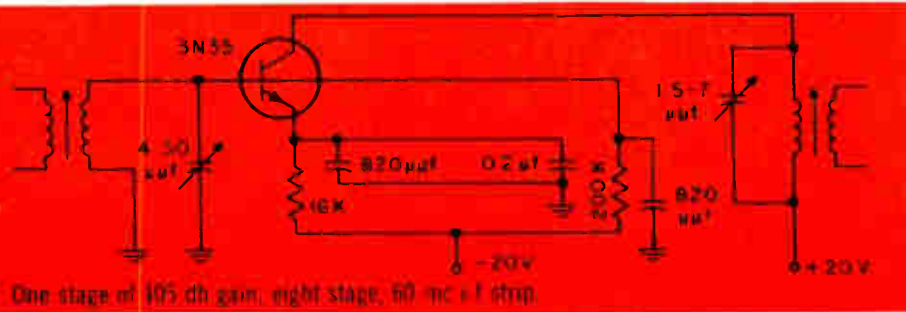




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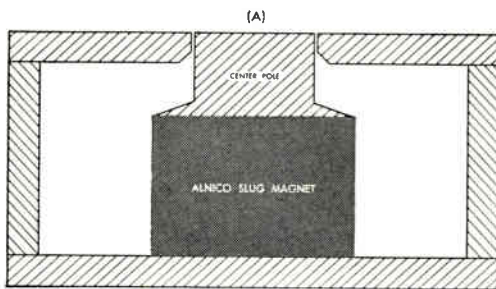
*Torque Drives* using Indox V discs can be magnetized with multiple-pole faces.

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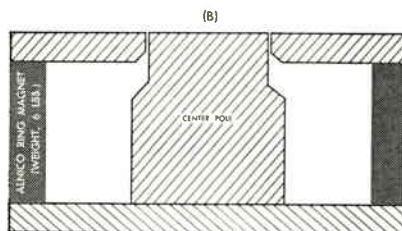
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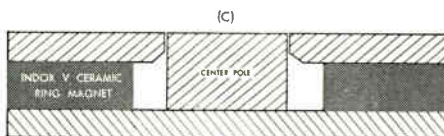
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## COMMUNICATIONS

**A Quartz Stabilized 4 kc/s Oscillator for the K24/P Carrier Telephone System**, B. Gniwowska. "Prace. ITR." Vol. 2, No. 2 (5). 12 pp. In connection with the investigation of typical quartz stabilized oscillator circuits employing "XY-cut" quartz crystals fundamental properties of several oscillator circuits have been compared. These comprise: circuits with or without negative feedback as well as those with or without automatic control. Essential properties of this kind of oscillator circuits have been discussed, along with a number of points pertaining to the design of the circuits under consideration. (Poland.)

**Equivalent Impedances and Diagrams of Medium Voltage Over-Head Lines Of The Four Wire-Ground Type**, Z. Kowalski. "Roz. Elek." Vol. 4, No. 3, 1958. 63 pgs. (Poland.)

**A Review on the Analysis Of Transients In Electrical Circuits Using The Laplacian Transformation**, P. Rajgopala Rao. "J. ITE." Sep. 1958. 4 pp. (India, in English.)

**Frequency Stable Oscillators As Current Or Voltage Sources**, W. Herzor. "Nach. Z." Nov. 1958. 7 pp. The paper explains that considerations in terms of characteristic impedances can lead to conclusions whether a bridge type oscillator is suitable as a current source or as a voltage source under the condition of the best possible frequency stability. (Germany.)

**RC-Amplifier with 60 Mc/s Bandwidth**, K. J. Schmidt-Tiedemann. "El. Rund." Dec. 1958. 3 pgs. The transmission function of a RC amplification circuit in which the stray capacitances are compensated with the help of inserted cathode amplifiers is derived and discussed. Hints at the optimal design, especially in reference to the distribution of the stray capacitance to two neighbouring valves are derived from this method. A bandwidth of 62.5 Mc/s at 5.3 fold amplification is obtained by a two-stage amplifier. (Germany.)

**A Low Capacitance Input Circuit**, J. C. S. Richards. "El. Eng." Dec. 1958. 3 pp. It is customary to connect an electronic measuring instrument to an apparatus under test by means of several feet of coaxial cable, having a capacitance of 50 to 100 pF. Various methods of reducing the effect of this cable capacitance are discussed. A circuit is described in which a compact probe containing only passive elements is used in conjunction with a single valve feedback amplifier to give an input capacitance of less than 5pF, and a gain of unity over a bandwidth of 2Mc/s. (England.)

**Filter Attenuation Characteristics. Derivation of Formulae Allowing Slide-Rule Computation**, M. D. Johnson and D. A. G. Tait. "El. Eng." Dec. 1958. 2 pp. Expressions for the attenuation of ideally-terminated m-derived filters are derived in a form that avoids the use of hyperbolic functions. It is found that the resulting expressions are quite simple, and an attenuation curve is given showing their application to a specific case. (England.)

**The Magnetic-Amplifier Applied To Voice-Frequency Ringers**, T. W. Carreyett. "Brit. C. & E." Jan. 1959. 3 pgs. In line transmission equipment, one type of voice-frequency ringer circuit is that which converts an incoming ringing frequency to a lower frequency for local application. Similarly in the outgoing direction the local low ringing frequency is converted to a higher one which can be accommodated in one of the transmission channels. These operations are performed by frequency selection circuits, which result in the operation of the necessary relays. This article discussed the possibilities of employing a magnetic amplifier for this conversion or switching action instead of the conventional valve circuit. The advantages of employing this means of amplification are discussed. (England.)

**The Frequency Band Occupied By A Transmitted Random Train Of Signals**, M. S. Gurevich. "Radiotek." Nov. 1958. 9 pp. The paper treats the difficulties which arise in determining the width of the band occupied by the transmission of random radio-telegraph signals; methods for overcoming these difficulties are indicated. Relationships are derived which facilitate a comparison between the spectra of random and periodic signals. The "average" width for the band of random signals is determined for a particular case. Practical suggestions are given with regard to an experimental determination of the band width occupied by the transmission of random signals. (U.S.S.R.)

**Single-Grid Frequency Conversion of Amplitude-Modulated Signals**, A. Cielecki. "Prace. ITR." Vol. 2, No. 2(5). 44 pp. In the paper an analysis is presented of non linear distortions arising at single-grid frequency conversion of amplitude-modulated signals. Problems of cross modulation, secondary modulation, contents of harmonics in modulation envelope and change of modulation depth are examined. Special consideration is given to the problem of cross modulation as the most important disturbance caused by non-linearity of tube characteristics. Direct influence of heterodyne voltage on all types of distortions and disturbances is also shown. At the end of theoretical part a new method is given of determining coefficients of non-linearity of tube characteristics by measurement of cross modulation. (Poland.)

**Remote Control and Supervision for Communication Links**, G. Glunder. "Nach. Z." Nov. 1958. 5 pp. The requirements for remote control and supervision equipment in communication links are discussed. The selectors used for this equipment are operated by a pulse-telegram method. 25 different informations can be transmitted by the remote supervision equipment from each sub-station to one or several main stations and up to 30 pairs of instructions can be transmitted by the remote control equipment from the main stations to any of the substations. A further 240 informations can be obtained from each substation by means of request circuits. (Germany.)

**Radio Interference From Fluorescent Lamps**, H. J. J. Van Boort et al. "Phil. Tech." Nov. 22, 1958. 10 pp. Radio reception is sometimes subject to interference from high-frequency oscillations generated in fluorescent lamps and entering the receiver via the mains. Quantitative information on this irregular phenomenon is obtained with a standard test arrangement, the results being analyzed statistically. The symmetrical and asymmetrical components of the interference voltage were measured in this way on various types of lamps and ballasts. (Netherlands, in English.)

**Ionospheric Absorption Over Delhi**, B. V. T. Rao and M. K. Rao. "J. ITE." Sept. 1958. 4 pgs. An automatic method of measuring ionospheric absorption on vertical incidence pulsed transmissions has been developed at the Research Department of All India Radio. The equipment and some preliminary observations have been described earlier. Regular measurements by this recorder were commenced in June 1954 and are still in progress. The present paper deals with the analysis of further measurements made till October 1957. (India, in English.)

**Slit Resonators As Low Frequency Sound Absorbers**, D. Govinda Ragavan. "J. ITE." Sept. 1958. 7 pgs. The behaviour of Helmholtz type slit resonators used as low frequency absorbers has been studied in the laboratory as well as in a reverberation test chamber. The theo-

retical values in regard to resonant frequency, bandwidth and maximum absorption tally fairly well with the values obtained in the test chambers and in studios. Such low frequency resonators are in use at present in some of the A.I.R. studios. (India, in English.)

**Transmission By Meteor Scatter**, E. Roessler: Janet. "El. Rund." Dec. 1958. 7 pgs. Meteor scatter gives rise to VHF ranges far beyond the optical horizon. The summarising work gives information on the wave-propagation process, space division, and considerations of frequency bandwidth, also aerial gain. Finally, the American equipment known as JANET in literature is considered. (Germany.)

**Properties of Networks with Rectifiers and of Active Normal 2k-Terminals Networks**, G. Biorci. "Alta. Freq." Oct. 1958. 16 pp. Several general properties of networks containing ideal rectifiers are stated and proved. They simplify the analysis of such networks. Then the networks containing either one or two or three rectifiers are examined. It is shown that the number of normal networks which have to be analyzed in order to determine the state of the rectifiers (conduction or not conduction) is one, two and three respectively. (Italy.)

**Step Detection**, A. R. Billings. "El." Dec. 5, 1958. 3 pp. The spectrum of a step-detected signal is derived both for an ideal and a practical step detector. It is shown that the attenuation distortion produced by step detection is small, and that step detection, when applied to time-division multiplex systems, can produce a considerable reduction in adjacent-channel crosstalk. (England.)

**A Track Switching System for a Magnetic Drum Memory**, D. D. Majumder. "El. Eng." Dec. 1958. 4 pp. An electronic track switching system using a rectifier function mesh, and magnetic gating transformers is described. The same information channel and magnetic head with one winding can be used for both recording and playing back signals. Superiority of the system with respect to cost, reliability, and performance is claimed by the author. (England.)

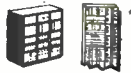


## COMPONENTS

**Printed Wiring in Radio Sets**, R. Van Beek and W. W. Boelens. "Phil. Tech." Nov. 22, 1958. 9 pp. Attempts to mechanize the wiring of electronic apparatus have led to the development of "printed wiring." Advantages of this process from the standpoint of organization are that it saves factory space and personnel and practically eliminates the wiring faults that are inevitably made with conventional wiring in the early stages of the production run of a new radio set. (Netherlands, in English.)

**The Cooling of PVC Coated Conductors During The Production Process**, G. Buhmann. "Nach. Z." Nov. 1958. 4 pp. The length of the water trough for cooling PVC coated wires in the production process depends mainly on the speed of the process and on the type of conductor. The required cooling period can be determined experimentally in two different ways. In the first case, the period for cooling a conductor from 160° to approximately 100° C is determined by means of a measurement of the electrical resistance in the copper. On the other hand, the maximum velocity beyond which the insulation is flattened, can be determined for each type of wire when the length of the water trough is given. The permissible final temperature has been determined to be 90-100° C. The length of the water trough required for any speed of processing and for any type of wire can be determined from the result of these measurements. (Germany.)

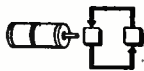
**New Types of Germanium Diodes and Their Circuit Applications**, G. Grimsdell. "El. Eng." Dec. 1958. 2 pp. The properties of the recently introduced gold-bonded diodes and small-area junction diodes are compared with those of the well-known point-contact types, and the relative advantages and disadvantages are outlined. The requirements of controlled hole-storage and controlled turn-on time are discussed with particular reference to the new types. (England.)



## COMPUTERS

**Ferroelectric Storage Devices**, S. Moreleigh. "El. Eng." Dec. 1958. 7 pp. An important requirement of the modern digital computer is an efficient memory device to enable the high speed storage and recovery of data at will. This has led to a critical examination of the properties of all media possessing two stable states. Among the most important characteristics of a digital storage system are economy in power requirements for the processes of reading and writing information, speed of operation, size and cost per unit of stored data, simplicity of construction, and overall reliability. (England.)

**Ultrasonic Mercury Delay Lines**, C. F. Brocklesby. "E. & R. Eng." Dec. 1958. 7 pages. (England.)



## CONTROLS

**Choice of Power Unit of Optimal Automatic Control Systems**, L. N. Fitsner. "Avto. i Tel." Dec. 1958. 11 pp. The paper deals with choice of power unit of optimal automatic control systems. To illustrate the suggested method, a servosystem is considered, its power unit is a d-c electric motor. (U.S.S.R.)



## GENERAL

**On Determination of an Optimal Dynamic System**, N. I. Andreev. "Avto. i Tel." Dec. 1958. 14 pp. The paper deals with sufficient conditions of extremum for a functional that is assumed as a criterion while comparing different dynamic systems. The paper includes two instances that illustrate described way of selecting an optimal dynamic system. (U.S.S.R.)

**Application of the Electroluminescence Phenomenon to Amplifying the Image**, J. Wojciechowski. "Roz. Elek." Vol. 4, No. 3, 1958. 32 pp. The electroluminescence phenomenon in solids is characterized in the beginning of the paper. This phenomenon, observed for the first time by Destriau in 1936, consists in the luminescence of special kind of phosphors by the application of an alternating field to the phosphor suspended in the dielectric of a capacitor. (Poland.)

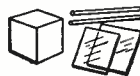
**The Solution of Some Heat Conduction Problems by Unidimensional Laplace Transformation**, R. Hofmann. "Arc. El. Uber." Vol. 2, No. 10, Oct. 1958. 7 pp. The paper determines the temperature distribution in a finite cylinder, whose one front comes into contact with a hot disk from the time  $t=0$  onward. This problem of heat conduction is encountered, for instance, when a carbon film resistor attached to supporting material is exposed to a temporary load. (Germany.)

**The Training of Electronic Maintenance Engineers, Part 1**, H. C. A. Dale. "Brit. C. & E." Jan. 1959. 5 pp. (England.)



## INDUSTRIAL ELECTRONICS

**Microwave Generators with Closed Operating Space for Dielectric Heating of Viscuals and Industrial Products**, W. Schmidt. "El. Rund." Dec. 1958. 4 pgs. The present second part of the article describes in detail the measuring technique of microwave generators with closed operating space for dielectric heating of viscuals and industrial products. Following facts are considered: microwave generator in equivalent circuit diagram, magnetron-generator diagram, measurement with signal generator of low performance level, measurements with magnetrons of high performance level, noise voltage measurements. (Germany.)



## MATERIALS

**The Selection of Material for Electromagnetic Shielding of Rooms**, A. P. Efimov. "Radiotek." Nov. 1958. 7 pp. The paper studies the requirements which must be satisfied by the materials which are to be used for the electromagnetic shielding of rooms at high frequencies. A comparison is made between the shielding properties of sheet and mesh-type materials of copper and steel. (U.S.S.R.)

**Data on Ferrite Core Materials**, A. C. Hudson and E. J. Stevens. "El. Eng." Dec. 1958. 2 pp. Charts are presented which permit comparison of the permeability and loss at low levels for various ferrites, and some other core materials, over the frequency range 100 kc/s to 100 Mc/s. The loss is represented in terms of an inherent low-level 'Q' of the material, for convenience in design calculations. An example of a simple transformer design using the charts is given. (England.)



## MEASURE & TESTING

**A Resonance Method for Measuring the Equivalent Parameters of Quartz Crystals**, L. A. Korneev. "Radiotek." Nov. 1958. 8 pp. The paper proposes a new resonance method for measuring the equivalent parameters of quartz crystals. This method is adequate over a wide range of frequencies, and particularly at shortwave frequencies. An evaluation is made of the errors involved in measurements using this method. (U.S.S.R.)

**Testing of Transformer Steel Sheets of Polish Make for Telecommunication Purposes**, R. Pac. "Prace. ITR." Vol. 2, No. 2(5). 7 pp. Transformer steel sheets having a permeability in excess of 700 Gs/Oe (A3 class according to DIN 41301) are widely used in telecommunication equipment. This kind of steel sheets, 0.35 mm thick, having a permeability of at least 700 Gs/Oe and losses  $V_{10}$  at most 1.3 W/kg have been tested so far by a non-destructive method applied to the whole sheets. This method employed a testing equipment developed at the Telecommunication Institute of Industry. Introduction of new technology resulted in the production of improved steel sheets with reduced losses. (Poland.)

**Low Voltage Sources at High Frequency**, H. Schoenman. "Prace. ITR." Vol. 2, No. 2(5). 20 pp. The paper discusses actual problems connected with the design and testing of sources of very low voltages in the frequency

range up to about 300 Mc/s, including general aspects of these, with particular reference to phenomena occurring at high frequencies. There have been described: practical design and application of attenuators using wire-wound or composition resistors, difficulties involved in their application at high frequencies, as well as principle of operation, essential features and application of Selbe's micropotentiometer. (Poland.)

**The Accuracy in the Measurement of Self-Capacity of Coils**, A. Jellonek. "Roz. Elek." Vol. 4, No. 3, 1958. 36 pgs. The paper is devoted to the comparison of various measurement methods of self-capacity of coils and to the discussion of the accuracy achieved. (Poland.)

**Measurements of Small Direct Magnetic Fields with Flux-Gate Magnetometers**, P. J. Nowacki, et al. "Roz. Elek." Vol. 4, No. 3, 1958. 27 pgs. This paper describes measurements of small direct magnetic fields by using flux-gate magnetometers. It is explained what are the operating conditions of single-core magnetometers, when the arrangements are supplied from a sinusoidal voltage source or from a sinusoidal current source. (Poland.)

**Q-Value Measurements by Means of a Standing Wave Indicator on Cavity Resonators Connected with Transmission Lines**, W. Hans Urbarz. "Nach. Z." Nov. 1958. 6 pp. When cavity resonators are connected with transmission lines, all technically possible cases can be reduced to the case of a cavity or its equivalent circuit in series or in parallel to the characteristic impedance of the transmission line. The Q-value of such cavities can be determined from the mismatch and from the position of the minimum at frequencies near resonance when a standing wave indicator is used. The method of measurement stated in literature for the case of a cavity in a parallel circuit is systematically expanded to cover a number of technically interesting types of coupling. Some simple equations for the evaluation of the measurements are given for the discussed types of cavity coupling and are proved theoretically. (Germany.)

**On the State of Oscilloscope Technique**, C. Heindl. "El. Rund." Dec. 1958. 4 pgs. Whereas amplifier circuits having been described in the first part of the article, the present second part deals with time-deflection circuits and triggering. (Germany.)



## RADAR, NAVIGATION

**An Electronic Line Storage Device for Bandwidth Compression of Periodically Repeated Signals, Particularly for Radar PPI Displays**, K. Lange. "Nach. Z." Dec. 1958. 9 pgs. Periodically repeated noisy groups of signals with a large bandwidth can be combined by means of a storage method to form a single group of signals with a smaller bandwidth and an improved signal/noise ratio. The integration of corresponding instantaneous values in the signal groups is carried out effectively in an electronic line charge storing tube. (Germany.)



## SEMICONDUCTORS

**A Storage Scaler Using Transistors**, A. S. Selivanov. "Radiotek." Nov. 1958. 5 pp. The paper studies the special features involved in the operation of a storage scaling cell with a transistorized retarded blocking-oscillator. Formulas are derived for computing a temperature-stable circuit and recommendations are given for the design of frequency dividers. (U.S.S.R.)



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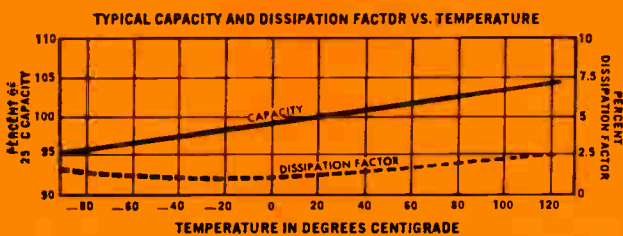
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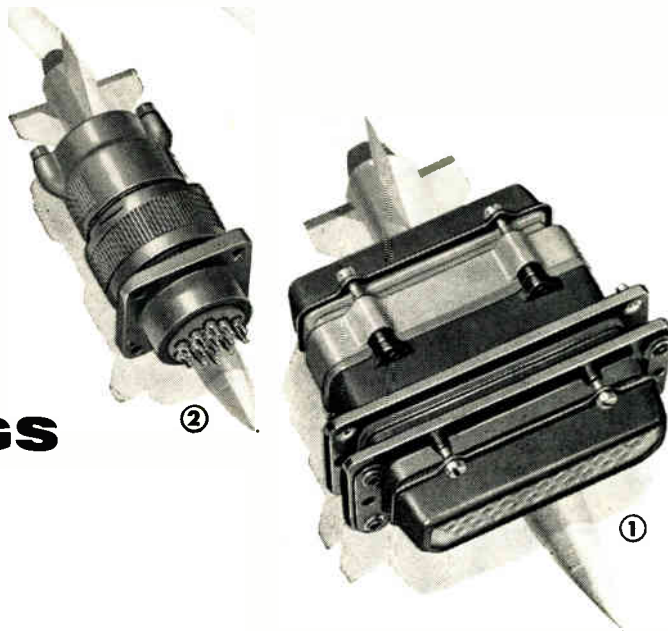


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**Measurements of Photoconductivity and Life-Time of Minority Carriers in Semiconductors**, G. Bedendo and D. Sette. "Atla. Freq." Oct. 1958. 35 pp. An apparatus which allows the study of the photoconductivity and the measure of the life-time and mobility of minority carriers in semiconductors is described. A light beam illuminates during short periods of time part of a face of a parallelepiped semiconductor monocrystal which is placed in a constant current electrical circuit: the conductivity changes due to radiation produce a voltage signal between the ends of the crystal. The signal is amplified and applied to an oscilloscope. (Italy.)

**The Characteristic Curves and Noise of Silicon-P-N-Diodes and Silicon Transistors**, B. Schnedder and M. J. O. Strutt. "Arc. El. Uber." Vol. 12, No. 10, Oct. 1958. 12 pp. The characteristic curves of silicon diodes show marked deviations from those of germanium diodes. One of the causes of these deviations resides in recombination and generation of carriers within the depletion layer. This cause is considered here and a formula is given for the rate of recombination as dependent on carrier densities, life times, situation within the depletion layer and applied voltage. (Germany.)

**The Electrical Properties of a Storing Switch Transistor**, W. Munch. "Nach. Z." Nov. 1958. 6 pp. The electrical properties of a storing switch transistor (1) are investigated. A square root law exists for the relationship between the collector impedance in a cut-off state and the collector voltage, while the base impedance changes very little with voltage. The family of curves for the input characteristics, which resemble those of thyristors, is discussed. The on-off ratio, i.e. the ratio of impedances in the cut-off state and in the conducting state, lies in the order of  $1 \times 10^5$  to  $5 \times 10^5$ . The temperature response of the most important electrical properties of switch transistors with different base materials is described. (Germany.)

**The Junction Transistor as a Network Element at Low Frequencies**, III, J. P. Beijersbergen, et. al. "Phil. Tech." Nov. 22, 1958. 13 pp. The problem of stabilizing the D. C. operating point of transistors is compared with the corresponding problem in tube practice. The operating point of a transistor may shift considerably when the ambient temperature changes. A graphical method is discussed whereby this phenomenon can be accurately analyzed for a type of circuit guaranteeing a certain prescribed degree of stabilization of the operating point is also discussed, and is illustrated with a practical example. The design in question also allows for the spread in properties exhibited, by individual transistors. The advantages of using a thermistor are explained. The physical background of the effect of temperature on transistor behaviour is dealt with in an appendix. (Netherlands, in English.)

**Transistor Switch Design**, Arthur Gill. "El." Dec. 5, 1958. 1 pp. Four significant parameters affecting transistor switches are tabulated for eight transistor types. Data presented permits designer to match transistor pairs for optimum operating characteristics. (England.)

$$\Delta G = \Delta G / \epsilon \eta \mu \rho \epsilon$$

## THEORY

**Mathematic Simulation of Dry Friction**, G. I. Monastyrshin. "Avto. i Tel." Dec. 1958. 16 pgs. Simulation of dry friction is analyzed for three cases: when start friction is equal to motion friction, when start friction surpasses motion friction and when start friction depends on unmoved contact duration. Block-diagrams simulation of solid motion with one rate of freedom and block-diagrams of simulation of small oscillations of gimbal gyroscope axis are depicted. Simulation of control systems by means of differential amplifier is treated, differential equations of the systems

are not solved as to higher order derivatives. (U.S.S.R.)

**Asymmetrical Modulations Study**, G. Bronzi. "Atla. Freq." Oct. 1958. 24 pp. Referring to the definitions of inphase and quadrature components of asymmetrical modulations, the harmonic analysis of asymmetric-modulated-carrier function is determined for the calculation of the distortions; after having examined some types of these modulations employed in practice, by applying the developed theory it is showed the better qualitative response of single side-band on the double side-band modulation on the radiocommunications. (Italy.)

**A Simple Derivation of the Sommerfeld Integral for the Dipole Function**, O. Steiner. "Arc. El. Uber." Vol. 12, No. 10, Oct. 1958. 6 pp. The paper derives with full details the representation of the dipole function by a Sommerfeld integral. The here appearing special Fredholm integral equation of the first kind for a weight function is stated and solved with simple means. The determination of the limits of integration leads to four independence conditions for the weight function. (Germany.)



## TRANSMISSION

**The Attenuation Constant in the Circular Waveguides with Absorbing Walls**, L. Caprioli. "Atla. Freq." Oct. 1958. 18 pp. Making use of the results exposed in another paper in which, among other, is obtained a general expression of the attenuation constant valid also for frequencies near or equal to cut-off values, it is here explained a comparative study of this expression with those generally used in practice and deduced by means of energetic methods or other applications of the perturbations theory. (Italy.)

**Directional Couplers to the Generation of the TE<sub>01</sub>-Mode in a Circular Waveguide**, A. Jauermann. "Arc. El. Uber." Vol. 12, No. 10, Oct. 1958. 7 pp. The TE<sub>01</sub> mode in a circular waveguide can be generated with a directional coupler that effects a preferred conversion of, for instance the TE<sub>10</sub> mode in the rectangular waveguide into the desired TE<sub>01</sub> mode in the circular waveguide. The appearance of additional undesired modes cannot be fully eliminated, however. The present paper calculates the mode selectivity of a long-slot directional coupler; it depends on the cross-sectional dimensions of the waveguides. (Germany.)

**Synthesis of a Bending Waveguide with Continuous Course of Curvature**, M. G. Andreasen. "Arc. El. Uber." Vol. 12, No. 10, Oct. 1958. 9 pp. To minimize the amplitudes of the undesirable modes excited at the curved section, discontinuities of the curvature must be avoided. For a specified maximum of energy conversion into a specific undesirable mode the most favorable bending curve is derived. Particular emphasis is here placed on the coupling between the fundamental modes of circular and square waveguides and the higher modes with the lowest cutoff frequencies. (Germany.)

**Reflections at Waveguide Flange Connections**, U. Kienlin and A. Kurzl. "Nach. Z." Nov. 1958. 4 pp. Waveguides with rectangular cross-sections are frequently used as transmission lines in radio links. Reflections occur at the indispensable flange connections due to production tolerances and unavoidable assembly deviations, even when the flanges are provided with dowel pins or precision shank bolts. (Germany.)

**Low-Loss Structures in Waveguides**, M. F. McKenna. "El." Dec. 5, 1958. 3 pp. The relative variations of electric-field intensity inside a rectangular waveguide at certain positions in front of a low-loss structure when terminated in a variable reactance are shown

to give information leading to the evaluation of the parameters of the equivalent of the structure. The experimental procedure to be followed for determining the parameters of simple obstacle structures is also discussed. (England.)

**Electromagnetic Wave Propagation in Cylindrical Waveguides Containing Gyromagnetic Media**, Part 2, R. A. Waldron. "J. BIRE." Nov. 1958. 14 pgs. (England.)



## TUBES

**Experimental Results in Using High-Power Oscillator Tubes in a Pulse Mode**, Z. M. Leonova, M. I. Pass, F. Ia. Porotskii and G. F. Solov'ev. "Radiotek." Nov. 1958. 5 pp. The paper studies the possibility of using high-power oscillator tubes with active cathodes in a pulse mode (such tubes are ordinarily used in a continuous mode of operation). The experimental results show that it is possible to expand the frequency range and to increase appreciably the power output in the pulse. Test results are cited. (U.S.S.R.)

**Oscilloscope Tube with Traveling Wave Deflection System and Large Field of View**, W. F. Niklas and J. Wimpfen. "J. BIRE." Nov. 1958. 8 pgs. The frequency response of conventional deflection systems, i.e. the influence of the transit time, the rise time and oscillations, is discussed in a somewhat abbreviated form. It is shown that an unbalanced or balanced helix system offers great advantages for high-speed oscillography. A new traveling-wave oscilloscope tube is described which possesses a balanced helix system as signal plates. (England.)

**The Engineering of Low-Noise Traveling-Wave Tubes**, F. J. Bryant, et. al. "Brit. C. & E." Jan. 1959. 6 pgs. The traveling-wave tube has tended to be considered by many systems engineers as a laboratory curiosity, requiring complex, clumsy and costly accessories, and expert attention. Consequently, attention has been turned of late to the engineering of tubes that are simple to use in the field, and this paper describes two traveling-wave tubes designed with this object in view. Both are low-noise tubes, one for the range 4,200 to 7,000 Mc/s and the other for 1,200 to 1,400 Mc/s, and both are encased, ready matched, in their own coaxial transformer assemblies. (England.)

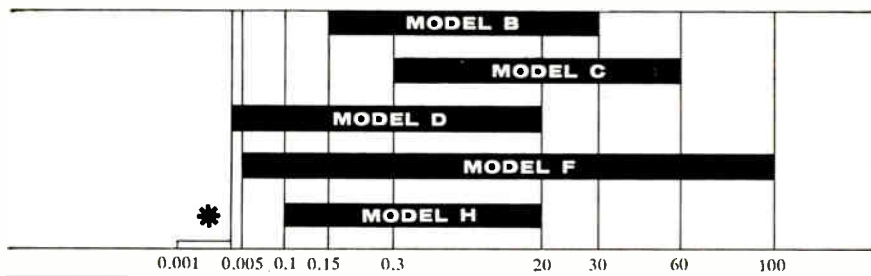
**A New Method for Coding High-Power Valves by Vaporization of Water**, P. E. Cane and W. E. Taylor. "J. BIRE." Oct. 1958. 6 pp. The problem of disposing of the heat generated in the anodes of high power valves is discussed, and brief reference is made to the different methods of construction adopted in valves of this class. Existing methods of cooling are examined and their limitations stated. The mechanism of transfer of heat from a copper anode to the surrounding water is considered, and its application to valve cooling is discussed. A new method of cooling by vaporization of water is then dealt with. Consideration is given to the construction of vapor cooled valves, followed by an explanation of the complete system. (England.)

**The Trochotron**, N. P. R. Sherry. "Brit. C. & E." Nov. 1958. 2 pp. This counting valve provides facilities for count rates as high as one million per second. Some special properties are determined by electrons moving in trochoidal paths. (Trochoid—path traced out by a point in the plane of a curve that rolls on another curve.) (England.)

**Electron Oscillations in Vacuum Tubes**, F. Mohring. "El. Rund." September 1958. 4 pp. The mechanism of oscillation is described and the frequency behaviour of these oscillations described by illustration of experimental curves. (Germany.)

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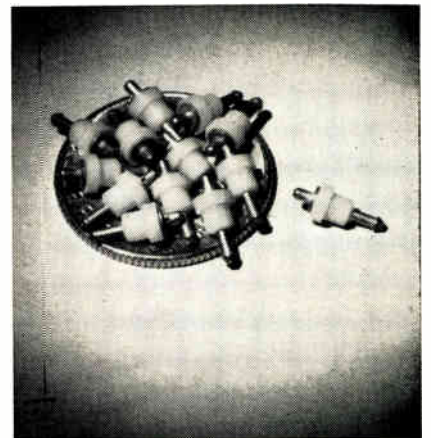


stages of transformerless, battery-operated portable radio receivers, phonographs, and audio amplifiers, or in conventional class B push-pull or class A audio-amplifier circuits. In a typical class B, the two driven by a 2N217 class A driver provide a power output of approximately 100 mw at a power gain of 54 db. In a typical push-pull circuit, two 2N647's driven by another 2N647 can provide a power output of 100 mw at a power gain of 66 db. RCA, Semiconductor Div., Somerville, N. J.

Circle 254 on Inquiry Card, page 117

### SUB-MINIATURE TERMINAL

The "Press-Fit" Type FT-SM-125 uses a truncated end for one of the two lugs, acting as a stop to prevent wrapped wire leads from slipping off until they can be soldered. The other lug is the usual plain pin. The terminals measure 0.306 in. overall



height, fits into a 0.081 in. dia. hole, and can be accommodated in any chassis up to 0.035 in. thick. They are available in 10 code colors. Sealectro Corp., Mamaroneck, N. Y.

Circle 255 on Inquiry Card, page 117

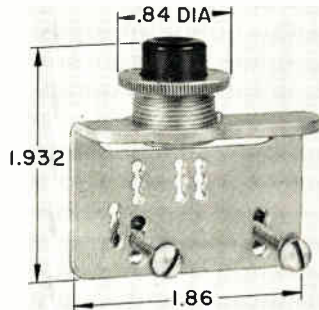




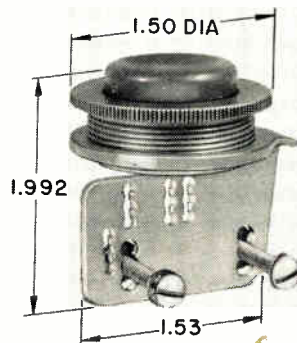
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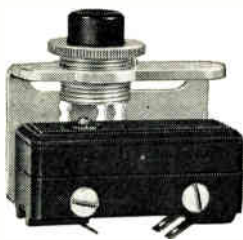
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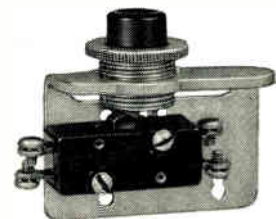
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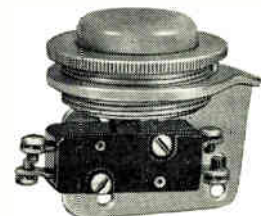
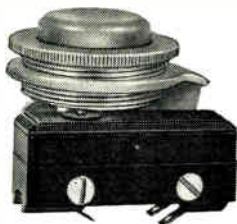
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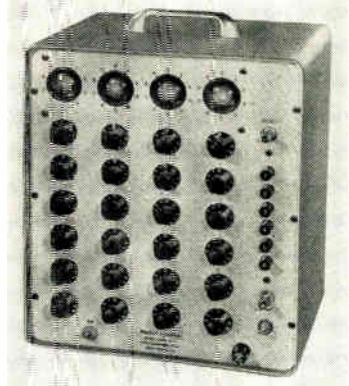
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Circle 69 on Inquiry Card, page 117

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Circle 256 on Inquiry Card, page 117

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Circle 257 on Inquiry Card, page 117

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# MOTOROLA mesa transistors



*a progress report*

BY DR. C. LESTER HOGAN

General Manager

The first two Motorola Mesa transistors, the 2N695 switch (with a rise time less than 3  $\mu\text{sec}$ ) and the 2N700 (a 200 mc amplifier), were announced in August, 1958. Our pilot line facility at that time had a capacity to produce several hundred devices per day and our plans were to move into full scale production during the first few months of 1959. We expected this capacity to be able to meet any possible demand which our customers might place on us. However, the reception of these devices surpassed all expectations and requests for samples far exceeded our pilot production. Naturally, we have been very happy with the response, but our main concern has been the integrity of our product, and we have steadfastly refused to proceed with expanded production until we satisfied ourselves that each new process would yield the extremely high quality and reliability which we intend to be synonymous with the name Motorola Mesa.

As many of you already know, the two Motorola Mesa transistors now available are unusual devices. The active region of these transistors covers an area less than that of a human hair. Yet they are manufactured by methods so precise that they do not need to be selected, as are most transistors today, but are made within extremely close tolerances to the electrical and mechanical characteristics desired. The elements which are used in their fabrication have

been carefully selected so that each and every transistor can be baked out under high vacuum at 300°C before being hermetically sealed.

This is just one of the extra steps we at Motorola are taking to insure the integrity and reliability of these devices. The size of the transistor, the ultra-precise methods which we use in its fabrication, and the basic design of the Motorola Mesa itself all combine to give you the most reliable transistor the industry has yet seen. There is no doubt in our minds that the Mesa is "the" transistor of the future.

With this conviction guiding us we have been putting great emphasis on production tooling for Motorola Mesas and within a few weeks we shall swing into large scale manufacture of the Mesa transistor. At that time, we shall be in a position to accept production orders for these transistors of the future.

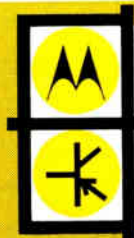
Even with this emphasis on production, basic research and development has not been neglected. Motorola's development team has expanded its study of the Mesas. Extensions of the design to higher power and higher frequency are ready for introduction in the very near future. Before long, we shall have a whole family of Motorola Mesas with the same integrity and reliability of these first two devices . . . a family of devices that will open up entirely new areas of transistor application.

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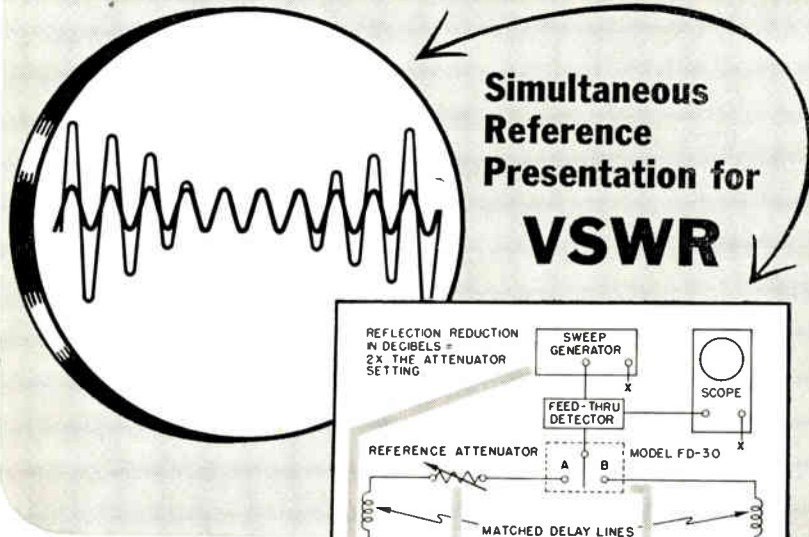
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## MOTOROLA SEMICONDUCTORS

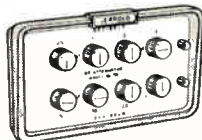
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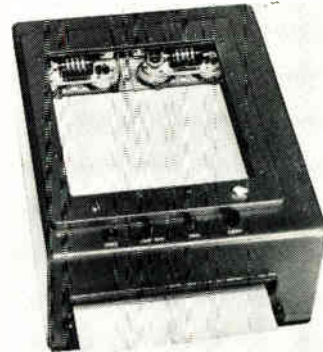
The Jerrold Building, 15th and Lehigh  
Philadelphia 32, Pa.

Jerrold Electronics Corp., Ltd., Toronto, Canada • Export—Rocke International, New York, New York

## New Products

### READOUT-RECORDER

Servo Monitor, a 2 channel readout-recorder for monitoring servo systems, simplifies data gathering by providing permanent chart records of angular or displacement data of a

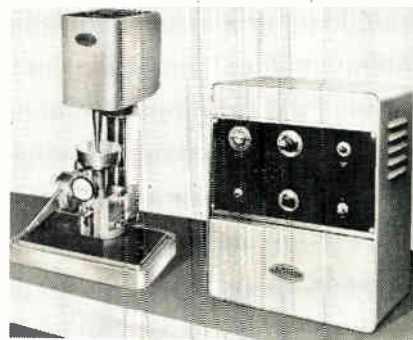


servo transmitter. Applications: readout for analog computers, servo recording, production testing and inspection. High speed recorder features zero time flyback. Chart speeds, in a wide range, are 5, 10, 20, 40, and 80 in. per hr. It has rotating styli coupled with a 4-digit counter which adds and subtracts. Meets MIL E 16400. Brush Instruments, 37th and Perkins Ave., Cleveland 14, Ohio.

Circle 258 on Inquiry Card. page 117

### ULTRASONIC GRINDER

Model 2-335 ultrasonic impact grinder uses a magnetostrictive transducer to permit a 100% duty cycle. It is used for cutting, slicing, drilling, grinding and trepanning regular or irregular shapes. Among the substances that can be worked are semiconductors, ceramics, ferrites, carbides, and metals. The cutting head has cutting force adjustment and a



built-in force dial. The slurry tray is removable for cleaning, and tool cones can be interchanged. The ultrasonic driver produces 100 w. Raytheon Manufacturing Co., Waltham, Mass.

Circle 259 on Inquiry Card. page 117



**IMPROVED  
CHARACTERISTICS**

**...OF  
SPECIAL  
INTEREST  
TO EVERY  
ENGINEER**

**DELCO  
HIGH POWER  
TRANSISTORS**



**UNEXCELLED FOR SWITCHING, POWER HANDLING, EFFICIENCY, RELIABILITY**

TYPICAL CHARACTERISTICS AT 25°C.

	2N1100	2N1099	2N174A	2N174	2N173	2N278	2N277	2N443	2N442	2N441
Maximum Collector Current	15	15	15	15	15	15	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	50	40	60	50	40 volts
Saturation Resistance	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03 ohms
Thermal Gradient (Max.) (Junction to Mounting Base)	.8	.8	.8	.8	.8	1.0	1.0	1.0	1.0	1.0 °C/watt
Base Current $I_B$ ( $V_{EC}=2$ volts, $I_C=5$ amps)	135	100	135	135	100	100	100	150	150	150 ma
Collector to Emitter Voltage (Min.) Shorted Base ( $I_C=.3$ amps)	80	70	70	70	50	45	40	50	45	40 volts
Collector to Emitter Voltage Open Base ( $I_C=.3$ amps)	70	60	60	60	50	45	40	55	45	40 volts

\*Designed to meet MIL-T-19500/13A (Jan) 8 January 1958 †Formerly DT100 ‡Formerly DT80

Check your requirements against the *new, improved* characteristics of Delco High Power transistors. You will find improved collector-to-emitter voltage . . . higher maximum current ratings—15 amperes, and extremely low saturation resistance. Also, note the new solid pin terminal design.

*And of special importance to you is the fact that diode voltage ratings are at the maximum rated temperature (95°C.) and voltage.*

Write today for engineering data on the *new, improved* characteristics of *all* Delco High Power transistors.

**DELCO RADIO**

Division of General Motors • Kokomo, Indiana

BRANCH OFFICES

Newark, New Jersey  
1180 Raymond Boulevard  
Tel: Mitchell 2-6165

Santa Monica, California  
726 Santa Monica Boulevard  
Tel: Exbrook 3-1465

# ANN OUN CING

CONVAIR INSTRUMENTS  
*designers and builders of:*  
*electromechanical instruments*  
*mechanical instruments*  
*ac & dc measuring instruments*  
*transducers*

# 2900A

DC VOLTMETER  
 $\pm 10$  MICROVOLTS TO  $\pm 1000$  VOLTS



Range:  $\pm 10$  microvolts to  $\pm 1000$  volts, in 9 decade steps.

Zero Drift: Less than  $\pm 1$  microvolt (referred to the input) over 2-hour period.

Power Sensitivity: 10-14 watts at full scale.

Amplifier Output: Approx.  $\pm 1$  volt at 0.1 milliamperes for full scale reading.

Combines direct reading voltmeter with chopper-stabilized DC amplifier  
 ... Accuracy within  $\pm 3\%$  (above noise level) of full

scale... Zero-center meter movement provides polarity indication without switching or lead reversal... Rugged, all transistor, etched-circuit construction... Illuminated mirror scale.

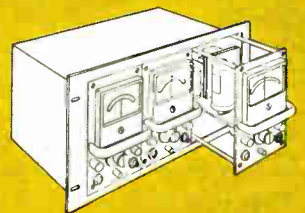
*A twist of a knob releases chassis from hand carrying case, for insertion in 3-unit modular rack.*

Prices:\*

Model 2900A DC Voltmeter	\$395.00
Model 2901A Hand Carrying Case	90.00
Model 2902A 3-Unit Rack	175.00

For complete information, write today for CI Bulletin No. 29-2.

\* (ALL PRICES FOB SAN DIEGO)



CONVAIR INSTRUMENTS / CONVAIR, A DIVISION OF GENERAL DYNAMICS CORPORATION

3595 FRONTIER STREET,  
 SAN DIEGO, CALIFORNIA



# CALL THE MAN FROM TENSOLITE FOR HIGH-TEMPERATURE WIRE AND CABLE



Tensolite facilities are devoted exclusively to the engineering and manufacture of insulated wire and cable...featuring TEFLON® insulation for high temperature (−90 deg. C. to +250 deg. C.) applications. This specialization is your assurance of high quality in craftsmanship and materials, as well as prompt, efficient service at lowest possible cost.

## HOOK-UP WIRE

### TYPE E-EE TO MIL-W-16878

#### FLEXOLON WIRE

A new concept in high temperature insulation developed by Tensolite's research and development laboratories. FLEXOLON wire provides the best properties of wrapped and extruded fluorocarbon insulation. Important features of this versatile hook-up and lead wire are:

- 250-foot minimum continuous production lengths guaranteed.
- Solid and striped combinations.
- Most flexible of all hook-up wire construction.
- High temperature range of −90 deg. C. to +250 deg. C.
- Greatest miniaturization in MIL-SPEC hook-up wire (smallest hook-up wire in the world).
- Abrasion-protected striping (the Color Guard Striping process).
- High dielectric strength (far exceeds required 600 V and 1000 V ratings).
- Consistent concentricity.
- Superior abrasion and cut-through resistance.

#### TENSOLOX WIRE

Insulated with fluorocarbon high temperature resin.

Choose from:

**Parallel wrapped**...utilizing an exclusive patented technique which assures greater concentricity and maximum flexibility (solid colors only).

**Spiral wrapped**...with special cross-lapped construction and unlimited color coding; striping that meets commercial and military specifications.

**Extruded**...featuring an extruded homogeneous fluorocarbon resin (solid and inked stripe combinations).

#### TENSOLEX WIRE

Insulated with extruded vinyl plastic.

Types B and C meet MIL-W-16878. They are high temperature hook-up wires rated for continuous use from −55 deg. C. to +105 deg. C. with or without nylon jackets.

Types WL and SRIR are manufactured in accordance with the joint Army-Navy specification JAN-C-76 (Qualification approval Certificates Nos. 13725 and 13606A).

Types LW and MW are general purpose hook-up wires specifically designed for radio instrument, and military electronic applications. Designed to meet MIL-W-76A, they are recommended for use at temperatures up to 80 deg. C. in the internal wiring of electrical and electronic equipment.

#### TENSOLITE WRAPPED VINYL WIRE

Super-flexible wire designed for miniaturization applications at operating temperatures from −40 deg. C. to +60 deg. C.

AIRFRAME WIRE	COAXIAL CABLE	MULTI-CONDUCTORS	MAGNET WIRE
<p><b>TENSOLOX AIRFRAME WIRE</b></p> <p>Insulated with high-temperature resin, it is manufactured in compliance with MIL-W-7139A. Important features are:</p> <ul style="list-style-type: none"> <li>• −90 deg. C. to +250 deg. C. temperature range.</li> <li>• 600 Volt and prescribed overload operation.</li> <li>• Rugged, abrasion resistant construction.</li> <li>• Short-time emergency operation in event of fire.</li> <li>• High resistance to chemicals.</li> <li>• Excellent flexibility.</li> </ul>	<p><b>TENSOLOX MINIATURE COAXIAL CABLE</b></p> <p>Designed to meet MIL-C-17B, it is ideal for high frequency operation from −90 deg. C. to +250 deg. C. Insulation assures extremely low loss, high dielectric strength, and complete resistance to moisture and chemicals. A great variety of outer jackets permits the selection of cable well suited for many application requirements.</p>	<p><b>TENSOLOX MULTI-CONDUCTOR CABLE</b></p> <p>Using conductors designed to meet MIL-W-16878, types E and EE. A large variety of standard and custom-designed constructions from single to 50 conductor assemblies are available.</p> <p><b>TENSOLITE MULTI-CONDUCTOR CABLE</b></p> <p>Highly flexible, with vinyl insulation, it is available to meet a wide range of application requirements.</p>	<p>High temperature magnet wire—designed to meet MIL-W-19583—is ideal for coils and windings requiring high temperature application. It is supplied in wall thicknesses ST, HT, TT and QT in AWG sizes 18 through 44.</p>

Write for catalog containing complete technical information

Dept. TEN-1

**Tensolite** INSULATED WIRE CO., INC.

West Main Street, Tarrytown, N. Y. • Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

© DUPONT

# NEW FANSTEEL

"PP" TYPE

## Tantalum Capacitor

**NOW**  
**VIBRATION**  
**and SHOCK**  
**RESISTANT**



NEW ANODE  
 BASE  
 SUPPORT

## At No Increase In Price!

Now, with more rugged construction and a specially designed anode base support, the new Fansteel Type "PP" Capacitor is especially adaptable for circuitry where exceptional resistance to vibration and shock is required... *at no increase in price.* The new "PP" also has better low temperature characteristics.

The Fansteel Type "PP" retains all its high performance features—outstanding frequency stability, negligible electrical leakage—proved in countless applications demanding unquestionable reliability and dependability. It occupies minimum space, and yet provides extremely high capacity ratings for its size.

Get complete information today. Write for Bulletin 6.100



RELIABILITY

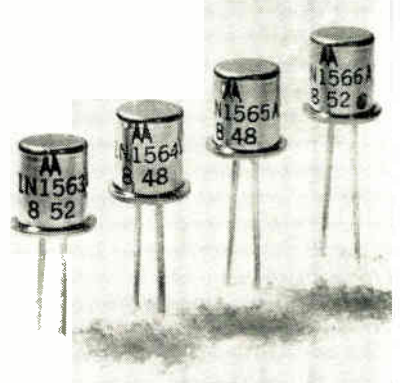
C592A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U. S. A.

### New Products

#### SILICON RECTIFIERS

Types 1N1563A through 1N1566A offer peak inverse voltages of 100 through 400. One cycle average reverse current is limited to 150  $\mu$ a max. when rectified output is 250 ma.



and ambient temp. is 150° C. Forward rectified currents are 1.5 a. and 250 ma. at 25° C and 150° C ambient temp. Designed for use in magnetic amplifiers, the welded, hermetically sealed, single-ended package can be used with both printed circuit and chassis construction. Motorola, Inc., Semiconductor Products Div., 5005 East McDowell Rd., Phoenix, Arizona.

Circle 200 on Inquiry Card, page 117

#### TRANSISTOR TESTER

Model TT-205, a general purpose transistor tester for lab, field, and industrial use, measures small signal beta, collector leakage current, and collector resistance on all npn, pnp, surface barrier, grown or diffused junction transistors. One selector switch selects 11 operating points. It is self calibrating and transistor under test is operated in a temperature stabilized circuit insuring that each unit is tested under identical biasing conditions. It uses 3 transis-



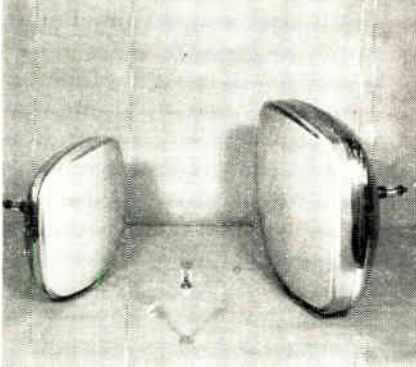
tors; one as a stable oscillator (1000 CPS), and two as a special purpose, low level, synchronous linear detector. Sonex, Inc., 73 S. State Rd., Upper Darby, Pa.

Circle 201 on Inquiry Card, page 117



**New****Products****"SHORT" PICTURE TUBES**

Two "extra short" 110° picture tubes, operate at voltages available in conventional receivers and reduce over-all front-to-back length up to 2½ in. Type 17DKP4 has an over-

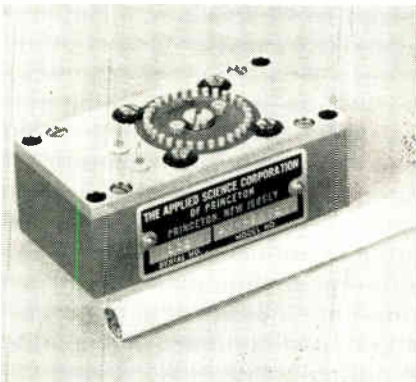


all front-to-back length of 10 11/16 in. Type 21EQP4 measures 12 9/16 in. Both models are aluminized, incorporate a non-ion trap construction and use magnetic deflection. They utilize Sylvania's tri-potential focus electron gun. The lens is formed by three separate voltages applied to three short gun elements. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Circle 202 on Inquiry Card, page 117

**ROTARY SAMPLING SWITCH**

The ASCOP Command Commutator, a spring driven, rotary sampling switch, has no r-f noise generation, no gyroscopic effect, no heat generation, and low average power consumption. For missile and space telemetering systems, it is hand-wound before flight. It makes one sampling cycle per command. Release of the mechanism is by pulse signal into a solenoid device. It can be operated from the ground or from functions in an airborne vehicle and provides up



to 100 sampling revolutions without rewinding. Typical sampling speeds are ½ or 1/50 of a second per revolution. Applied Science Corp. of Princeton, P.O.B. Princeton, N. J.

Circle 203 on Inquiry Card, page 117

# ANOTHER NEW Silicon Rectifier

FROM

# FANSTEEL



## 35 AMP. Silicon Power Rectifier

Here's the newest addition to Fansteel's growing line of reliable silicon rectifiers. The 4A carries a full 35-amp. load—up to 100 amps in bridge circuits—with rated peak inverse voltages from 50 to 400 V. in 50-volt multiples. And it's built to withstand junction temperatures up to 165°C., storage temperatures from -65°C. to 200°C.

This new low-loss unit mounts snugly in any position. Entire unit is hermetically sealed, with heavy-duty construction to give long trouble-free performance and maximum dependability in high load circuits.

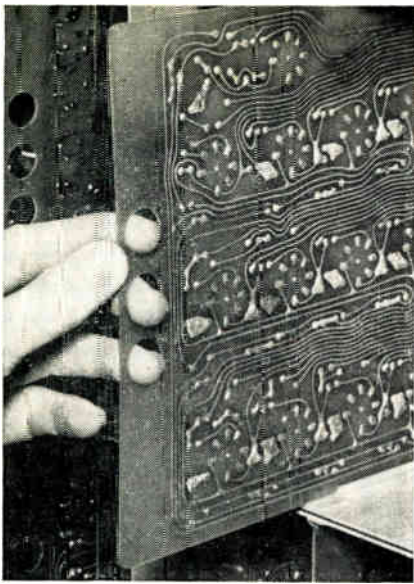
Write for Bulletin 6.305

**FANSTEEL**

**RELIABILITY**

E591A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U. S. A.



Now... "telephone quality"

## PRINTED CIRCUIT BOARDS

from Stromberg-Carlson

Expanded facilities now make it possible for you to get the *same* high quality printed circuit boards we produce for our own telecommunication and electronic applications.

We print and etch one or two sides; we provide eyelets or terminals and can provide gold plating where desired.

All boards will be manufactured with the same rigid process control demanded by our electronic switchboard, automatic toll ticketing, carrier and other precision equipment. In addition, you get these chief advantages:

1. **Quality:** assured by rigid control over incoming materials as well as process.
2. **Low Cost:** low tooling cast on quality short-run precision work means lower cost to you.
3. **Volume:** screen printing makes volume production economical. Delivery to meet your scheduling.
4. **Excellent Solderability** is assured without the need for costly solder plating.

Tell us about your particular job requirements. We will furnish price and delivery information immediately.

## STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION  
Telecommunication Industrial Sales  
126 Carlson Road, Rochester 3, N. Y.

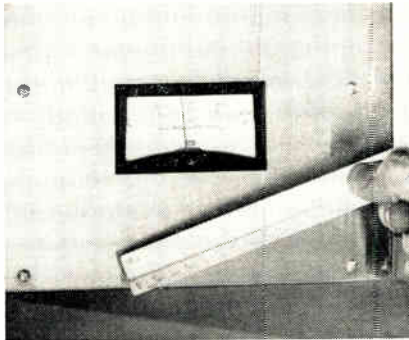


Circle 78 on Inquiry Card, page 117

## New Products

### PANEL METER

Model 361 panel meter embodies the design concept of the Model 561 meter and occupies only 3½ by 2 in. panel space. It projects 3/16 in. Sensitivity ranges are 0 to 5  $\mu$ a—0 to 50



a, and 0 to 5 mv—0 to 500 v. The dial and window are slanted for easier reading and may be illuminated through a translucent rear window. The meter slips through a rectangular panel hole and is held in place by rear screw-on clamps. It requires no positioning holes for mounting studs. Assembly Products, Inc., Wilson Mills Rd., Chesterland, Ohio.

Circle 204 on Inquiry Card, page 117

### CURRENT GOVERNOR

A programmable constant current source, the Model CS-11, furnishes currents from 1  $\mu$ a to 100 ma. in steps of 1  $\mu$ a at load voltages from 0 to 50 v. Accuracy at any setting is 0.02% +0.1  $\mu$ a short term stability 0.001%, line regulation is better than 0.0005%, and load regulation better than



0.002%. Applications include: meter calibration, measurements of zener diodes, transistors, potentiometers, bolometers, thermistors, clutches, solenoids, batteries, fuses, magnetic cores, filaments, transducers, and other current sensitive devices. North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, L. I., N. Y.

Circle 205 on Inquiry Card, page 117

### SILICON RECTIFIERS

High current silicon power rectifiers provide dc forward currents up to 250 a and max. peak inverse voltage range from 50 v to 500 v. They can be used at high temperatures,

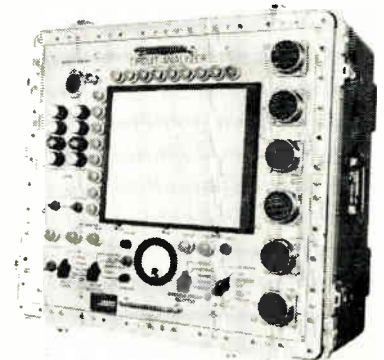


can operate at a junction temperature of 190°C, and meet Mil Specs. They are hermetically sealed against environmental extremes of temperature, vibration and shock. To increase reliability and freedom from contamination, no soft solders or fluxes are used in sealing. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 206 on Inquiry Card, page 117

### CIRCUIT ANALYZER

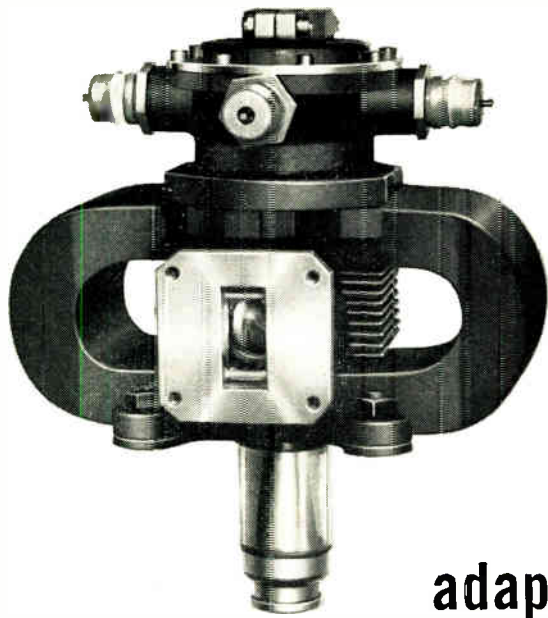
Model 144, for accurate, automatic testing of complex, multiple, interconnected circuitry for shorts, continuity, and insulation flaws; and functional tests of relays, solenoids, actuators, and other resistive devices at the rate (approximate) of 10 circuits per sec. An electronic "Go" and "No-Go" method of detection is



used to guard against borderline defects which normally pass undetected. Defects are located and identified by a visible matrix type reference chart. Indicating fuses are on the front panel. Circuit testing capacity is 144 circuits. Meets Mil-T-945A. DIT-MCO, Inc., Electronics Div., 911 Broadway, Kansas City, Mo.

Circle 207 on Inquiry Card, page 117





# FASTEST TUNING PULSE MAGNETRON TUNES HYDRAULICALLY

## adapts to current systems

This is the first public announcement of the first hydraulically-tuned pulse magnetron. It permits a powerful new capability in anti-jamming pulse-to-pulse frequency diversity operation.

Designated L-3211 and equipped with an hydraulic tuning actuator we developed, *this is the fastest tuning, medium power magnetron in production today.*

The L-3211 is designed for X-band operation with electrical characteristics similar to those of our standard field-proved 6543 magnetron. The principles of its design make it adaptable to other power levels and frequency bands.

Tubes of this family greatly enhance system

tuning capability, approaching that of voltage-tuned tubes, with much greater efficiency and less system complexity. The L-3211 affords a means of upgrading both new and existing radar systems in operational effectiveness. (We also can provide information on a "need-to-know" basis on classified tubes that have even greater capabilities than the L-3211.)

In constructing the L-3211 we use certain techniques proprietary with us . . . techniques which guarantee a long operating life and a long shelf life. Ageing-in prior to full-power operation is unnecessary.

It is another one of a large number of micro-wave tubes used in radar and countermeasures

built to specifications established by Litton Industries . . . specifications which have become recognized as standards by the military services.

Our Applications Engineering Lab is well equipped\* to analyze your problem. It has been remarkably successful in finding fast and accurate solutions to difficult system problems. Let it solve yours. We'll be glad to answer your specific inquiries, or to send you a copy of our catalog. Litton Industries Electron Tube Division, Office E7, 960 Industrial Road, San Carlos, California.

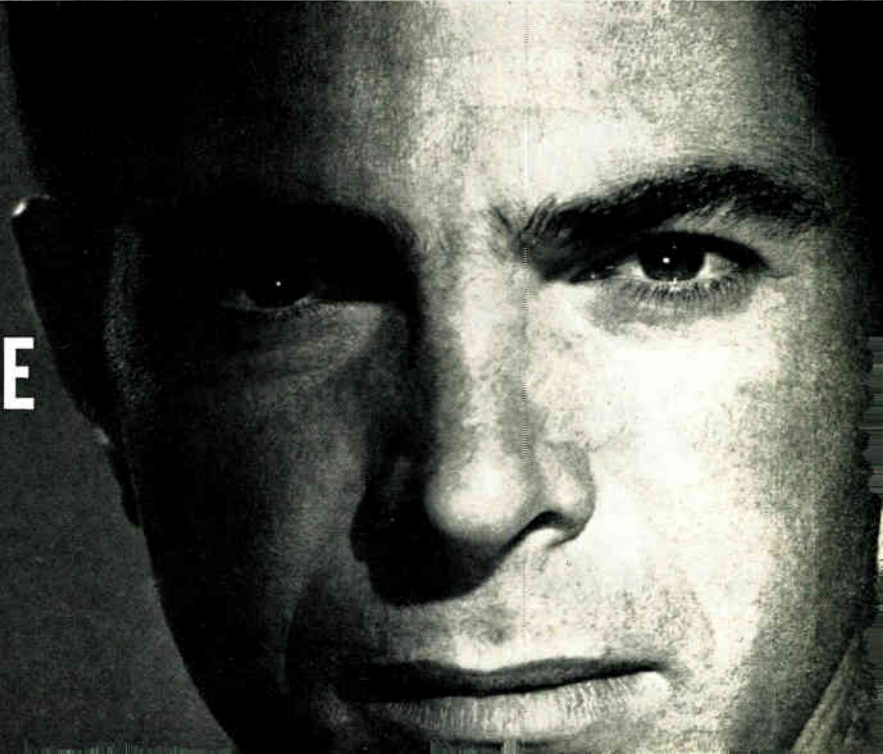
\*Incidentally, so is our Personnel Department.



## LITTON INDUSTRIES Electron Tube Division

MAGNETRONS • GAS DISCHARGE TUBES • CARCINOTRONS • TRAVELING WAVE TUBES  
KLYSTRONS • BACKWARD WAVE OSCILLATORS • NOISE SOURCES • DISPLAY TUBES

# CAPABILITY THAT CAN CHANGE YOUR PLANNING



diffused junction performance



COMMERCIALLY PRICED



for INDUSTRIAL use!

u. s. semcor medium power

## COMMERCIAL RECTIFIERS

with single DIFFUSED silicon junction

New Streamlined Tubular Case Provides  
Maximum Power in Absolute Minimum Space  
(only .250" x .290")

U. S. Semcor now offers PIVs to 500 volts in both axial lead and stud mount encasements that completely eliminate any hex or top hat flange, allows most compact placement in printed board circuits. The diffused silicon junction all-welded construction assures more rugged, reliable performance at a new industry-low cost at this standard of quality.

**HIGH FORWARD CONDUCTION**—5 amps forward on stainless steel heat sink . . . **LOW SATURATION CURRENT**—one milliamp or less at the rated PIV . . . **HIGH PEAK INVERSE VOLTAGES**—50 volts to 500 volts . . . **STREAMLINED CONFIGURATION**—no awkward hex or top hat flange . . . **CASE STYLES**—Choice of axial or stud mounted units . . . **STAINLESS STEEL CASE**—Rugged, all-welded construction for permanent corrosion resistance



Single Diffused Junction

Provides matched coefficients of expansion of internal lead wire and diode case, prohibits separation even under extreme shock.

For a call from our nearest Field Engineering Representative—or for complete technical data—write today to Sales Engineering Department.

US SEMCOR

U. S. SEMICONDUCTOR PRODUCTS, INC.

3526 WEST OSBORN ROAD • PHOENIX, ARIZ. • Applegate 9-5591

Over 55,000 square feet of modern dust proof, air-conditioned facilities devoted exclusively to the research, development and production of electronic devices.



## New Products

### TRANSISTOR INDEX

The index, used to facilitate selection of transistors, consists of a deck of punched Keysort business cards. Each card describes a particular transistor by means of both sorting

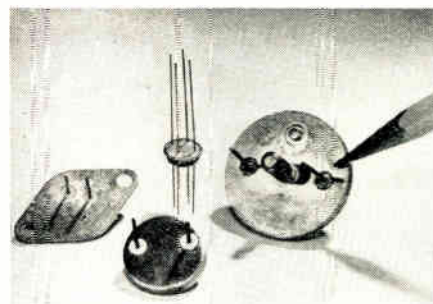


slots and data printed on the card. Selection is accomplished manually by means of a key-sort needle. Sorting on all ten available parameters is accomplished within two or three minutes. For unique requirements, approximately 40 unused holes are available for insertion of additional data. It contains data on substantially all military and commercial transistors manufactured by 24 major companies. Zeus Engineering Co., 635 South Kenmore Ave., Los Angeles, Calif.

Circle 208 on Inquiry Card, page 117

### COPPER SEALING GLASS

Code 7295, copper sealing Multi-form glass, can be hermetically fused directly to copper with an expansion-match seal. It has an expansion ( $154 \times 10^{-7}/^{\circ}\text{C}$ ) which closely matches that of copper. Working point of the Multi-form glass is  $665^{\circ}\text{C}$ ; annealing point,  $366^{\circ}\text{C}$ ; and strain point,  $344^{\circ}\text{C}$ .



Log volume resistivity (in ohm centimeters) at  $250^{\circ}\text{C}$  is 6.7 and at  $350^{\circ}\text{C}$  is 5.0. The durability of the new glass in water is about the same as Corning's 0080 lime glass. Corning Glass Works, Corning, New York.

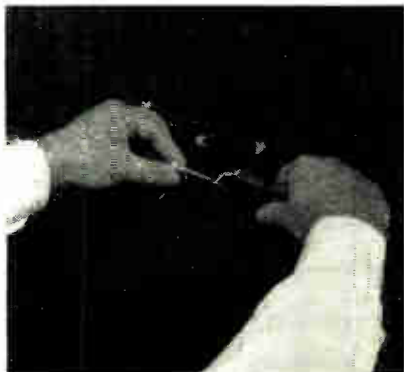
Circle 209 on Inquiry Card, page 117



**New**  
**Products**

**PLASTIC WIRING TIE**

A flexible plastic tie can bind wiring harnesses neater and faster. Made of nylon base Moldarta material it features a ratchet-like design for self-adjusting to a wide range of wire

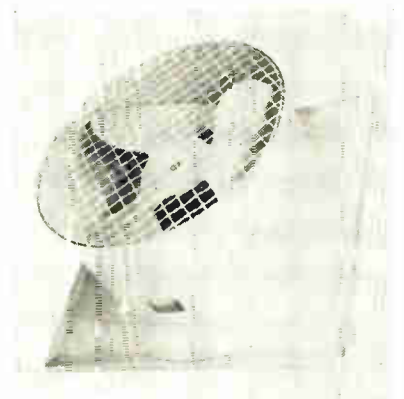


bundle diameters. The tie is fungus and moisture resistant. The tooth form allows bending to a low limit of 1/32 in. A double tooth is used in the buckle to obtain ratchet holding ability almost equal to the basic tensile strength of the strap. The "V" ridge along the underside of the tie prevents side slip. The flat surface of the leader eliminates the danger of cutting into the insulation. Westinghouse Electric Corp., Component Products Dept., 4-S-18, East Pittsburgh, Pa.

Circle 210 on Inquiry Card, page 117

**AXIAL FLOW FAN**

Flow fan, Model Y1241-3, is a tube-axial fan suitable for cooling electronic cubicles, flushing racks, and cabinets in commercial and military applications. The 1/150 H.P. motor



at 1550 RPM delivers 430 CFM at 0 in. S.P. It operates from 115 v, 60 CPS source. It is 11 1/2 inches by 5 5/32 inches deep. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y.

Circle 211 on Inquiry Card, page 117

**u.s. semcor** medium power...

**AXIAL LEAD RECTIFIER**

with single DIFFUSED silicon junction

**PEAK PERFORMANCE WITH AXIAL LEAD MOUNTING VERSATILITY**

U. S. Semcor now offers outstanding new advantages in high rectifier efficiency in a sub-miniature package, and the widest PIV range — 50V to 900V — with a single diffused junction. These axial lead diodes provide extremely high forward conduction combined with an absolute minimum saturation current, ideal where low back current is required. For complete data write for Catalog DJR-401.

**NEW STREAMLINED CONFIGURATION**

250' x 250' case size and elimination of top hat flange, allows more compact placement.

- AXIAL LEADS**—permit automatic machine insertion, for point to point printed board wiring.
- MOUNTING FLEXIBILITY**—can be positioned in any attitude without impeding performance.
- STAINLESS STEEL CASE**—rugged, all welded construction, gives permanent corrosion resistance, protection from radiation effects.
- HIGH FORWARD CONDUCTANCE**—one amp at one volt forward, with maximum forward current to back current ratio.
- RELIABILITY**—is inherent in the design, to meet the most severe environmental tests.
- CHARACTERISTICS**—in any combination to fill your standard or special applications for high back resistance, quick recovery, high conductance and high temperature operation.



**Single Diffused Junction**

Provides matched coefficients of expansion of internal lead wire and diode case, prohibits separation even under extreme shock.



**U. S. SEMICONDUCTOR PRODUCTS, INC.**  
100 WEST GARDEN ROAD, WILMINGTON, DEL. 19804

For a full product line, contact Field Engineering Department — or for complete technical data — write for wire today to Sales Engineering Department.

# 26 NEW TYPES ADDED TO BENDIX NOISE SOURCE TUBE LINE!

Freq. Range KMC	Band	Waveguide Number	Bendix Type Number	RETMA Type No.	Mount Type	Recommended Mode of Operation (Note 2)	Anode Current Ma (Note 1)	Tube Drop Volts (Note 1)	Tube Excess Noise Ratio DB (Note 3)
1.12-1.70	L	RG-69/U	RXB103085	6881 7101	10°E	D.C.	250	130	15.2
			TD-21		90°H	D.C.	250	65	15.2
			TD-29		90°H	A.C. and D.C.	250	130	18.0
			TD-33		90°H	A.C. and D.C.	250	75	15.2
2.6-3.95	S	RG-48/U	TD-12	6358 6782	10°E	D.C.	250	80	15.2
			TD-22		90°H	A.C. and D.C.	250	45	15.2
			TD-31		10°E	A.C. and D.C.	250	85	15.2
			TD-32		10°E	A.C. and D.C.	250	140	18.0
			TD-34		10°E	D.C.	250	155	18.0
			TD-35		90°H	A.C. and D.C.	250	80	18.0
			TD-38		10°E	PULSE*	(250)	(90)	15.2
3.30-4.90	S	WR-229	TD-24	6852	10°E	A.C. and D.C.	250	65	15.2
			TD-30		10°E	A.C. and D.C.	250	110	18.0
3.95-5.85	C	RG-49/U	TD-10	6356	10°E	D.C.	250	70	15.2
			TD-39		10°E	PULSE*	(250)	(80)	15.2
			RXB103422		10°E	D.C.	250	(110)	18.0
5.85-8.20	X	RG-50/U	TD-10	6356	10°E	D.C.	250	70	15.2
			TD-39		10°E	PULSE*	(250)	(80)	15.2
			RXB103422		10°E	D.C.	250	(110)	18.0
8.20-12.40	X	RG-52/U	TD-11	6357 6882	10°E	D.C.	200	75	15.2
			TD-23		10°E	D.C.	200	115	18.0
			TD-40		10°E	PULSE*	(200)	(85)	15.2
			RXB103093		90°H	D.C.	200	(35)	15.2
			RXB103394		90°H	A.C. and D.C.	(100)	(50)	15.2
12.4-18.00	K	RG-91/U	TD-18	6684	10°E	D.C.	200	70	15.2
			RXB103399		10°E	D.C.	200	(110)	18.0
			RXB103409		10°E	A.C. and D.C.	(100)	(65)	15.2
			TD-41		10°E	PULSE*	200	(80)	15.2
			RXB103411		90°H	A.C. and D.C.	(100)	(50)	15.2
			RXB103254		90°H	D.C.	200	(40)	15.2
18.0-26.5	K	RG-53/U	TD-13	6359	10°E	D.C.	200	65	15.2
			RXB103423		10°E	D.C.	200	(100)	18.0
			TD-42		10°E	PULSE*	(200)	(75)	15.2
			RXB103411		90°H	A.C. and D.C.	(100)	(50)	15.2
26.5-40.0	K	RG-96/U	RXB103251		10°E	D.C.	(150)	(120)	15.2

NOTE 1: Anode current and tube drop are D.C. values. Values in parentheses are tentative.

NOTE 2: D.C. operation—Cathode at one end only.  
A.C. and D.C. operation—Cathodes at both ends.  
Pulse operation—Cathode at one end specially designed for pulse operation.

NOTE 3: The Excess Noise Ratio in DB is  $10 \log \left( \frac{T_{eff}}{290} - 1 \right)$

\*If the anode current during the "on time" of a square pulse (of greater than 100 micro sec. duration) is nominally the same as the rated D.C. anode current, the tube drop during this period will be approximately the same as the rated D.C. tube drop.

Expanding its line from 9 types to 35 types, Bendix Red Bank now offers a great variety of noise source tubes.

But great variety is only one advantage. Noise source tubes that are free from ambient temperature corrections are the result of making tubes so that no correction in noise figures is necessary from  $-55^{\circ}\text{C.}$  to  $+85^{\circ}\text{C.}$  What's more, long life and unusual stability result from precise quality control—far beyond the usually accepted tolerances for such products.

Whatever your applications, whether for  $10^{\circ}$  or  $90^{\circ}$  angle mounting, check with our specialists for the most efficient solution. Write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

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

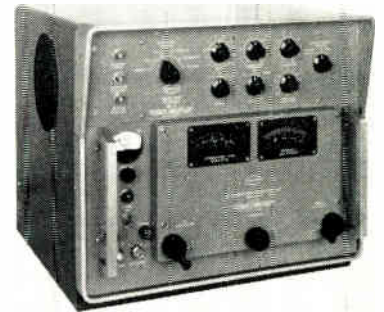
**Red Bank** Division



## New Products

### SIGNAL GENERATOR

Microwave signal generator, Model PMX—frequency range 4,450 to 11,000 MC features a wide range of modulation capabilities, and non-contacting klystron cavity chokes for



noiseless tuning. It generates internal pulse, square wave, or FM signals—or can be externally modulated. Internal pulse range—0.2 to 10  $\mu\text{sec.}$  variable width; 2 to 2000  $\mu\text{sec.}$  delay; and 10 to 10,000 pps repetition rate. Pulse rise and decay time—0.1  $\mu\text{sec.}$  FM generation is a linear sawtooth wave with a 5 MC deviation. Unit is capable of internal, external, pulse or sine wave synchronization and generates  $\pm$  synchronizing pulses, delayed or undelayed. Polarad Electronics Corp., 43-20 34th St., Long Island City, N. Y.

Circle 212 on Inquiry Card, page 117

### "BATHTUB" CAPACITORS

Two types of drawn metal case capacitors supplement the company's line of  $125^{\circ}\text{C}$  cylindrical case metallized designs. Type 144P use a dual dielectric of metallized paper and polyester film. Type 143P Metallized Paper Capacitors are for applications



not requiring high insulation resistance or other characteristics of the Type 144P. Both types can be used in most low-noise level circuits. Sprague Electric Co., 233 Marshall St., North Adams, Mass.

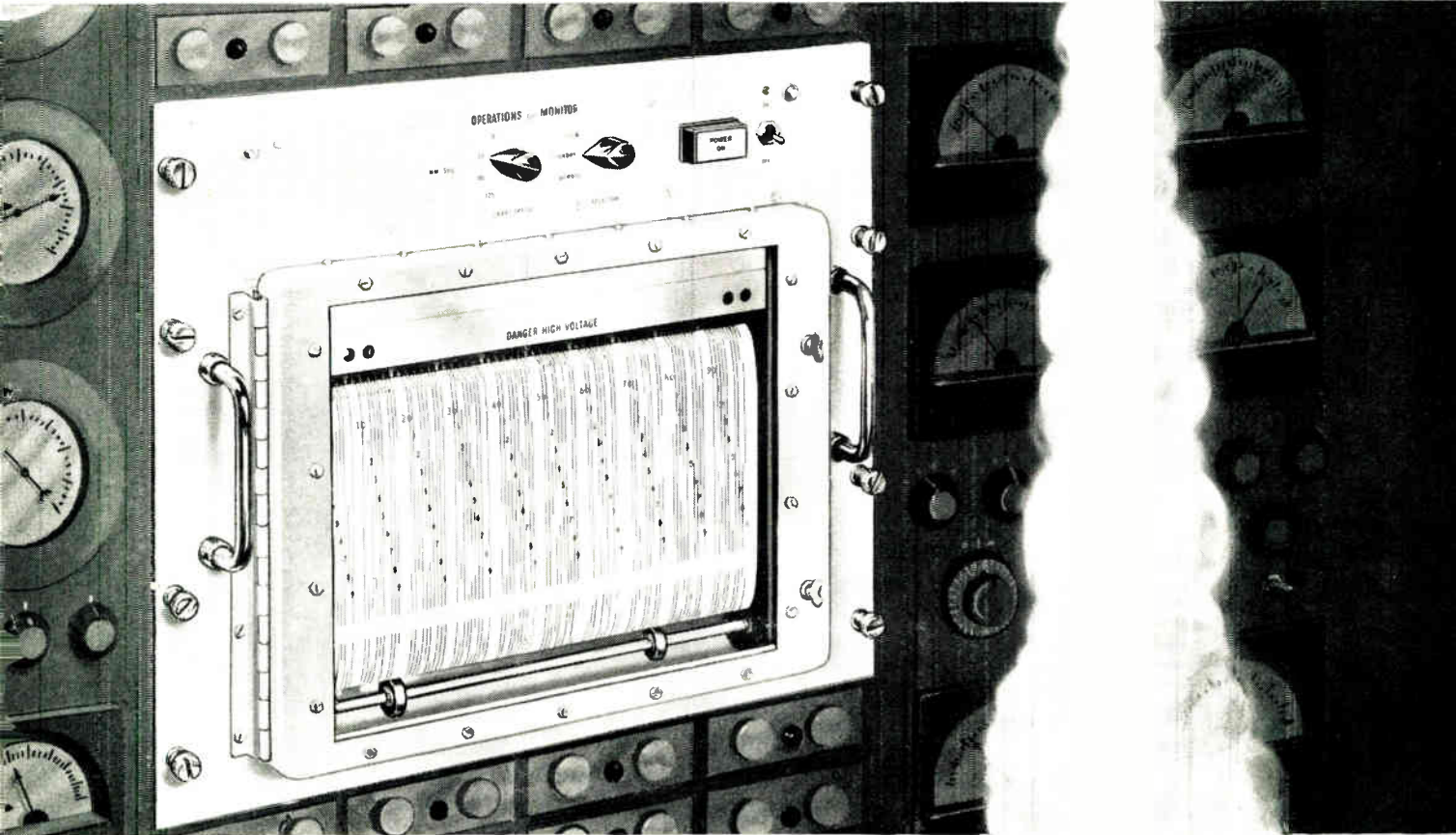
Circle 213 on Inquiry Card, page 117



BUILT TO MIL SPECS...



# one Brush Monitor records 100 countdown operations simultaneously!



Built to military specifications and performing to extremely rigorous military requirements, the Brush Operations Monitor can prevent aborts and destructs costing millions of dollars.

For quick, accurate and immediately visible go and no-go information, 100 operations are recorded simultaneously on a 500' moving chart only 12" wide. You have an *immediate* picture of an entire situation with each event shown in a time relationship to all other events. It is now being used for major check-out of propulsion systems, electrical test racks, fault isolation programmers and launch control vehicles.

Brush is now in production on this Mil Operations Monitor and prompt delivery can be made to your requirements. Phone or wire Brush for complete information and application assistance.

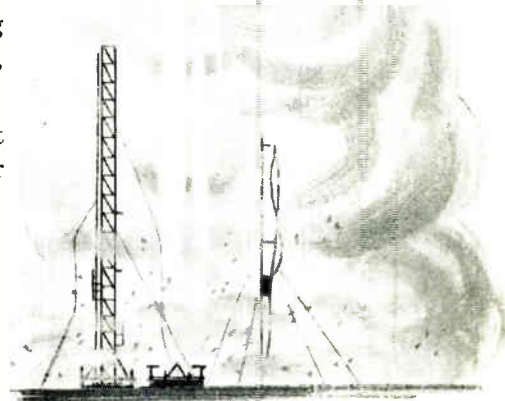
**brush** INSTRUMENTS

DIVISION OF

3405 PERKINS AVENUE

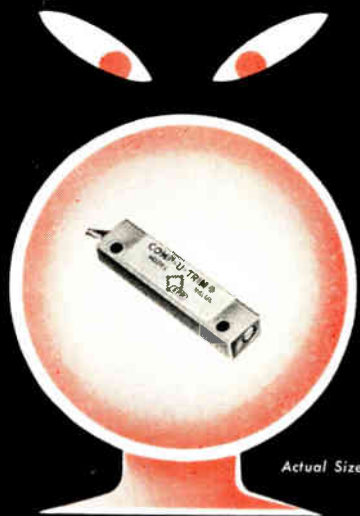
**CLEVITE**  
CORPORATION

CLEVELAND 14, OHIO



# A LOOK INTO THE FUTURE OF TRIMMING POTENTIOMETERS

From the applied research laboratories of the leading manufacturer of precision wire wound components, comes a complete line of wire wound trimming potentiometers . . . radically new in concept . . . that will set the standard in our industry for years to come . . . not a repackaging of a design that was outdated before our first missile was launched . . . but a wholly new design from the inside out . . . to meet the requirements of today . . . and to-morrow.

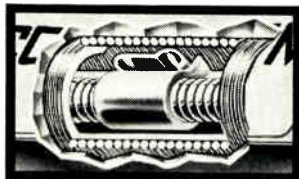


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from stock.**



## COMP-U-TRIM<sup>®</sup>

Shown above is Comp-U-Trim Model "E" . . . a totally encapsulated wire wound linear potentiometer . . . designed to meet the needs of the missile age . . . virtually unaffected by environmental conditions . . . a patented technique affords a resistance element 250% greater in area than any comparable component . . . the cutaway view below illustrates the unique construction of the Comp-U-Trim . . . the resistance element is wound on dimensionally stable and heat resistant seatrite.



### FEATURES

- Metal case
- Internally positioned wiper
- 0% end resistance
- Recessed adjustment screw
- Totally encapsulated
- Positive end stops



World's **FINEST** manufacturer of precision wire wound components.

**EASTERN PRECISION RESISTOR CORPORATION**

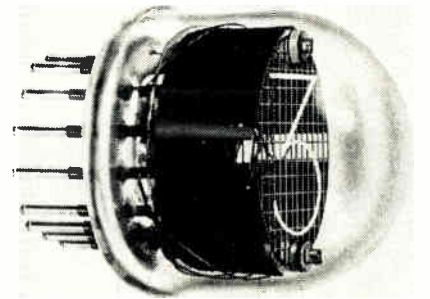
675 Barbey Street, Brooklyn 7, New York

Send now for new 12 page brochure on Trimming Potentiometers

## New Products

### INDICATOR TUBE

The B-5031 is an all-electronic (long life—10,000 hrs.) indicator which presents numerals (0 through 9) in a common in-line viewing area. Similar in mechanical and electrical

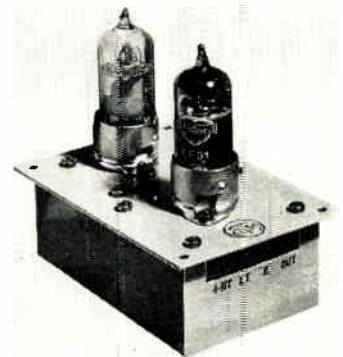


characteristics to the Standard Type 6844-A, the only change for interchangeability is a reduction in the value of series anode resistance under rated conditions. First of a series to be made available in production quantities, the series will correspond to the regular type Nixies: The Miniature (7009), the Standard (6844-A), the Super (7153), and the Jumbo (BD-307). Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

Circle 214 on Inquiry Card, page 117

### CRYSTAL OSCILLATOR

Near zero warm-up time and high stability are featured in oscillator. Stability of  $\pm 5$  ppm over the range  $-20^{\circ}$  C to  $+70^{\circ}$  C (temp. coefficient  $0.04$  ppm/ $^{\circ}$  C) with aging characteristic of less than  $\pm 0.2$  ppm. Any frequency in the range 4 MC to 16 MC

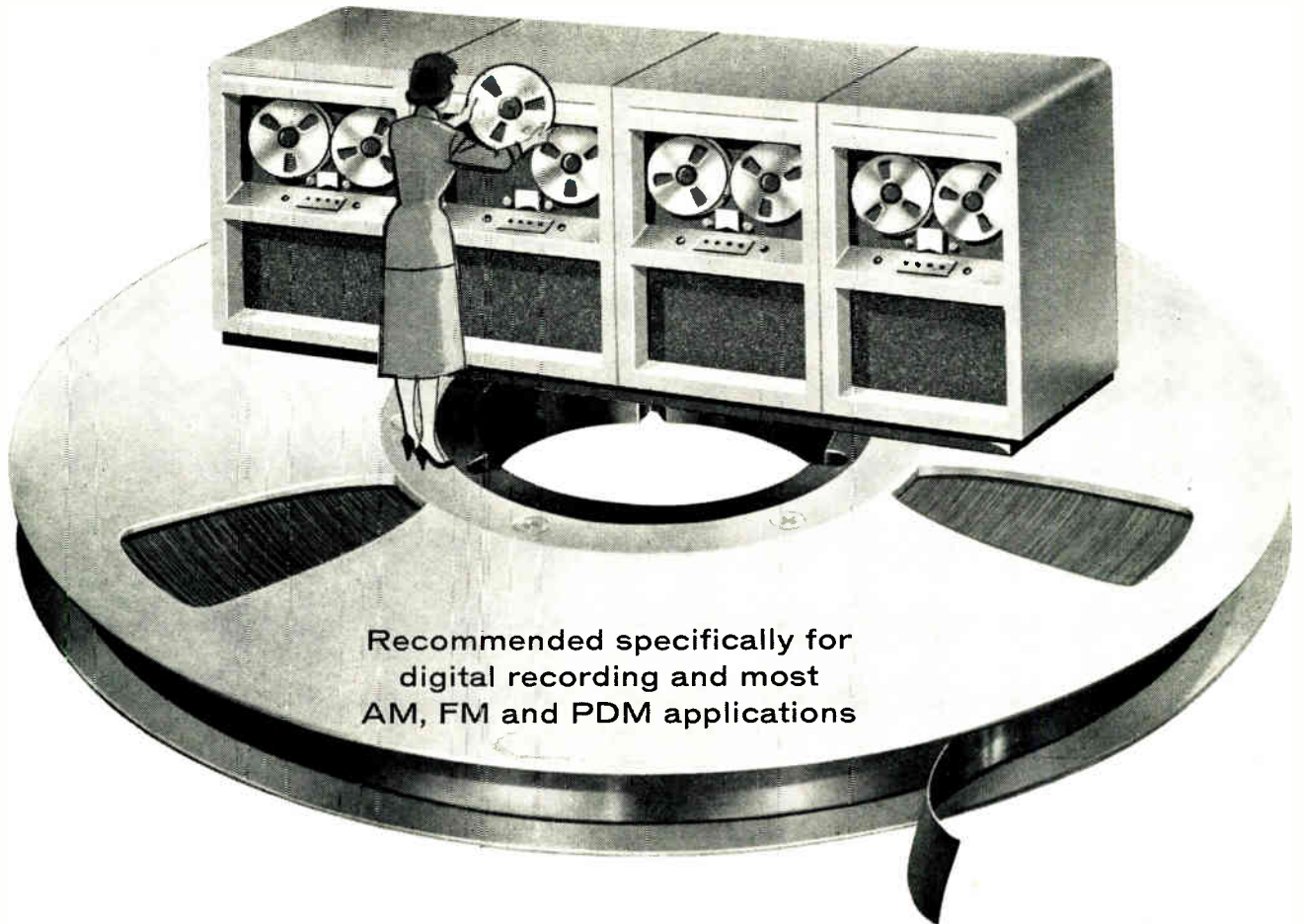


can be supplied and multiple frequency units are available. The unit weighs 9 oz. and is tested to withstand accelerations to 10g. Marconi Instruments, 111 Cedar Lane, Englewood, New Jersey.

Circle 215 on Inquiry Card, page 117



# NEW SANDWICH TAPES!



Recommended specifically for  
digital recording and most  
AM, FM and PDM applications

"SCOTCH" BRAND Sandwich Instrumentation Tapes eliminate ruboff and head buildup—reduce head wear—last longer

Here's the solution to the problem of excessive wear and ruboff—"SCOTCH" BRAND Sandwich Instrumentation Tapes. These tapes have a thin layer of plastic over the magnetic coating. This layer protects the iron oxide to produce a smooth, low-frictional head-to-tape operation that eliminates ruboff, head buildup and connected problems.

The addition of this protective layer (50 micro-inch thickness) naturally modifies the magnetic properties of the tapes somewhat. This amounts to a slight (but not critical) reduction in the high frequency or short wave length response. The medium and long wave length responses are completely unaffected. In all applications where extremely high frequency response is not required, "SCOTCH" BRAND Sandwich Tapes offer the ultimate in performance, combined with new freedom from maintenance problems.

**Three Sandwich Tapes are now available:**

- #188—For applications requiring standard output level. 1.5 mil polyester base, 0.35 mil magnetic coating, 50 micro-inch protective layer.
- #186—For instrumentation and computer applications higher than standard output. 1.5 mil polyester base, 0.50 mil magnetic coating, 50 micro-inch protective layer.
- #189—Standard output level with 50% more recording time. 1.0 mil polyester base, 0.35 mil magnetic coating, 50 micro-inch protective layer.

**WRITE TODAY** for illustrated brochure on Sandwich Tapes. Special reels, end-of-reel sensing items and other accessories required for digital computer operations are also available. Address: Instrumentation Tape Division, 900 Bush Avenue, St. Paul 6, Minn.



REG. U.S. PAT. OFF.  
**SCOTCH**  
BRAND  
**Magnetic Tapes**

**MINNESOTA MINING AND MANUFACTURING COMPANY**

... WHERE RESEARCH IS THE KEY TO TOMORROW



"SCOTCH" and the plaid design are registered trademarks of 3M Co., St. Paul 6, Minn. Export: 99 Park Ave., New York 16. Canada: London, Ontario.

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COMPLETE 452-PAGE  
1959 CATALOG**

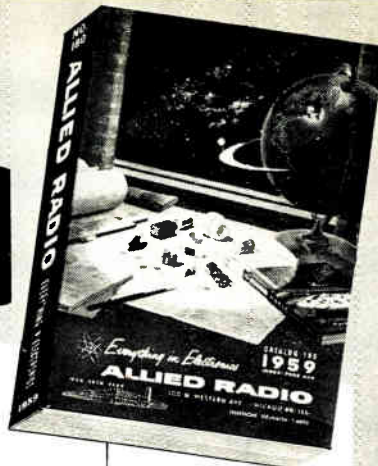
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the world's largest stocks of  
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Simplify and speed your purchasing of electronic supplies and equipment: send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types and makes), transistors, test equipment (see our money-saving KNIGHT-KITS), audio equipment and electronic parts. Our expert Industrial supply service saves you time, money and effort. Send today for your FREE 1959 ALLIED Catalog—your complete Buying Guide to quality Electronic Supplies for Industrial and Communications use.

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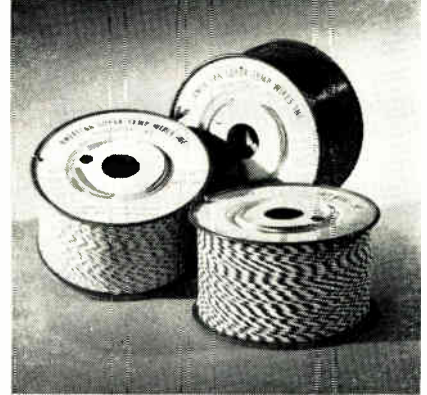
**OUR 38th YEAR**

Circle 86 on Inquiry Card, page 117

**New Products**

**HOOK-UP WIRE**

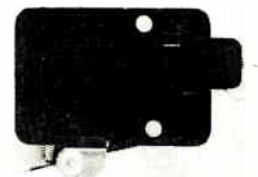
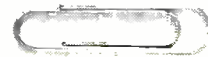
Extruded polyvinyl chloride hook-up wire conforms to MIL-W-16878 B (Navy) Types "B," "C," and "D." Temperature ratings in  $-55^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$  continuous operation. Type



B, rated at 600 v is produced in AWG sizes 32 thru 16. Type C, rated at 1000 v in AWG sizes 24 thru 14. Type D rated at 3000 v in AWG sizes 24 thru 6. Colors conform to MIL-STD 104 and spiral striped insulation may be had with one or two tracers on a background color. The thermoplastic insulated line is available with or without nylon jackets. Conductors are soft-tinned copper wire. American Super-Temperature Wires, Inc., 2 West Canal St., Winooske, Vermont.  
Circle 216 on Inquiry Card, page 117

**TAPE RECORDER SWITCH**

This switch, about the size of a standard paper clip, automatically shuts off a tape recorder if the tape should break. The device incorporates a non-magnetic nylon leaf with rounded surfaces over which the tape passes. In the event of tape breakage, pressure upon the leaf is released, shutting off the recorder. The main body of the switch is less than  $1\frac{1}{2}$  inches in length. It is UL

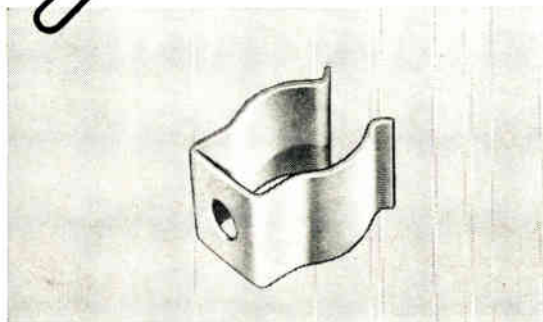


approved at 3 a and 250 vac. Movement differential is 0.233 inch maximum, and operating force is as low as 6 grams. Acro Division, Robertshaw-Fulton Controls Co., P.O. Box 449, Columbus 16, Ohio.

Circle 217 on Inquiry Card, page 117

*for maximum reliability*

**HOLD  
and  
COOL**  
transistors  
with



**BIRTCHEr TRANSISTOR CLIPS**

**MATERIAL**

Beryllium #25

**FINISH**

Choice of Cadmium, black Ebanol or Silver plated

**SIZES**

Available in sizes and modifications to retain all popularly used transistors.

Birtcher TRANSISTOR CLIPS perform the dual functions of retention and heat reduction. Being made of tempered beryllium copper they grip the transistor securely and hold it in place even under severe conditions of shock and vibration. In addition they provide an excellent heat path to drain off heat into chassis or heat sink.

**THE BIRTCHEr CORPORATION**

**INDUSTRIAL  
DIVISION**

4371 Valley Blvd.,  
Los Angeles 32, Calif.

Write for catalog

Circle 87 on Inquiry Card, page 117



# Narda SonBlasters offer the most complete line of lowest-cost mass-produced ultrasonic cleaners!

Narda's mass-production techniques assure you the most complete line of ultrasonic cleaners at the lowest prices in the industry! From the smallest 35-watt to the amazing 2500-watt unit with a tank capacity of 75 gallons, Narda's SonBlasters are available now—off-the-shelf—for immediate delivery. And with a full 2-year warranty besides!

What do you want to clean? Transistors, semi-conductors, other electronic, automotive, missile and avionic components, instruments, timing mechanisms—Narda's SonBlasters clean

'most any mechanical, electrical or horological part or assembly you can think of—and clean faster, better and cheaper.

No matter what you need in ultrasonic cleaning equipment, you'll find Narda's complete line of production-size units have the quality, power, performance, capacity and appearance of cleaners selling up to three times their price! Write for more details now and we'll include a free questionnaire to help determine the precise model you need. Address: Dept. EI-19.



**Generator G-202** Transducerized Tank NT-202  
35 watts Capacity: 3/8 gallon

An amazingly efficient, yet inexpensive, ultrasonic cleaner. Duty cycle timer permits operator to turn the unit on, set it, and leave; the SonBlaster will turn off automatically at the end of the cycle. Four choices of timers—from 0-15 min. to 0-120 min. Also available without timer at slightly lower cost (G-201).

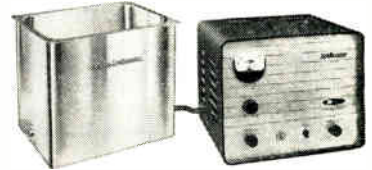
**\$220**



**Generator G-601** Transducerized Tank NT-602  
60 watts Capacity: 1 gallon

A more powerful production-type unit, with a special circuit and selector switch permitting operator to alternate between two tanks, when items being cleaned require different solutions or a two-step process.

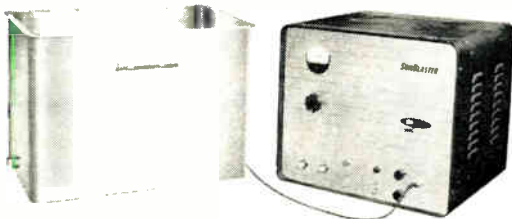
**\$350**



Transducerized Tank NT-1505 Generator G-1501  
Capacity: 5 gallons 200 watts

The lowest price in the industry for a tank of this capacity and activity. Generator also will operate 2, 3 or 4 submersible transducers at one time, with just a turn of the load selector switch on the front panel.

**\$695**



Transducerized Tank NT-5001 Generator G-5001  
Capacity: 10 gallons 500 watts

Generator features standby switch for longer life and load selector switch on the front panel to operate up to 8 submersible transducers or 8 NT-602 or 2 NT-1505 transducerized tanks at one time. Larger tanks available on special order.

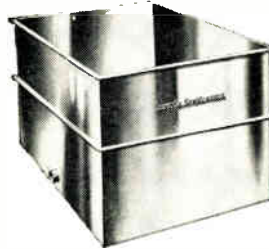
**\$1325**



**Submersible Transducer NT-605**

Heli arc welded stainless case, hermetically sealed for safe, leak-proof immersion. Radiating face: 27 sq. in. Effective plane of radiation: 40-50 sq. in. (approximately 10" x 5"). Effective cavitation of volumes up to 1200 cu. in. at 24 in. tank height (5 gal.) and 2400 cu. in. at 48 in. tank height (10 gal.). Bulkhead electrical fitting on back allows all wiring connections to be made on outside of tank. For use in any arrangement or location in any shape tank you desire to use. Also available—model NT-604, identical with NT-605, except for pipe thread instead of bulkhead fitting, permitting electrical connections inside of tank.

**\$130**

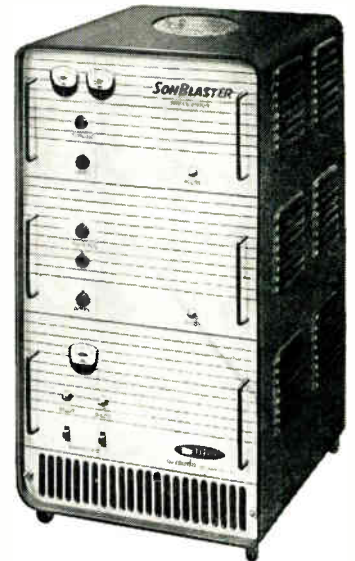


Transducerized Tank NT-25001  
Capacity: 75 gallons

Powerful unit drives the largest mass-produced industrial-size transducerized ultrasonic cleaning tank made! Also energizes up to 40 Narda 60-watt submersible transducers (NT-604 or -605). Capable of energizing tanks measuring up to 150 square feet of area by 2' or 3' high.

**\$4360**

**Generator G-25001**  
2500 watts



Consult with Narda for all your ultrasonic requirements. The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers which can be adapted to any size or shape tank you may now be using. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available—and at the lowest price in the industry!

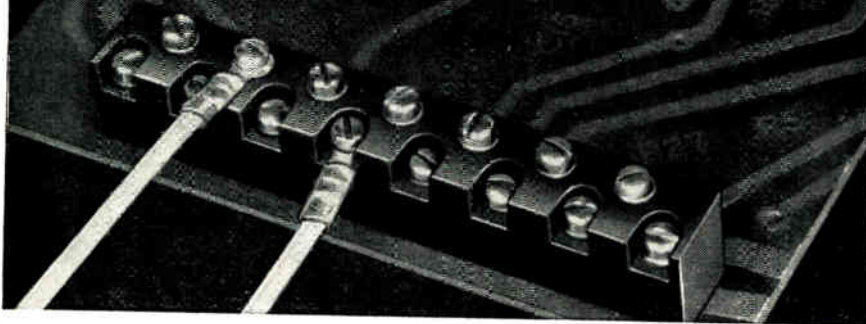
For custom-designed installation and unique electro-acoustic applications, including cleaning, soldering, welding, drilling and non-destructive testing, consult our subsidiary, Alcar Instruments Inc., at the address below.



the narda ultrasonics corporation

625 MAIN STREET, WESTBURY, L. I., N. Y.  
Subsidiary of The Narda Microwave Corporation

# MINIATURE TERMINAL BLOCKS for PRINTED WIRING



You can simplify those external connections to printed-wiring boards, no matter how jammed up. Kulka Type 520 miniature terminal blocks mount on board, with terminal pins slipping into standard connector mounting holes for dip soldering. Screw connections for external leads. Readily connected or disconnected. Available in 2 to 24 terminals. Entire printed-circuit board with terminal blocks and lead wires, can be encapsulated if desired.

### WRITE FOR LITERATURE . . .

Descriptive bulletin on request. If you do not already have the big Kulka Terminal Block Catalog in your reference file, ask for it.

## KULKA ELECTRIC CORP.

633-643 So. Fulton Avenue  
Mount Vernon, N. Y.

Circle 89 on Inquiry Card, page 117

# RUGGED and RELIABLE New! TRANSISTORIZED

The  
**A. W. HAYDON COMPANY'S  
TRANSISTORIZED SUB-MINIATURE  
ELECTRONIC TIME DELAY RELAYS!**

### SAVE SPACE AND WEIGHT!

	Miniature Series	Sub-Miniature Series
Cross Section	1 1/16" x 1 1/32"	3 1/32" x 1 3/16"
Length	2 1/4" long	2" long
Weight	6 ounces	3 ounces
WRITE FOR:	Bulletin AWH TD-503	Bulletin AWH TD-504

### TEST-PROVED PERFORMANCE!

High Temperature: 125°C (250°F)  
Vibration: 2000 CPS at 15 g.  
Contact arrangements up to 4 pole double throw.  
Unique transistorized R.C. time constant network.  
Time Delays from 50 MS to 120 seconds. Longer Delays available.  
Hermetically sealed housings.

MEET  
REQUIREMENTS  
OF MIL-E-5272A.



The  
**A. W. HAYDON Company**

219 NORTH ELM STREET, WATERBURY 20, CONNECTICUT  
Design and Manufacture of Electro-Mechanical Timing Devices



MINIATURE ELECTRONIC TIME DELAY RELAYS 31200 SERIES

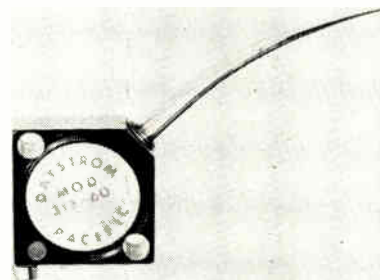
SUB-MINIATURE ELECTRONIC TIME DELAY RELAYS 31300 SERIES



## New Products

### POTENTIOMETERS

Upgraded version of the 1/2 in. Squaretrim line potentiometers, Model 313, is first of a new series of high temperature precision units. Resistance values are from 10 ohms to 50

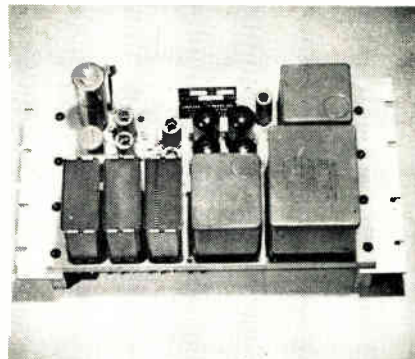


K ± 5.0%. Operating temperatures of this miniature 1.5 w potentiometer range from -55° to +200°C. One watt is dissipated at +95°C. Meets or exceeds MIL-STD-202 Method 202 shock and vibration, and NAS 710 noise specifications. A 360° sweep of the wiper requires 42 turns of the adjustment screw giving precision adjustments. Daystrom Pacific, Potentiometer Sales, 9320 Lincoln Boulevard, Los Angeles 45, Calif.

Circle 218 on Inquiry Card, page 117

### PRECISION POWER SUPPLY

Type 2111F is a precision frequency power supply featuring an accuracy of ± 20 parts per million from 15°C to 35°C for an output of one fixed frequency in the range 60 to 500 cycles. Input—115 v ± 15%, 50 to 500 cps. Output wattage—50 w adjustable from 0 to 115 v. Operating Temperatures—+50°C to -50°C. Termination—Screw, Bar-



rier. Size—Chassis plate 10 in. x 16 in. wide or with adapters to mount plate vertically in a 19 in. x 10 1/2 in. rack space. Weight is 38 lbs, net. American Time Products, Inc., 580 Fifth Ave., New York 36, N. Y.

Circle 219 on Inquiry Card, page 117





# For Every Fuse Application

*there's a safe and dependable  
BUSS or FUSETRON Fuse*

## The complete BUSS and FUSETRON fuse line includes:

Single-element fuses for circuits where quick-blowing is needed; — or single-element fuses for normal circuit protection; — or dual-element, slow-blowing fuses for circuits where harmless current surges occur; — or indicating fuses for circuits where signals must be given when fuses open. Fuses range in sizes from 1/500 amperes up — and there's a companion line of fuse clips, blocks and holders.

## Each fuse electrically tested to assure you dependability

Every BUSS or FUSETRON fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

You get the safest, most modern protection possible when you specify BUSS or FUSETRON fuses. You'll save time and trouble too, by using this one source for all your fuse needs.

*For more information,  
write for bulletin SFB.*

BUSSMANN MFG. DIVISION McGraw-Edison Co.  
University at Jefferson, St. Louis 7, Mo.

259

*Tell us your requirements and we'll have a fuse to match, for example:*

For fuses that abolish needless blows . . . specify . . . **Fusetron fuses**

1/4 x 1 1/4 inch.  
Glass tube.



dual-element — slow blowing type

These fuses avoid needless blows from starting currents or surges. Yet protection is afforded against short-circuits or continued overloads.

Test specifications — carry 110%, open at 135% within 1 hour.

Voltage	Amperes
250 or less	up to 2
125 or less	up to 7
32 or less	up to 30

For Signal or Visual indicating fuses . . . specify . . . **Fusetron FNA fuses**

13/32 x 1 1/2 inch.



Fusetron fuse with indicating pin which extends when fuse is blown. Can be used in BUSS fuseholders to give visual signal or, if desired, pin can be used to actuate a light or audible signal by using fuses in BUSS Signal fuse block.

0 to 2 1/2 ampere sizes and 12 to 15 ampere sizes listed as approved by Underwriters' Laboratories.

Voltage	Amperes
250 or less	1/10 to 30.

For fast acting fuses for protection of instruments specify **BUSS AGC fuses**

1/4 x 1 1/4 inch.  
Glass tube.



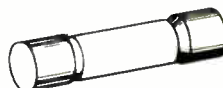
In sizes up to 2 ampere, for circuits of 250 volts or less, they provide high speed action necessary to protect sensitive instruments or delicate apparatus.

Listed as approved by Underwriters' Laboratories.

Test specifications — carry 110%, open at 135% in 1 hour or less. 1/500 to 2 ampere sizes also will open at 200% load in 5 seconds or less.

For high interrupting capacity fuses . . . specify . . . **BUSS KTK fuses**

13/32 x 1 1/2 inch.



Capable of safely interrupting 68,000 amperes at voltages of 500 or less, AC or DC.

Test specifications — Carry 110%, open at 135% in 1 hour or less.

Voltage	Amperes
500 or less.	1/10 to 30.

**BUSS fuses are made to protect,—not to blow, needlessly.**

*BUSS makes a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.*

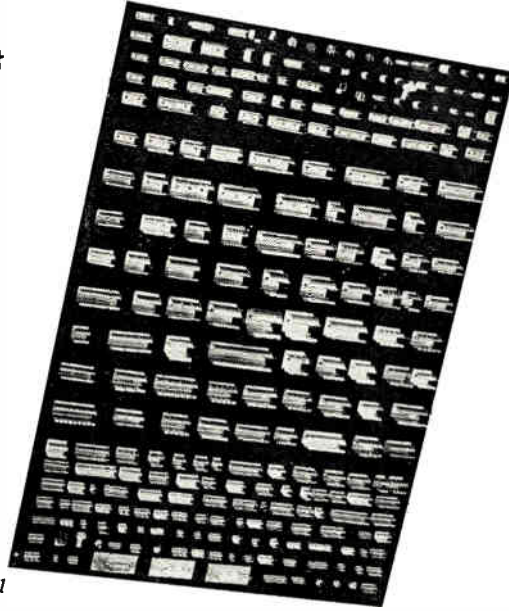


## Meet the industry's top efficiency team . . .

Augat's complete  
line of Component  
Cradles and Clips

Here's positive, lasting protection against external shock and vibration. Augat cradles are especially designed to clamp sub-miniature and miniature tubes, transistors, resistors, capacitors, diodes, crystals, etc.

They assure longer life of tubes and transistors by reducing temperature through conduction.



Representative Display

Write today for additional information and samples.

# AUGAT BROS. INC.

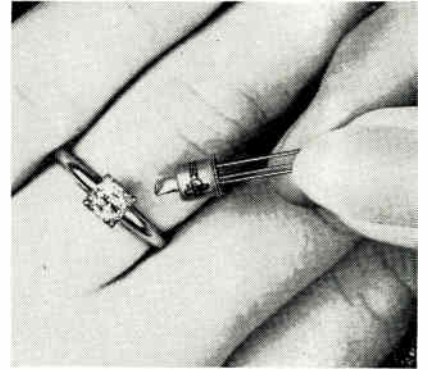
31 PERRY AVENUE • ATTLEBORO, MASS.

Circle 92 on Inquiry Card, page 117

## New Products

### UHF TRANSISTORS

Ultra high frequency, diffused base "mesa" germanium transistors are suited for ultra high speed switching applications. Switching speeds are in the millimicrosecond range and a

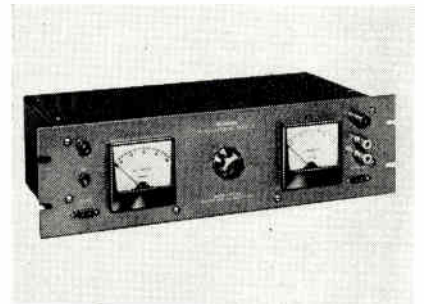


typical alpha cutoff frequency is 250 MC. It is rated to dissipate in excess of 150 mw in free air and will operate at temperatures up to 100°C. It is available in a miniature round-welded case less than 1/2 the size of the standard JETEC-outline TO-5 unit. Case is compatible with the 100-mil grid mounting system. TI-2N559 meets and exceeds reliability specs as outlined in MIL-T-19500A. Texas Instruments Incorporated, P.O. Box 312, Dallas, Texas.

Circle 220 on Inquiry Card, page 117

### POWER SUPPLIES

Variable ac power supplies for use where maximum va utilization is required, the MVAU series has no moving parts, vacuum tubes or internal adjustments. Featured are: high quality waveform, voltage and current meters of 2% accuracy, output terminals on front and rear, and complete short circuit protection. The units have va ratings of 60 to 500 and from 3 to 20 a. They are continuously adjustable from 0 to 130 v with out-



put voltage regulation  $\pm 1.0\%$ . Output is isolated from line. Harmonic distortion is less than 3% RMS and response time is less than 1 1/2 cycles. Nutron Mfg. Co., Inc., 67 Monroe Ave., Staten Island, N. Y.

Circle 221 on Inquiry Card, page 117

Model 868A \$475

### MAKE NO MISTAKE...

... this New Universal Bridge is DIRECT READING on all 21 ranges. Results are obtained without calculation, the balance is sharp but easily found, the design is functional. Mistakes are almost impossible with Model 868A—a bridge you will enjoy using.

21 Ranges:  
1  $\mu$ H to 100H. 1  $\mu$ F to 100  $\mu$ F. 0.1  $\Omega$  to 10M $\Omega$ .  
Dual Frequency, 1kc & 10kc. 400 cps to order.  
Built-in Oscillator and tuned VTVM Detector.  
Variable Bridge Voltage, meter-monitored.



**MARCONI**  
INSTRUMENTS



111 CEDAR LANE • ENGLEWOOD, NEW JERSEY



# Cambion<sup>®</sup> Miniature Jacks and Plugs

Ideal for  
computer patchwork panels



Take your pick from the large selection of CAMBION miniature jacks and plugs. Varying widely in types, these top quality, precision made units are ideal for quick, tight, space-saving patchwork on panel boards.

The jacks make perfect electrical connections, thanks to their special beryllium copper compression springs, floating D keys and solid fronts. Jacks are available in shank lengths for varying panel thicknesses. Pin diameters of the plugs are .080", .062" and .045".

For full information, write Cambridge Thermionic Corporation, 504 Concord Avenue, Cambridge 38, Massachusetts.

Circle 94 on Inquiry Card, page 117

## CUSTOM WAVEGUIDE ASSEMBLIES ... to Precision Tolerances

BRASS OR ALUMINUM



- ALL MODERN JOINING AND PRODUCTION TECHNIQUES
- PIONEERS OF ALUMINUM FLUX DIP BRAZING
- COMPLETE MICROWAVE ELECTRICAL TEST FACILITIES
- DEPENDABLE ON-TIME DELIVERIES

Send for copy of "Report on Flux Dip Brazing"

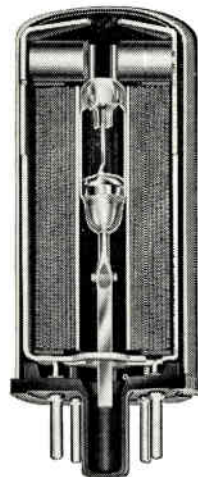
**WAVELINE** INC.  
CALDWELL, NEW JERSEY

Telephone: CApital 6-9100  
TWX Caldwell, N. J. 703

Circle 95 on Inquiry Card, page 117

**FAST!**  
up to 200 cps  
**SENSITIVE!**  
low as  $\pm 2.5$  milliwatts

## NEW CLARE type HGS Mercury-wetted Contact Relay



Cutaway view of a CLARE Type HGS Relay. Mercury-wetted contact switch is sealed in glass and surrounded by the operating coil. Biasing magnets are attached to the upper ends of the side plates.

**IDEALLY SUITED TO HIGH SPEED  
SWITCHING DEVICES**

The Type HGS Relay is a new variety of CLARE Mercury-wetted Contact Relay, developed to meet the needs of modern design engineers for faster and more sensitive relays. It is especially suited to all types of high-speed switching devices, over-voltage and overload protection devices and high-power chopper applications.

Operating speeds may be up to 200 cps or more. Sensitivity may be as low as  $\pm 2.5$  milliwatts for a bi-stable adjustment, as low as 5 milliwatts for a single-side-stable adjustment. Contact rating is 2 amperes, 500 volts, with a limit of 100 volt-amperes.

The new CLARE Type HGS Relay is similar to the revolutionary Types HG and HGP except that the HGS is always biased with permanent magnets.

Send for CLARE Sales Engineer Bulletin No. 125 for complete information on the new Type HGS Relay. Bulletins 120 and 122 describe HG and HGP Relays. Write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address CLARELAY.

**CLARE RELAYS**  
FIRST in the industrial field

Circle 96 on Inquiry Card, page 117

# NOW TRANSISTORIZED!

# IMC

# SIZE 8 MOTORS



*Feature  
Extra-Short  
Length  
with*

## High Torque/Inertia Ratio

NOW TRANSISTORIZED! . . . IMC's Size 8 Servo Motors are providing top performance and reliability for critical functions in missile computer network systems. Designated BT-705-1, these units have a control phase that features a high-impedance, center-tapped winding for transistor operation.

These tiny powerhouses are especially miniaturized for aircraft and missile applications which require a high-torque to inertia ratio. Unit is shown actual size above.

BT-705-1 meets or exceeds MIL-E-5272B and operates within an extended temperature range of  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ . The 700 frame series encompasses a range of inputs from 6 to 57 volts. Full data on request.

### CHARACTERISTICS — 700 FRAME MOTORS

		Fixed Phase	Control Phase
Frequency, CPS	400	26	20-0-20
Stall Torque	0.33	*Current amperes	0.151
No Load Speed, RPM	6200	*Power Input, watts	2.7
Max. Power Output, watts	0.50	*Power Factor	0.69
Torque @ Max. Power Output, Oz. In.	0.195	*R, ohms	119
Speed @ Max. Power Output, RPM	3500	*X, ohms	125
Rotor Inertia, gm cm <sup>2</sup>	0.65	*Z, ohms	172
*Theoretical Acceleration, rad/sec <sup>2</sup>	35,500	*Effective Resistance, ohms	250
Weight, Oz.	1.6	*Parallel Tuning Condenser for Unity P.F., ufd	1.7
			0.7

\*MEASURED AT STALL

IMC's versatile engineering staff is available to meet your specific design requirements.



## INDUCTION MOTORS CORP.

570 Main St., Westbury, L. I., N. Y., Phone: EDgewood 4-7070  
6058 Walker Avenue, Maywood, California

New	
	Products

### NICKEL CADMIUM CELLS

Sintered-plate button cells, the VO.180 and VO.100, are the size of a nickel and weigh ¼ oz. Combined in cylindrical stacks they form batteries of almost any voltage. The

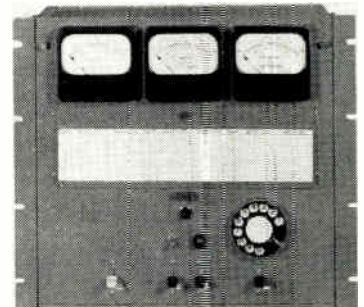


cells recharge with a current equal to 1/10 their normal capacity. With proper charging, they can be recharged indefinitely. They are non-gassing upon recharge, require no filling or electrolyte, operate at normal temperature ranges, and have low internal resistance. They find application in paging units, telemetry, missiles, emergency lighting, and portable consumer products. Gulston Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle 222 on Inquiry Card, page 117

### REMOTE CONTROL SYSTEM

Designed for unattended operation, this system offers directional and multiple transmitting; 38 switching circuits with in-built facilities for expansion to 78; operation on loop resistance up to 5000 ohms; large illuminated numbers to indicate circuit dialed; pulse, reset, and switching functions controlled from transmitter for local operation; no simplex, phantom, or ground return with straight wire system; supplies 19 wired meter



circuits (20 additional unwired if needed); no problem with 60 miles of cable; standardization of all equipment. Panel size is 19 in. x 15¼ in. Gates Radio Co., 123 Hampshire St., Quincy, Ill.

Circle 223 on Inquiry Card, page 117



# Creative Microwave Technology

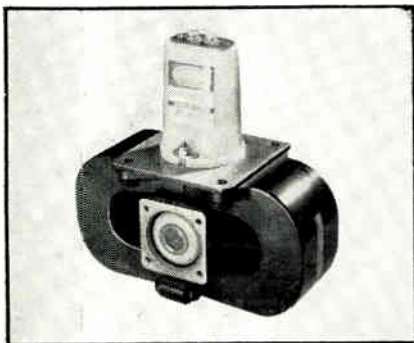
Vol. 1

No. 1

Published by MICROWAVE and POWER TUBE DIVISION  
RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASSACHUSETTS

## NEW DEVELOPMENTS IN ELECTRONIC TUBES AND CERAMICS

Where abnormal conditions of vibration (25 to 2000 cps at 10G) are encountered, such as in advanced airborne applications, this pulsed-type X-band (9245 ± 40 Mc) air-cooled RK6967A/QK366A magnetron oscillator maintains exceptional frequency stability and operational reliability. Optimum performance is assured by a double-end supported cathode and aluminum-clad integral magnets. Nominal peak

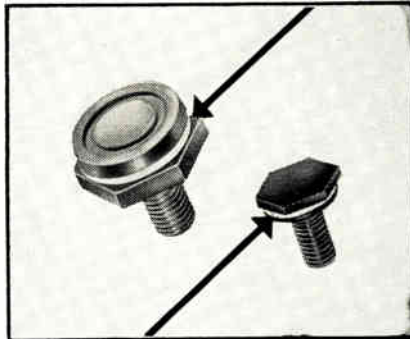


power output is 100 kw at typical pulse conditions of 0.5 μ sec. (.001 duty cycle). The tube operates at a peak anode voltage and current of 15 kv and 13.5 amp. respectively.

Circle No. 3 on Inquiry Card

\* \* \*

Integrally insulated semi-conductors can now be produced by using high-alumina ceramic stem assemblies. Heat dissipating ceramic wafer (arrow) in the base insulates up to 2000 volts dc and withstands soldering temperatures as high as



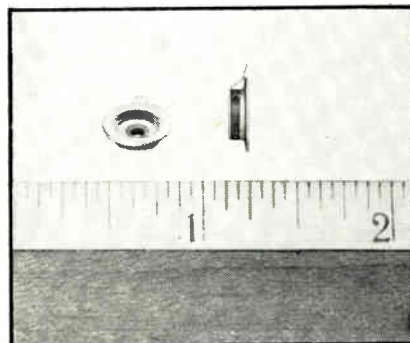
1100C. Bases can be directly mounted to chasses or cold plates. Stems are available to all semi-conductor manufacturers.

Circle No. 4 on Inquiry Card

\* \* \*

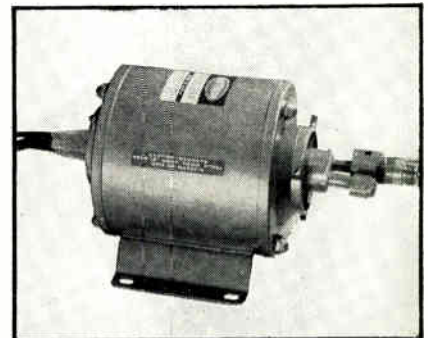
Miniature gyro feed-throughs provide take-off points from gas-filled gimbal housings. These high-alumina, vacuum-tight, R-95 ceramic assemblies can be soldered to housings at temperatures up to 1000C. They also assure positive electrical insulation with leakage less than one micro-ampere per 500 volts dc.

Circle No. 5 on Inquiry Card



Designed for voltage tunable CW or pulsed operation over the Government X-band (8500 to 9600 Mc), the QK-684 integral magnet backward wave oscillator delivers 10 to 50 mW over delay-line voltages ranging from 215 to 325 vdc. Regulation of a special control grid facilitates pulsed or amplitude modulation to meet power and frequency requirements. Models available for coupling to standard, type "N" connectors.

Circle No. 6 on Inquiry Card



\* \* \*

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

Circle No. 7 on Inquiry Card

A Leader in Creative Microwave Technology



# Varian STRIP CHART Recorders



## Unique combination of performance, size and price

**OVER 1000 TIMES AS SENSITIVE** as galvanometer recorders... and Varian's null-balance potentiometer needs no power from the source being measured. Rugged, stable mechanism allows ink or inkless recording—easy-to-read rectilinear chart—source impedances of up to 100,000 ohms.

**LESS THAN HALF AS WIDE** as a standard 19-inch rack. Two Varian G-11A's mount side by side on a rack panel 10 $\frac{3}{8}$  inches high. Or as a portable, the G-11A is an easy-to-handle 15 pounds. The G-10 sits on less than one square foot; its horizontal chart is handy for jotting notes.

**MORE VERSATILE AND ADAPTABLE** than any similar recorder—adjustable zero, adjustable span (from 9 to 100 mv on the G-11A), multiple chart speeds (up to four on the G-11A), and plug-in input chassis for different recording requirements.

**PRICES THAT BEGIN** at \$365 for the G-10 and \$470 for the G-11A. Because unneeded performance costs money, Varian has intentionally designed for 1% limit of error and 1-second balancing time. Thus, Varian provides needed ruggedness, dependability and operating features at moderate cost.

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND STANDARD OPTIONS

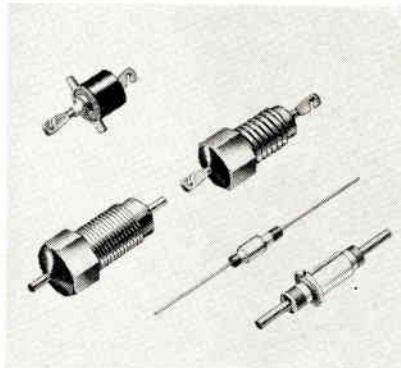


Circle 99 on Inquiry Card, page 117

## New Products

### FEED-THRU FILTERS

Low pass, feed-thru filters eliminate high frequency radiation and feed back in low power circuits in the frequency range from 50 MC to 5000 MC. Effective capacitance at VHF,

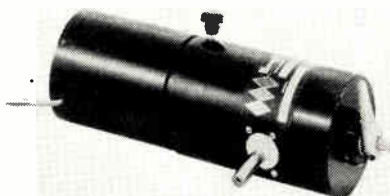


UHF, and higher frequencies is greater than is indicated by the nominal capacitance measured at 1KC, providing an increase in filtering effect of up to 60 db. For selective frequency attenuation, units may be supplied with cascaded elements. Voltage ratings are up to 500 vdc at temperatures to 125°C ambient. Max dc and low-frequency current is 5 a. Standard r-f current at rated dc voltage is 0.25 a. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.

Circle 224 on Inquiry Card, page 117

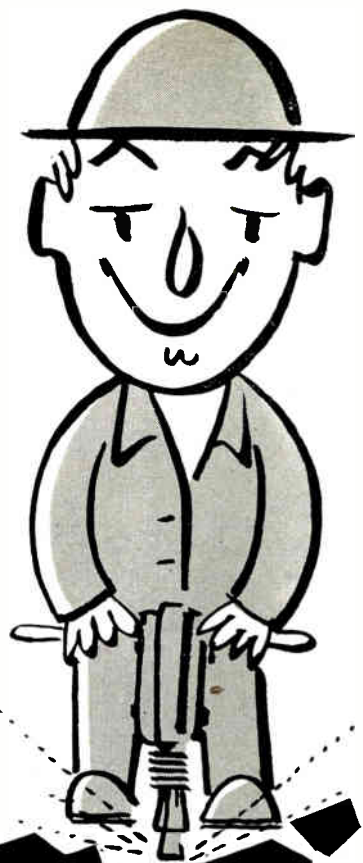
### VARIABLE SPEED DRIVE

The Servotran, a lightweight miniature variable speed drive offers frequency response equivalent to a hydraulic system and triple that of an electrical system in a mechanical drive weighing 1 $\frac{3}{4}$  lbs. The drive without motor is 3 $\frac{3}{4}$  in. long by 2 in. in dia. A maximum of 2 in.-oz on the control shaft changes speed from full forward to full reverse in 0.05 sec. Output torque is constant and



efficiency is between 85% and 95%. Applications include: actuators, computers, recorders, integrators, and in airborne instrumentation. Humphrey Products Division, 3794 Rosecrans St., San Diego, Calif.

Circle 225 on Inquiry Card, page 117



ADVANCED

ELECTRONICS

MAKES RF

NOISE

SUPPRESSION

FILTERS

Write, wire or phone today for Technical Bulletin AE-101

**ADVANCED ELECTRONICS CORP.**  
12 COMMERCIAL ST.  
HICKSVILLE, L. I., N. Y.  
EDgewood 4-0500

Circle 100 on Inquiry Card, page 117



# AT LAST!

## PRECISION CUTTING TOOLS DESIGNED FOR PROFESSIONALS

Get rid of clumsy, dangerous razor blades and jack-knives. Here are your kind of tools for all cutting, slicing, trimming and slitting jobs.

### x-acto® PRECISION KNIVES

A wide range of surgically-sharp, instantly interchangeable blades to fit light, medium and heavy-duty handles.



#### TRY-OUT OFFER!

Aluminum knife handle and sample blade assortment.  
Special Price \$1.00

Send for knife and blade catalog.

HANDICRAFT TOOLS, INC.  
a division of  
**X-ACTO, INC.**  
48-41J Van Dam St.  
L. I. C. I., N. Y.



Circle 101 on Inquiry Card, page 117



### 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: 1/4" I.D. to 4" O.D. to 1 1/2" high

#### LABORATORY USE

- Change wire and core size in 45 sec.

#### PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

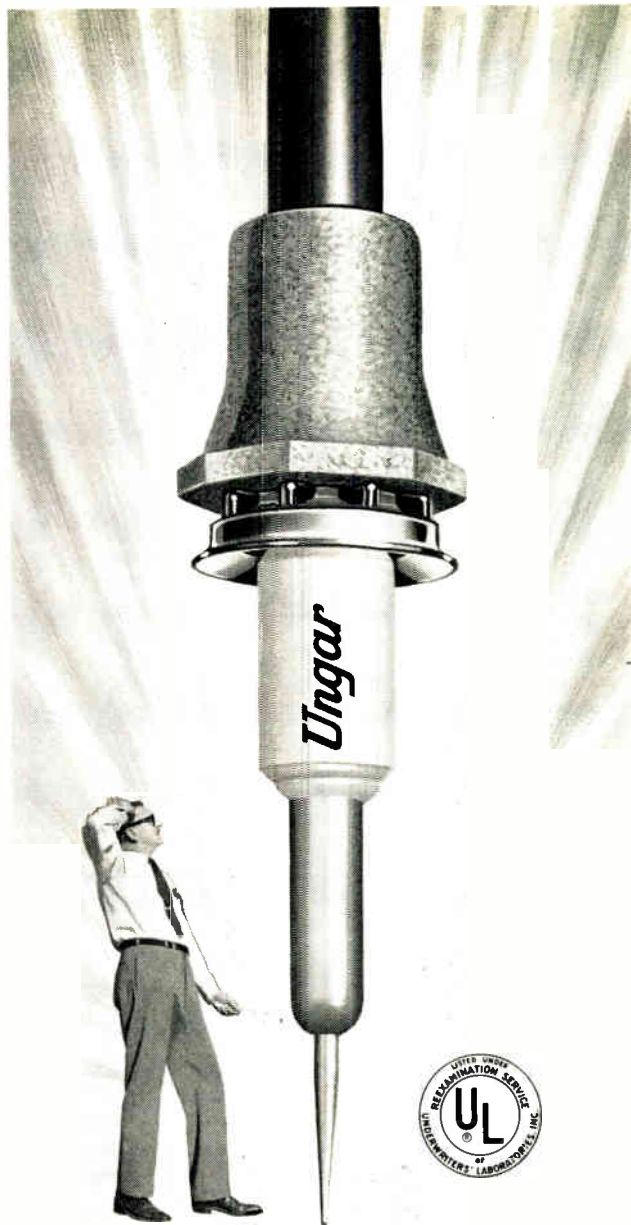
write or telephone for literature

**ARNOLD MAGNETICS CORP.**  
4615 W. Jefferson Blvd., Los Angeles 16, Calif.  
REpublic 1-6344

Circle 102 on Inquiry Card, page 117

ELECTRONIC INDUSTRIES • February 1959

ELECTRONIC INDUSTRIES • February 1959



## How BIG should a soldering iron be?

*The smaller the better...* and here's why. On production lines the light weight of Ungar's small pencil type soldering iron reduces worker fatigue. Small size tips balanced with the right amount of heat produce perfect soldered connections... avoid damaging heat radiation.

Any way you look at it, your soldering irons need be no bigger than Ungar's... they insure accuracy, greater reliability of the finished system.

Write for free catalog and new soldering booklet.

**Ungar® Electric Tools, Inc.**

4101 Redwood Ave., Los Angeles 66, Calif.

Circle 103 on Inquiry Card, page 117

Circle 105 on Inquiry Card, page 117



New

**RELIABILITY...  
THE SOLUTION  
TO YOUR  
ELECTRONIC  
COMPONENT  
PROBLEMS**

Designing reliability into electronic components and instrumentation is Borg Equipment Division's business. Borg's reliable engineering, research and production facilities are at your service for commercial or military projects. Bring your component reliability problems to Borg. You'll enjoy working with our cooperative, creative engineering staff. The result will be a sound, practical and reliable solution at a considerable saving of time and money. Here are just a few of the products manufactured by Borg . . .

FREQUENCY STANDARDS

AIRCRAFT INSTRUMENTS

POTENTIOMETERS

MULTI-TURN COUNTING DIALS

FRACTIONAL H. P. MOTORS

SPECIAL DESIGNS

WRITE FOR COMPLETE ENGINEERING DATA



*Built  
by Borg*

**BORG EQUIPMENT DIVISION**

Amphenol-Borg Electronics Corporation  
JANESVILLE, WISCONSIN

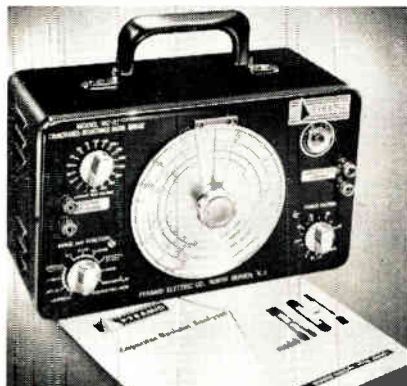
Circle 106 on Inquiry Card, page 117

New

Products

### R-C-RATIO BRIDGE

Resistance-Capacity-Ratio Bridge, Model RC-1, portable tester features: Special 3 v amplifier for checking electrolytics used in miniaturized equipment, capacity ranges from 10



$\mu$ f to 2000  $\mu$ f, resistance ranges from 0.5 ohm to 200 megohm and ratio test ranges from 0.05 to 20. Power factor is 0 to 60% (on capacitors from 0.1  $\mu$ f to 2000  $\mu$ f). Capacitor test voltage is continuously variable between 0 and 500 vdc. Ratio test provides quick reactance ratio between any two capacitors, inductors or resistors between 0.05 to 1 and 20 to 1. Power requirements: 117 v, 60 cps, ac only, 25 w. Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J.

Circle 244 on Inquiry Card, page 117

### TACHOMETER GENERATOR

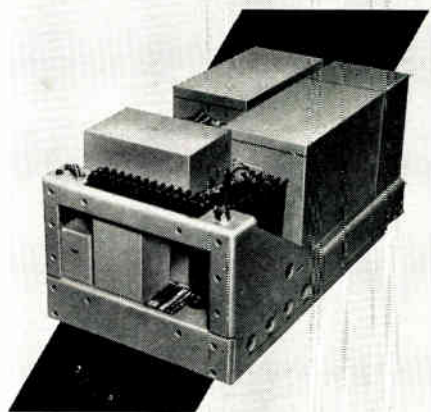
Long brush life and good voltage linearity are featured in this dc tachometer generator. The manufacturer guarantees a brush life of 100,000 hrs (over ten years) of continuous operation at 3600 RPM. Linearity from 0 to 12,000 RPM is better than 1/10 of 1% of the voltage output at 3600 RPM. Special brush materials are used, and the commutator



is fabricated from an alloy containing more than 85% pure silver. Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N. J.

Circle 245 on Inquiry Card, page 117

*New* ADVANCED  
DESIGN "B" LINE  
60 AND 400 CPS



## HIGH POWER TRANSISTOR MAGNETIC SERVO AMPLIFIER

For AC servo motor control —  
50 watts to 3000 watts

#### FEATURING

- Extreme reliability
- Wider ambient temperature range
- Faster response
- Smaller size at higher power ratings
- Higher gains
- Improved core design
- Silicon rectifiers used exclusively
- Greater flexibility
- Ideally suited for operating with Diehl Servo Motors

Signal Input AC or DC  
Military Specifications  
Provisions for System  
Feedback • Completely  
Static • Output 115V AC  
Phase Reversible

For complete 60 cps and  
400 cps specs request Bulletin S-961.



**MAGNETIC  
AMPLIFIERS, INC.**

632 TINTON AVENUE • NEW YORK 55, N. Y. • CYPRESS 2-6610

West Coast Division

136 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2665

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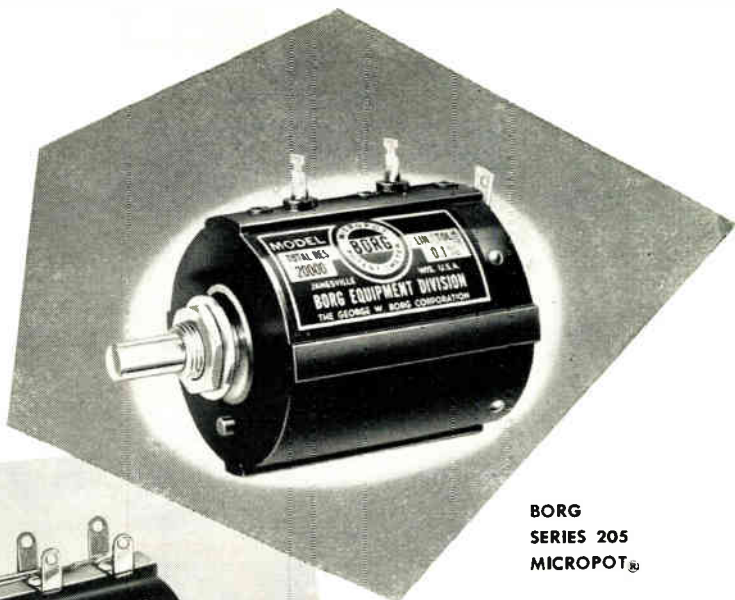
# TREAT 'EM ROUGH..

## MICROPOTS

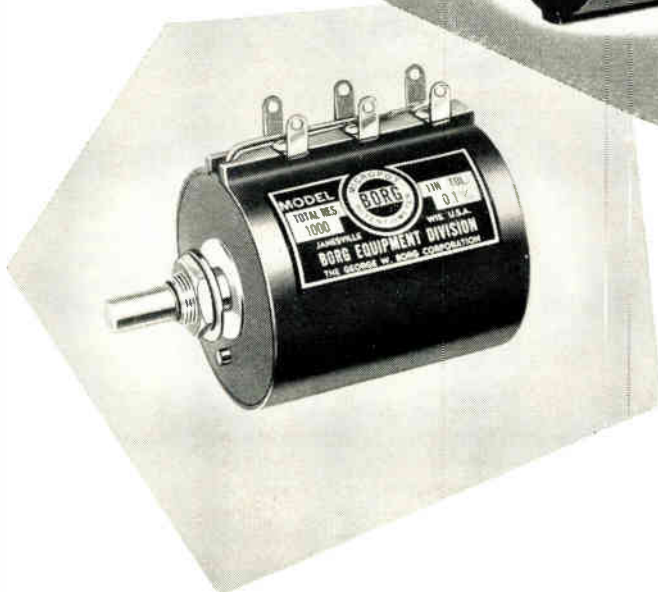
CAN

TAKE

IT /



BORG  
SERIES 205  
MICROPOT®



BORG  
SERIES 1100  
MICROPOT®

We're rough on Borg Micropots, too — when it comes to testing for reliability. Take Series 205 and 1100 Micropots for example . . .

	Mechanical Rotation	Electrical Rotation	Linearity Accuracy	Torque Starting	Torque Running	Life Expectancy
Series 205	3600°+15°-0°	3600°+14.4°-0°	±0.1% to ±0.05%	-3.0" oz.	-1.5" oz.	1,000,000 revolutions plus
Series 1100	3600°+30°-0°	3600°+15°-0°	±0.5% to ±0.1%	-3.0" oz.	-1.5" oz.	500,000 revolutions plus

Testing of this type tells us how life and reliability are affected . . . the environmental limitations for each model . . . which series to recommend for your specific job!

You may be using high-priced pots unnecessarily in your present project. You may be able to reduce the number of components in your circuits. Remember . . . the fewer the components, the greater the reliability!

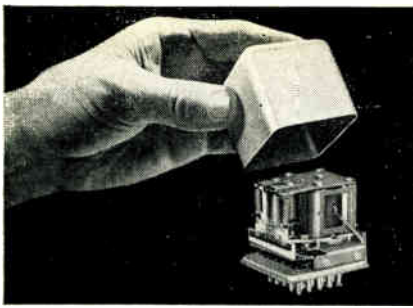
Let us send you the name of your nearest Borg "Tech-Rep" and a complete rundown on all Borg Micropots today.

Write  
for  
CATALOG  
BED-A90



MICROPOTS  
MICRODIALS  
MOTORS

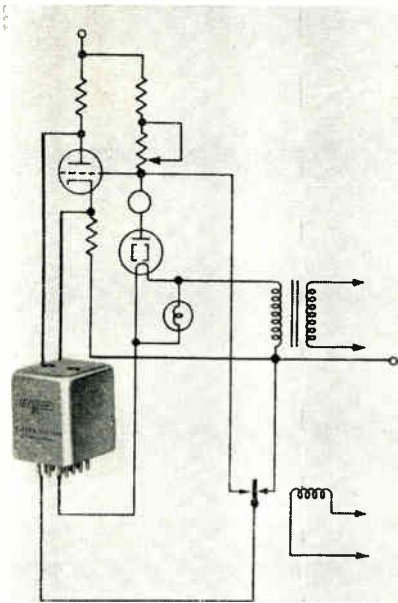
**BORG EQUIPMENT DIVISION**  
Amphenol-Borg Electronics Corporation  
JANESVILLE, WISCONSIN



## REGOHM

voltage regulation  
down to  $\pm 0.05\%$

### EXTENDS TUBE LIFE



The sensitive yet rugged REGOHM controls input voltage to eliminate the power-source variations which cause premature tube failure. Automatic and precise, this plug-in unit assures constant voltage input.

More and more designers are including REGOHM in circuits, because of its:

- STEPLESS CONTINUOUS CONTROL
- WIDE FREQUENCY RANGE
- PERMANENT ADJUSTMENT
- FREEDOM FROM MAINTENANCE
- RUGGED DESIGN
- LIGHT WEIGHT
- LONG LIFE
- LOW COST

Design data, performance specs and case histories of those applications you wish to explore will be sent on request.

# REGOHM

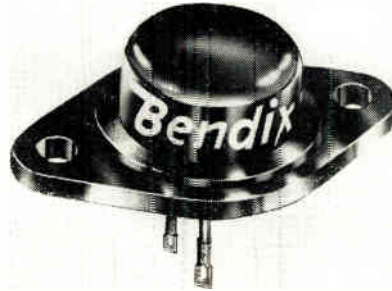


**ELECTRIC REGULATOR CORPORATION**  
NORWALK CONNECTICUT  
Circle 109 on Inquiry Card, page 117

## New Products

### POWER TRANSISTORS

This Diffused-Alloy Power (DAP) transistor series, 2N1073, A, B, combines higher frequency and greater circuit stability with more power. Characteristics are: collector voltage

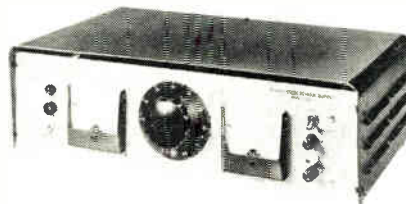


ratings up to 120 v., low input resistance (2 ohms typical), collector currents up to 10a. and switching times less than 1  $\mu$ sec in high speed circuits. Power gain is 5 to 10 times greater, and switching speeds and frequency response are 3 to 5 times faster than standard alloy types. Saturation resistance is about  $\frac{1}{2}$  that of regular alloy germanium power types. They can be developed to handle 1200 w in switching applications. Semiconductor Products, Bendix Aviation Corp., Long Branch, N. J.

Circle 246 on Inquiry Card, page 117

### POWER SUPPLY

Eight standard models (T-200 series) provide output ranges for both transistor and vacuum tube circuitry. They provide 0.1% or 30 mv line or load regulation, 50 micro-second recovery time, 0.2% twenty-four hour stability, and short circuit



proof design. Forced air cooling provides good heat dissipation and insures reliable operation under severe conditions. Armour Electronics, Inc., 4201 Redwood Ave., Los Angeles, Calif.

Circle 247 on Inquiry Card, page 117

If you produce  
**FERRITES**  
**ELECTRONIC CORES**  
**MAGNETIC RECORDING**  
**MEDIA**

... then let WILLIAMS  
help by supplying you  
with latest, authoritative  
technical data on

**PURE FERRIC  
OXIDES**  
**MAGNETIC IRON  
OXIDES**  
**MAGNETIC IRON  
POWDERS**

Since final quality of your production of ferrites, electronic cores, and magnetic recording media depends on proper use of 3 specialized groups of magnetic materials ... you'll find it mighty helpful to have all the latest, authoritative technical data describing the physical and chemical characteristics of each. This information is available to you just for the asking. So send today. Meanwhile, here are highlights of each product group.

**Pure Ferric Oxides:** For the production of ferrite bodies, we manufacture a complete range of high purity ferric oxide powders. These are available in both the spheroidal and acicular shapes, with average particle diameters from 0.2 to 0.8 microns. Impurities such as soluble salts, silica, alumina and calcium are at a minimum.

**Magnetic Iron Oxides:** For magnetic recording—audio, video, instrumentation etc.—we produce a group of special magnetic oxides with a range of controlled magnetic properties. Both the black ferroferric and brown gamma ferric oxides are available.

**Magnetic Iron Powders:** For the fabrication of magnetic cores in high-frequency, tele-communication, and other magnetic applications, we make a series of high purity iron powders.

*These materials are products of Williams research facilities. For your convenience, we maintain fully equipped laboratories for the development of new and better inorganic materials. We also investigate new fields of application. Please write, stating your problem. We'll be glad to cooperate. Address Dept. 30, C. K. Williams & Co., 640 N. 13th St., Easton, Pa.*

# WILLIAMS

**COLORS & PIGMENTS**

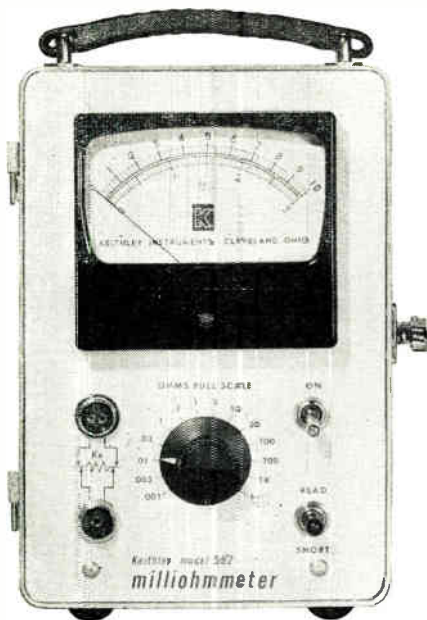
**C. K. WILLIAMS & CO.**

East St. Louis, Ill.

Easton, Penna. • Emeryville, Calif.

Circle 110 on Inquiry Card, page 117





## a good way to measure 0.00003 ohm

The Keithley 502 Milliohmmeter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- 13 overlapping ranges from 0.001 ohm to 1000 ohms full scale.
- accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- 2 microwatts maximum dissipation across sample.
- no calibration or zero adjustments.
- instantaneous indication of resistance without zero drift or errors due to thermal EMF's.
- lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

**KEITHLEY**  
INSTRUMENTS, INC.

12415 Euclid Ave., Cleveland 6, Ohio

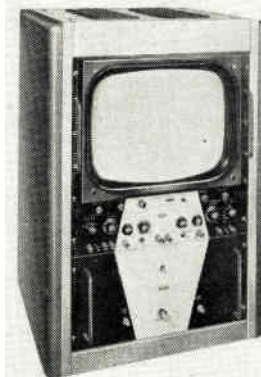
Circle 111 on Inquiry Card, page 117



## New Products

### OSCILLOSCOPE

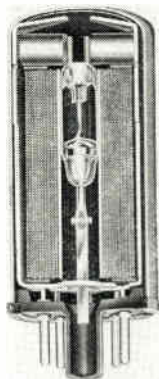
Designed for use with telemetering and data processing equipment this large screen oscilloscope, Model 917, has a 17 inch CRT. Component parts can be removed and mounted in a standard 19 inch rack. The X and Y axis have 1.0% linearity. Featured are: magnetic deflection, constant deflection sensitivity, hand calibrated controls, small spot size, and high resolution. Amplifier response is rated



at 10 mv sensitivity up to 500 KC, with accurately calibrated time base system for driven and recurrent operations. Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn, N. Y. Circle 248 on Inquiry Card, page 117

### RELAY

The Type HGS mercury-wetted contact relay, for high-speed switching devices, is similar to the Types HG and HGP except that it is always biased with permanent magnets adjustable for single-side-stable or bi-stable operation. Operating speeds may be up to 200 CPS or more. Sensitivity may be as low as  $\pm 2.5$  mw. for a bi-stable adjustment; as low as 5 mw. for a single-side-stable adjustment. Contact rating is 2 a,500 v,

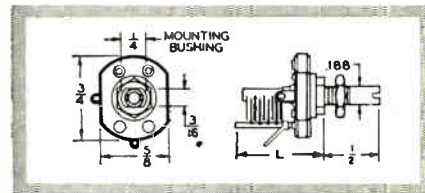


with a limit of 100 va. Trouble-free operation and absolutely no contact bounce are featured. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 11, Ill. Circle 249 on Inquiry Card, page 117



## Perfect for compact RF equipment . . .

These tiny variable capacitors provide the ideal solution to compact design problems. Requires just  $\frac{5}{8}$ " x  $\frac{3}{4}$ " panel area—the longest model extends only  $1\frac{17}{64}$ " behind panel. Soldered plate construction, oversized bearings, and heavily anchored stator supports provide extreme rigidity—torque is steady—rotor stays "put" where set! Bridge-type stator terminal provides extremely low inductance path to BOTH stator supports. Nickel-plated rotor contact—steatite end frames DC-200 treated. Single section, butterfly, and differential types available.



**SPECIALS**—Johnson Miniature Air Variables are available in production quantities with the following features: 1. Locking bearing. 2. 180° stop. 3. Various shaft extensions. 4. High torque. 5. Silver or other platings.

For complete information on these miniature capacitors or other Johnson electronic components—write for your free copy of our newest components catalog.

Free  
Catalog

Contains complete specifications on all Johnson electronic components.



**E. F. Johnson Company**

2119 Second Ave. S.W. • Waseca, Minnesota

Circle 112 on Inquiry Card, page 117

**AMCI**TYPE **1108B**

# NEW INSTRUMENT LOAD

## for TYPE N

*Provides excellent stability...  
plus low reflection*



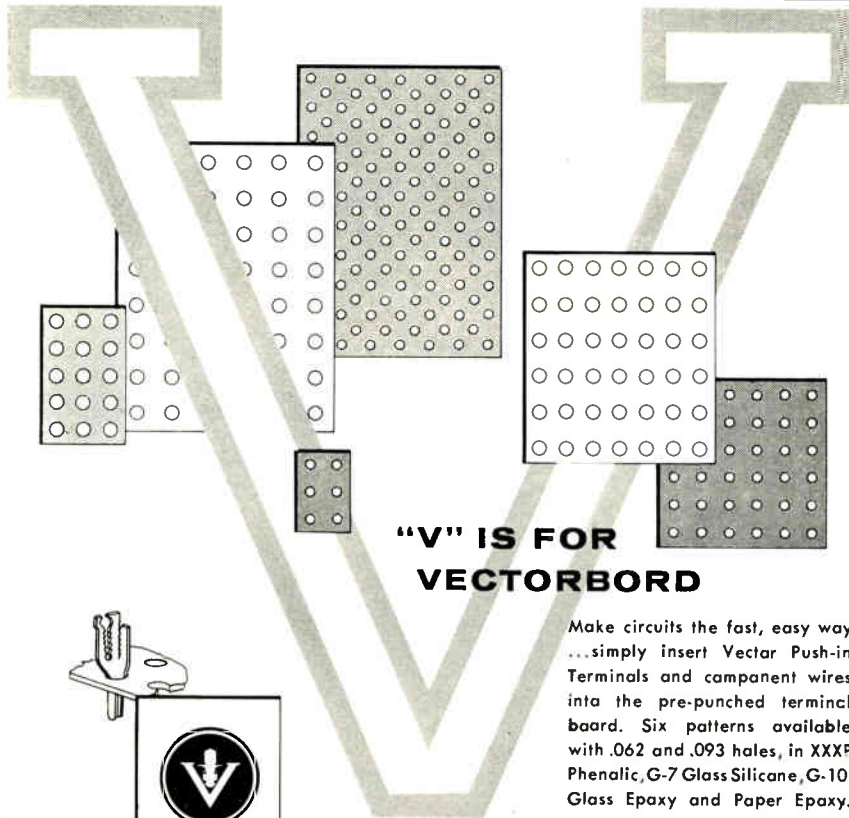
AMCI TYPE 1108B SHOWN FULL SIZE

- A nearly reflectionless termination for 50-ohm coaxial transmission lines over the frequency range of 0 to 1100mc.
- Suitable as a secondary standard.
- VSWR under 1.02.
- Rated maximum input power: 0.5 watt.
- Designed around a metal-film-on-glass type of resistor.
- Other connector types available on request.

Write for  
complete information  
on AMCI  
Instrument Loads



Circle 113 on Inquiry Card, page 117



### "V" IS FOR VECTORBOARD

Make circuits the fast, easy way  
...simply insert Vector Push-in  
Terminals and component wires  
into the pre-punched terminal  
board. Six patterns available  
with .062 and .093 holes, in XXXP  
Phenolic, G-7 Glass Silicane, G-10  
Glass Epoxy and Paper Epoxy.



Write for complete information to

**VECTOR ELECTRONIC COMPANY**

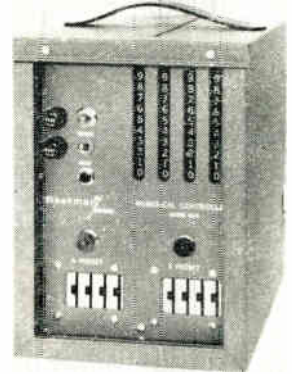
1100 FLOWER STREET, GLENDALE 1, CALIFORNIA

TELEPHONE: CHapman 5-1076

Circle 114 on Inquiry Card, page 117

**New****Products****NUMERICAL CONTROLLER**

Model 5800 Series will count a total of 100,000 events at a max rate of 5000/sec. Solid state transducers supply input information. Front-panel switches select one or two count

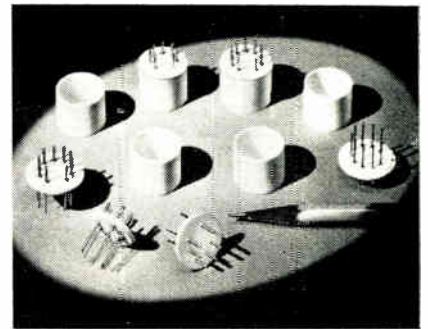


totals at which output signals occur. Outputs are relay contact closures rated at 5 a. Typical controllable operations are: coilwinding, cutting to length, making up batches of items, metal forming and testing or sorting with regard to some physical characteristic. Dust tight housings accommodate standard conduit connections. Wide variations in electrical parameters are compensated for. Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Circle 250 on Inquiry Card, page 117

**SEALED HEADERS**

Tantalum pins with nickel braze alloy, combined in a strong hermetic seal with an AlSiMag Alumina Ceramic base and envelope are for vacuum tube use. These headers allow higher bake-out temperatures



during subsequent assembly to the envelope. The materials have been carefully selected for their low vapor pressure characteristics. American Lava Corporation, Chattanooga 5, Tenn.

Circle 251 on Inquiry Card, page 117





## YOU'VE GOT TO HAND IT TO ENGINEERING!

You've got to hand it to the engineering profession. The "slide-rule" boys know quality when they see it . . . and they won't be satisfied with anything less. Take solder, for example. Engineers depend on KESTER FLUX-CORE SOLDER in their work because they know Kester's reputation

for quality and precision manufacturing . . . a reputation built up over more than 50 years. That's why Kester's the preferred choice of a great majority of electronic manufacturers. *Engineers know that a few pennies saved on a "second-line" solder product can waste dollars!*

# KESTER SOLDER

SEND TODAY for your copy of the 78 page Kester Textbook, "Solder . . . Its Fundamentals and Usage." It's Free.

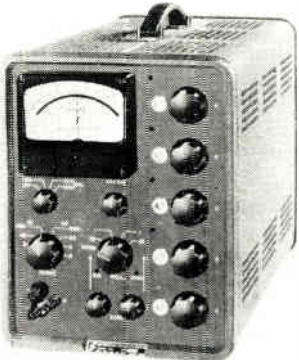
*Company*

4201 Wrightwood Avenue, Chicago 39, Illinois  
Newark 5, New Jersey, Brantford, Canada

<b>New</b>	
	<b>Products</b>

**DC-AC VOLTMETER**

Model 803 precision dc and ac differential voltmeter features better than 0.05% dc and 0.2% ac accuracy from 0.1 v to 500 v. Frequency response of the ac converter section is

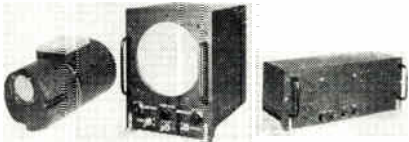


from 30 cps to 5 kc. Other features: direct in-line digital readout, automatic punctuated decimal point, jeweled, shock-mounted precision mirror scale meter, standard cell reference, chopper-stabilized null detector, and swing out front panel for easy access. It is suited for applications which demand extreme accuracy and high orders of resolution. John Fluke Mfg. Co., Inc., 1111 W. Nickerson, Seattle 99, Wash.

Circle 252 on Inquiry Card. page 117

**TV SYSTEM**

Transistorized military TV system for closed-circuit TV in aircraft ships, and vehicles, the MTS-4 system, meets military environmental specs. The 55 lb. system consists of three components: a camera unit, a control unit, which provides power and synchronization to both camera and monitor; and a TV monitor unit. It will perform as specified for at least 8 hr. after warmup without ad-



justment of any controls not accessible to the operator. Operating controls require adjusting once per 30 min. period. Dage Television Div., Thompson Ramo Wooldridge, Inc., Michigan City, Ind.

Circle 253 on Inquiry Card. page 117



**CHICAGO**  
MILITARY STANDARD  
**TRANSFORMERS**



**Stocked for Immediate Delivery**

Through your electronic parts distributor

These CHICAGO transformers are designed and built in accordance with MIL-T-27A, Grade 1, Class R specifications, maximum operating altitude 50,000 feet, minimum life expectancy 10,000 hours. They are housed in Military Standard Case size AJ (1 1/8" x 1 1/8" x 2 3/8"), weighing only 0.6 pounds.

**M. S. AUDIO TRANSFORMERS**

Catalog No.	MIL-T-27A Part No.	Application	Impedance	Operating Level	Pri. DCMA
AMS-1	MS-90000	P-P Plates to P-P Grids	Pri: 10,000 ohms CT Sec: 90,000 ohms CT 22,500 ohms CT	15 dbm.	10
AMS-2	MS-90001	Line to Voice Coil	Pri: 600 ohms CT 150 ohms Sec: 4/8/16 ohms	2W	—
AMS-3	MS-90002	Line to P-P Grids	Pri: 600 ohms CT 150 ohms Sec: 135,000 ohms CT	15 dbm.	—
AMS-4	MS-90003	Line to Line	Pri: 600 ohms CT 150 ohms Sec: 600 ohms CT 150 ohms	15 dbm.	—
AMS-5	MS-90004	Single Plate to Line	Pri: 7600/4800 ohms Sec: 600 ohms CT/150 ohms	2W	40
AMS-6	MS-90005	Single Plate to Voice Coil	Pri: 7600/4800 ohms Sec: 4/8/16 ohms	2W	40
AMS-7	MS-90006	P-P Plates to Line	Pri: 15,000 ohms CT Sec: 600 ohms CT/150 ohms	2W	10
AMS-8	MS-90007	P-P Plates to Line	Pri: 24,000 ohms CT Sec: 600 ohms CT/150 ohms	1W	20
AMS-9	MS-90008	P-P Plates to Line	Pri: 60,000 ohms CT Sec: 600 ohms CT/150 ohms	5W	20

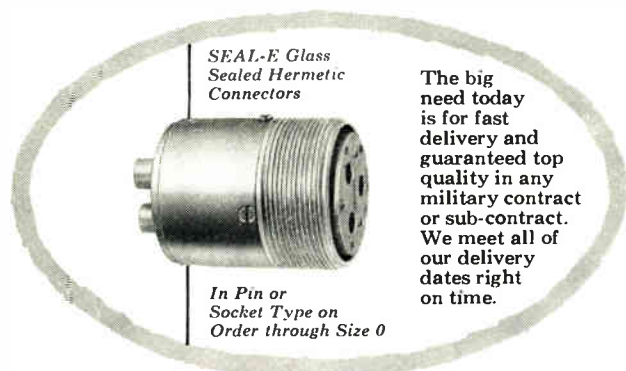
An extensive line of transistor audio transformers, in MS cases are also available. For detailed information on these and many other CHICAGO Military Standard units, write for Catalog CT8-58

**CHICAGO STANDARD** Transformer Corporation  
3516 West Addison Street • Chicago 18, Illinois  
Export Sales: Roburn Agencies, Inc., 431 Greenwich St., New York 13, N.Y.



a reliable source for glass sealed  
connectors long noted for performance...

## OFFERS IMPROVED AN-E TYPES OF CONNECTORS



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Sealed Hermetic  
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In Pin or  
Socket Type on  
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need today  
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quality in any  
military contract  
or sub-contract.  
We meet all of  
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# CONSECO

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EXPERIENCE — CAPACITY — SERVICE

Circle 118 on Inquiry Card, page 117

## Q: What is a Kodak Ektron Detector?

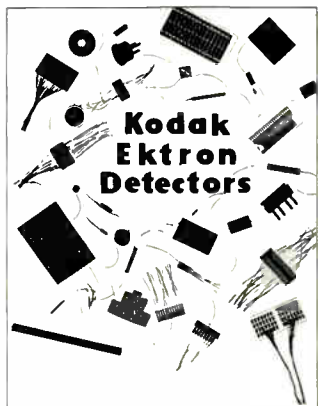
**A:** It is a semi-conductive resistor. The photosensitive area can be laid down in any pattern. Response extends to 3.5 microns in the infrared. Unaffected by vibration; high signal-to-noise ratio.

**Q:** What can it be used for?

**A:** For such applications as an infrared sensor in weapons systems, and in instrumentation for process control, analysis, and safety.

**Q:** How can I get the facts about spectral response, types, availabilities, and the like?

**A:** By writing for a new brochure called "Kodak Ektron Detectors."



Kodak  
Ektron  
Detectors

Write to:

Apparatus and Optical Division  
EASTMAN KODAK COMPANY, Rochester 4, N. Y.  
Circle 119 on Inquiry Card, page 117

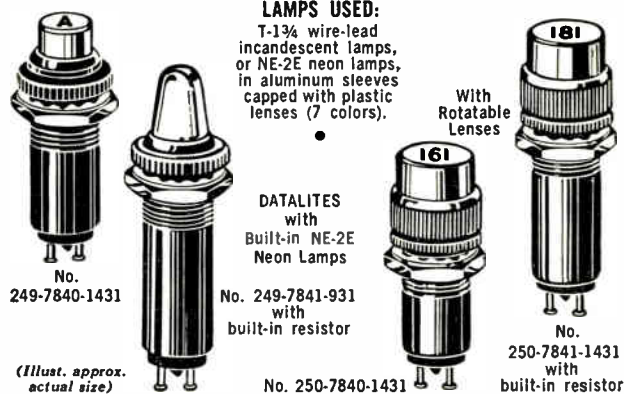


In this brochure—complete facts on DIALCO's

# DATALITES®

For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: **Lamp Holders with DIALCO's own replaceable Lamp Cartridges** (see above); or **integrated DATALITES with Built-in Neon Lamps** which are **not replaceable** (see below). Ultra-compact, single units mount in  $\frac{3}{8}$ " clearance hole; the twin-lamp assembly mounts in  $\frac{3}{4}$ " clearance hole.



### LAMPS USED:

T-1 $\frac{3}{4}$  wire-lead  
incandescent lamps,  
or NE-2E neon lamps,  
in aluminum sleeves  
capped with plastic  
lenses (7 colors).

With  
Rotatable  
Lenses

DATALITES  
with  
Built-in NE-2E  
Neon Lamps

No. 249-7841-931  
with  
built-in resistor

No. 250-7840-1431

No. 250-7841-1431  
with  
built-in resistor

(Illust. approx.  
actual size)

DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with or without built-in resistors*. The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160*. Send for it now.

**SAMPLES ON REQUEST—AT ONCE—NO CHARGE**



Foremost Manufacturer of Pilot Lights

# DIALIGHT CORPORATION

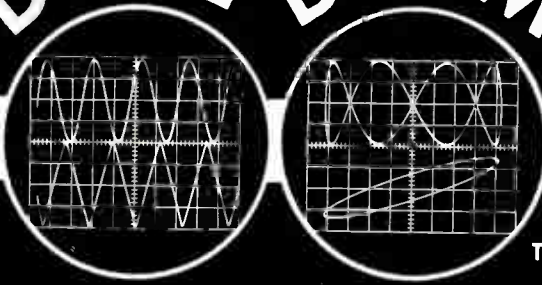
50 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600  
Circle 120 on Inquiry Card, page 117

# NEW DUAL BEAM

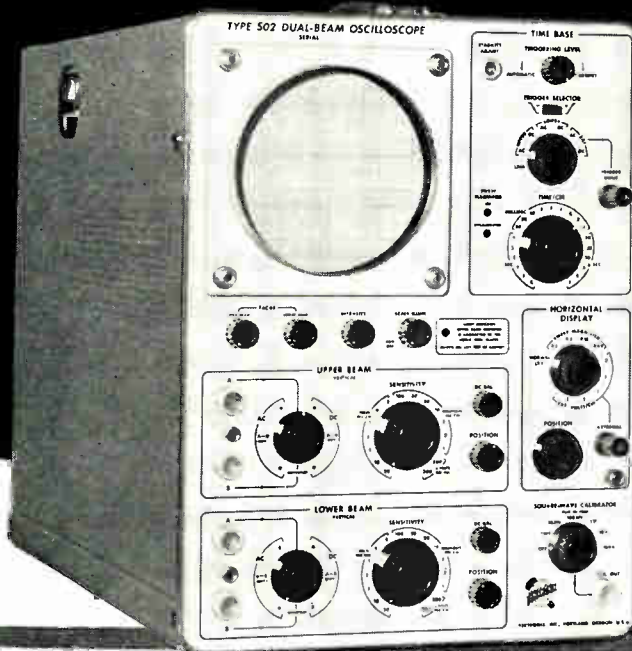
# TYPE 502 OSCILLOSCOPE



Dual display on linear time base.



Dual display for X-Y curves.



**TWO-GUN CATHODE-RAY TUBE.**

**200  $\mu\text{v}/\text{cm}$  SENSITIVITY, BOTH BEAMS.**

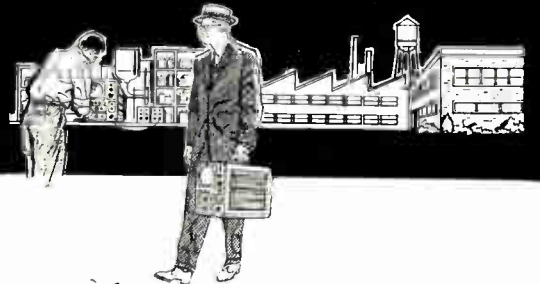
**DIFFERENTIAL INPUT, ALL SENSITIVITIES.**

**2, 5, 10, and 20 TIMES SWEEP MAGNIFICATION.**

**X-Y CURVE TRACING with TWO BEAMS—(horizontal input sensitivity to 0.1  $\text{v}/\text{cm}$ ).**

**SINGLE-BEAM X-Y CURVE TRACING at 200  $\mu\text{v}/\text{cm}$ , BOTH AXES.**

**EXTRA FEATURE—Both amplifiers have transistor-regulated parallel heater supply.**



**Here are a few uses for the Type 502:**

**IN ELECTRONICS**—Use the Type 502 as a general-purpose oscilloscope and also to show simultaneously the waveforms at any two points in a circuit, e.g. input and output, opposite sides of a push-pull circuit, trigger and triggered waveform, etc.

**IN MECHANICS**—Display, compare, and measure outputs of two transducers on the same time base; plot one transducer output against another—pressure against volume or temperature for instance; measure phase angles, frequency differences, etc.

**IN MEDICINE**—Display, compare, and measure stimulus and reaction, or the outputs of two probes, on the same time base; use differential input to cancel out common-mode signals, or to eliminate the need for a common terminal; use in routine investigations, etc.

**IN ALL FIELDS**—The Type 502 can save you more than its cost in time—in as little as one application!

## TYPE 502 CHARACTERISTICS

### HIGH-GAIN AMPLIFIERS

200-microvolts/cm deflection factors, both dc-coupled and ac-coupled. 16 calibrated steps from 200  $\mu\text{v}/\text{cm}$  to 20  $\text{v}/\text{cm}$ .

Passbands—dc-to-100 kc at 200  $\mu\text{v}/\text{cm}$ , increasing to dc-to-200 kc at 1  $\text{mv}/\text{cm}$ , dc-to-400 kc at 50  $\text{mv}/\text{cm}$ , and to dc-to-1 mc at 0.2  $\text{v}/\text{cm}$ .

Differential Input, Both Channels—Rejection ratios: 1000-to-1 at 1  $\text{mv}/\text{cm}$  or less, 100-to-1 at 0.2  $\text{v}/\text{cm}$ , 50-to-1 at 5 to 20  $\text{v}/\text{cm}$ .

Constant Input Impedance, 1 megohm, 47  $\mu\text{mf}$ , both channels.

### WIDE-RANGE SWEEP CIRCUIT (Common to both beams)

Single-knob control for selecting any of 22 accurately-calibrated sweep rates from 1  $\mu\text{sec}/\text{cm}$  to 5 sec/cm.

Sweep Magnification—2, 5, 10, and 20 times, accurate within the maximum calibrated sweep rate.

Automatic Triggering—fully automatic, or preset with amplitude-level selection when desired. Sweep can also be operated free-running.

### X-Y CURVE TRACING OPERATION

Horizontal-input amplifier permits curve-tracing with both beams simultaneously at sensitivities to 0.1  $\text{v}/\text{cm}$ . For curve-tracing at higher sensitivities (to 200  $\mu\text{v}/\text{cm}$ ) with one beam, one of the vertical amplifiers can be switched to the horizontal-deflection plates.

### OTHER FEATURES

Amplitude calibrator, 1 mv to 100 v in decade steps—square wave, frequency about 1 kc.

3-kv accelerating potential on new Tektronix 5" dual-beam crt. 8-cm by 10-cm near-display area, each beam, 6-cm overlap.

Electrically-regulated power supplies. Price ..... \$795  
f.o.b. factory

# Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

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**TEKTRONIX ENGINEERING REPRESENTATIVES:** Hawthorne Electronics, Portland, Oregon., Seattle, Wash.; Hytronic Measurements, Denver, Colo.; Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.



**FOR LEAK-DETECTION DEVICES**



**NITROUS OXIDE**

EASILY  
SNIFFS OUT  
MICROSCOPIC  
LEAKS

Infrared determination of nitrous oxide provides a safe, sensitive and flexible method of leak detection. This method is not affected by usual atmosphere components such as moisture, carbon dioxide and hydrocarbons. In addition, nitrous oxide will not harm pieces being tested and is more economical than other gaseous agents.

**OHIO NITROUS OXIDE: ODORLESS AND INERT • NONTOXIC  
• NONCORROSIVE • NONFLAMMABLE • ECONOMICAL**

**FREE TECHNICAL AID** is available in the use of nitrous oxide for leak detection. For further information, please request the following bulletins:

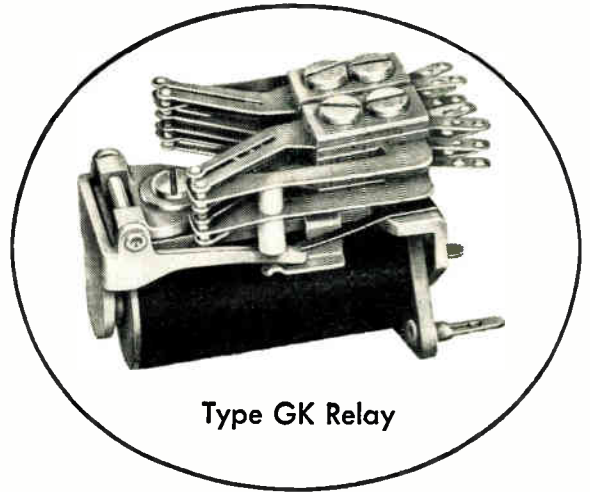
- 1A Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests
- 1B Gas Service Equipment for Nitrous Oxide Supply



**OHIO CHEMICAL & SURGICAL EQUIPMENT CO.**  
(A Division of Air Reduction Company, Incorporated)   
MADISON 10, WISCONSIN

Circle 122 on Inquiry Card, page 117

**ALLIED'S *New* General Purpose Relay\*  
FOR D-C OPERATION**



Type GK Relay

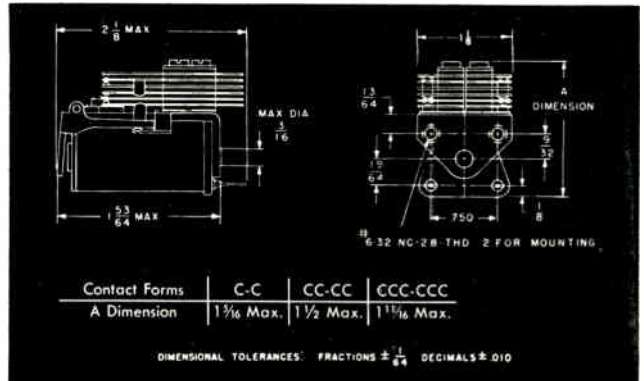
Long life, stability and high reliability are the features of this new general purpose relay.

Allied's type GK relay uses twin contacts with bifurcated stationary contact arms. Designed for a wide variety of Industrial and Military applications, Allied's type GK relay has a capacity of 20 springs which can be assembled in a variety of combinations of A, B, C and D contact forms.

**Here are the facts:**

- Operating Voltage:** up to 220 volts d-c
- Contact Rating:** up to 4 amperes at 150 watts
- Temperature Range:** -55°C to +85°C
- Vibration:** 10 to 55 cps at .062 inch double amplitude
- Operating Shock:** up to 30 g

\*For complete details send for Allied's GK catalog sheet.



**Ideal for ANTENNA CONNECTIONS PHOTO-CELL WORK MICROPHONE CONNECTIONS**

**JONES SHIELDED TYPE PLUGS & SOCKETS**

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS

For quality construction thru-out, and fine finish, see diagram above.

101 Series furnished with 1/4", .290", 5/16", 3/8", or 1/2" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation; sockets bakelite. Assembly meets Navy specifications.

202 Series Phosphor bronze knife-switch type socket contacts engage both sides of flat plug contacts—double contact area. Plugs and sockets have molded bakelite insulation.

For full details and engineering data ask for Jones Catalog No. 22

**JONES MEANS PROVEN QUALITY**

**HOWARD B. JONES DIVISION**  
CINCH MANUFACTURING CORPORATION  
CHICAGO 24, ILLINOIS  
SUBSIDIARY OF UNITED-CARB FASTENER CORP.

Circle 123 on Inquiry Card, page 117

**ALLIED CONTROL**  
ALLIED CONTROL COMPANY, INC.,  
2 East End Avenue, New York 21, N. Y.

**15,000 hours at 55°C**  
**without servicing or oiling**  
*and still going strong!*



Air-Marine Motors go to sea on USS Seawolf, Navy's newest atomic-powered submarine.

**SEAWOLF'S VITAL ELECTRONIC EQUIPMENT COOLED BY AIR · MARINE MOTORS**

**15,000 TO 20,000 HOURS UNDER THE SEA!**

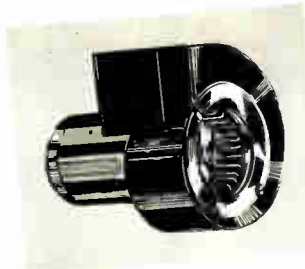
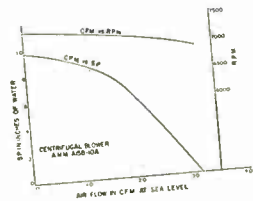
When the U.S. Navy's atomic-powered submarine—miracle of modern engineering—churns through the waters at 50 fathoms down, its vital electronic equipment is constantly protected day and night by a battery of the most rugged blowers ever devised.

Incorporating into its design equipment never before mounted for undersea service, Navy engineers were confronted with a critical cooling problem, for the Seawolf was to stay submerged week after week and month after month. And such equipment must be dependably and constantly cooled.

Tough project? Not at all for Air-Marine. It's highly trained staff of engineers pooled their knowledge and promptly designed, to rigid Navy specifications, blowers that could run continuously toward a 10,000 hour life—more than a solid year—delivering uninterrupted cooling for the A-sub's vital installations.

Whatever your problem—small or large—this same experienced engineering staff is yours to command. Contact Air-Marine for your motor needs—for the best motors skill can produce—the finest money can buy.

115V 400CY 1PH 1.0MFD



Air-Marine's Seawolf Motor



**air · marine motors, inc.**

369 Bayview Avenue  
 West Coast Factory: 2221 Barry Ave.

Amityville, N. Y.  
 Los Angeles, Calif.

Above is an air-marine motors advertisement which first appeared in July, 1957.

See us at the IRE Show • Booth 2315

**"Man-in-Space"**

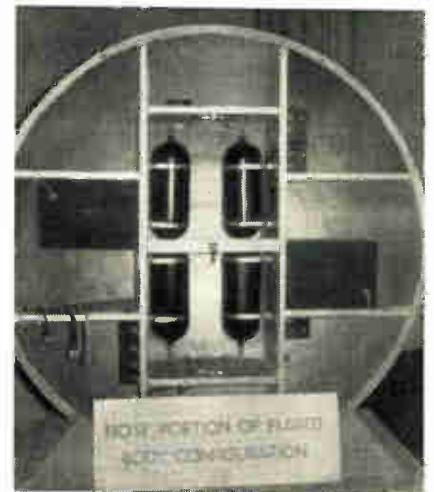
(Continued from page 59)

age delivered to the eventual contractor—in this case, McDonnell.

What the GE engineers learned, then, in the course of their research on nose cone design becomes a part of the final design of the capsule to be built by McDonnell. It will be one of the determining factors in the satellite's configuration, speed, orbit, time in orbit, trajectory, launch direction and re-entry angle.

In that sense, it is interesting to look at the GE capsule. Specifications, details and mock-ups (see photos) show the simplicity of the design. The manned, instrumented satellite is designed to mount on existing hardware; the Atlas booster need only be adapted for it.

The space pilot rides in an acorn shaped capsule, in a personally form-fitted chair of foam plastic. In front of him is a trapezoidal instrument panel approximately 32 inches across, 20 inches high. A small mirror in the center of this



Instrument placement in nose of satellite is symmetrically balanced for reasons of weight

panel reflects his facial expressions to a TV camera over his right shoulder, transmitting back to earth.

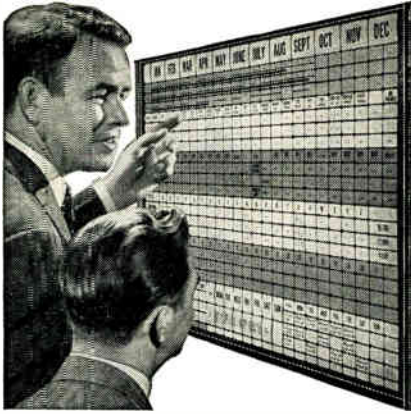
Two-way contact with the ground is supplemented by a 3-button telegraph for emergency use that also serves as a dexterity test when he is "weightless."

Other dexterity tests will continually check his mental and physical state. Perhaps he will be

(Continued on page 156)



## How To Get Things Done Better And Faster



### BOARDMASTER VISUAL CONTROL

- ☆ Gives Graphic Picture — Saves Time, Saves Money, Prevents Errors
- ☆ Simple to operate — Type or Write on Cards, Snap in Grooves
- ☆ Ideal for Production, Traffic, Inventory, Scheduling, Sales, Etc.
- ☆ Made of Metal, Compact and Attractive. Over 300,000 in Use

Full price **\$4950** with cards

**FREE** 24-PAGE BOOKLET NO. Z-40  
Without Obligation

Write for Your Copy Today

### GRAPHIC SYSTEMS

55 West 42nd Street • New York 36, N.Y.  
Circle 126 on Inquiry Card. page 117



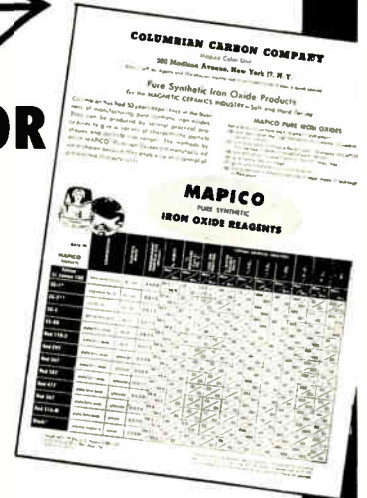
## WRITE FOR

this useful  
informative chart on

## MAPICO

pure synthetic  
iron oxide  
reagents for

## FERRITES



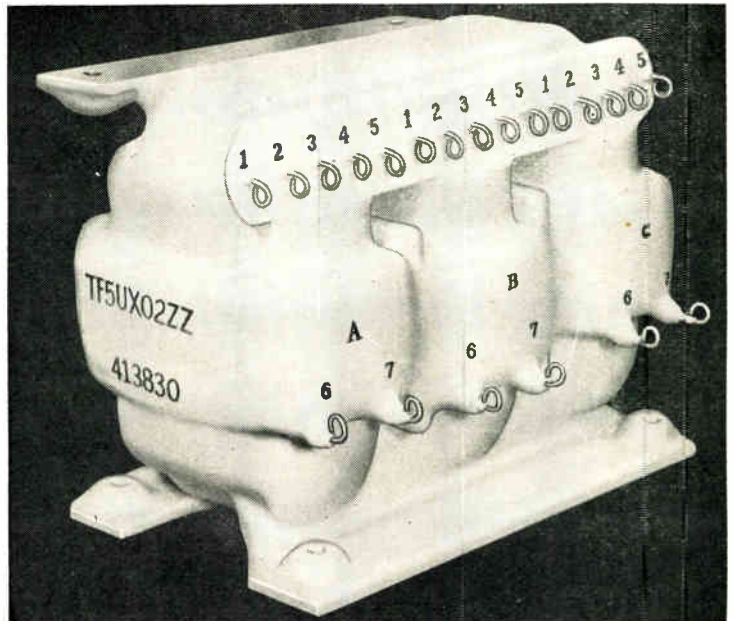
This handy card gives you details on composition, particle shape and chemical analyses of Mapico's wide range of pure synthetic iron oxides. Unequaled for uniformity . . . Mapico oxides are available in three different particle shapes, with several ranges of particle size . . . provide controlled electronic characteristics and shrinkage. A request on your letterhead will bring you this free chart and working sample.

## Columbian Carbon Company

380 Madison Avenue, New York 17, N. Y.  
Circle 127 on Inquiry Card. page 117



is built to function  
properly at  
**350°C**



• Acme Electric engineers have the "know how" and available facilities to design and build transformers that will maintain their specified performance under environmental conditions up to 350°C.

If the equipment you build requires transformers to operate trouble free under high temperature conditions, get in touch with Acme Electric.

PO-3210

## ACME ELECTRIC CORPORATION

892 WATER STREET

CUBA, N. Y.





## Clean precision parts more safely

New Freon\* solvents by Du Pont minimize cleaning hazards

- **Low toxicity**—"Freon" solvents are odorless and much less toxic than ordinary solvents—vapors won't cause nausea or headaches.
- **Won't burn or explode**—Underwriters' Laboratories report "Freon" solvents non-explosive, non-combustible and non-flammable.
- **Non-corrosive**—"Freon" solvents remain neutral through repeated degreasing use without the need of inhibitors.
- **Negligible effects on plastics, elastomers, insulation and color codes**—"Freon" solvents remove oil and grease with minimum swelling of plastics or rubber and without crazing or softening paint, wire coatings or insulation.
- **Leaves no residue**—"Freon" solvents evaporate completely, leave no deposit.

New "Freon" solvents by Du Pont degrease sensitive mechanical and electronic assemblies without damage to delicate parts. Since no inhibitors are needed, no residue is left on the parts, and "Freon" solvents can be recovered and reused without re-inhibiting. Write for free "Freon" solvents booklet. E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division 552, Wilmington 98, Delaware.

\*Freon is Du Pont's registered trademark for its fluorinated hydrocarbon solvents.



**FREE BOOKLET!**  
No obligation—write for booklet which tells how new "Freon" solvents by Du Pont minimize cleaning hazards.



Better Things for Better Living  
... through Chemistry

Circle 129 on Inquiry Card, page 117

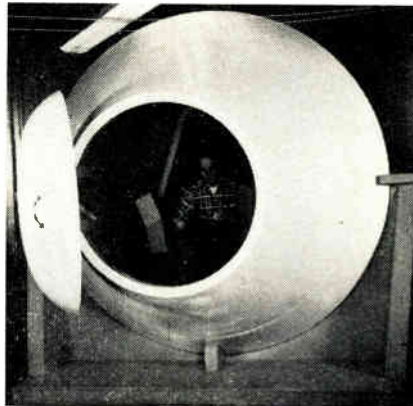
(Continued from page 154)

asked to thread a needle while weightless, or determine which is the heaviest of several differently colored balls.

### Emergency Controls

An "Abort" button will stop the count-down at any time prior to launching. Eject buttons on both arms of his chair must be pressed simultaneously to ignite the retro rocket that will separate the capsule from the booster missile.

In case of a misfire a few feet off the ground the rocket blasts



Another of GE's capsule designs with a more 'futuristic' split instrument panel.

his capsule 4,000 feet into the air, to float back down by parachute.

Assuming that the flight is normal and the capsule is placed in orbit, several passes around the Earth will be completed before the re-entry is initiated. On these trips around the Earth the capsule will be flashing through space at 18,000 mph.

To begin the re-entry, the capsule is swivelled around and the retro rocket fired forward, braking the speed and causing the capsule to spiral back down into the Earth's atmosphere. At 40,000 ft. the landing chute will open, carrying the capsule down to a safe landing.

Back on earth a tracking beacon, radio, flashing lights, sofar bombs for underwater sound, and die markers will help searching parties locate the capsule in the shortest possible time. A big rubberized "doughnut" will soften the impact if the capsule lands on the ground or will keep it afloat if it drops into the ocean.

Psychological comfort will be the chief problem during the lonely  
(Continued on page 158)

## NEW MEASUREMENTS Standard Signal Generator for mobile communications...



The Model 560-FM Standard Signal Generator is specifically designed to meet the exacting requirements of the Mobile Communications industry.

Model 560-FM  
Price - \$640.00

- Frequency ranges 25-54, 140-175, 400-470, 890-960 Mc.
- Fine tuning control shifts carrier  $\pm 8$  Kc.
- Peak deviation to  $\pm 16$  Kc. read directly on meter.
- Residual FM less than 100 cycles at 460 Mc.
- Output 0.1 to 100,000 microvolts accurate  $\pm 10\%$  across 50 ohm termination.
- Excellent stability.
- Modulation by 1000 cycle internal or by external source.

WRITE FOR BULLETIN

Laboratory Standards

**MEASUREMENTS**  
A McGraw-Edison Division  
**BOONTON, NEW JERSEY**

Circle 130 on Inquiry Card, page 117



## HI-POWER EFFICIENCY



RIGHT ANGLE ADAPTER, 350-5000 MCS.



CABLE CONNECTOR, 350-5000 MCS.



WAVEGUIDE TO COAX ADAPTER, 2350-3600 MCS.



S-BAND SCIMITAR ANTENNA, 2350-5000 MCS.



COAX SLOTTED LINE, 1500-5000 MCS.



LT TO "N" TYPE TRANSITION, 350-5000 MCS.

These operational configurations comprise a representative selection of Tamar "hardware" designed and tested to meet all military and industrial specifications.



**TAMAR ELECTRONICS, INC.**

2339 COTNER AVENUE • LOS ANGELES 64, CALIFORNIA  
Circle 131 on Inquiry Card, page 117

## BIWAX-EPOXY FORMULATIONS

- MIL and Industrial Specifications.
- Single component systems.
- Thixotropic formulations.
  - Packaging service minimizes waste—it can be keyed to your production schedules.
  - Encapsulating service facilities.

Send for Informative BIWAX-EPOXY COMPOUNDS Data Sheet



Send for **GENERAL SPECIFICATIONS CHART** on **INSULATING and SEALING COMPOUNDS**  
3440 HOWARD STREET • SKOKIE, ILLINOIS  
Telephones: ORchard 3-1050 • AMbassador 2-3339

**BIWAX**

**BIWAX CORPORATION**

Over 30 years of formulating experience

Circle 132 on Inquiry Card, page 117



## Build your own ELECTRONIC ORGAN

*New organ builder's manual gives you the facts!*

Profusely illustrated, 123 page manual gives complete specifications, prices, and parts lists for hi-fidelity 2, 3, or 4 manual electronic organ. Horseshoe or straight stopboard.

Send \$200 to

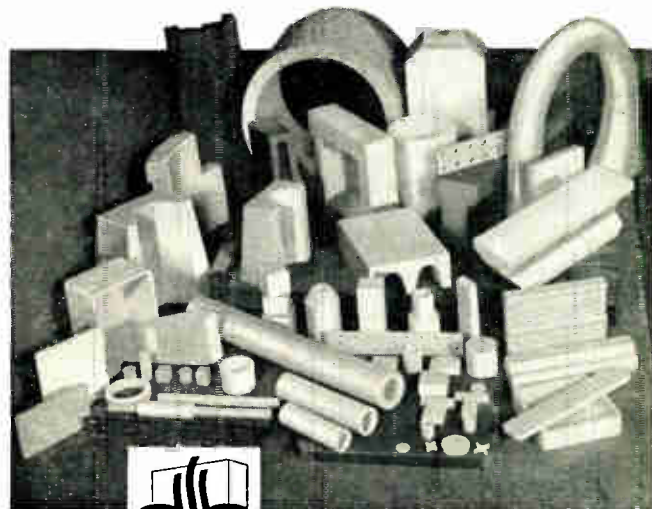
**ELECTRONIC ORGAN ARTS, INC.**

4878C Eagle Rock Blvd., Los Angeles 41, Calif.

Circle 133 on Inquiry Card, page 117

Improve processes, increase yields, cut costs with

## Engineered Ceramics



If you use ceramics in your operations, it's a good bet that you're no stranger to the many problems inherent in this field. Heavy loads at high temperatures, chemical attack, extreme thermal shock, and severe abrasion are only some of the operating conditions with which you may have to contend. We're here to offer you constructive help in solving any such ceramic service problem. In the electronic, ceramic, abrasive, chemical and other technical fields our customized service can very well help improve your processes, increase yields and cut costs. Our high alumina, silicon carbide, mullite, zircon and other specialized refractories and ceramic component parts are engineered to your individual requirements. Why not let us study your sketches, analyze your requirements and recommend the materials and methods to improve your product and the efficiency of your operation. Just write or call us.

## Engineered Ceramics Manufacturing Company

1439 West Fulton Street, Chicago 7, Illinois • CHesapeake 3-7633  
Circle 134 on Inquiry Card, page 117

*Telonic*  
SWEEP GENERATORS  
with  
**NEW**  
SWEEP-LINE  
DESIGN



- new cabinet
- new circuits
- greater than ever performance
- smart appearance
- faster delivery schedules

Telonic Sweeps feature 5% flatness, less than 10 microvolt leakage. Dependable for production, precise for engineering. Variety of markers. Crystal controlled single or harmonic plug-in with external marker provisions on all models. Variable markers available on many models.

Telonic Sweep-Line cabinet features hinged top for easy accessibility, slide-track mounting, perforated top and cooling vents. Dimensions — 20" x 10" x 15". Attractive two-tone finish is satin black and aluminum grey.

All models previously available are now included in the new Sweep-Line

MODEL NO.	SWEEP RANGE
H-3	1 mc to 300 mc
H-D Models	10 kc to 100 mc
L-D Models	3.5 mc to 140 mc
S-D Models	85 mc to 1260 mc

Many other Telonic instruments are available, including variable sweep rates and WATTS of power.

Delivery of Telonic Sweeps is 3 to 6 weeks. Prices range from \$645 to \$745—optional fixed marker plug-ins and variable markers extra.

*Telonic*  
INDUSTRIES, INC.  
BEECH GROVE, INDIANA

Circle 135 on Inquiry Card, page 117

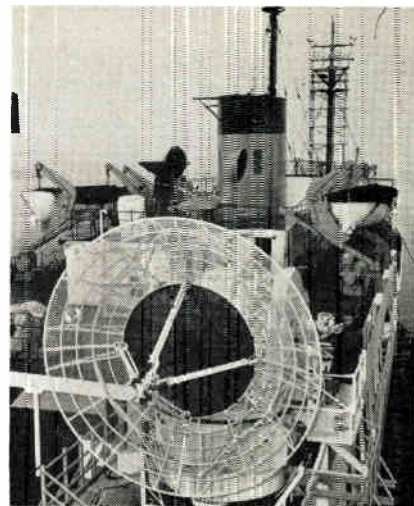
(Continued from page 156)

hours that the pilot is encapsulated in orbit. He will read the many dials on the board before him in a rigidly programmed sequence. From the optical periscope his eye will move to the clock measuring elapsed time, to the radiation counter, to the dials that indicate the humidity and temperature of the cabin. At the same time his telemetering gear will be flashing this same data back to ground stations.

At regular intervals he will talk to the ground, then move on to perception tests and dexterity tests.

### Floating Lab to Track Ballistic Missiles

Experimental ballistic missiles fired over the Atlantic Missile range will be tracked in flight and their performance checked by a new "missile measurement ship," the S.S. American Mariner. The Liberty type ship, a former U. S. Maritime training ship, structurally modified and outfitted with advanced radar, optical and other electronic equipment will provide the most precise data yet collected at sea to complement ground-station missile measurements. Radar

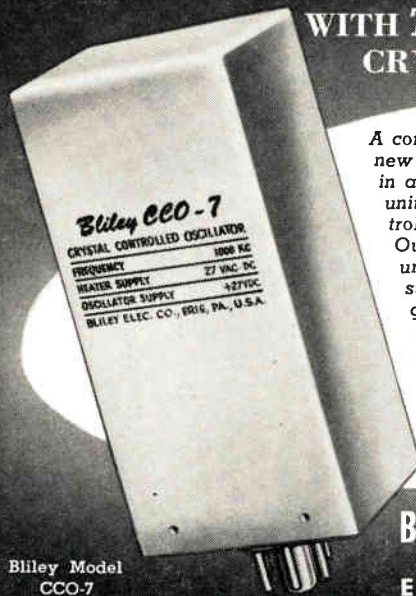


Missile ship, S.S. American Mariner's tracking antennas are largest afloat.

and other electronic equipment were designed and installed by the Missile and Surface Radar Dept., Radio Corporation of America. RCA will also operate the ship's complement of electronic equipment. Non-radar measuring projects were designed by the Barnes Engineering Co.

The project was sponsored by the Advanced Research Projects Agency of the Dept. of Defense and the Army Rocket and Guided Missile Agency of the Army Ordnance Missile command.

## Stability .. 4 PARTS IN 10 MILLION WITH TRANSISTORIZED CRYSTAL CONTROL



A complete packaged assembly, the new Bliley CCO-7 oscillator is first in a series of transistorized plug-in units for precision frequency control and reference.

Outstanding stability of  $4 \times 10^7$ , under adverse conditions, is assured by such design features as glass sealed crystal units, printed circuitry and built-in temperature control. The entire unit is hermetically sealed.

For complete details request Bulletin 516.

*Bliley*

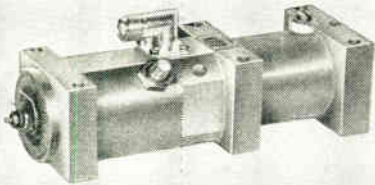
**BLILEY ELECTRIC CO.**  
UNION STATION BUILDING  
ERIE, PENNSYLVANIA

Bliley Model  
CCO-7

Circle 136 on Inquiry Card, page 117



# NEW



**"S" - BAND**

**pulse oscillator  
model no. 306**

- offering superior stability for both vibration and temperature under extreme environmental conditions . . .
- small-size and light-weight

**TUNING RANGE** 300 MC (Nominal)

**POWER OUTPUT** 1.5 KW peak minimum at .001 duty cycle, 1  $\mu$ sec pulsewidth, 1000 pps

**TUBE** GE 6442 triode

**OPERATING CONDITIONS** 3000 V at 2.5 amp peak (Nominal) Heater 6.3 V ac or dc (5%)

**VIBRATION** 20 g . . . 20-2000 cps (FM 2 MC max.)

**SHOCK** 70 g while operating (frequency shift 1 MC max.)

**Temperature** -50 C to 100 C (4 MC max.)

**FIXED CATHODE** Plate tuned (only tuning adjustment)

**TUNING LOCKING DEVICE** Output connector (type N, TNC, or BNC, nominally 50 ohms)

**OVERALL DIMENSIONS** Length 6-1/4"; Width 2"; Height 1-7/8" excluding connector

**WEIGHT** 20 oz.

**MOUNTINGS** Integral parts of the oscillator — included in the dimensions and weight, above

**OTHER MICROWAVE COMPONENTS** S, C, and X — bands available.

SEND FOR LITERATURE



Circle 137 on Inquiry Card, page 117

## Space Communications

(Continued from page 58)

tically, it is difficult to separate these effects from those due to satellite's spinning or moon's libration. Therefore, the fading characteristic is a combination of many effects.

In general, a fading margin of say 10-20 db or even more should be allowed for a workable system. This is derived from the sketchy data available. Extensive signal level measurements on long term basis are required to determine the more reliable statistical fading characteristics.

(Continued next month)

## Space Communications Proposals Being Aired

For the first time, specific provision for "space" communications in the international table of frequency allocations is contemplated in proceedings to revise the radio regulations of the International Telecommunication Union (ITU).

The F.C.C. has invited comments to an American proposal to accommodate requirements for radio communications with or between objects in space and to establish and define the first Earth/Space (radio communication between earth and objects in space) and Space (radio communication between objects in space) services.

The proposal involves radio control of natural or artificial space objects, and radio communication in that connection. It would embrace the moon, planets, satellites and space vehicles beyond the earth, but not aircraft, missiles or rockets limited to flight over the earth's surface.

All of the frequencies allocated would be from the Government 25-6-25.65, 100-150, 1700-1725, 1825-1850, 2275-2300, 8300-8400, 15150-15250 and 31500-31800 Mc bands.

These frequency bands are intended to accommodate such functions as tracking, telemetry, command (i.e., turning on or off transmitters aboard space vehicles from the earth or from other space vehicles), communications between earth and space vehicles, and for communications between space vehicles themselves.

★★★★★ ★★★★★

IN EVERY FIELD, THERE IS ONE  
FOREMOST NAME . . . IN SONIC  
ENERGY, THAT NAME IS BENDIX

## THE QUESTION IS: CAN YOU AFFORD TO BE WITHOUT SONIC ENERGY CLEANING?

Some people shy away from Sonic Energy Cleaning (without investigating it) because they feel they may not be able to afford it.

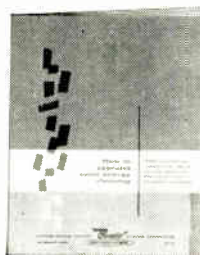
Truth is—if Sonic Energy can be applied to your cleaning problem effectively—you can't afford to be without it. In most Sonic Energy Cleaning installations, the savings realized the first year more than pay for the original cost—to say nothing of the additional advantages of fewer rejects and improved product performance.

As the pioneer and foremost authority on Sonic Energy, Bendix has proved these facts over and over. That's why today we can put so much experience to work on your problems.

One example of our ability to serve industry is our Sonic Energy Applications Laboratory. It is unequalled for facilities and practical production experience to provide the most efficient answer for cleaning applications that can use Sonic Energy to advantage.

To such professional capabilities, add the most complete and versatile line of Sonic Energy Cleaning systems, and you have the full reason why so many companies with a cleaning problem come to Bendix® for the answer.

FREE! NEW REPORT ON  
SONIC ENERGY CLEANING  
NOW AVAILABLE



Explains the principles and workings of the process in detail. Describes and analyzes typical results. Outlines five-step plan that will help you determine feasibility of Sonic Energy Cleaning for you. To get your copy

write: PIONEER-CENTRAL DIVISION, BENDIX AVIATION CORPORATION, 2708 HICKORY GROVE ROAD, DAVENPORT, IOWA.



SONIC ENERGY CLEANING

Circle 138 on Inquiry Card, page 117

# STANPAT SOLVES THE GHOSTING PROBLEM

**NEW resin-base STANPAT  
ELIMINATES GHOSTING,  
offers better adhesion qualities  
on specific drafting papers!**

## THE PROBLEM

Some of our longtime customers first called our attention to the "ghosting" problem. Certain tracing papers contain an oil which could be leached out by the STANPAT adhesive (green back) causing a ghost.

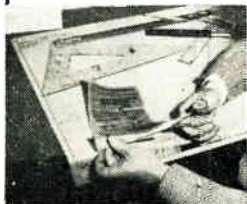
## THE SOLUTION

A new STANPAT was developed (red back), utilizing a resin base which did not disturb the oils and eliminates the ghost. However, for many specific drafting papers where there is no ghosting problem, the original (green back) STANPAT is still preferred.

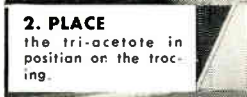
## WHICH ONE IS BEST FOR YOU?

Send samples of your drawing paper and we will help you specify. Remember, STANPAT is the remarkable tri-acetate pre-printed with your standard and repetitive blueprint items—designed to save you hundreds of hours of expensive drafting time.

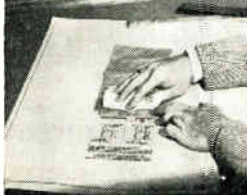
## SO SIMPLE TO USE



**1. PEEL**  
the tri-acetate adhesive from its backing.



**2. PLACE**  
the tri-acetate in position on the tracing.



**3. PRESS**  
into position, will not wrinkle or come off.

## STANPAT CO.

WHITESTONE 57, N. Y. Dept. 87  
Phone: FLushing 9-1693-1611



Enclosed are samples of the drafting paper(s) I use (identify manufacturer). Please specify whether Rubber Base or Resin Base STANPAT is most compatible with these samples.

Send literature and samples of STANPAT.

Please quote price on our enclosed sketches which we are considering to have pre-printed.

NAME \_\_\_\_\_

FIRM \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

ZONE \_\_\_\_\_ STATE \_\_\_\_\_

Circle 139 on Inquiry Card, page 117

## GOVERNMENT ELECTRONIC CONTRACT AWARDS

(Continued from page 12)

Amplifiers	168,796
Analyzers, spectrum	1,318,470
Antennas, systems & assemblies	168,792
Batteries, dry	2,178,358
Batteries, primary, water activated	81,868
Computer-indicator, Radiac	170,647
Connectors, cable & cable assemblies	302,043
Capacitors	88,035
Direction finder sets	115,942
Dummy loads	43,960
Equipment, telemetry	87,510
Horn, waveguide	26,026
Meter, volt	25,816
Multimeters	102,300
Networks, pulse	80,019
Paper, recording electrosensitive	208,958
Power supplies	171,844
Radar sets, accessories & components	89,557
Receiver, radio	120,773
Receiver, telemetry	58,288
Receiver-transmitters	90,994
Recorder-reproducers, accessories & components	140,289
Relay, armature	236,783
Relay assemblies	95,325
Relay, solenoid	32,832
Repairs, klystron tube	49,527
Repairs, magnetron tube	36,894
Research & development	1,798,322
Resistors	185,544
Signal generators	58,125
Spare parts, audio oscillator	27,740
Spare parts, radar	221,275
Spare parts, radiosonde	228,320
Switchboard equipment	265,894
Switch, pressure	32,477
Switch, rotary	36,100
Switch, toggle	25,575
Systems, telemetry	48,730
Tape, magnetic	105,244
Technical services	634,854
Test set, radio	339,451
Transducers	93,650
Transponders	25,024
Tube, cathode ray	27,300
Tube, electron	1,751,957
Tube, klystron	25,800
Tube, magnetron	884,072
Wire	484,415

*This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in November, 1958.*

## NEW EDP CENTER



IBM's Thomas J. Watson, Jr. (l) and Albert C. Simonds, Jr., chairman of The Bank of New York inspect scale model of bank's new IBM 650 Magnetic tape system.

# New ROHN SELF SUPPORTING COMMUNICATION TOWER



- ★ 120 ft. in height, fully self-supporting!
- ★ Rated a true HEAVY-DUTY steel tower, suitable for communication purposes, such as radio, telephone, broadcasting, etc.
- ★ Complete hot-dipped galvanizing after fabrication.
- ★ Low in cost—does your job with BIG savings—yet has excellent construction and unexcelled design! Easily shipped and quickly installed.

**FREE** details gladly sent on request.  
Representatives coast-to-coast.

## ROHN Manufacturing Co.

116 Limestone, Bellevue,  
Peoria, Illinois

"Pioneer Manufacturers of  
Towers of All Kinds"

Circle 140 on Inquiry Card, page 117



# 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

## ELECTRONICS AWARD



Edward R. Jahns, Chief Engineer, Hoffman Electronics Corp., Consumer Products Dept. receives the company's 1958 Presidential Award, \$1,000 and a scroll, given for outstanding individual technical achievement.

## One-Third of Nation's Engineers in R & D

American industry employed 738,000 scientists and engineers,  $\frac{2}{3}$  of the nation's total, as of Jan. 1957. The remaining engineers and scientists were in educational, governmental or related fields. One-third of industry's engineers and scientists were in research and development. The largest occupational group were the engineers—528,000. Among the scientists, chemists were the most numerous group—72,000. Employment in other scientific fields was: Life scientists (medical, agricultural, and biological)—16,000; earth scientists (geologists and geo-physicists)—14,200; Physicists and mathematicians—24,500; and metallurgists—10,800. 600,000 technicians worked with the scientists and engineers in all activities. About 160,000 of these worked in R & D.

## Final Report of Engineer Study Group Warns, "Work Only Started"

The President's Committee on Scientists and Engineers was dissolved on Dec. 31, 1958. Plans are being made to transfer some of its functions to other governmental agencies. Since the Committee was formed in 1956, it has initiated: the "Local Action Program" to stimulate formation of groups representative of all sectors of American life which will

### Incentive Plans Boost Profits-Wages, Cut Costs

act to improve science and mathematics programs in the schools; Area Utilization Conferences designed to conserve scientific and engineering manpower. A guidance and Counseling Program, a counterpart to the Local Action Program, which provided "kits" of guidance materials entitled "Counseling High School Students on Careers in Science and Engineering"; A Working Committee on Technical Support for Scientists and Engineers, to help find ways of encouraging industry to meet its current shortage of technicians; and the Public Information Program which served as a clearinghouse for ideas and documentation of the national and local programs.

Wage incentive plans have increased productivity in 29 industries by 63.55%, employee earnings increased by 20.6%, and the companies realized an average saving in unit labor costs of 25.91%, reveals a nation-wide survey of 17 management consulting firms conducted by George Elliot Co., Inc., 400 Park Ave., New York, N.Y. Specifically, the figures show that for every 1% increase in wages, productivity increased by 3.1% and unit labor costs reduced by 1.25%.

The final results of the survey were weighted by eliminating the top 25% and the bottom 25% of the cases reported.

The complete breakdown showed that increased productivity ranged from 100% for the tobacco industry to 39% for the automobile and auto equipment industry. Variations were due to several factors. The most important is that some industries were more alert to cost reduction possibilities than others. Other reasons stated were that in some industries the manufacturing process determines output more than others while other industries have done more work simplification and methods improvement.

**FOR MORE INFORMATION . . .**  
on positions described in this section fill out the convenient inquiry card, page 119.

act to improve science and mathematics programs in the schools; Area Utilization Conferences designed to conserve scientific and engineering manpower. A guidance and Counseling Program, a counterpart to the Local Action Program, which provided "kits" of guidance materials entitled "Counseling High School Students on Careers in Science and Engineering"; A Working Committee on Technical Support for Scientists and Engineers, to help find ways of encouraging industry to meet its current shortage of technicians; and the Public Information Program which served as a clearinghouse for ideas and documentation of the national and local programs.

In its final report to the President the committee emphasized that "only a start has been made on the immense task before us—It would be misleading to the American public and a disservice to the nation to leave the impression that the termination of the committee means that the job has been completed." Much progress has been done, it said, in focusing the public's attention on the problem, but it was doubtful if the sudden spurt of public interest, spurred by the satellites, has created enough conviction about the seriousness of the manpower problem to provide a sound and lasting basis for the formulation and execution of a national policy to deal with it.

It called attention to the "un-

(Continued on page 170)

By RICHARD E. SHAFER

Asst. to the President  
Professional Consultants, Inc.  
3515 Thorndale Rd.  
Pasadena 10, Calif.

*The considerations—what to build, financing, competitive action, marketing—that should precede a decision to develop a product are outlined. More important, means of obtaining their answers are detailed.*

## The 'New Product'—

Ed.: Only one out of every five "New Products" succeeds on the market. A relatively small percentage of the failures can be laid to the engineer's functions of design, development and production. Many other factors enter into the "New Product" venture, factors that the engineer should be familiar with in order to understand his role in the overall picture.

duction; new items; old items; items modified, with functions or features added or deleted; and/or accessory units for old or new products.

The other questions always involved are: What is competition doing (or may do)? Facilities, capital, manpower required?

- Preparing new products.
- Producing new products.
- Selling, distributing, and servicing new products.

Sometimes a product developed on military funds is readily adapted for commercial use. Frequently, however, company funds must support the R&D effort. It is, therefore, important to forecast as accurately as possible:

1. Cost and time for development and readying for production.
2. Extent of markets, location, and potential volume over specific periods.
3. Any patent royalties that may be involved.

These factors are essential in determination of investments required prior to the time sales will start. How many net sales required to regain the initial investment, considering current overhead and other costs that continue during the period when the product is

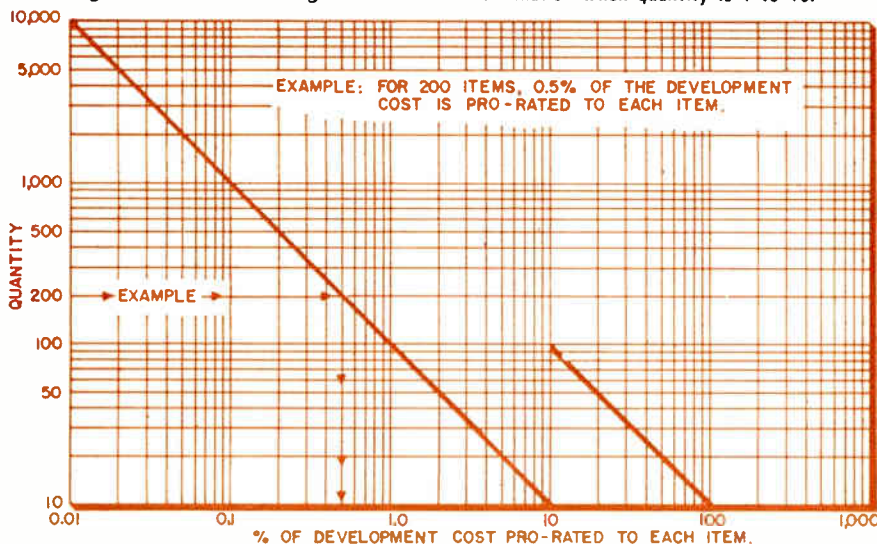
**T**HE field of product development has been the subject of much speculation as well as scientific analysis. Basic questions include: What to build? How to build it? When to build it? How to distribute

and sell at a profit? How to handle service and replacements?

### Considerations

A product may involve: design only; small quantities; mass pro-

Fig. 1: The line on the right is used for determination when quantity is 1 to 10.





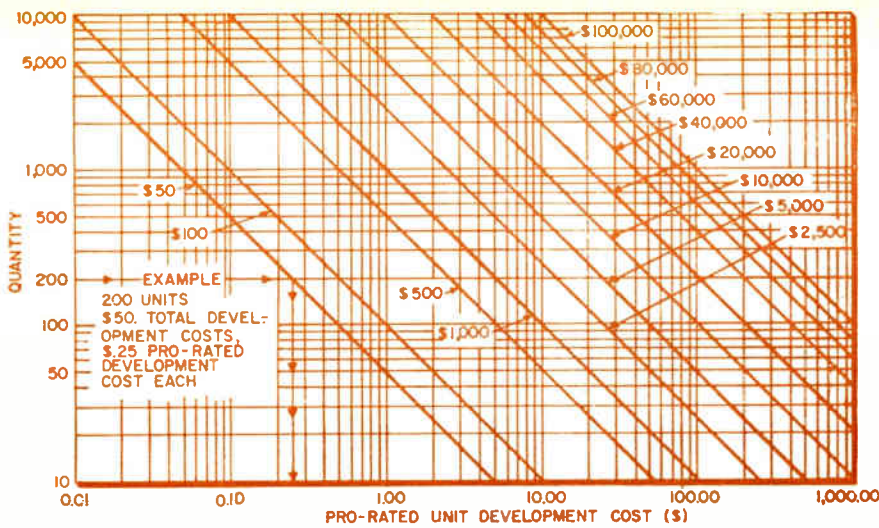


Fig. 2: The specific costs for a project are easily prorated to the number of units.

# What's Behind It?

being sold, may also be determined.

Fig. 1 is helpful in estimating pro-rated development costs per unit sold. It is noted, e.g., that for a produced quantity of 500, the pro-rated development cost for each unit is 0.2% of the total expenditure.

Fig. 2 shows specific costs for a particular project.

As the general objective of most product development is profit, there must be a continuous scanning of several parameters to improve the profit picture. Fig. 3 indicates these parameters.

The check list for evaluation of products and markets shown in Table 1 has proved helpful in attaining uniform comparisons.

## Objective

In general, of course, the objective is to find out what the customer wants or needs and supply it. Sometimes the customer or client, whether an individual, group, company, government, or other, must have a need called to his attention before he is aware the need exists. It may also happen that in filling one need, the requirements for additional products or services are created.

Frequently, the stated needs of a customer, particularly on a scientific or engineering level, must be modified in line with current scientific frontiers, time, and money available, or other factors. Or, decisions may be made to stop at a certain period, with whatever compromises may be acceptable.

An innovations planning activity can generally supply advice on time required to advance scientific frontiers.

General fields of company interest may include:

- a. Airborne and space—aircraft, missiles, weather, signalling or relaying, etc.
- b. Surface vehicles—tanks, trucks, automotive, trains, and others.

- c. Waterborne—propelled, stationary, manner, etc.
- d. Business—stores, banks, manufacturing, etc.
- e. Household—various.
- f. Municipal—various.
- g. Medical—treatment, diagnosis, materials, drugs (production), etc.
- h. Educational.
- i. Games and entertainment.
- j. Agriculture—plant growth factors, insect and disease control, food processing, handling, packaging, distribution, storage, preservation etc.

## Data Sources

Sources of data for new and/or improved products or markets include:

- a. Suggestions or assignment of company employees such as marketing, engineering, sales, etc. This is effective when the personnel have access to the data under "b," below.
  - b. Collection of manufacturers' data, catalogs, films, service manuals, magazines and reprints, all on equipment now or previously available in the fields of company interest.
  - c. College personnel and their research organizations.
  - d. Items produced at the request of the military, prime, or subcontractors, commercial sources, or submitted by individuals from outside the company.
  - e. Surveys to uncover needs for new products by means of questionnaires, personal discussions, awards, etc. Some of the points to cover are: Why needed—safety, convenience, functioning, etc.; and also what price range, estimated quantities, duty cycles, etc.
- (Continued on page 166)

Table 1  
Check List for Evaluation of Products

Major program	Major product classification
Item in program	Mechanical, Electronic
Use	Hydraulic, Pneumatic
Customer	Thermal, Electrical
Suppliers	Operating power required
Sales or lease volume per year	Environmental conditions
Rental or retail cost	Specifications
Packaging	Operating personnel
Sales method or organization	Common elements
Service method or organization	Functions, assemblies, circuits, parts
Survey cost	Engineering personnel required
Development cost	Facilities required

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- Radar circuit design
- Antenna design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstron, traveling wave tube and backward wave oscillator
- Display and storage devices

## CIVILIAN POSITIONS OPEN

### 2-WAY RADIO COMMUNICATIONS

- VHF & UHF Receiver • Transmitter design & development • Power supply
- Systems Engineering • Selective Signaling • Transistor Applications • Crystal Engineering • Sales Engineers

### PORTABLE COMMUNICATIONS

- Design of VHF & UHF FM Communications in portable or subminiature development.

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# MOTOROLA

## Industry News

(Continued from page 46)

N. H. Sperber has been appointed Publicity manager for Raytheon Manufacturing Co. He formerly operated his own public relations firm in New York and Boston.

V. C. Horner, formerly Vice President and Sales Manager of Byron Jackson Tools, Inc. has been named Vice President and General Manager of BJ Electronics.

H. E. Shane is now Industrial Systems Manager at General Controls Co. He was formerly Manager of Oil Field Automation at American Electronics, Inc.

L. P. Clark, National Vice-chairman of the IRE, PGTRC, has joined Radiation Inc., as Assistant to the President for Marketing and Products.

Dr. B. M. Oliver, Vice President—Research and Development, Hewlett-Packard Co., is now Director-at-Large of the Institute of Radio Engineers. He was formerly with Bell Telephone Laboratories.



B. M. Oliver



F. A. Martin

F. A. Martin is now General Sales Manager for the Parts Division of Sylvania Electric Products, Inc. He was formerly in charge of sales activities.

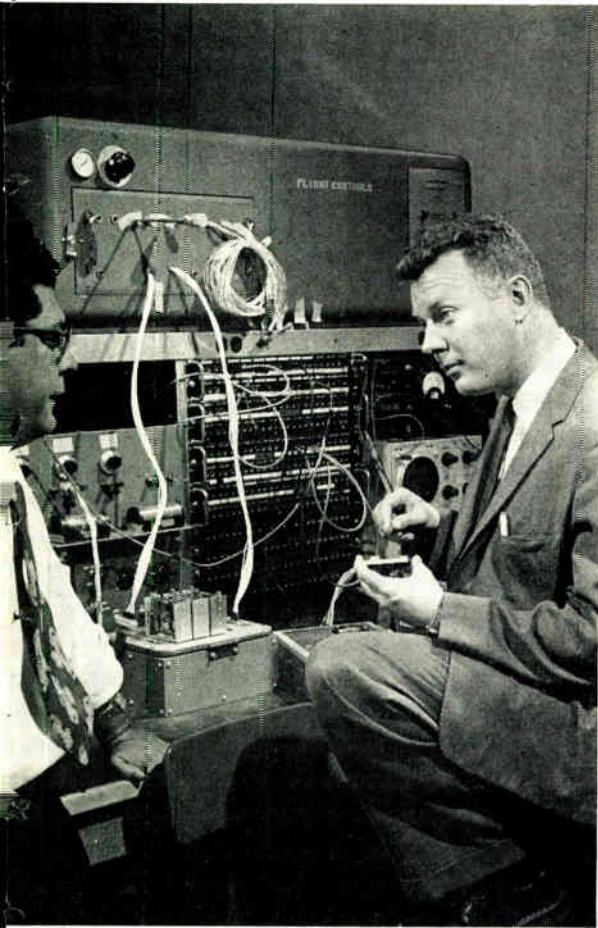
G. N. Thayer, Vice President—Operations and a Director of the Ohio Bell Telephone Co., has been elected to the Board of Directors of Clevite Corp.

H. M. Stearns, President of Varian Associates, has been named a Fellow of the IRE. He was cited for his contributions in the field of microwave tubes and doppler radar.

R. B. Bean, executive of the Automatic Electric Co., has been named Assistant Director of the Communications Industries Division, Business and Defense Services Administration, U. S. Department of Commerce.



# EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY



Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements.

## ... Flight Controls

Flight Controls offers one of the most challenging areas of work at Lockheed's Missiles and Space Division.

From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems. Rapid progress is being made in this field to advance the state of the art in important missile and spacecraft projects under development at Lockheed.

Flight controls programs include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems designs.

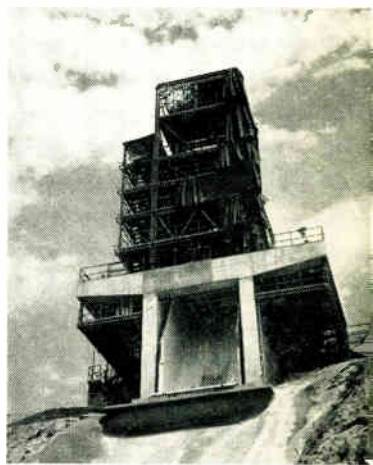
Lockheed Missiles and Space Division is weapons systems manager for such major, long-term projects as the Navy Polaris IRBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7; and other important research and development programs.

Scientists and engineers desiring rewarding work with a company whose programs reach far into the future are invited to write: Research and Development Staff, Dept. B-48, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, N. Y. and at Suite 300, 840 N. Michigan Avenue, Chicago 11, Ill.

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Pre-flight check-out on final assembly on X-7 missile. The X-7 holds free-world's speed and altitude records for air breathing missiles.



One of Lockheed's test stands with dynamic thrust mount to simulate flight environment.

## **Lockheed**

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IMPORTANT ANNOUNCEMENT TO ALL ENGINEERS—EE, ME, AE, CE:

# A New Organization Now Forming at General Electric to Integrate and Direct Systems Management of Prime Defense Programs

From within General Electric, and from industry at large, talented scientists and engineers from diverse disciplines are coming together to form the nucleus of the new Defense Systems Department.

The responsibilities of this new group encompass management of theoretical and applied research as well as advanced development on major terrestrial and space-age systems.

Engineers and scientists interested in exploring the broad new possibilities in the Defense Systems Department are invited to investigate current openings.

Direct your inquiry in confidence to Mr. E. A. Smith  
Section 2-D



DEFENSE SYSTEMS DEPARTMENT  
**GENERAL ELECTRIC**

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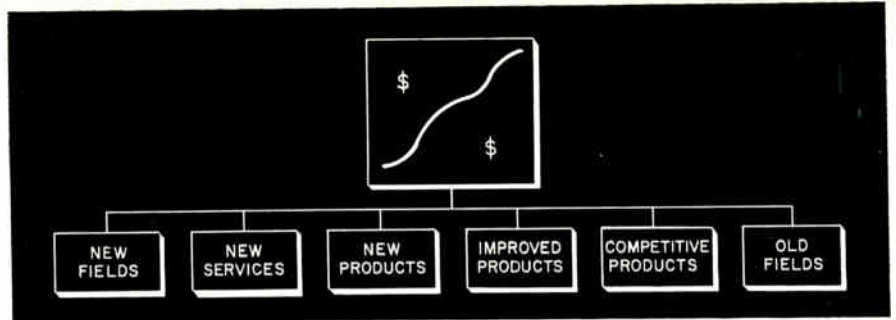


Fig. 3: Parameters which must be continually scanned to improve the profit picture.

## 'New Product'

(Continued from page 163)

life, weight, etc. The surveys would include:

1. Users and operators such as pilots, technicians, company officers, engineers, military and government officials, service organizations, etc. Brochure circulation is included.
2. Safety and certification groups and organizations.
3. Patent searches, licensing, development.
4. Ads for new products in technical magazines to reach qualified personnel.
5. Consulting firms who locate or develop new products.
6. Trade journals, sales reports, statistics.

### Survey Results

These activities will aid in answering questions such as:

- a. What is not being produced at all or inadequately so that pres-

ent or new requirements are not met.

- b. What is being produced that could be modified to better meet functional, operational, styling, or other requirements or lower costs.
- c. What items now in the customer's possession should have new accessories in order to improve present functions or add new functions and yet not reduce reliability or impair main purposes of original device.
- d. What combination of functions can a new device perform.
- e. What items should no longer be produced due to obsolescence, or should be completely re-designed due to improved techniques, more reliable or lighter weight components or materials, more severe environmental requirements, customer preference, etc.

With adequate consideration of these factors, much of the risk and guesswork can be removed from the fields of product development.

\* \* \*

## FAT

(Continued from page 83)

It had to be high speed processing in order to keep costs low.

Philco provided one answer in 1953 with the announcement of its Surface Barrier Transistor, (SBT), a high frequency transistor which could be produced in quantities using electrochemical techniques.

Philco researchers and equipment designers went to work on the problem about four years ago. They proposed to design and build a series of machines that would utilize automation as far as possible to produce transistors of high quality at increased production rates and low cost—transistors

destined for the entertainment industry.

The result is now in operation; a Fast Automatic Transfer ("FAT") series of machines that can turn out transistors roughly three times faster than conventional methods can produce them. Using 18 workers (two daily shifts of nine operators each), a total of 1,000,000 transistors can be assembled and tested a year. Pricing is roughly equivalent to electron tubes.

Another "F.A.T." line series should be in operation by the first of April and several more are scheduled.

Two units of the machine are completely automated, requiring no  
(Continued on page 170)



# Operations Research

Mathematicians, Physicists and Engineers with experience or strong interest in Operations Research on large-scale automated systems will be interested in the major expansion program at System Development Corporation.

SDC's projects constitute one of the largest Operations Research efforts in the history of this growing field. The projects are concerned primarily with man-machine relationships in automated systems in a number of fields, including air operations. The application of new and advanced digital computer techniques is particularly important in optimizing these man-machine relationships.

Senior positions are among those open. Areas of activity include: Mathematics, System Analysis, Forecasts, Cost Analysis, Operational Gaming, Design Analysis, Performance Evaluation.

Those who have professional questions or desire additional information are invited to write Dr. William Karush, Head of the System Development Corporation Operations Research Group at 2428 Colorado Avenue, Santa Monica, California.

---

### **"Method for First-Stage Evaluation of Complex Man-Machine Systems"**

*A paper by I. M. Garfunkel and John E. Walsh of SDC's Operations Research Group is available upon request. Address inquiries to Dr. William Karush at System Development Corporation.*

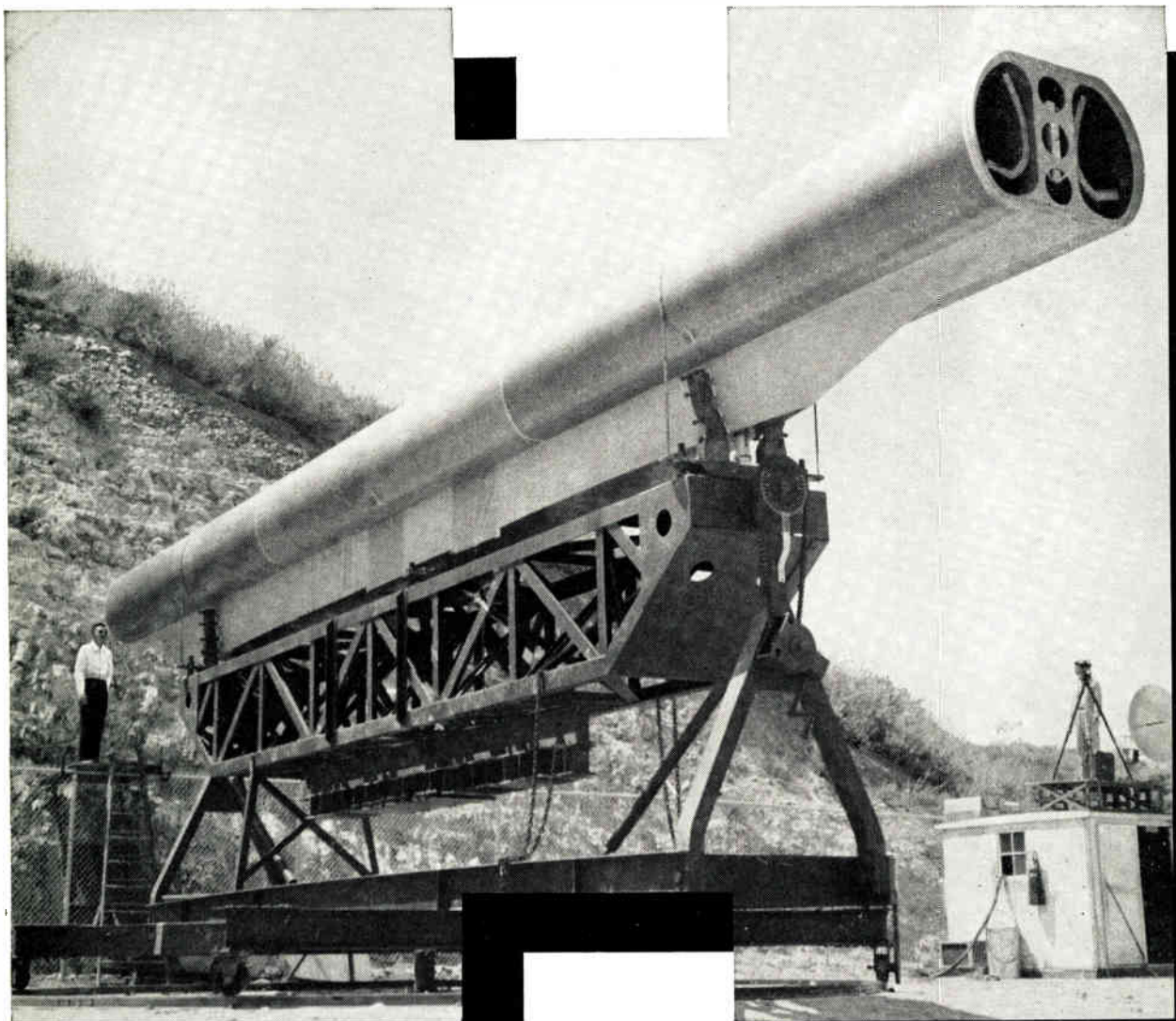
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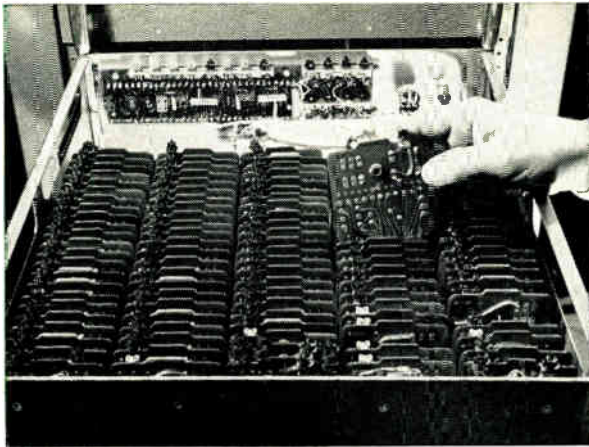
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# The new long look







**Test Equipment** designed and built by Hughes El Segundo is as sophisticated as the Hughes Electronic Armament Systems which it tests.



**His lab is the cockpit.** Wherever Hughes systems and missiles are employed, Hughes Field Engineers are on hand to work directly with squadron personnel.

## in sky scanning

A totally new idea in reconnaissance radar, SIGHTSEER (at left) is a side-looking, microwave search antenna within a completely self-contained detachable pod. Carried under the Convair B-58 Supersonic Bomber as a 58-foot package, SIGHTSEER has all hardware and black boxes built-in. It is roll stabilized—when the aircraft changes flight attitude, the antenna maintains its normal axis.

SIGHTSEER was designed and developed by the Microwave Laboratory of Hughes. This Microwave Laboratory is presently engaged in every field of electronics for airborne, missile, communication, and ground and ship-based radar systems—with operational ranges from 50 to 70,000 megacycles.

The “systems orientation” represented by the new SIGHTSEER reflects Hughes philosophy of integration. The Microwave Laboratories, for example, support the Systems Development Laboratories as well as the Hughes Ground Systems Group in Fullerton.

Advanced Research and Development at Hughes creates stimulating opportunities for creative engi-

neers in Airborne Electronics Systems, Space Vehicles, Plastics, Nuclear Electronics, Global and Spatial Communications, Ballistic Missiles and many others.

Similar opportunities exist at Hughes Products, where basic Hughes developments are translated into commercial products—semiconductors, specialized electron tubes, and industrial systems and controls.

From basic research through final application, Hughes offers a unique opportunity for personal and professional growth.

*Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:*

Digital Computer Engr.	Communications
Microwaves	Radar
Semiconductors	Circuit Design
Field Engineering	Systems Analysis
Microwave & Storage Tubes	Reliability Engineering

*Write in confidence, to Mr. Tom Stewart,  
Hughes General Offices, Bldg. 6-C2, Culver City, California.*

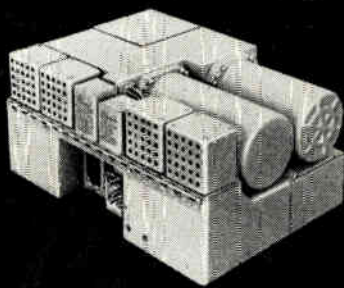
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These positions require men capable of coordinating the design and development of complete electronic control and flight data systems for use in current and future high performance aircraft and missiles.
- **SERVO-MECHANISMS AND ELECTRO-MAGNETICS** Requires engineers with experience or academic training in the advanced design, development and application

of magnetic amplifiers, inductors and transformers.

- **FLIGHT INSTRUMENTS AND TRANSDUCERS**  
**DESIGN ANALYSIS:** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.  
**DEVELOPMENT:** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction, freedom from vibration effects and compensation of thermo expansion are important.
- **PROPOSAL AND QUALTEST ENGINEER** For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience is required.

.....  
*Forward resume to:*  
**Mr. G. D. Bradley**  
 .....

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## Engineer Study

(Continued from page 161)

mistakable" evidence that the Soviet Union and Red China are making an all-out effort to profit from what may be called "the scientific revolution."

The report emphasized that our scientific, technological and other manpower problems have been intensified rather than diminished since the Committee was organized in 1956. The Committee strongly recommended that the Federal Government assume responsibility, in the Executive Office of the President, for coordinating and stimulating the Nation's efforts in the development and utilizations of highly trained manpower.

## FAT

(Continued from page 166)

manual labor, and these two combined account for 33 operations required in the production of transistors. Types of transistors initially being produced by this method are high and middle frequency varieties which are tailor-made for the requirements of the entertainment field.

The implications are obvious. Thousands more transistors per year mean thousands more transistorized products; and at the same time, more jobs in transistor production and more transistorized products sold by more dealers to more consumers—a healthy thing for the nation's economy. They mean that the entertainment industry can be supplied with all the transistors it needs, now that the prohibitive price barrier will be broken.

The "F.A.T." line does not obsolete all other methods of transistor production. It does open wide the gates of this field, create more employment, provide an answer for the booming demand and prove again that man, plus imagination and skill, can find an answer.

Significant price reductions on Philco Corp. transistors effective immediately on most alloy junction types as well as many precision electro-chemical types of transistors, are announced as proof.



## Personals

J. P. Moffat is now Chief Engineer, Electro Mechanical Instrument Div., Consolidated Electrodynamics Corp. He was formerly Director of Quality Control.

R. E. Honer is now Assistant Chief Engineer—Electronics at Convair (San Diego) Division of General Dynamics Corp. He was formerly head of the division's radiation systems section.

H. Altman is now an Executive Engineer at ITT Labs. He will be responsible for engineering administration of programs in the missile groups special projects lab at Nutley and at installations in other parts of the country. He holds 12 patent applications, and has participated in programs involving guidance systems for the Talos, Rascal, and Bomarc missiles.



H. Altman



E. C. Kluender

E. C. Kluender has been named Manager of Military Systems Engineering at General Electric's Communication Products Department. He will coordinate systems planning for the G-E Military Communications Group. He has worked on the design of Navy transmitters and contributed to the design of several radars, tank sets, and military microwave equipment.

W. G. Newton has been appointed to the newly created post of Corporate Industrial Engineering Manager at Beckman Instruments, Inc. He has been Chief Industrial Engineer at General Aniline and Film Corp.

A. Brenner is now Project Engineer at the Narda Microwave Corp. He will work with the design and development of microwave components. He was formerly with FXR Inc., and Polarad Electronics Corp.

J. M. Quirk has become Applications Engineer for capacitance level instrumentation and associated control systems at Robertshaw-Fulton Controls Co. He was formerly with Fluor Corp. Ltd., and the So. California Gas Co.

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**Senior Systems Analysts**—Require Senior Systems Analysts with strong theoretical and design knowledge in the electronic engineering field including familiarity with electronic and electro-mechanical digital machines. Should possess minimum of 3 years' experience with commercial application digital data processing equipment, however, would consider experience with scientific or defense application systems. Operational experience with a large data processing system is a distinct asset. Will be required to analyse and direct product improvement on large general purpose computer or small special purpose desk computer series. Advanced degree desired.

**Senior Circuit Designers**—Experienced in the design, development and analysis of transistorized computer circuits. Familiar with the application of magnetic cores to computer high-speed memory design. Growth opportunities involving decision making, concerning reliability, cost and component selection are offered. Advanced degree desired.

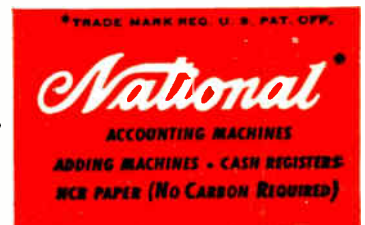
**Senior Circuit and Logical Designers**—Similar experience and duties as noted for Senior Circuit Designer, plus evaluation and de-bugging arithmetic and control areas of computer systems. Advanced degree desired.

## DATA PROCESSING ENGINEERS

**Senior Electronic Design Engineers**—Experienced in development of logical design using standard computer elements, must also evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding. This data processing system is concerned with bank automation.

## SEND RÉSUMÉ TO:

Mr. K. N. Ross  
Professional Personnel Section E,  
The National Cash Register Co.  
Dayton 9, Ohio





## REPS WANTED

An English manufacturer of power supplies is looking for reps to handle their equipment in the U. S. (Box R2-1, Editor Electronic Industries).

Manufacturer of test equipment for servo components and systems seeking representation in New England, Chicago area, Texas, Ohio and D. C. area. Contact Sales Manager, Theta Instrument Corp., 48 Pine St., East Paterson, N. J.

Mid-Eastern Electronics, Inc., has appointed Michael S. Coldwell, Inc., Hartford, Conn., as rep in the New England area.

Owen Laboratories, Inc., has announced the appointment of Carlson Electronic Sales as reps in Illinois, Indiana and Wisconsin; Arthur T. Hatton & Co., in Connecticut, Maine Vermont, Massachusetts, New Hampshire and Rhode Is.; Kelly Enterprises in Colorado, southern Idaho, New Mexico, Wyoming, and the Luscombe Engineering Co. in northern California.

Cochrane-Barron Co., sales reps for William Brand & Co., Inc., have opened a new office at 318 West States Ave., Phoenix, Arizona.

Eugene Roth, Inc., White Plains, N. Y., is now sales rep for New Jersey from Trenton north, and Norman H. Yoder, King of Prussia, Pa., is sales rep in southern New Jersey, Pennsylvania and Delaware for Anti-Corrosive Metal Products Co.

McCarthy Associates, Pasadena, Calif., has opened a new sales office at 1014 East Camelback Road, Phoenix, Arizona. The company represents instrument manufacturers.

Mansol Ceramics Co. has named three new sales reps. They are: H. S. Bancroft & Co. — Virginia, Eastern Pennsylvania, southern New Jersey, Delaware, Maryland and District of Columbia, Henry Lavin Assoc.—New England, and Henry Lazor — New York State from the Westchester County line north.

The following are now reps for Phillips Control Corp.: Ralph B. Black, Albuquerque, New Mexico, T. R. Van Wagoner, Salt Lake City, Utah, and Carl Hower, Scottsdale, Arizona.

W. E. Fry Co., Kansas City & St. Louis, Mo., is now sales rep for Cle vite Corp. The company will serve Missouri, Kansas, Nebraska, southern Illinois and western Iowa.

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**BECAUSE...you** will broaden your disciplinary background by seeing the total systems picture—from design to hardware. You will be able to communicate directly with the people who design the actual flight vehicle structures and related subsystems

**BECAUSE...you** will be a "ground floor" participant in Republic's new \$35 million R&D program, conceived to bring about revolutionary advances in aircraft, missile and space technology

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Please send resume in complete confidence to:  
Mr. George R. Hickman, Engineering Employment Manager



## REPUBLIC AVIATION

Farmingdale, Long Island, New York



# News of Reps

Hoffman Laboratories Division, Hoffman Electronics Corp., has appointed three new reps: Anderson Electronics Co., Roseville, Mich. for Michigan, Electro-Mechanical Instruments, Inc., Pasadena, Calif. for San Francisco and surrounding area and F. F. Sylvester Associates, Springfield, N. J. for New Jersey and metropolitan New York.

L. C. Dirting, Jr., is now Customer Relations Rep in the Dayton, Ohio area for ITT Laboratories. His offices are at 333 W. First St.

M. D. Shriver, former Vice President of Panellit, Inc., has formed Milard D. Shriver Co., Inc., 3025 W. Mission Rd., Alhambra, Calif., as a sales and engineering firm specializing in instrumentation and control work. Territory served is the entire state of California.

General Ceramics Corp. has announced the following new reps: Chapin & Associates, Los Angeles, for southern California, Cerruti & Hunter Associates, Redwood City Calif., for northern California, and W. E. Fry & Co., for Arizona and New Mexico.

The Electronic Representatives Association, Heart of America Chapter, has elected R. E. Clemenson, President; L. F. Florence, Vice-President; W. G. Kelley, Sec'y, and J. O. Schmitz, Treasurer. Three trade divisions, Audio, Industrial, and Distributor, have also been established.

The Visual Electronics Corp. is now handling all sales of Conrac, Inc. equipment to the broadcasting industry.

R. G. Bowen Co., Inc., Denver, Colo., is now the Rocky Mountain area rep for Ungar Electric Tools, Inc.

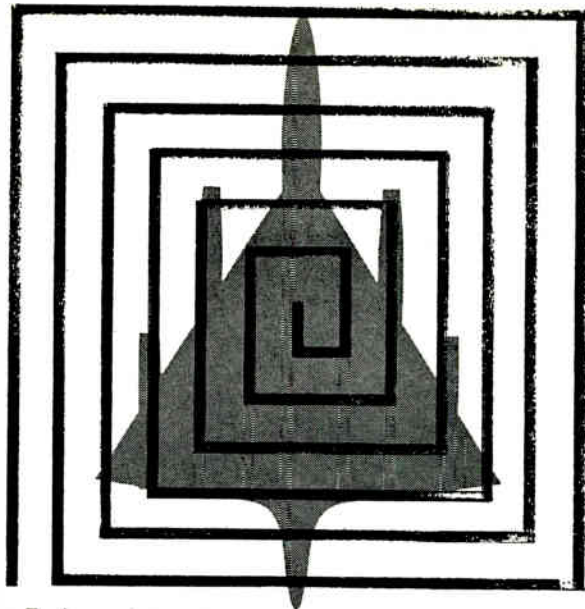
George G. Scott Co., Glen Cove, N. Y., has been appointed sales rep for Technical Wire Products Inc., in western Connecticut, northern New Jersey and New York state.

R. W. Marshall, Minneapolis, Minn., is now sales rep in Eau Claire and La Crosse counties, Wisconsin and all of Minnesota for Chicago Telephone Supply Corporation.

Systron Corp. has named Instruments for Measurements Co. (InForM) as manufacturer's rep in southern California, Arizona and southern Nevada.

T. R. Jewell, Grand Rapids, Mich., is now rep for the Electronics Div. of the Iron Fireman Mfg. Co.

Vicom, Inc., Rochester, N. Y., is the new U. S. rep for W. Watson & Sons, an English microscope manufacturing firm.



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New process controls highlighted by high sensitivity hermetic seal testing, pre-tinning of internal parts, automatic welding of the hermetic seal case and individual handling of units in process insure improved reliability, uniformity of electrical properties, high mechanical strength and superior hermetic seal. All transistors are pre-aged for 100 hours at 100°C.

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HIGHER OPERATING VOLTAGES

HIGHER SWITCHING SPEEDS  
WIDER APPLICATION RANGES

SPECIFICATIONS: POWER DISSIPATION: 150 MW @ 25° C STORAGE TEMPERATURE: -65° C to +100° C								
TRANSISTOR TYPE (EIA)	POLARITY	CUT-OFF STATE		CONDUCTING STATE (SATURATED)		TYPICAL SWITCHING CHARACTERISTICS WITH CIRCUIT GAIN OF 20 AT I <sub>c</sub> LISTED UNDER CURRENT GAIN		ALPHA CUT-OFF
		Collector-Base Rating BVCBO	Oper. Volt V <sub>CE</sub> min. I <sub>C</sub> MAX = 10μA V <sub>BB</sub> = 1.5V R <sub>BB</sub> = 62K	h <sub>FE</sub>	Conditions	Delay + Rise Time t <sub>d</sub> + t <sub>r</sub> μSEC	Storage + Fall Time t <sub>s</sub> + t <sub>f</sub> μSEC	
2N317A	PNP	25V	12V	20 - 60	I <sub>c</sub> = 400ma, V <sub>CE</sub> = .25V	0.3	0.7	20
2N316A	PNP	30V	18V	20 - 50	I <sub>c</sub> = 200ma, V <sub>CE</sub> = .2V	0.4	0.9	12
2N358A	NPN	30V	20V	25 - 75	I <sub>c</sub> = 300ma, V <sub>CE</sub> = .25V	0.4	0.9	9
2N357A	NPN	30V	25V	25 - 75	I <sub>c</sub> = 200ma, V <sub>CE</sub> = .25V	0.5	0.9	6
								Minimum
2N523A	PNP	20V	10V	100 - 400	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	0.2	0.6	21
2N522A	PNP	25V	12V	80 - 300	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	0.3	0.8	15
2N521A	PNP	25V	15V	60 - 250	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	0.4	0.9	8
2N447A	NPN	30V	15V	80 - 300	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	0.4	0.7	9
2N446A	NPN	30V	18V	60 - 250	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	0.7	1.0	5
2N445A	NPN	30V	20V	40 - 150	I <sub>c</sub> = 20ma, V <sub>CE</sub> = .25V	1.0	1.3	2

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**CLOSING DATE FOR INSERTION ORDERS AND PLATES—MAY 1st, 1959**

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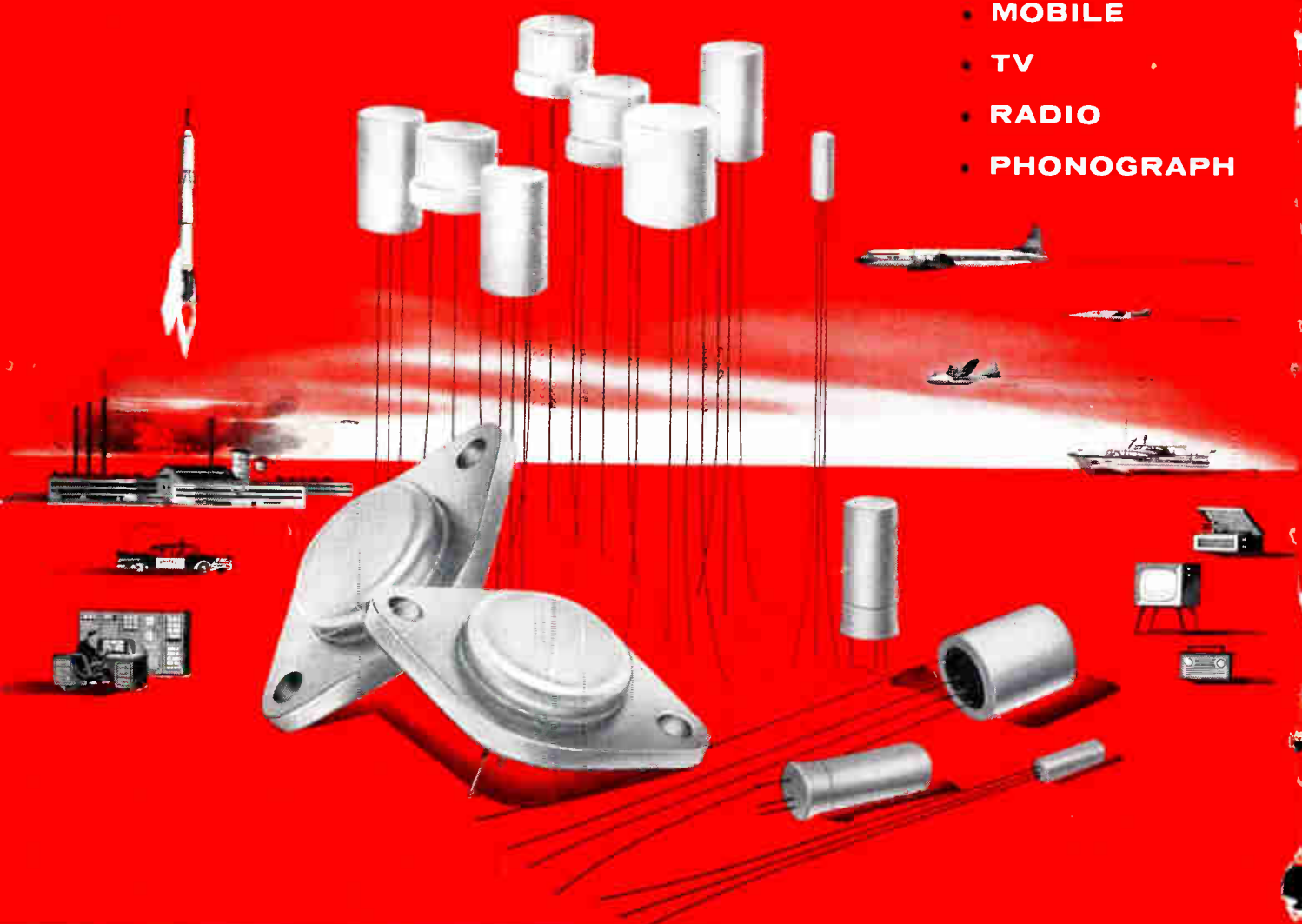
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