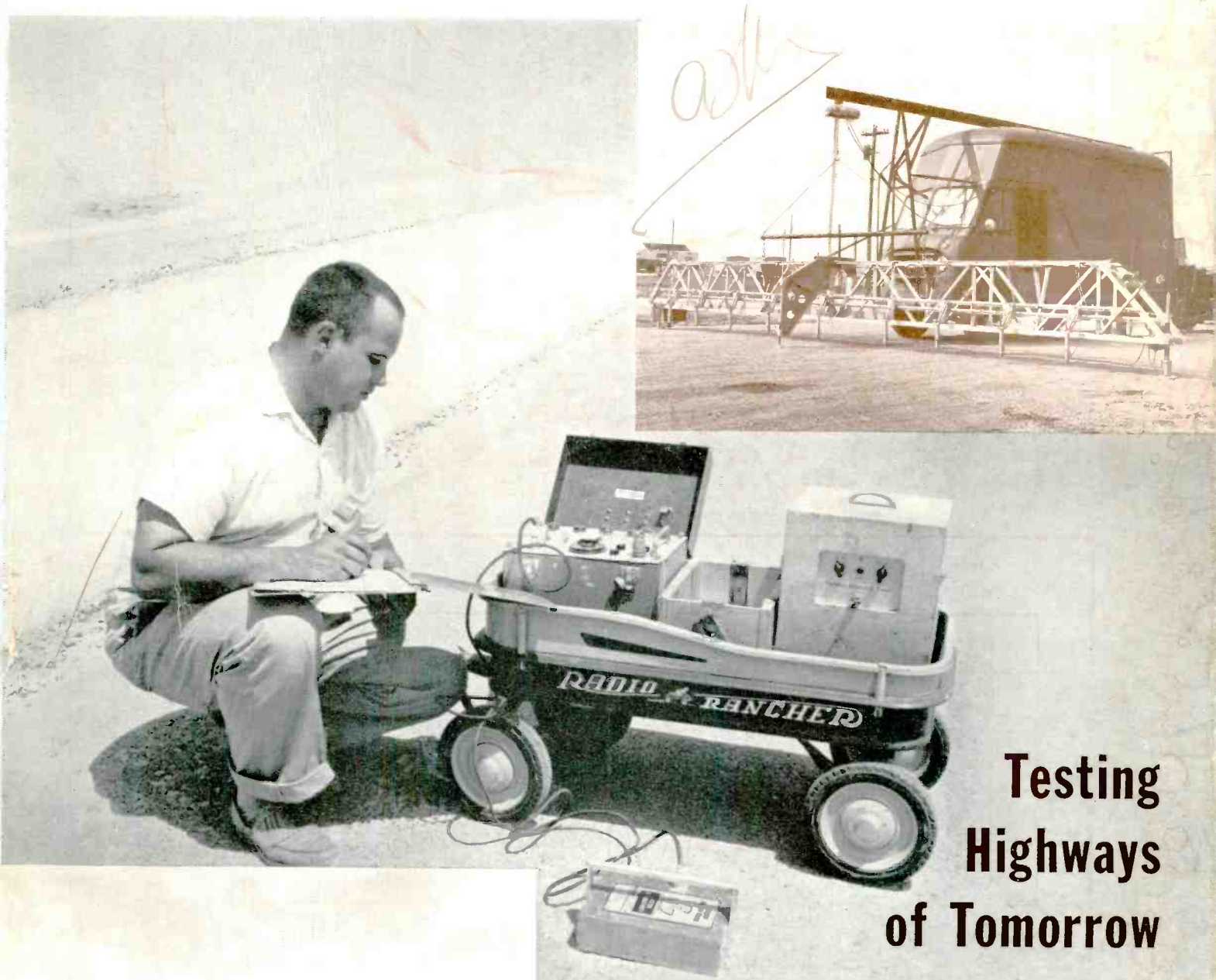
Training Missilemen: Big Business

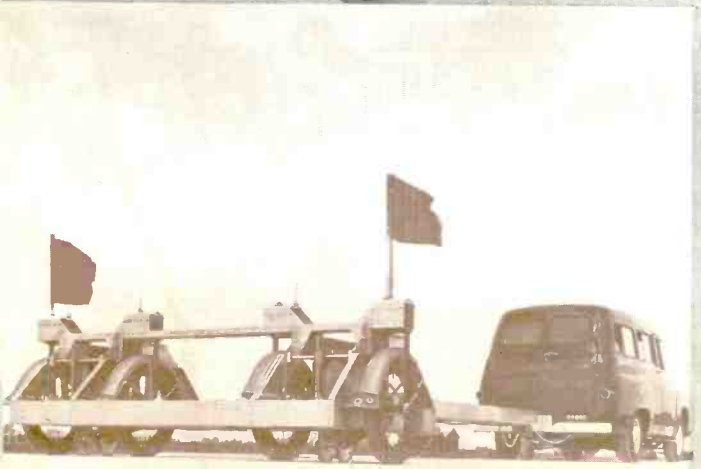
page 32

DECEMBER 18, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 51 PRICE SEVENTY-FIVE CENTS





Testing Highways of Tomorrow

page 69

Creative Microwave Technology

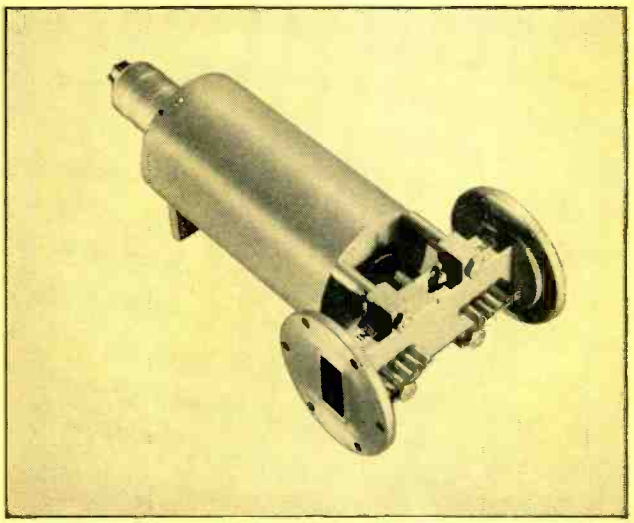
Published by Microwave and Power Tube Division, Raytheon Company, Waltham 54, Mass., Vol. 1, No. 6

NEW 5-WATT TRAVELING WAVE TUBE DESIGNED FOR MICROWAVE RELAY LINKS

The versatile modulation characteristics of this broadband power amplifier are particularly well suited for microwave communication applications. The tube, identified QK-542, is a permanent-magnet focused CW type, operates in the 5,900 to 7,400 Mc frequency range, and has a nominal saturated power output of 5 watts.

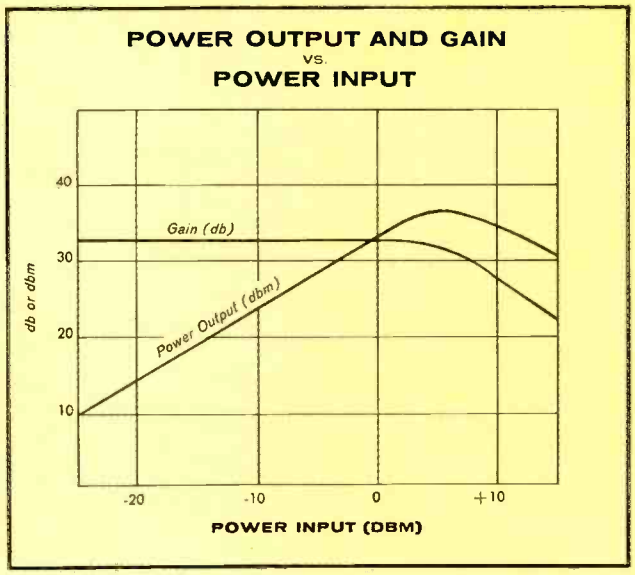
High amplification over a wide range of power levels results in small-signal gain of up to 35 db. A special control electrode facilitates low-voltage pulsed or amplitude modulation.

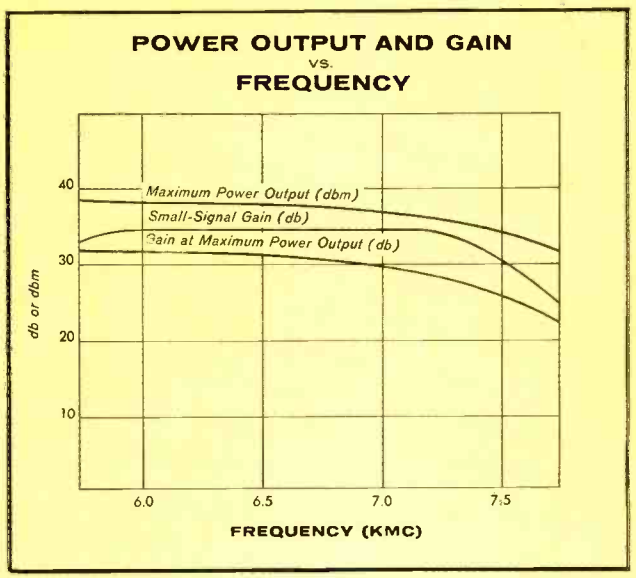
The tube is supplied with an integral waveguide coupler package which accommodates UG 344/U waveguide-type flanges. When supplied with an optional coaxial output coupler package, tube will operate over the 4,000 to 8,000 Mc range.



Typical Operating Characteristics

Frequency Range	5,900 to 7,400 Mc
VSWR (Input and Output)	2.1:1 max.
Small-Signal Gain	32 to 35 db
Gain (Saturation)	25 to 27 db
Power Output	5 watts





Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

electronics

DECEMBER 18, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 51

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Issue at a Glance

Business

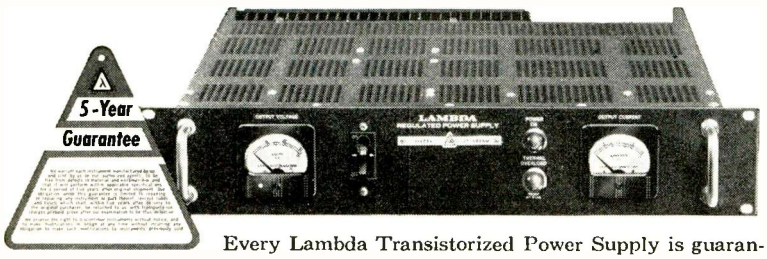
Engineering

Departments

31 reasons why Transistorized GUARANTEED

LAMBDA LT TRANSISTORIZED POWER SUPPLIES

IMMEDIATE DELIVERY FROM STOCK



Every Lambda Transistorized Power Supply is guaranteed to perform within applicable specifications and is further warranted to be free from defects in material and workmanship for a period of five full years. This plus the excellent experience of present users is your assurance of getting the finest in power supply service when you specify Lambda.

Voltage Bands .....0-8, 8-16, 16-24, 24-32 VDC

Line Regulation .....Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation .....Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input .....105-125 VAC, 50-400 CPS

Electrical Overload Protection .....Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

Thermal Overload Protection .....Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size .....3½" H x 19" W x 14⅜" D.

CONVECTION COOLED

No internal blowers – No moving parts

0-32 VDC • 0-1 AMP • 0-2 AMP

- **Ambient 50° C at full rating.**
- **High efficiency radiator heat sinks.**
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.

- **Compact. Only 3½" panel height.**
- **Short-circuit proof.**
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.

- **All transistor. No tubes.**
- **Fast transient response.**
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

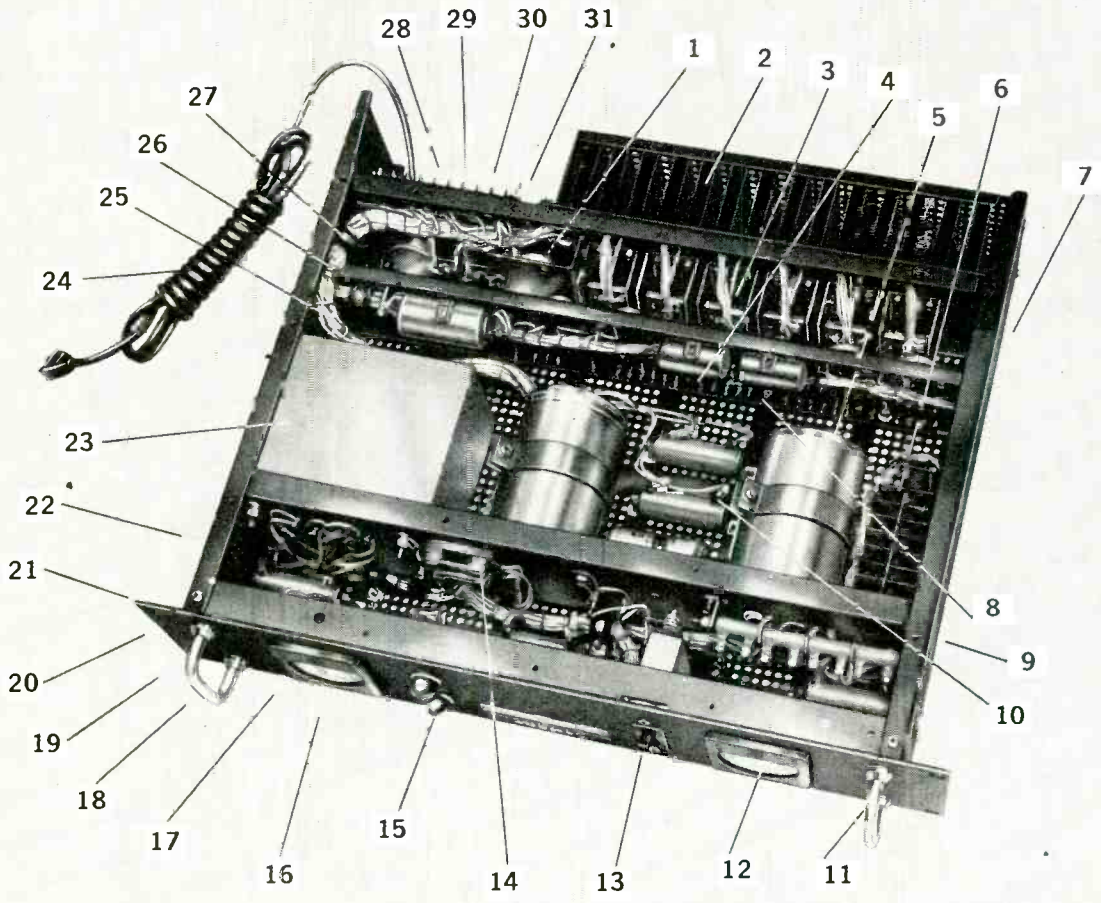
- Model LT 1095 **$285**
- Model LT 1095M (metered) **$315**
- Model LT 2095 **$365**
- Model LT 2095M (metered) **$395**

SEND FOR COMPLETE DATA

Write for information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.

LAMBDA ELECTRONICS CORP.
11-11 131 STREET • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500

Lambda Power Supplies are FOR 5 YEARS!



1 Thermal overload breaker for excess ambient temperature protection

2 High efficiency, convection heat sinks

3 Industrial type power transistors inherently protected against overload

4 Highly stable Zener voltage reference diode

5 Special, high-purity foil, hermetically sealed, long-life electrolytic capacitors

6 Silicon rectifier

7 Excellent regulation, low output, impedance, low ripple

8 Stable, low-noise wire-wound reference networks and multipliers

9 Unit welded chassis and frame

10 Every connection and solder joint individually inspected and checked

11 Sturdy gripping handles

12 Meters on "M" models

13 Magnetic circuit breaker

14 Fuses, internal failure protection

15 Thermal overload indicator light

16 Fast transient response

17 Every specification lab-checked before shipment

18 Rated for full load over entire voltage range

19 Advanced packaging for optimum thermal and mechanical design

20 Rated for 24-hour continuous duty

21 Compact — only 3½" panel height

22 Rated for operation from 50-400 cycle source

23 Hermetically-sealed transformer — designed to Mil-T 27A

24 Heavy-duty extra-length industrial cord

25 Harness wiring

26 Nylon jacketed vinyl wire

27 Sturdy cable clamp anchors

28 Remote DC vernier adjustment terminals

29 Remote sensing terminals

30 All controls clearly identified and marked

31 Heavy-duty barrier-type terminal block located for convenient rack cabling

electronics
December 18, 1959 Vol. 32, No. 51

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SHOPTALK . . . editorial

KEEPING IN THE KNOW. Electronic engineering moves fast indeed. Many an engineer whose work has kept him engrossed in the minutiae of some project has looked up from his breadboard to find a whole new subject has passed him by. More and more employment ads specify that an engineer's degree must be less than 10, 5 or even 2 years old. What's more, even technicians today are often expected to know computer techniques, binary arithmetic, Boolean algebra, transistor and pulse circuits.

How to keep up? One way is by reading ELECTRONICS magazine.

We have published nearly 500 technical feature articles in the past year. That is a significant percentage of all technical articles published in the free world. We have more than two dozen editors continually scouting for articles, then carefully selecting only the most significant and authoritative. The time you spend with us can give you the equivalent of many nights in graduate school, many days at professional meetings. You can keep in the know the convenient way by curling up at home these winter evenings while scanning the whole spectrum of the industry through the eyes of our editors.

Coming In Our December 25 Issue . . .

ANNUAL INDEX. As we mentioned above, ELECTRONICS will have published in 1959 nearly 500 engineering feature articles on subjects ranging from amplifiers to Zener diodes. Since we pride ourselves on the fact that our feature articles form, for many subscribers, a ready and very useful reference library, we're naturally interested in helping you find your way quickly among this mass of information. Our 32-page annual index, which appears in next week's issue, will help you locate specific articles by title, subject or author. The index this year contains 4,000 technical and 2,000 business entries, covers departmental as well as feature material, and is twice as big as last year's.

ELECTRON DEVICES. Interest in new and improved electron devices manifests itself each year in increasing attendance at the Electron Devices Meeting in Washington. This year 1,300 more engineers attended sessions at which 62 technical papers were presented.

In our next issue, Assistant Editor Wolff presents a roundup of some significant developments unveiled at the two-day conclave. In his article you'll find information about: a selective-erasure storage tube, the latest in electroluminescent devices, a reflected-beam kinescope, new low-noise devices, and a parametric amplifier which requires low pump power.

AIR CONDITIONING. Use of analog computers for analyzing the thermal behavior of dwellings has been limited to studies of special enclosures, using general-purpose equipment. Now W. L. Wright and C. A. Booker of Westinghouse in Cheswick, Pa., describe an analog computer designed specifically to determine residential air conditioning loads. The concept is based on using thermal circuits that represent unit areas of the physical structure.

DESIGNING AGAINST RADIATION. As brought out in a recent ELECTRONICS article (p 55, Nov. 27), the tolerance of solid-state circuits to nuclear radiation can be increased through proper choice of transistors. Next week, J. R. Bilinski and R. Merrill of GE in Ithaca, N. Y., present some nomographs that will help circuit designers select the best transistor for a radiation environment.

←CIRCLE 3 ON READER SERVICE CARD

SPRAGUE® RELIABILITY
in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

NEW SMALLER SIZE

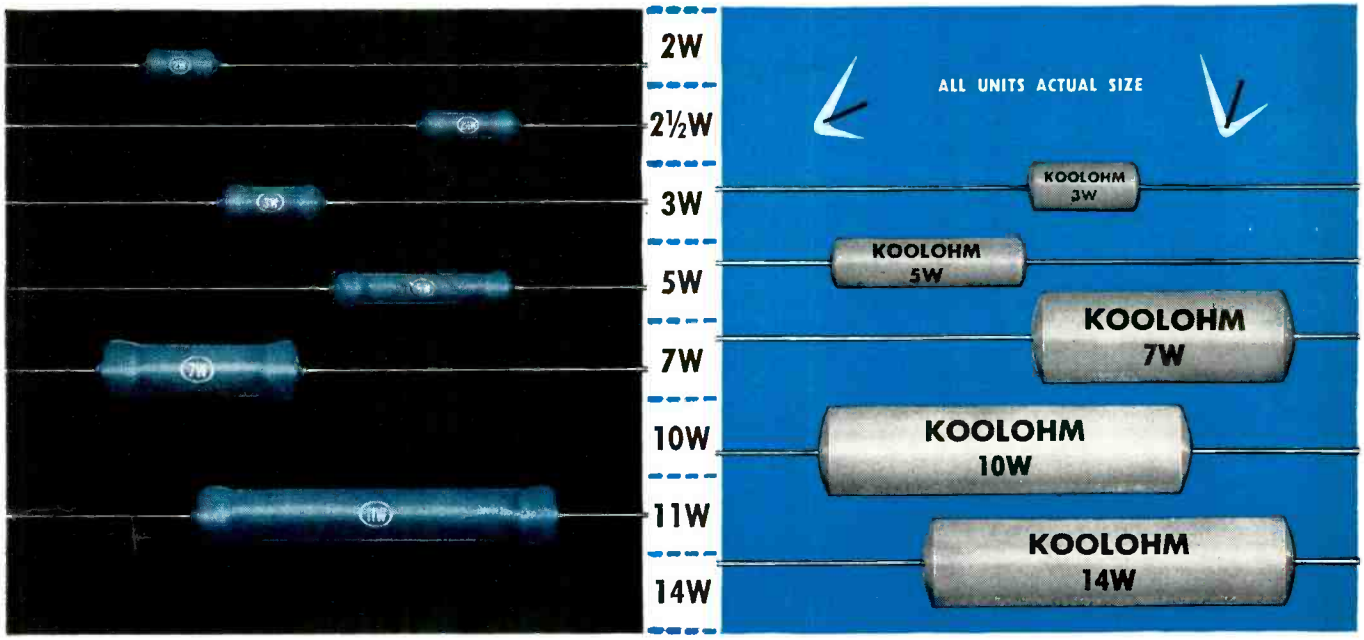
KOOLOHM®

INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



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SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS
INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

NOW from INDIANA STEEL

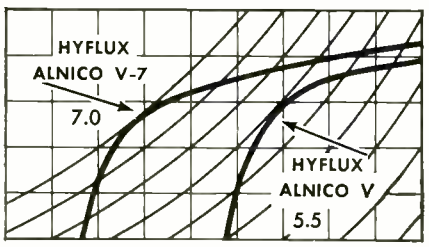
NEW HIGH ENERGY ALNICO V-7 PERMANENT MAGNETS ACHIEVE TYPICAL ENERGY VALUES OF 7 MILLION FOR THE FIRST TIME!

For the design engineer with a special application problem

Hyflux Alnico V-7 is a new high energy material now available for special applications requiring either *greater energy* per unit weight or volume, or *equal energy* from a lighter or smaller magnet.

Compared with the previous energy leader — Alnico V, new Hyflux Alnico V-7 represents a significant advance in the energy level of permanent magnets. To show this, a portion of the Demagnetization and Energy Product Curve has been enlarged and depicted here.

The curve for Hyflux Alnico V-7 shows a typical energy value of 7.00



million. By comparison, Alnico V has a typical value of only 5.50 million.

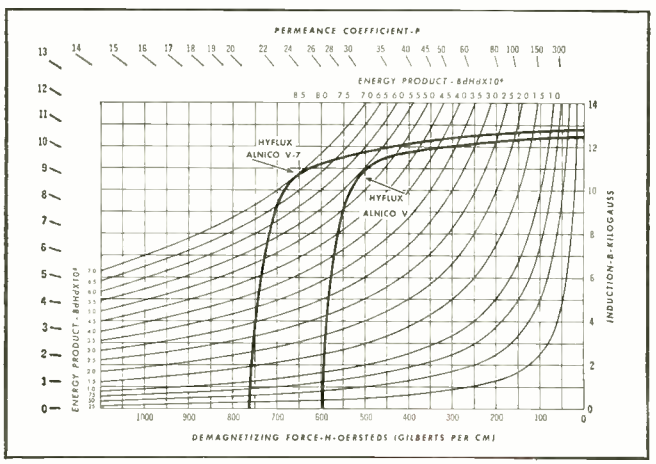
The reason for this remarkable performance lies in the very high degree of crystal magnet orientation found in the material. As a result, Hyflux Alnico V-7 produces *more magnetic energy per unit volume or weight* than any other permanent magnet material presently available.

Other characteristics of Hyflux Alnico V-7 are equally impressive. For example, residual induction (B_r) is 12,750 gausses, and the coercive force (H_c) is 765 oersteds. For Alnico V the B_r is only 12,500 gausses and the H_c 600 oersteds. Improvements such as these point the way to important design breakthroughs in many fields.

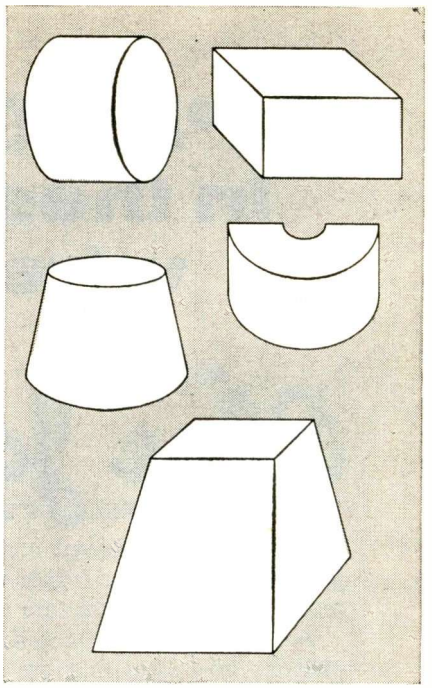
When To Use Hyflux Alnico V-7

A premium material, Hyflux Alnico V-7 is particularly suited for use in space age or other critical equipment requiring a greater level of energy, or where smaller size and weight without loss of energy is needed.

1. **Military Electronics.** Use Hyflux Alnico V-7 for light-weight ground and airborne generators and alternators (in a full range of frequencies).
2. **Testing Equipment.** Use Hyflux Alnico V-7 in meters, recording instruments, oscillographs, magnetometers and galvanometers.
3. **Miniature and Sub-miniature Components.** Use Hyflux Alnico V-7 for missile-borne guidance and recording equipment.



DEMAGNETIZATION AND ENERGY PRODUCT CURVE



Designing With Hyflux Alnico V-7

The nature of the material is such that orientation (and magnetization) must be straight, eliminating the familiar horseshoe shape. Cylinders, rectangles and other prismatic shapes, however, are possible, as are certain conic or pyramidal frustums. Pole faces may be ground quite easily. Side surfaces may also be ground, but somewhat slower than normal.

TYPICAL CHARACTERISTICS OF HYFLUX ALNICO V-7

(in comparison with Alnico V)

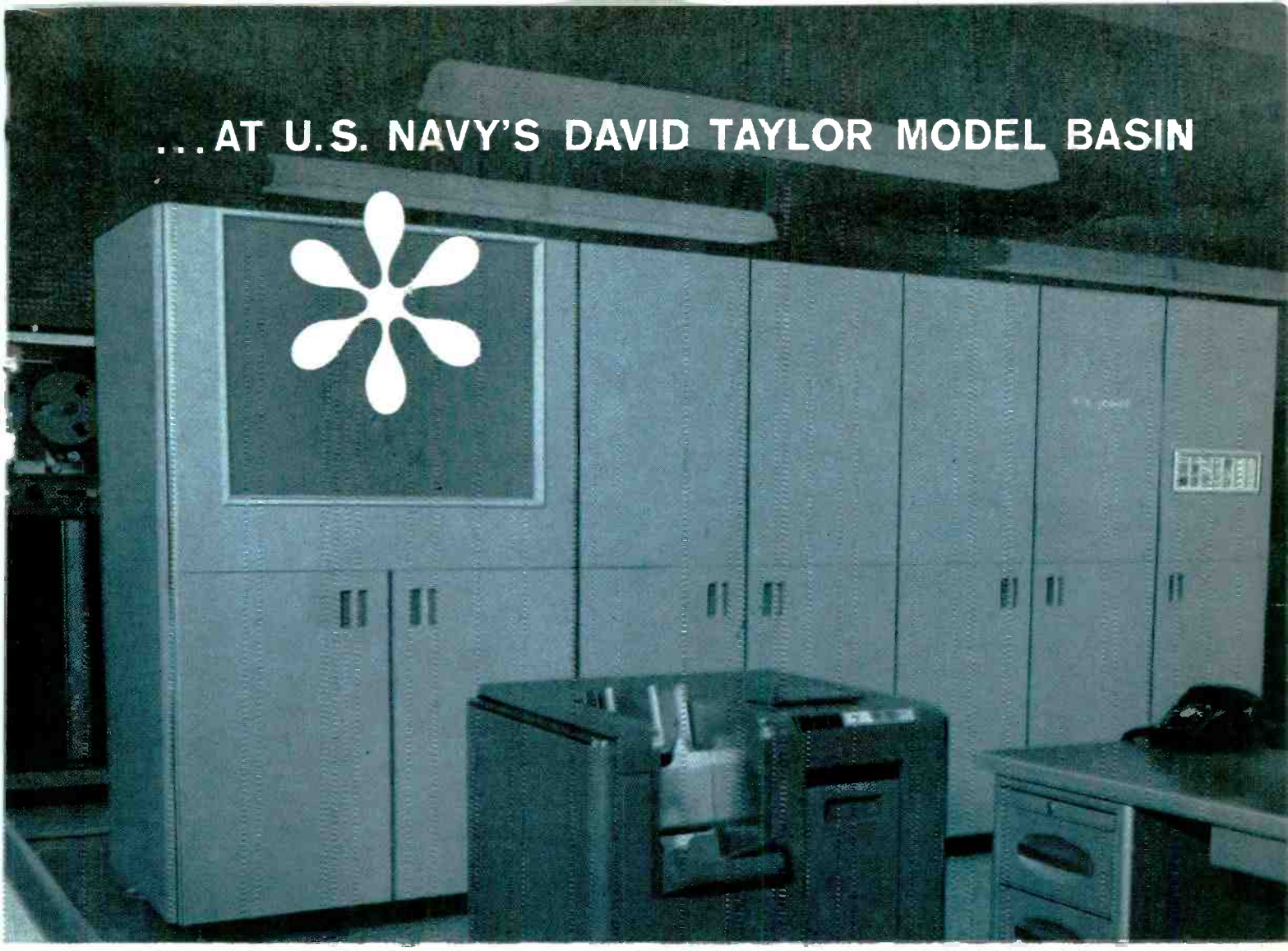
PROPERTIES	Hyflux Alnico V-7	Alnico V
Residual Induction (minimum) B_r Gausses	12,750	12,500
Coercive Force (minimum) H_c Oersteds	765	600
Peak Energy Product $B_dH_d$max x 10^6	7.00	5.50
Peak Magnetizing Force Oersteds	3,000	3,000
Weight (lb per cu in)	0.265	0.265
Mechanical Properties	Hard-Brittle	Hard-Brittle

For more information on new Hyflux Alnico V-7 and its role in the design future of your firm, write Dept. A-12.

INDIANA STEEL PRODUCTS
Division of Indiana General Corporation
Valparaiso, Indiana
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS
In Canada: The Indiana Steel Products Company of Canada Limited, Kitchener, Ont.

INDIANA PERMANENT MAGNETS

CIRCLE 7 ON READER SERVICE CARD→



FASTEST COMPUTER READOUT MICROFILM PRINTER IN USE TODAY!

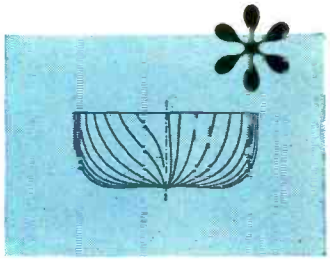
FIFTEEN THOUSAND plotting points or alphanumeric characters per second are being recorded *now* on the Stromberg-Carlson S-C 4020 high-speed microfilm printer at the U.S. Navy's David Taylor Model Basin in Carderock, Md. Either on-line or off-line operation is provided.

At the David Taylor Model Basin, the S-C 4020 is used in the applied mathematics laboratory for the solution of various Naval problems including ship design, hydrodynamics, structural mechanics and nuclear reactor design. It is ideal for all kinds of high-speed computer printing, filing and archive storage.

In typical graph plotting applications, the S-C 4020 can save as much as $4,840 a month. Assume that an average of 2,100 graphs with 375 points each are required each month. Twenty-five engineering aids can do this work by hand at an estimated cost of $8,800 a month. One S-C 4020 high-speed printer can do the same work for a capital expense of $3,960 —a saving of $4,840 a month.

Printers similar to the one in use by the U.S. Navy are coming off the production line right now. You can have your own printer saving hundreds of valuable man-hours within 6 months.

LITERATURE AVAILABLE —Write to Dept. A-14, Stromberg-Carlson-San Diego, 1895 Hancock Street, San Diego 12, California.



Selected data, either tabular or graphic, may be projected on the accessory viewing screen only 8 seconds after film exposure. The projection unit is useful for computer monitoring.

STROMBERG-CARLSON - SAN DIEGO

A DIVISION OF **GENERAL DYNAMICS CORPORATION**

CIRCLE 7 ON READER SERVICE CARD

unusual capabilities and stability

64 channels in 60″

On these two pages eight fully transistorized Model 850-1500P Preamplifiers appear actual size — each measures approximately 2″ x 7″ x 14½″. In racks of eight, 64 preamplifiers take only 56″ of panel space, and a blower unit another 4″. Necessary power and chopper excitation is provided by a completely transistorized Model 858-500P Power Supply that mounts at the rear of each 8-preamplifier unit, so that no additional panel space is required.

INPUT CHARACTERISTICS
Input circuit guarded, floating, isolated from output, can be grounded. Input impedance 200,000 ohms min. (Preamplifier also available at extra cost with 4-step attenuator with gains of 10, 20, 50 and 100 and smooth gain control to reach any intermediate setting.)

BANDWIDTH
DC to 70 cps (−3 db).

RISE TIME
25 ms to 99.9% of steady state value.

OUTPUT CHARACTERISTICS
Floating, independent of input, can be grounded.
Capabilities: ±1 v across 300 ohms, DC to 70 cps
±1.5 v across 300 ohms, DC to 40 cps
Output impedance 100 ohms. Output is across 300 ohm internal load, shunted by internal 4 mfd capacitance. Part or all of this resistance and capacitance can be supplied externally, in any combination to suit your application.

LINEARITY
±0.1% of full scale output (2 volts)

GAIN
100 (10 mv input for 1 volt output). Preamplifier with gain of 1000 (1 mv input for 1 volt output) also available on special order. Gain stability ±0.1% for min. of 24 hours.

INPHASE REJECTION RATIO
120 db at 60 cps, 160 db at DC, with 5000 ohms unbalance in source.

INPHASE TOLERANCE
250 VDC, 220 VAC

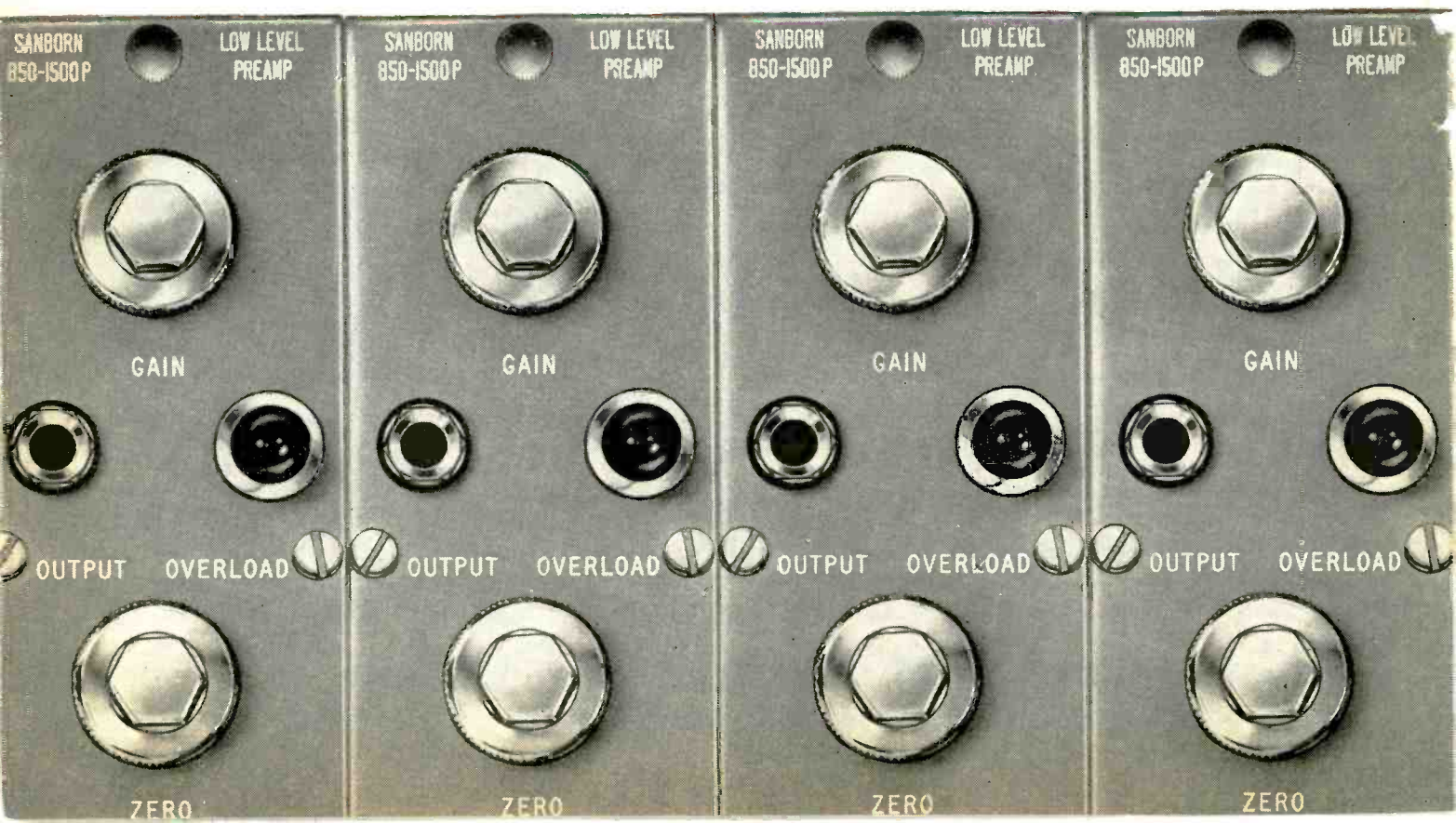
NOISE
2 uv peak-to-peak referred to input (measured over DC to 100 cps). Noise plus ripple for full scale signal not to exceed ±0.1% of signal (measured wide band-ripple is 880 cps).

DRIFT
±2 uv referred to input, at constant ambient temperature, after 30 minutes' warm-up. Input drift temperature coefficient ±0.2 uv/°C, max.

OVERLOAD RECOVERY
Preamplifier recovers from fully blocked condition within 20 milliseconds after removal of signal. 10 volts of signal at input will not damage preamplifier.

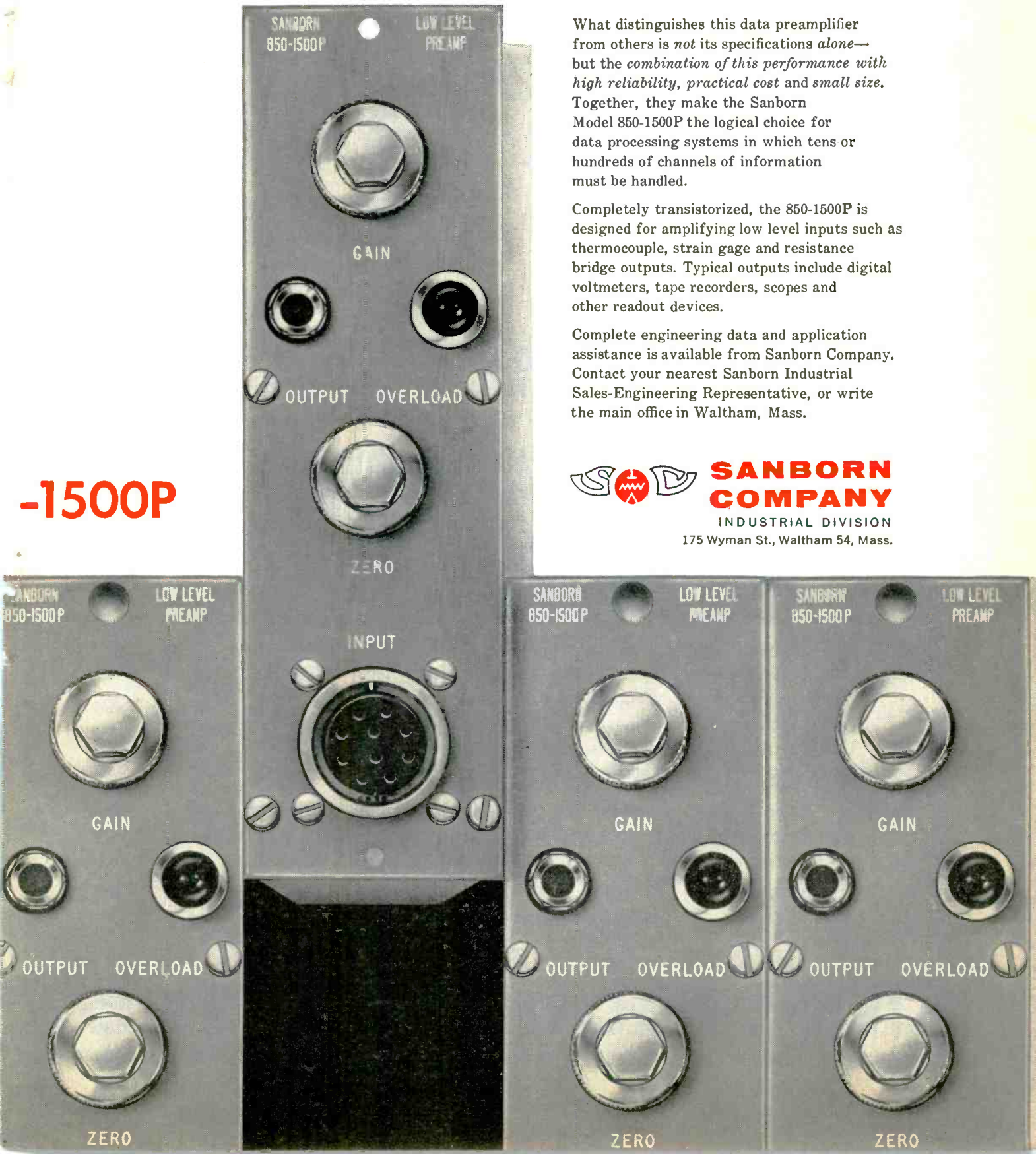
POWER REQUIREMENTS
Each Preamplifier requires 2.5 watts; Model 858-500P Power Supply handles up to eight Preamplifiers.

New Data Preamplifier model 850



$462.50
per channel, complete

Each Model 850-1500P Preamplifier costs $400, each Power Supply for every eight Preamplifiers, $500. Consider the substantial savings over equipment with comparable specifications – when economy "per channel" is multiplied by the number of channels you're using. (All prices are F. O. B. Waltham, Mass., within continental U. S. A.)



What distinguishes this data preamplifier from others is *not* its specifications *alone*— but the *combination of this performance with high reliability, practical cost* and *small size.* Together, they make the Sanborn Model 850-1500P the logical choice for data processing systems in which tens or hundreds of channels of information must be handled.

Completely transistorized, the 850-1500P is designed for amplifying low level inputs such as thermocouple, strain gage and resistance bridge outputs. Typical outputs include digital voltmeters, tape recorders, scopes and other readout devices.

Complete engineering data and application assistance is available from Sanborn Company. Contact your nearest Sanborn Industrial Sales-Engineering Representative, or write the main office in Waltham, Mass.

-1500P

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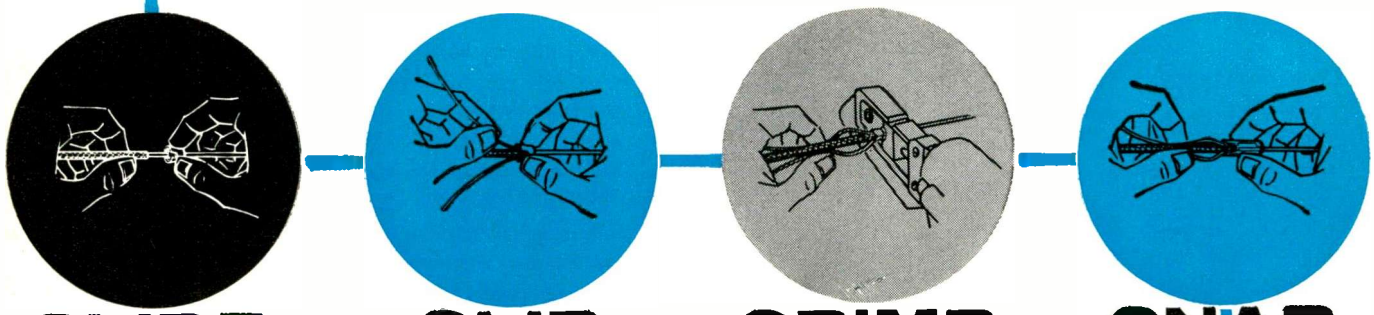
175 Wyman St., Waltham 54, Mass.

WHEN IT COMES TO SHIELDED WIRE



SLIDE on the ferrule

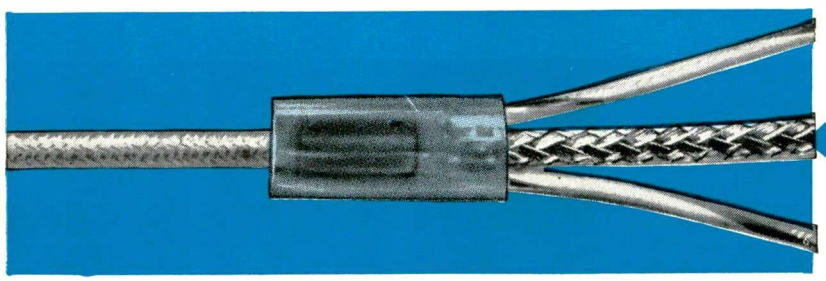
SLIP in the ground taps

CRIMP the three together

SNAP on the insulation

PRESTO!

the best insulated ferrule you can buy



How's that for speed! And the post-insulation of the Termashield Shielded Wire Ferrule is easily and quickly accomplished . . . you eliminate close tolerance cable stripping required by other techniques . . . you eliminate blind probing of taps into other type ferrules . . . you eliminate solder and burnt cable . . . you eliminate lost time . . . you eliminate doubt.

For positive attachment, top reliability, unbeatable speed and tangible economy, get A-MP Post-Insulated Termashield Shielded Wire Ferrules.

Write for more information.

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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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←CIRCLE 9 ON READER SERVICE CARD

CIRCLE 10 ON READER SERVICE CARD

ELECTRONICS NEWSLETTER

F-M AUTO RADIO selling for about $125 will be marketed next February by Motorola. Company says design of the set permits it to fit under the dashboard with three brackets for easy installation and removal. The radio can be used in any 12-volt American car built since 1955, or in any other 12-volt vehicle with a negative ground ignition system; set uses a regular car antenna. Adapter kits for rear-seat speakers will also be offered. The company estimates there are 15 million f-m receivers, believes "a good percentage" of these f-m listeners will want to keep tuned in while driving. Motorola says it has overcome technical difficulties which previously prevented mass production of an f-m receiver for the automobile market. The radio is powered by three transistors and seven tubes, provides 15 watts of peak power.

Italian business machine maker Olivetti is producing typewriter arm support-plates with a fixed program automatic electrohydraulic milling machine equipped with a transistorized control unit. Printed circuits are used for logical functions of program direction. Machine works two identical parts at once during a five-minute cycle of 275 operations.

CIVIL AIR REGULATIONS amendment is proposed by the Federal Aviation Agency that would require Agency approval of the performance standards of airborne radar and radio devices which now supplement required navigation and communications facilities. FAA says such gear may have a significant effect on air safety, asks for power to approve equipment before its experimental installation and invites comment on the proposed change in rules.

Nearly 61 percent of the nation's 66,000 general aviation aircraft were carrying receiver-transmitters in 1958, according to a Federal Aviation Agency survey. In 1954 less than 48 percent of 61,000 aircraft carried two-way radio equipment.

RED CHINA has developed a remote control system, presumably for power transmission, which uses telemetering gear and automatic control devices at unmanned substations. Peiping Radio, monitored in Tokyo, said recently that semiconductor devices, magnetic elements and some printed circuits are used. Work was done at the Institute of Automation and Telemechanics of the Chinese Academy of Sciences, counterpart of a similar institute in the USSR. Another Peiping broadcast boasted that Red China is now turning out electronic computers, telephone equipment and television transmitters. The broadcast said 110,000 radio sets were turned out last year, 5.5 times the number for the previous year.

NEW DEGAUSSING COILS gird the inside of the Navy's just commissioned guided missile destroyer, the *U.S.S. Dewey*, to neutralize magnetic distortions that trigger mines and attract torpedoes. The coils are energized by ITT Federal equipment which automatically compensates for varying magnetic currents as the ship passes from one location to another. Effect is a magnetic field opposite to that of the ship which makes the ship magnetically "invisible."

A second coast-to-coast microwave system may be operating by 1962. Western Union is reportedly planning such an expansion and, maybe later, a further extension southward. WU's present east-west system reaches Cincinnati and Chicago.

CHEMISTRY INFORMATION RETRIEVAL will be carried out by a new special computer under development in the USSR for the Council for Cybernetics of the Academy of Sciences. The machine will determine within seconds, says Tass, any possible chemical compounds that answer to input specifications. The machine will use an algorithmic technique, translating chemical characteristics into mathematical expressions and analyzing the expressions by matrix inversion and other linear methods. Answers will then be retranslated into chemical terms. Ultimately, Soviet planners hope to derive information about the physical and other properties of chemical compounds.

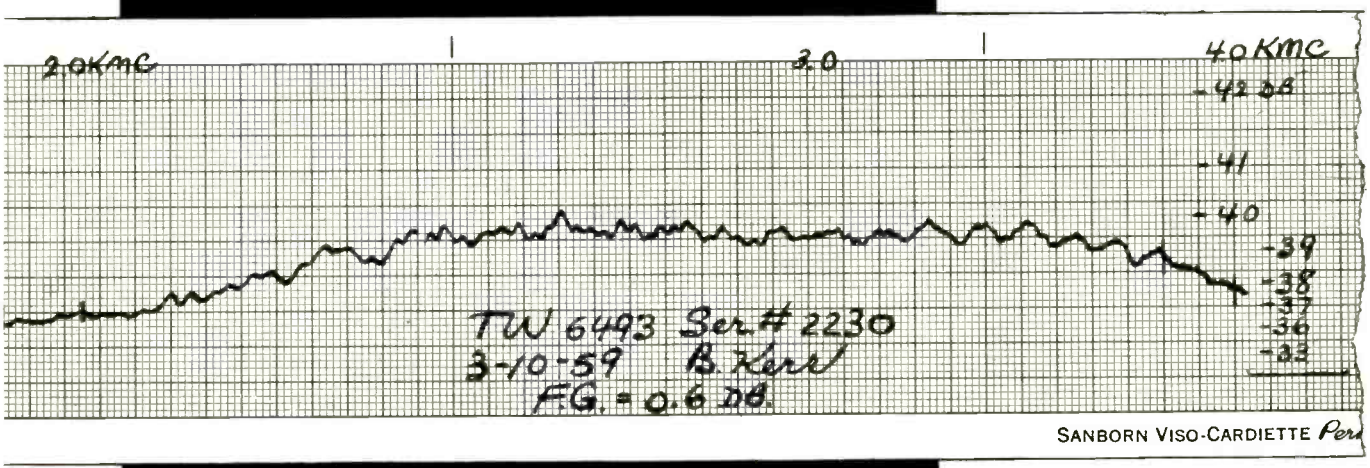
PERMANENT HEARTBEAT CONTROLLER has been attached to the heart muscle of a patient in the fourth case of its kind. A bipolar electrode was sewn into place against the heart wall of a 37-year-old man with a progressively worsening heartblock—a condition in which the filling and pumping chambers lose their synchronized rhythm and do not respond to drugs. Operation was performed at the University of California Medical Center in San Francisco. Plastic-coated wires, leading from the electrode out through the chest incision, were attached to a transistorized, battery powered pacemaker. Device is worn on a belt around the waist, delivering an electrical stimulus to the heart 60 times a minute. This maintains a firm and regular pulse.

Third International Conference on Medical Electronics will be held at Olympia, London, from July 21 to 27, 1960. Conference is being organized by the Electronics and Communications Section of The Institution of Electrical Engineers in association with the International Federation for Medical Electronics. A simultaneous exhibition is planned.

IMAGE INTENSIFIER which multiplies the brightness of a faint image 50,000 times has been developed at the Imperial College of Science in London. The intensifier tube, expected to find application in astronomy, nuclear physics and hospital X-ray use, is 18-in. long and 2-in. in diameter.

Microwave Component News from SYLVANIA

Now available—a wide range of traveling wave tubes



Actual strip chart recording of test on a production tube shows the uniform gain characteristics of this Sylvania tube over the 2.0 KMC to 4.0 KMC spectrum

ONLY SYLVANIA CAN OFFER YOU

AVAILABILITY — now in production, 16 types of traveling wave tubes covering the microwave spectrum from 1 to 11 kmc, and milliwatts to kilowatts. Backward wave oscillators are also available. Modifications and new designs for your special requirements are part of Sylvania's service.

HIGHEST GAIN — Sylvania's traveling wave tubes deliver 2 to 5 times the gain of competitive types. For example, TW-4002 delivers a minimum gain of 37 db over its full 2 to 4 kmc band.

GUARANTEED UNIFORMITY — Sylvania guarantees gain variations one-half those of other tubes; i.e. 2 to 3 db narrower limits. Other test limits are correspondingly more rigid.

PROVEN RUGGED DEPENDABILITY — Sylvania traveling wave tubes have proved their performance by meeting tough military standards and by being specified and used in modern supersonic aircraft.

Write for our new Traveling Wave Tube Catalog

For more information
write your nearest Sylvania tube sales office or
Sylvania Electric Products Inc.,
Special Tube Operations,
500 Evelyn Ave., Mountain View, Calif.

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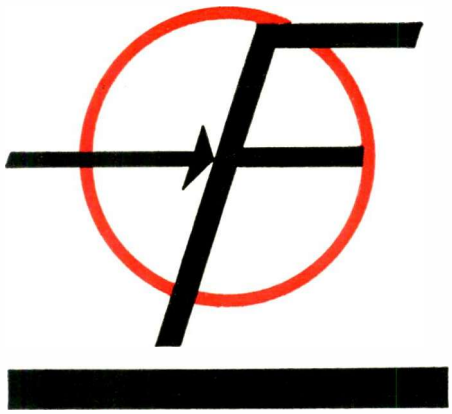

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*GENERAL PURPOSE types suitable for switching RF and DC applications over a wide current range.

2N696 & 2N697

*PNP COMPLEMENT to the 2N696 and 2N697

2N1131 & 2N1132

*HIGH VOLTAGE type particularly suited to video amplifiers and RF oscillators.

2N699

*LOW STORAGE types optimized for high current saturated switching circuitry.

2N1252 & 2N1253

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2N706

AVAILABLE IN QUANTITIES OF 1-999 FROM DISTRIBUTOR STOCKS OR DIRECT FROM THE FACTORY FOR ORDERS OF 1,000 OR MORE. COMPLETE SPECIFICATIONS FROM EITHER SOURCE.

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WASHINGTON OUTLOOK

FEDERAL COMMUNICATIONS COMMISSION is extending the grace period for vhf translators to March 31 of next year in the hope that Congress will act to legalize them. A bill to make the 1,000-odd existing installations legal was introduced in the Senate, where pressure from western senators pushed it through.

Almost all boosters (which pick up and rebroadcast on the same channel) have been changed over to become translators (which rebroadcast on a different vhf channel), because boosters are inclined to be unstable and to pick up false signals. Neither type of installation is now legal in the vhf range.

FCC is asking Congress to change the Communications Act to permit licensing of stations constructed prior to granting of a permit. This would cover all the translators, while the few remaining boosters would be out. In addition, FCC is proposing standards to legalize new low-power vhf translators up to 1 watt. More powerful ones would have to work in the uhf range, where translators are already legal.

The Commission is inviting comments until Jan. 11. Broadcasters are lobbying to require translators to get permission from the station whose signal they pick up. But mountain state legislators, whose constituents depend heavily on translators for tv, are powerful boosters for the proposed change.

- **Some Pentagon experts** are saying the recent cut in the B-70 program spells finis for manned bombers beyond the present B-52 and B-58 aircraft. The Defense Department's decision to "reorient" B-70 R&D means the Air Force will build two prototype planes capable of flying 2,000 mph but stripped of combat systems such as bomb-nav and defensive radar.

  The project's new objective is to demonstrate the aerodynamic feasibility of flying a large aircraft at three times the speed of sound rather than to develop a complete weapons system.

  Electronics producers such as IBM, Westinghouse and Motorola, which were contractors for the major subsystems, bear the brunt of the cutback. Scope of the project is being reduced from the $300 million originally planned for fiscal 1961 to only $75 million. Sperry Gyroscope is building a gyro platform for the two B-70 prototypes with target date in 1962, and is apparently unaffected by the cut in the program.

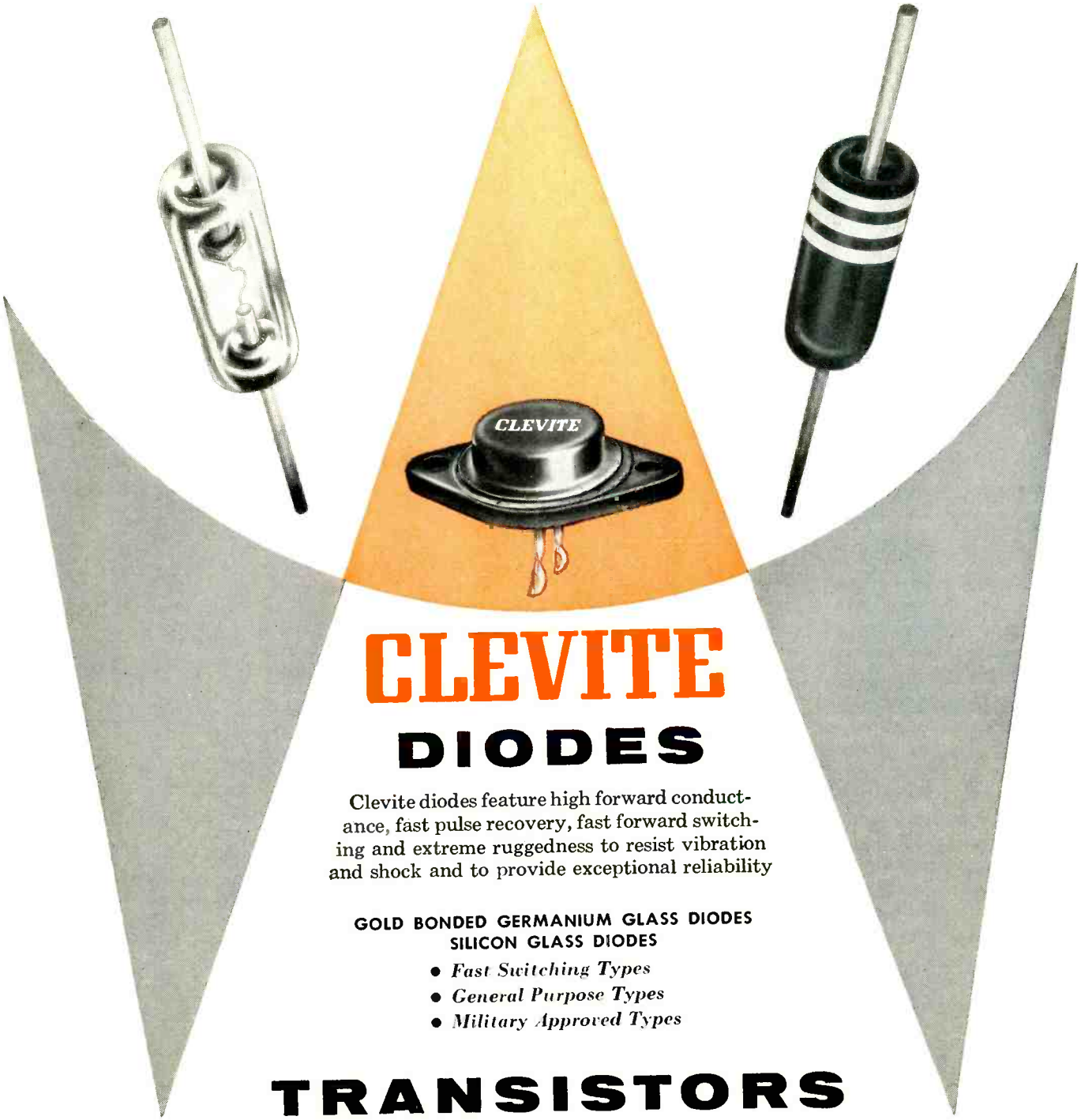
  As plans shape up now, the first B-70 will be test-flown in 1963, a year later than previously planned. The aircraft is now looked upon as a "composite" plane, likely to become a prototype for future transport or reconnaissance craft. Its potential as a bomber or missile platform hasn't entirely been ruled out, of course, but recent deemphasis on combat-system development plays down the plane's combat role.

- **FCC was up and charging** in other directions this week. For the first time in years it was threatening to revoke licenses and otherwise crack down on station owners who may have been involved in broadcasting hanky-panky.

  The agency ordered WGMA in Hollywood, Fla., to show why its license should not be revoked. WGMA is jointly owned by co-producers of two of the fixed quiz shows. FCC has not revoked a license since 1949, and picked up only three or four in its history.

  Various Commission actions and statements indicate that the FCC, suffering acute embarrassment in the public spotlight, will be tougher on all kinds of mis-, mal- and non-feasance in the future, whether it be bad programming, improper antenna-tower heights, or interference.

Constant reliability . . . duplicated in volume



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GOLD BONDED GERMANIUM GLASS DIODES
SILICON GLASS DIODES

- *Fast Switching Types*
- *General Purpose Types*
- *Military Approved Types*

TRANSISTORS

Low thermal resistance, low saturation resistance plus superior current gain and high reliability construction make Clevite transistors your first choice for such applications as power converters, audio amplifiers, power supplies and high current switching circuits.

GERMANIUM POWER TRANSISTORS

- *2 & 4 Watt Audio Types*
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- *High Power 65 Watt & 15 Amp Types*

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Short Form Catalog 59

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254 CRESCENT STREET • WALTHAM 54, MASS.

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RCA-7025... "low noise and low hum" characterize the performance of this high-mu twin triode—ideal for your pre-amplifier designs.

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RCA-7027-A "power deluxe"—up to 76 watts with only 2% distortion from a pair in Class AB1 audio service—new structure design provides exceptional electrical stability and reliability.

From pre-amplifier to power amplifier, mono or stereo, you can design a comprehensive line of high-fidelity products around these 4 RCA tube types. And your designs with RCA tubes add up to recognition . . . for quality, performance, prestige. Contact your RCA Field Representative for details. For technical data, write RCA Commercial Engineering, Section L-19-DE-3, Harrison, N. J.

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6355 East Washington Boulevard, Los Angeles 22, Calif., RAymond 3-8361

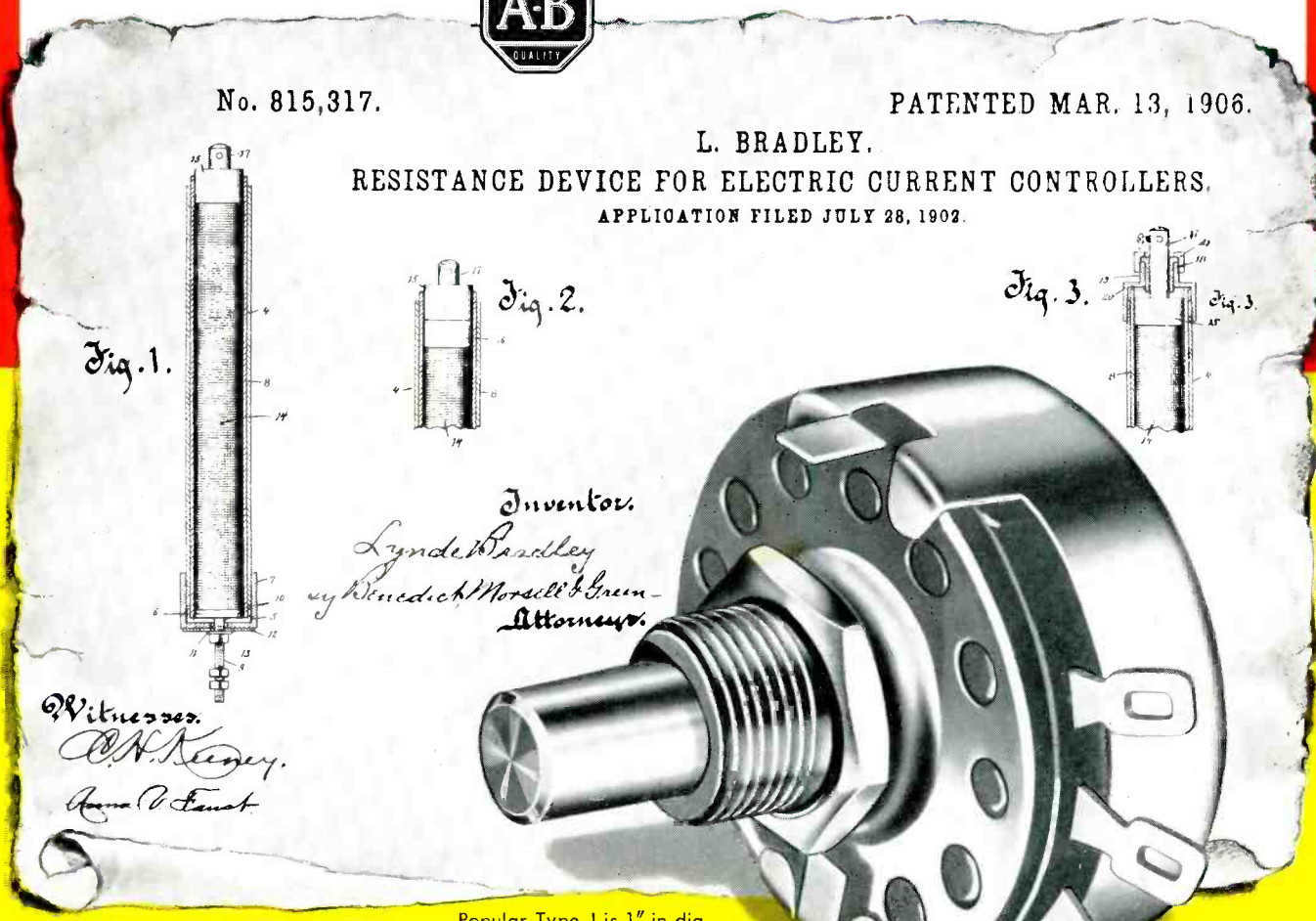
CIRCLE 17 ON READER SERVICE CARD→

More than 50 *years*

of Continuous Research

stands behind the Quality "Family" of

Allen-Bradley *Variable Resistors*



No. 815,317. PATENTED MAR. 13, 1906.

L. BRADLEY.

RESISTANCE DEVICE FOR ELECTRIC CURRENT CONTROLLERS.

APPLICATION FILED JULY 28, 1902.

Fig. 1.

Fig. 2.

Fig. 3.

Inventor.

Witnesses.

The original patent issued to Mr. Lynde Bradley in 1906 is reproduced above.

Popular Type J is 1" in dia. Rated 2 watts, 70°C. High temp. Type K rated 2 watts, 100°C, 1 watt at 125°C.

Tiny Type G, ½" dia. Rated ½ watt, 70°C. Type L, ½ watt, 100°C.

New Type R adjustable fixed resistor rated ¼ watt at 70°C ambient.

For over half a century, Allen-Bradley has set the pace in the development of quality variable resistors—and continues to do so today! With the original patent, illustrated above, Allen-Bradley introduced a new concept in the field of variable resistors. And in the early days of radio, Allen-Bradley variable resistors were so universally accepted for their smooth control that famous "Bradleystats" were a byword of the wireless era.

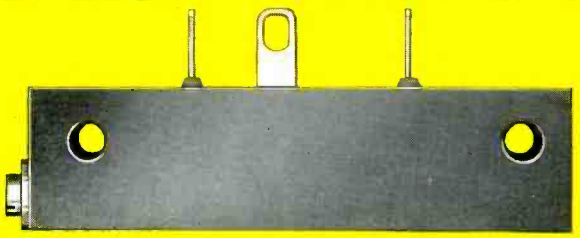
From this unique background comes today's famous A-B family of variable resistors, all of which feature the solid, hot molded resistance element—an *exclusive* A-B design that has proven unequaled for reliability and long life. It is because of this superlative performance that Allen-Bradley variable resistors enjoy the enviable reputation of being "required" in so many critical military and industrial applications.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

Quality Electronic Components

6-59-E



TYPE R ADJUSTABLE FIXED RESISTOR

Available from 100 ohms to 2.5 megohms.

ACTUAL SIZE

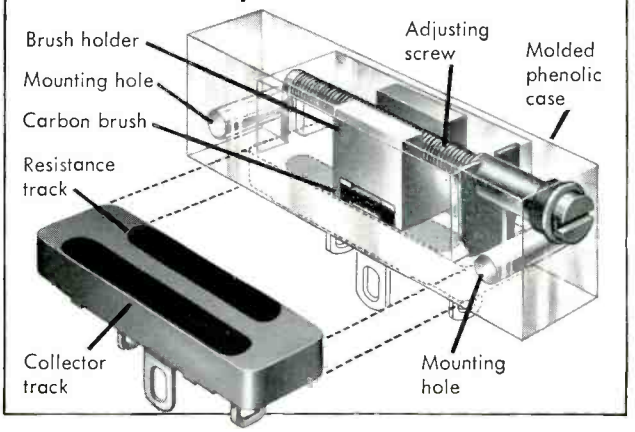
UNSURPASSED SHOCK RESISTANCE!

Allen-Bradley adjustable fixed resistors are especially designed to hold precise settings under extremes of shock and vibration

Through Allen-Bradley's exclusive process, the solid resistance element and the insulating mounting of the Type R control are hot molded into an integral unit. This makes the Type R adjustable fixed resistor virtually immune to shock and vibration. In addition, the moving element is self-locking to assure setting remains stable at all times. Operation of the Type R is exceptionally smooth—with never an abrupt change during adjustment.

The molded case of this adjustable fixed resistor is watertight and dust-tight, permitting the entire unit to be potted after adjustment. Write for Technical Bulletin 5205—it contains full details.

Phantom view of Type R 1/4 watt—
70° C adjustable fixed resistor



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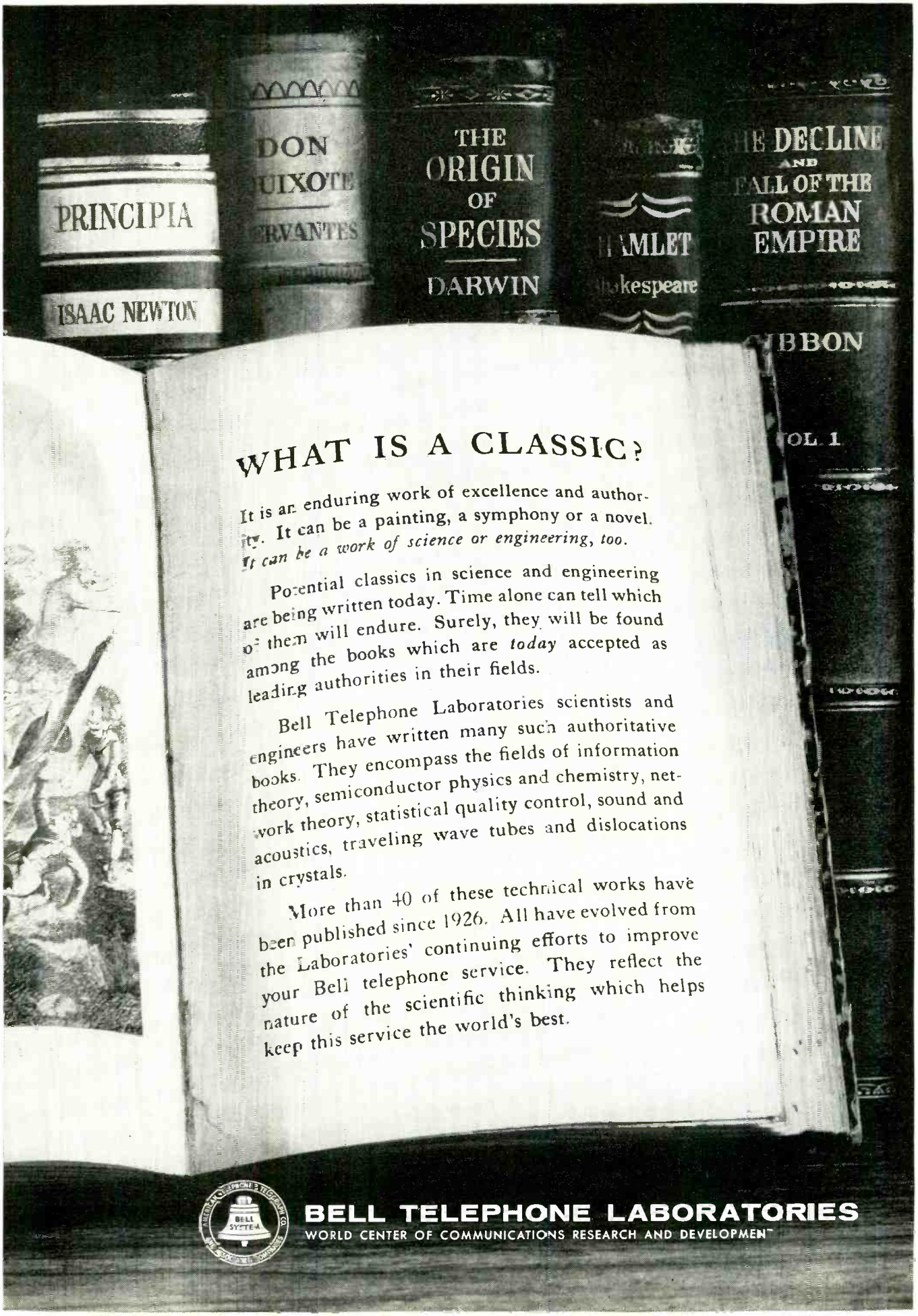
ALLEN-BRADLEY *Quality* Electronic Components

6-59-E1



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It is an enduring work of excellence and authority. It can be a painting, a symphony or a novel. *It can be a work of science or engineering, too.*

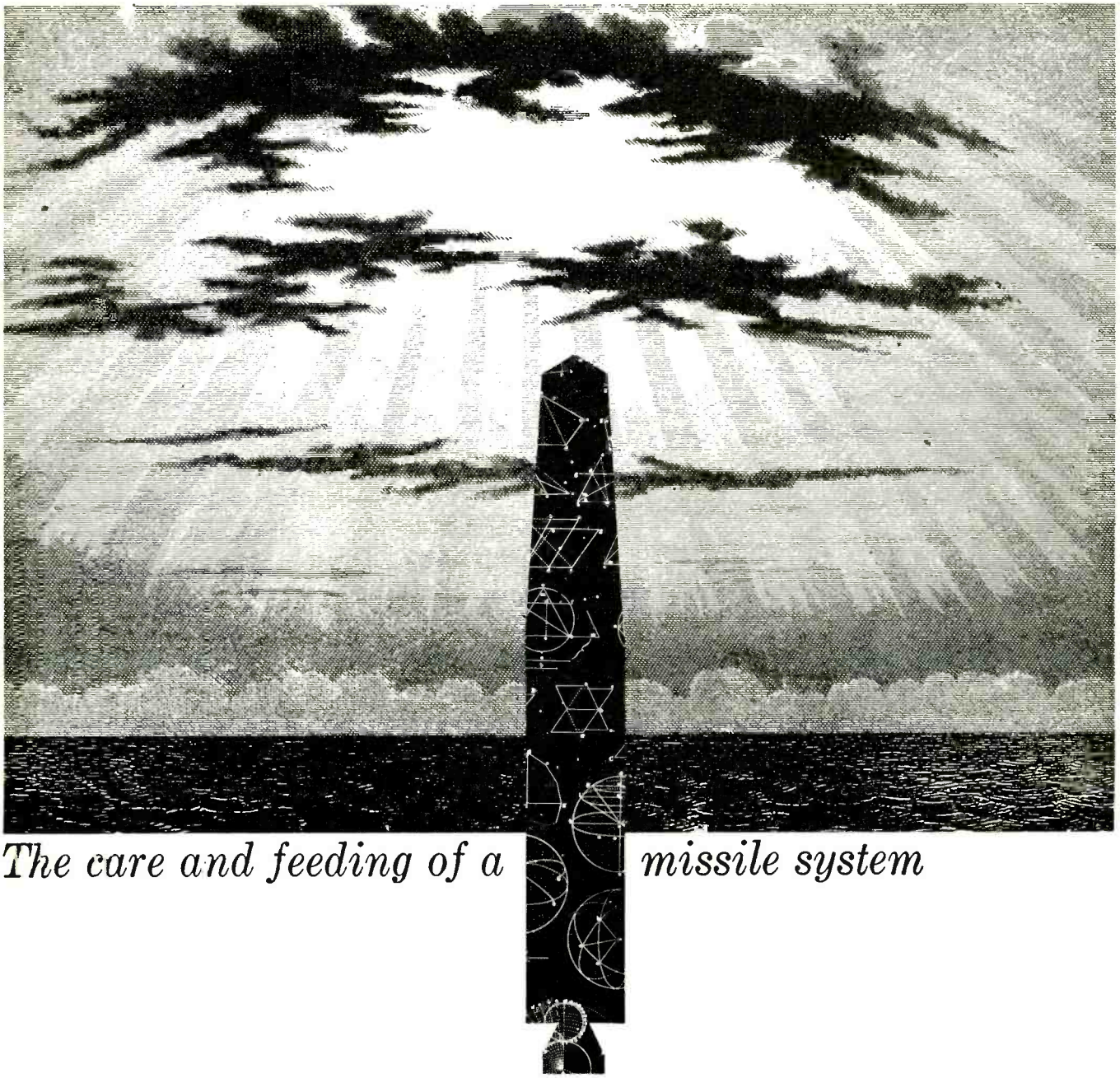
Potential classics in science and engineering are being written today. Time alone can tell which of them will endure. Surely, they will be found among the books which are *today* accepted as leading authorities in their fields.

Bell Telephone Laboratories scientists and engineers have written many such authoritative books. They encompass the fields of information theory, semiconductor physics and chemistry, network theory, statistical quality control, sound and acoustics, traveling wave tubes and dislocations in crystals.

More than 40 of these technical works have been published since 1926. All have evolved from the Laboratories' continuing efforts to improve your Bell telephone service. They reflect the nature of the scientific thinking which helps keep this service the world's best.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Some immediate openings are described on the facing page. Please read it carefully.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of **DOUGLAS**

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

Split Plan Up for Vote

MAILING OF 143,219 PROXIES to **Westinghouse** common stock holders for their votes on a two-for-one stock split on Jan. 4, has been announced. Company board of directors recommended the split in October when the dividend was raised from 50 to 60 cents a share. At that time the firm reported the highest third-quarter earnings in its history. Third-quarter net income of $22,075,000 showed an increase of 16 percent over earnings in the same period of 1958. Earnings also exceeded by 16 percent the preceeding 1959 quarter, highest April-June period ever. If the split is approved, the number of common shares will go from 25 to 50 million and par value will go from $12.50 to $6.25 a share.

• Stockholders of **Avien Inc.**, Woodside, N. Y., have voted to exchange all the company's class B stock for class A shares on a one-for-one basis. The decision will involve 313,096 shares. Also approved was a plan to increase the number of shares that can be optioned under the company's stock option plan. The move raises the present limit from 30,000 to 50,000 shares.

• **Monogram Precision Industries, Inc.**, Culver City, Calif., shareholders approved a restricted stock option plan at their Fall meeting. The plan calls for 60,000 shares to be distributed to key employees and to be used to assist in recruiting qualified engineers.

• **Victoreen Instrument**, Cleveland, is awaiting SEC approval of registration for $2½ million in 6-percent convertible subordinated debentures. The issue, which will be due in 1974, will be offered in coupon form in $1,000 denominations. The proceeds will be used to retire a bank loan, finance acquisition of **Standard Felt Co.**, and for other such corporate purposes as may be necessary.

• **Telechrome Mfg.**, Amityville, N. Y., has filed with SEC for registration of $750,000 in 6-percent convertible subordinated debentures due in 1969. The issue will be convertible into shares of the company's class A stock. Of the proceeds, $650,000 will be used to retire bank notes. The remainder will be used for new acquisitions in process and for general corporate expansion.

• **Perkin-Elmer Corp.**, Norwalk, Conn., reports net sales of $3,246,721 and net income of $55,550 for the quarter ended Oct. 31. This compares with $4,285,348 and $143,396 respectively for the same period a year ago. R. S. Perkin, chairman of the board, commented that many months elapse between receip and shipment of government orders, in explaining the diminished volume of sales, earnings.

25 MOST ACTIVE STOCKS

WEEK ENDING DECEMBER 4

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Reeves Sndcrft	4,164	13½	10¼	12¼
Sperry Rand	3,451	27⅜	24⅜	27⅛
Philco Corp	1,590	32¼	27⅛	32⅛
Elec & Mus Ind	1,468	11¾	11⅛	11¾
RCA	1,448	73¼	69⅜	70¾
Raytheon	1,273	58⅛	53⅞	57⅛
Avco Corp	1,064	15¾	14¾	15
Emerson	951	19⅛	15¾	19⅛
Burroughs Corp	925	37⅞	33⅝	36⅞
Gen Dynamics	877	51⅞	43⅜	49½
Intl Tel & Tel	729	40⅜	38½	40
Univ Control	722	19¾	18¼	18⅞
Gen Electric	642	93	89½	91⅞
Gen Inst	642	33⅛	29⅜	33
Compudyne	641	20	16¼	18¾
Admiral Corp	569	24¾	22⅛	24¾
Lear Inc	559	21¾	19⅝	19⅞
Siegler Corp	465	35⅞	32⅛	35½
Standard Coil	464	17¼	15⅛	17⅛
Harmon Kardon	459	8⅞	7	8¾
Ampex	437	134½	119½	123
Gen Tel & Elec	423	78⅛	75½	77⅜
Cons Electronics	408	58⅞	52¾	55⅝
Varian Assoc	406	51¾	46¾	47⅝
Loral Electronics	405	39⅞	34¼	37⅛

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Amphenol-Borg	$.35	Dec. 30
Anaconda Co.	1.00	Dec. 28
Bendix Aviation	.60	Dec. 29
Clevite Corp.	.30	Dec. 28
General Electric	.50	Jan. 25
Philco pfd.	.93¾	Jan. 1

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When you've got big plans for the future – you have good reasons for reading your businesspaper mighty carefully. This is where a man who means business gets facts, news, ideas... information he needs to do business. Issue after issue you find meaty stuff to keep your job and your business growing – in both the advertising and editorial pages of... your businesspaper.

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CSF

From Technical Breakthrough to Reliable Production

CARCINOTRONS*®

Backward Wave Oscillators have now attained the full cycle of the capability associated with all CSF products. This cycle, beginning with the pioneering research and development has led to the largest frequency coverage in Carcinotrons, is now completed with the reliable full scale production of these tubes.

Electronically tunable, the Carcinotron tube permits the largest range of uninterrupted tuning ever achieved by a single tube. Latest developments in CSF CW Carcinotrons include:

- milliwatts at 2 m/m wavelength
- watt at 4 m/m wavelength
- 10 watts at 8 m/m wavelength
- 5 kilowatts at 1 m wavelength

A partial listing is shown below of current CSF production of type "O" Carcinotrons, which have a complete coverage from 1 to 100 kMcs.

CO 515	980	— 2100 Mcs.
CO 521	8000	— 16,000 Mcs.
CO 2012 A	15,500	— 24,000 Mcs.
CO 1308 A	23,500	— 37,500 Mcs.

Current production of "M" type Carcinotrons between 1 and 10.5 kMcs includes:

CM 5200	1200 — 1500 Mcs	500 W Cw min
CM 440	2700 — 3400 Mcs	500 W Cw min
CM 7060A	3200 — 4000 Mcs	200 W Cw min
CM 730	8500 — 10,500 Mcs	80 W Cw min

American Radio welcomes inquiries about special development for particular needs.

*U.S. Patent No. 2,880,355

AMERICAN RADIO CO., INC.

445 PARK AVENUE, NEW YORK 22, NEW YORK

Subsidiary of Compagnie Générale de T. S. F. (CSF) Paris, France

CIRCLE 23 ON READER SERVICE CARD

Tests prove reliability of

Mass production of SCR's is now a reality. The experience, skill and manufacturing knowhow of General Electric's SCR production line is your assurance of dependable quality-controlled SCR's —an assurance unmatched by any other manufacturer.

WHAT THE SCR DOES

The SCR is a miniature semiconductor device that blocks positive forward voltage in its "off" or non-conducting state. However, by applying a small signal to the gate terminal it switches rapidly to a conducting state and acts like a single junction silicon rectifier. It is completely static, arcless and fast. It is almost 100% efficient. It contains no mechanisms subject to wear. As a result, the SCR can switch and control power either faster, more safely, less expensively or more reliably than the many devices it replaces: circuit breaker, relay, thyratron, magnetic amplifier, rotating amplifier and many others. Among the many hundreds of circuit designs are these:

Superior d-c motor operation from an a-c source. Eliminates motor generator sets, tubes or magnetic amplifiers to provide controlled d-c. Replaces mechanical speed and direction changers.

Superior a-c generation from a variable d-c source. First really practical method of using static inverters with ratings of several kilowatts.

Simpler conversion to high frequency. SCR converters are small and efficient. Extends use of high frequency power where desirable, as in fluorescent lighting systems.

Pulse modulators. Compact, yet rugged replacement for hydrogen thyratrons in radar and beacon modulators.

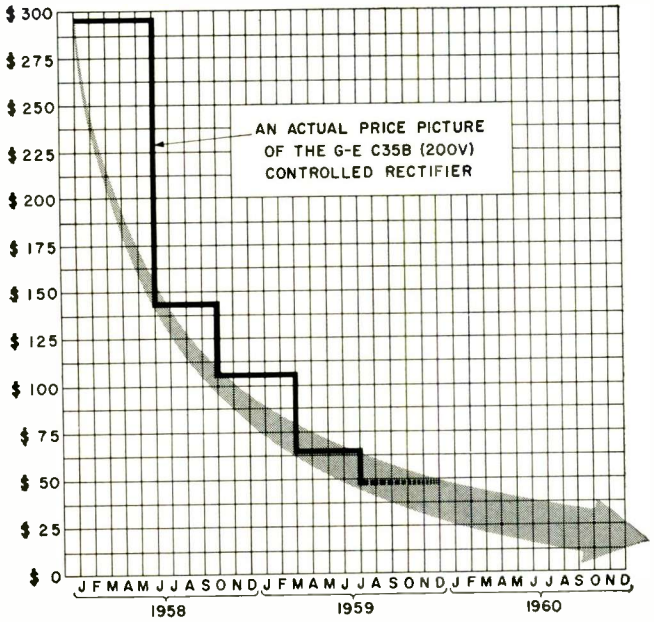
D-c regulation. Control large blocks of voltage with small losses by pulse width modulation. Eliminate bulky rheostats and adjustable d-c generators.

Other applications: Battery charging regulator, transient voltage protection, dynamic braking, constant current supply, static switching, regulated power supply, d-c to d-c conversion, temperature control.

silicon controlled rectifier

Prices again reduced, new circuits developed, customer designs move into manufacturing stage

Prices again have been reduced an average of twenty percent on General Electric's Silicon Controlled Rectifier, providing greater values to users. These new prices have been made possible through expanding production and lower manufacturing costs.



GENERAL ELECTRIC
CONTROLLED RECTIFIER PRICE TREND

TESTS AND FIELD REPORTS PROVE RELIABILITY

Reliability of General Electric SCR's has been steadily improved over two years of manufacturing experience. Typical test results point to the reliability achieved to date.

98% survival after 1000 hours of storage at 125°.

97% survival after 1000 hours of operation at maximum ratings at 125°C.

No thermal fatigue failures after 30,000 cycles from 20°C to 135°C and return.

Less than one percent failures experienced by customers (many of which were traced to misapplication).

SCR NOW BEING USED BY MANY COMPANIES

The evaluation stage is passing rapidly into the application stage. Many products incorporating the SCR are being marketed, for the applications are proved, circuits refined and quantity production is a reality. These are just a few of the many cases where an SCR is now doing a job more efficiently, less expensively, faster or more reliably than previous designs:

Power supplies incorporating transient voltage protection (for computers).

Radar modulator.

Static switch to replace mechanical relay for aircraft.

Three phase inverter.

Stage lighting lamp dimming.

Regulated power supply.

Battery charging regulator.

Constant current supply for a magnetic yoke.

SEND FOR DESIGN INFORMATION

Detailed application notes and article reprints are available for the guidance of designers. Your General Electric Semiconductor Sales Representative will be pleased to provide you with complete details. Or write to Section S25129, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York. Many local G-E Semiconductor Distributors also stock General Electric SCR units for fast delivery at factory-low prices.

MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent<5 millisec.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V_{RMS}), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I_F)	Up to 16 amperes							
Peak One Cycle Surge Current (I_{surge})	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I_G)	2 amperes							
Peak Gate Voltage (V_G) (forward)	10 volts							
Storage Temperature	−65°C to +150°C							
Operating Temperature	−65°C to +125°C							

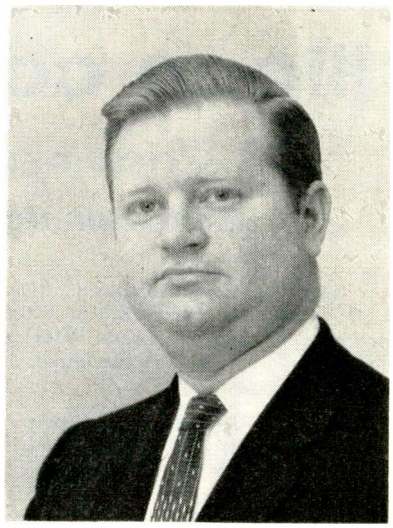
CHARACTERISTICS (At Maximum Ratings)	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Minimum Forward Breakover Voltage (V_{BO})	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I_R) or Forward (I_S) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage ($V_{F\,AVG}$)	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I_{GF})	25 ma							
Maximum Gate Voltage To Fire (V_{GF})	3 volts							
Typical Gate Current To Fire (I_{GF})	10 ma at +1.5 volts (Gate to Cathode Voltage)							

C-35 Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.
ZJ-50 Series—a high-current series now in development, and available on a prototype-sample basis.

GENERAL ELECTRIC

Semiconductor Products Department

Chuck Joyner: Gets new EIA duties



Bill Long: Joins Philco

New Market Data Head at EIA

A TOP-LEVEL marketing personnel change at the Electronic Industries Association heads this week's news.

Chuck Joyner has been named head of EIA's Market Data Department. He replaces Bill Long, who is joining the Lansdale Division of Philco Corp. in a long-range planning capacity.

The market data job at EIA has considerable significance to the electronics industry. The department is the repository of confidential sales and inventory information from which the association develops the industry-wide marketing statistics it supplies to members and the public.

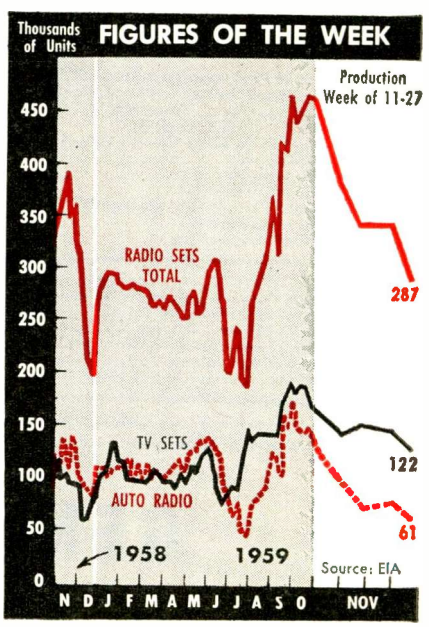
Long established the department in 1951 with a staff of three members. It now has a staff of 14. Department services have grown considerably since 1951. They include not only the collection and preparation of inventory and sales information but publishing of the annual EIA Fact Book and the processing of military data abstracts.

Works With Industry

Joyner received his statistical and marketing training from George Washington University. He joined EIA in 1952 and has been assistant manager since 1953.

The department now works actively with 200 marketing men in industry. It also sponsors periodic seminars in marketing research techniques. Within the last year, it has added a military economist to its staff and is making long-range studies and short-range analyses of the military market.

With the association's Military Products Division it has a computer program under study. This program includes a periodic determination of the number of computers in use, characteristics of companies in which computers are analyzed, the amount of peripheral equipment employed, and the various ways computers are used.



available from
inventory for
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silicon transistors with

400 mw POWER DISSIPATION

@25°C in free air!

All electrodes completely insulated from the JEDEC-30 package (TO-5)

These Hughes PNP fused junction silicon transistors...which are especially recommended for small signal current gain, DC amplifier and other applications...offer you the following advantages over competitive devices:

• BV_{CBO}, BV_{EBO}, and BV_{CEO} are symmetrical • lower leakage current • controlled gain band • lower saturation resistance • higher operating frequency

You receive still another benefit from these Hughes silicon transistors: proven reliability. Its reliability life tests at maximum operating temperature show a reliability factor of 4×10^{-5} or only one failure in 25,000 transistor hours of operating life.

Order today! These Hughes transistors are available from inventory at both the factory and at all Hughes distributors. Just call or write your nearest Hughes Semiconductor Sales office or distributor.

Specifications

Type	BV_{EBO} BV_{CBO} BV_{CEO}	H_{fe} Min.	H_{fe} Max.	Max. V_{CE} @ I_C=10ma @ I_B=2ma	Maximum I_{CBO}* and I_{EBO}*	Typ. F α b (MC)
2N1228	—15V	14	32	—0.2	—0.1μA	1.2
2N1229	—15V	28	65	—0.2	—0.1μA	1.2
2N1230	—35V	14	32	—0.2	—0.1μA	1.2
2N1231	—35V	28	65	—0.2	—0.1μA	1.2
2N1232	—60V	14	32	—0.2	—0.1μA	1.0
2N1233	—60V	28	65	—0.2	—0.1μA	1.0
2N1234	—110V	14	32	—0.2	—0.1μA	0.8

ALSO AVAILABLE WITH 1 WATT POWER DISSIPATION IN COAXIAL PACKAGE

*AT 80% OF MAXIMUM VOLTAGE

SEMICONDUCTOR DIVISION

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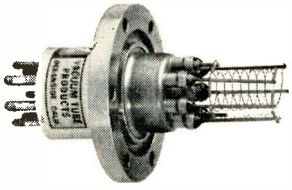
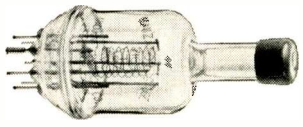
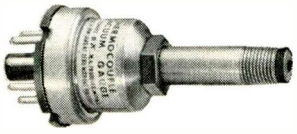
High-vacuum measurement–all types –one source



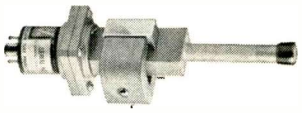
VTP 6578 IONIZATION GAUGE TUBE Especially designed for high ultimate vacuum applications; 3 filaments for long life. Reliable, positive calibration. Flanged for use in metal vacuum systems.



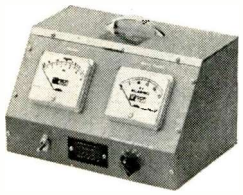
VTP 7169 IONIZATION GAUGE TUBE All glass. Designed for use in glass vacuum systems. Electrically identical to VTP 6578. Both may be outgassed easily by passing heater current through grid structure.



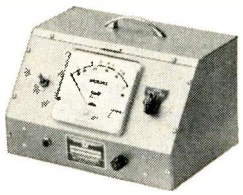
VTP 6343 THERMOCOUPLE GAUGE TUBE *Fast response: less than 0.1 second!* Pressure range: 0.1 to 1000 microns. Ruggedized all-metal construction. Useable for leak detection on vacuum systems as well as absolute pressure measurement.



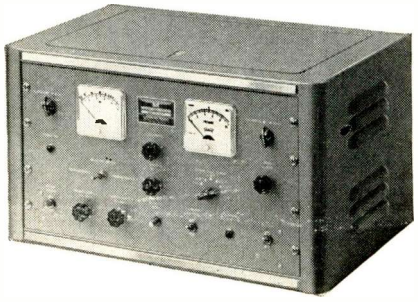
VTP PG-25 COLD CATHODE DISCHARGE TUBE Small, rugged, nonburnout, all-metal gauge tube for precise measurements and contaminating atmospheres. Easily dismantled for cleaning. Positive and accurate under all conditions.



VTP TC-43-1 THERMOCOUPLE GAUGE CONTROL Dual meter control. Indicating meters for heater current and system pressure. Rotary switch permits selective measurement of pressure at any one of four separate measuring points.



VTP PGC-25-01 DUAL RANGE PHILIPS GAUGE CONTROL Simple, inexpensive and rugged Philips gauge (cold cathode) control measures pressures in two ranges: (1) from 25 microns to 0.1 micron, (2) from 0.11 micron to 0.01 micron.



VTP 3-147 IONIZATION/ THERMOCOUPLE GAUGE CONTROL
Dual thermocouple control combined with ionization gauge control. Automatic lockout protects ionization gauge tube. Contact meter optional.

For your laboratory and production use, the world's most complete line of vacuum measurement devices is available from Vacuum Tube Products.

Backed by over 13 years of research, development and production experience in the high-vacuum field, these precision instruments offer you the maximum in accuracy and reliability—*plus long operating life!*

Precise, dependable VTP vacuum gauge tubes are especially designed to give you extra-long life *plus* interchangeability in existing systems.

For detailed information on VTP's complete line of vacuum gauge tubes and controls—or sound solutions to your particular vacuum measurement problems, write:

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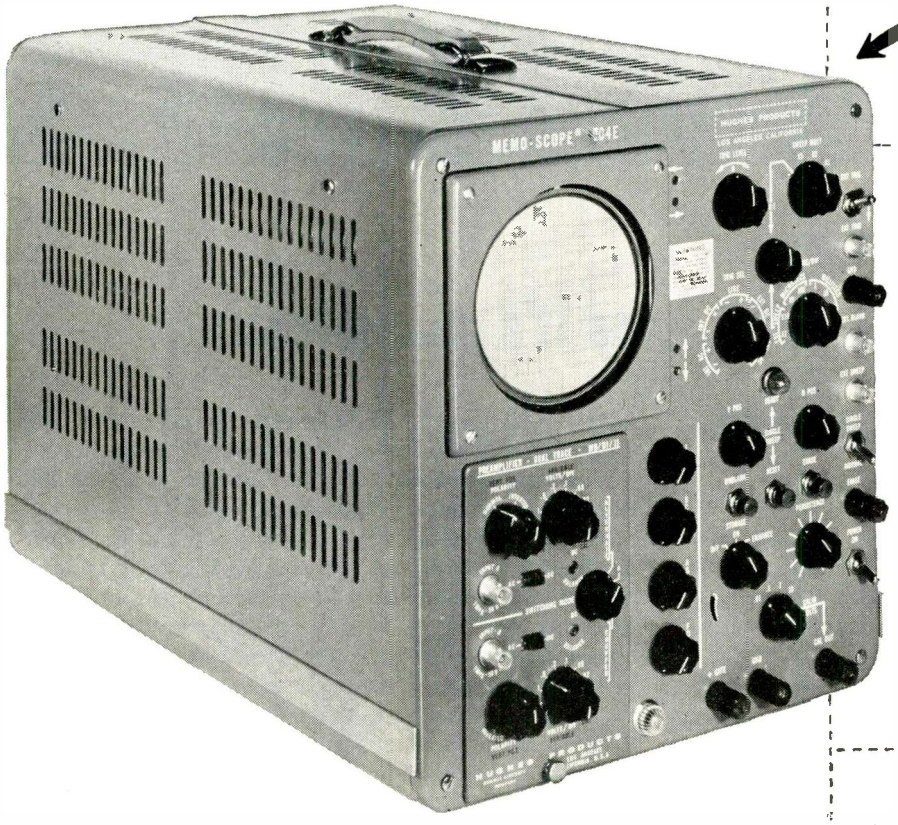
new improved "Memo-Scope®" oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because *new* features, *new* advanced circuitry, *new* panel layout and *new* mechanical design now assure maximum accuracy in all your transient measurements—*plus* higher performance, greater dependability and easier operation!



The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

new improved features

- Simplified panel layout, redesigned trigger circuit...assure easier operation,
- Advanced mechanical design gives:
  - Better cooling for longer component life,
  - Far greater accessibility for maintenance,
  - Increased ruggedness; resistance to vibration,
- Built-in single-sweep circuit ("1-shot" trigger) at no extra cost,
- Available for either 110 v. or 220 v. operation.

applications

- Data reduction equipment trouble-shooting
- Physical testing: shock, stress, strain
- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research ...and many others.

INDUSTRIAL SYSTEMS DIVISION

HUGHES PRODUCTS

For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California

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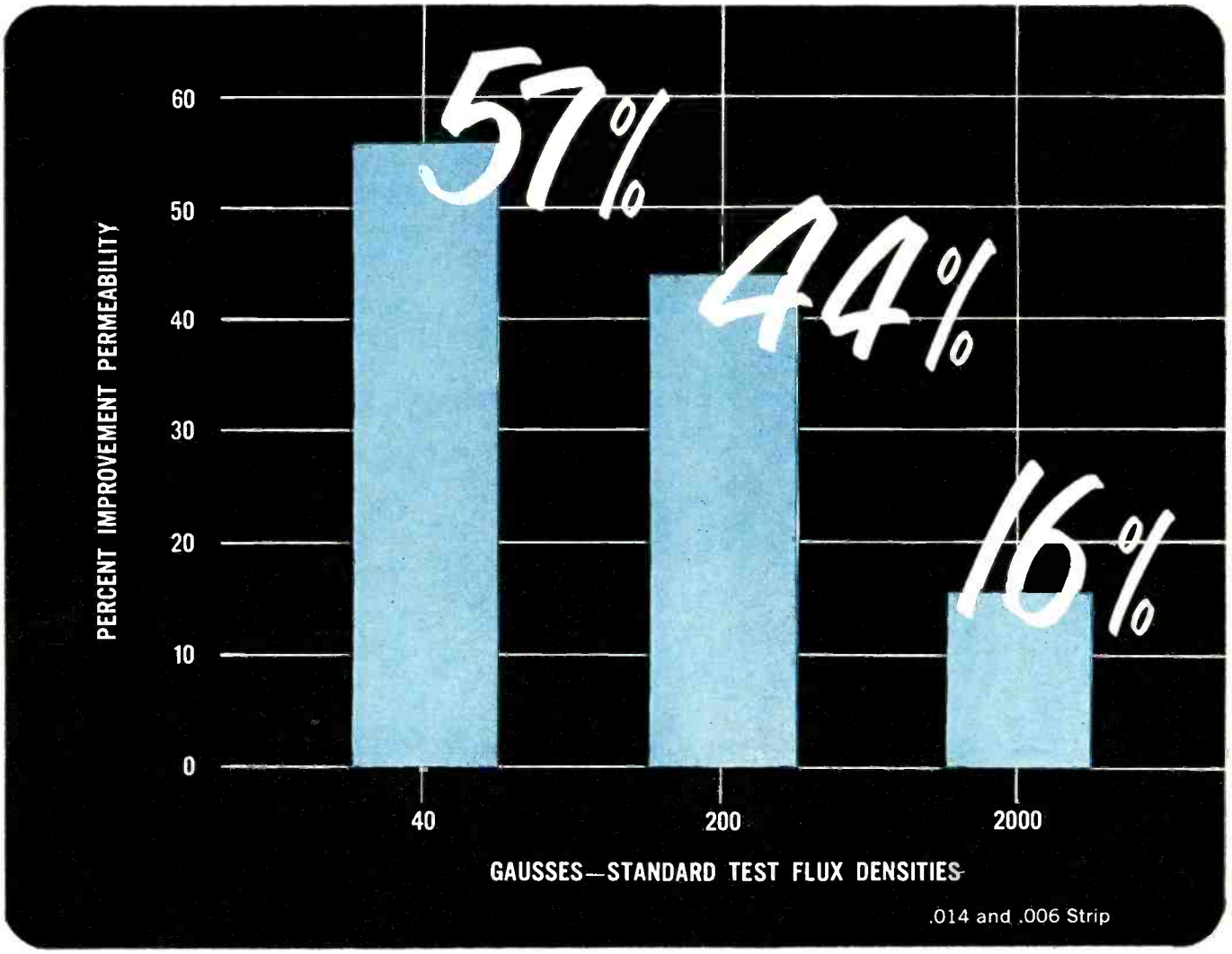
Experience**—the added alloy in **A-L Electrical Steels



Greater permeability for Allegheny Ludlum's AL-4750...and it's *guaranteed*

promises more consistency, higher predictability for magnetic cores

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

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

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. E-24.*

WSW 7491

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

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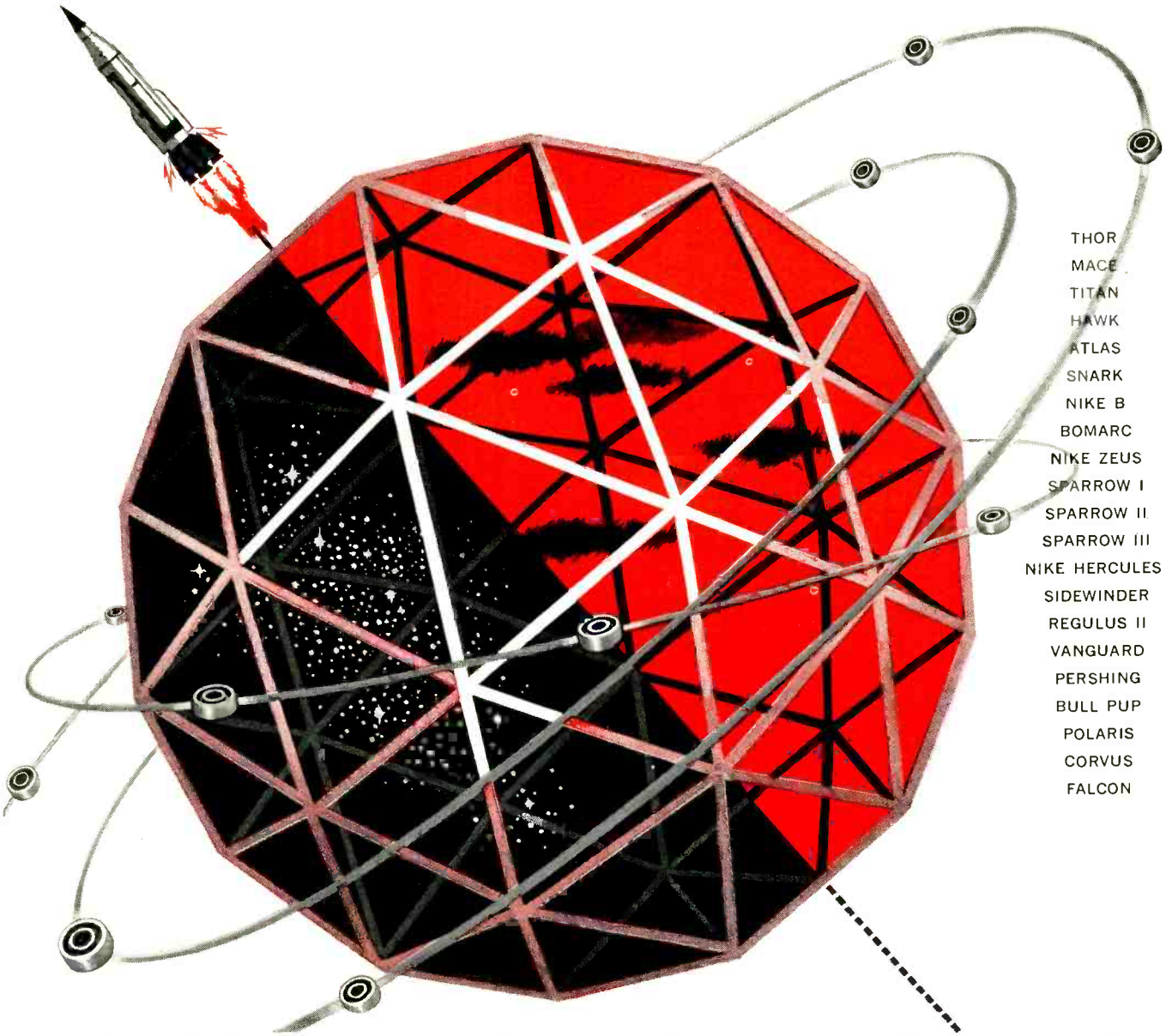


New ND Processes Improve Instrument Sensitivity!

In delicately-precise instrumentation, parts must react to relatively small rotive forces. Here . . . bearing torque is the highly critical factor. Separator selection, bearing finish and clinically clean assembly areas are extremely important.

It's here that New Departure is setting new industry standards! Special dies and in-process gauging of separators assure ball retention with improved torque and vibration characteristics. In addition, new N.D. honing processes and Talyrond gauging deliver uniform accuracy to millionths of an inch. Moreover, having originated the first bearing industry "white room", followed by continuous experience, New Departure's present day, modern assembly areas approach fantastic levels of cleanliness.

An everyday example of N.D.'s contribution to improved instrument sensitivity can be found in the Smithsonian Institution-selected Micro Clocks. These vitally important instruments are accurately tracking both U.S. and foreign satellite movements in time determinations of 1 milli-second . . . and better!

For new *performance* and *reliability* in your precision instruments, ask your N.D. Miniature/Instrument Bearing *Specialist* to sit in on early design level discussions. For further information call or write Department L.S., New Departure Division, General Motors Corp., Bristol, Conn.

ND

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Training Missilemen Creates New

Classroom gear sales exceed $100 million. Hundreds of courses on more than 40 missile systems are being run at factory and military sites

LONG BEFORE a missile system is in production, military crews are learning to operate and maintain it. Instruction of these crews has now become a large business for electronics firms. Supplying classroom equipment is even bigger.

Teaching the military to maintain and launch a single missile type often requires 15 different courses. These are held at factory sites and military bases.

Industry training contracts are awarded for course preparation, trainer fabrication, preparation of training sites, tuition, and purchase of equipment.

Buying Guidance Gear

"Classroom equipment" usually means prototype or operational subsystems of a missile. One of the biggest items bought for classroom instruction is guidance equipment. Atlas guidance gear now being used for instruction at Keesler AFB, Miss., cost about $10½ million.

Other types of guidance equipment bought for instruction include radio-inertial ground and airborne systems; all-inertial airborne; stellar-inertial; map-matching; semiactive, active and passive airborne radar; infrared; and tv-inertial.

Another large requirement for training is computers. Ground-based computers are used in the ballistic missile program; airborne computers are important elements in the larger guided missiles.

Other instruction gear includes automatic checkout equipment, ground support consoles, data reduction systems and ground communications.

Training is a continuous process. Tests during development of a missile system often result in the modification or replacement of subsystems. This calls for a new course as well as new classroom equipment. Normal turnover in military personnel is another big factor in the continued need for instruction.

USAF's Air Training Command has, to date, turned out about 9,000 missilemen. Current instruction consists of some 300 courses on more than 15 missile systems.

The series of events usually goes this way: individual training at the prime center or another ATC center; special training, conducted by the manufacturer; on-the-job training assistance; field training, conducted at the missile's operational sites, and crew training when requested by the using command.

The prime center does not conduct courses on all subsystems of a missile. Various portions are farmed out to other bases, "support centers," or to factories.

Much of the guidance equipment training goes on at Keesler AFB. Instructors are either factory instructors or military personnel formerly trained by factory instructors. Guidance training for the IRBM Thor, however, is conducted at AC Spark Plug's Milwaukee plant.

Lowry AFB, Colo., is prime center for the surface-to-surface Mace and the air-to-air Falcon GAR-3. Factory training has been phased out on these weapons. Classes are now manned by the military.

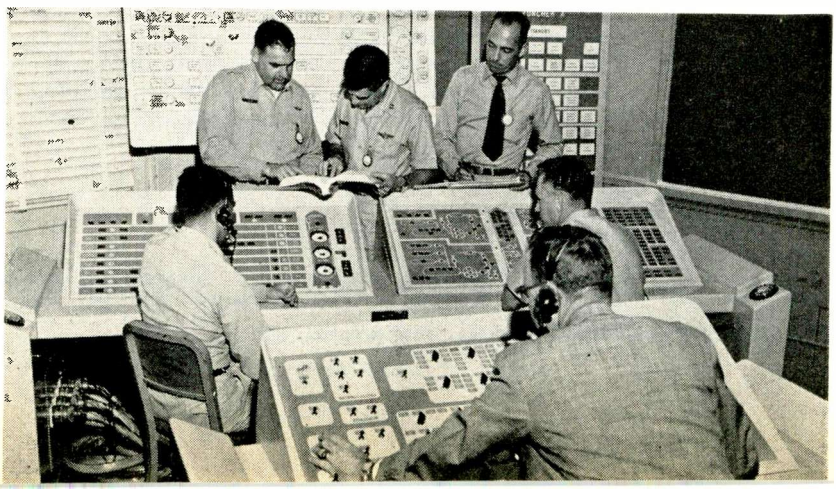
Northrop runs factory schools for Snark at Amarillo AFB, Tex., and Patrick AFB, Fla. Schooling is now in progress for Atlas at Convair's factory in San Diego. GE provides courses on Atlas at its Philadelphia plant, Lowry AFB, Keesler AFB, and Vandenberg AFB. Burroughs offers factory training for Atlas at Keesler AFB.

Martin gives classes on Titan at its Denver plant and Sheppard AFB. McDonnell for Green Quail at its St. Louis plant; North American for Hound Dog in the Downey, Calif., plant; Boeing for Bomarc in Seattle; Hughes for Falcons GAR 9 and 11 in Los Angeles.

Other companies conducting courses, says ATC, include Reeves Instrument, Laboratory for Electronics, Gilfillan, IBM, Western Electric, RCA Service, and Avco.

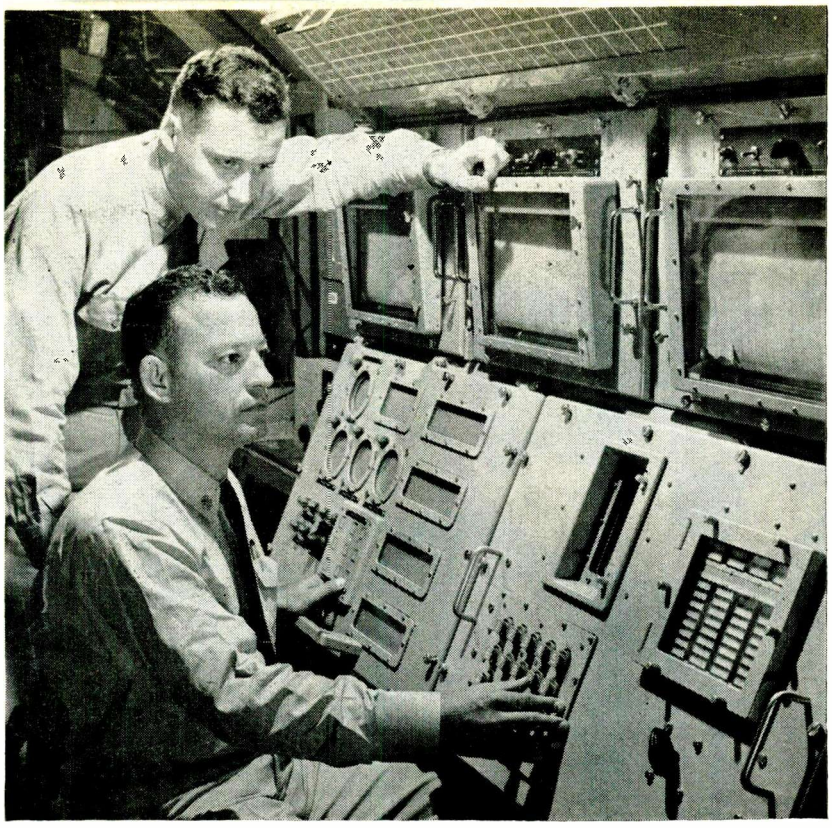
Navy trains missilemen at two U. S. Naval Guided Missiles Schools, one at Dam Neck, Va., the other at Pomona, Calif. At Dam Neck, courses are conducted on Terrier, Tartar, Talos, Polaris and Regulus I. Pomona provides instruction on Terrier and Tartar.

The Navy has special maintenance problems, according to the Dam Neck school officer-in-charge, Cdr. W. A. Arthur. These are caused by high humidity, vibration, ship's motion, and space limitations.



Officers practice Atlas launchings at Sheppard AFB, Tex., in course contracted to Convair

Revenue



Navigation officer of Polaris sub trains at Sperry's factory school. Eight courses on sub navigation gear have been given to 400 students here

Arthur says the complex nature of electronic devices obviates the classic circuit-tracing approach to electronics training. There simply isn't enough time. The trainee concerns himself more with the inputs, function, and outputs of individual modules.

Training men to operate and maintain the Polaris Fleet Ballistic Missile (FBM) and the associated submarine gear has posed problems almost as knotty as developing and building the hardware, Navy says.

At this stage of the program, most of the training takes place at factories where classroom work is supplemented by on-the-job training. When equipment for training becomes available to the Navy school system, training will be conducted within the Navy.

The Dam Neck school is the "prep" school for Polaris. Here, courses are conducted in digital computer techniques, binary circuits, binary mathematics, Boolean algebra, transistors, and pulsing circuits.

New Manuals Written

Factory training is being conducted under supervision of the Bureau of Naval Personnel. Missile training is going on at Lockheed, Sunnyvale, Calif.; Nortronics, Anaheim, Calif.; ITT, Nutley, N. J.; American Standard, Norwood, Mass.; Packard and Burns, Needham, Mass. Fire control and guidance classes are held at GE, Pittsfield, Mass.

So complex is the new equipment being used in the Polaris submarines that it has been necessary to write a whole new family of manuals to interpret the maintenance manuals for the crews. These new manuals are not primers but advanced engineering texts.

Individual training is also being conducted at the shipyards where the subs are being built. Simulators are used for operational training. This phase of the program will go into new quarters at New London, Conn., this spring.

Two ships, ex-Mariner class hulls especially converted and fitted out for the purpose, serve as floating test and training centers. The *USS Compass Island* is the proving ground for the ship's inertial navigation system (SINS). Her sister ship, *USS Observation Island*, equipped with two launching tubes and fire control gear, is the test base for missile launching.

The *Observation Island's* base of operations is Port Canaveral, adjacent to the Atlantic Missile Range. Here a Naval Ordnance Test Unit puts the Polaris test vehicle through the flight test and evaluation phase. At the same time, missile and fire control crews from the fleet ballistic missile subs get on-the-job training.

'Missile Academy'

Army's missile training is concentrated in five schools, factories, and operational missile sites.

Army Ordnance Guided Missile School at Huntsville, Ala.—called by the Army the "missile academy"—gives 57 courses on seven missile systems: Nike-Ajax, Nike-Hercules, Corporal, Redstone, Lacrosse, Hawk, and Jupiter. Most instruction emphasizes field and depot maintenance and supply. Students consist of Army, USAF, civilian personnel, and NATO technicians.

Academic training of missile technicians is only one of the school's missions. It must also originate and keep up-to-date all textbooks, lectures, films and audio-visual training aids used locally and throughout the Army. The school regularly televises courses on missiles to other training centers and uses tv in most of its own classrooms.

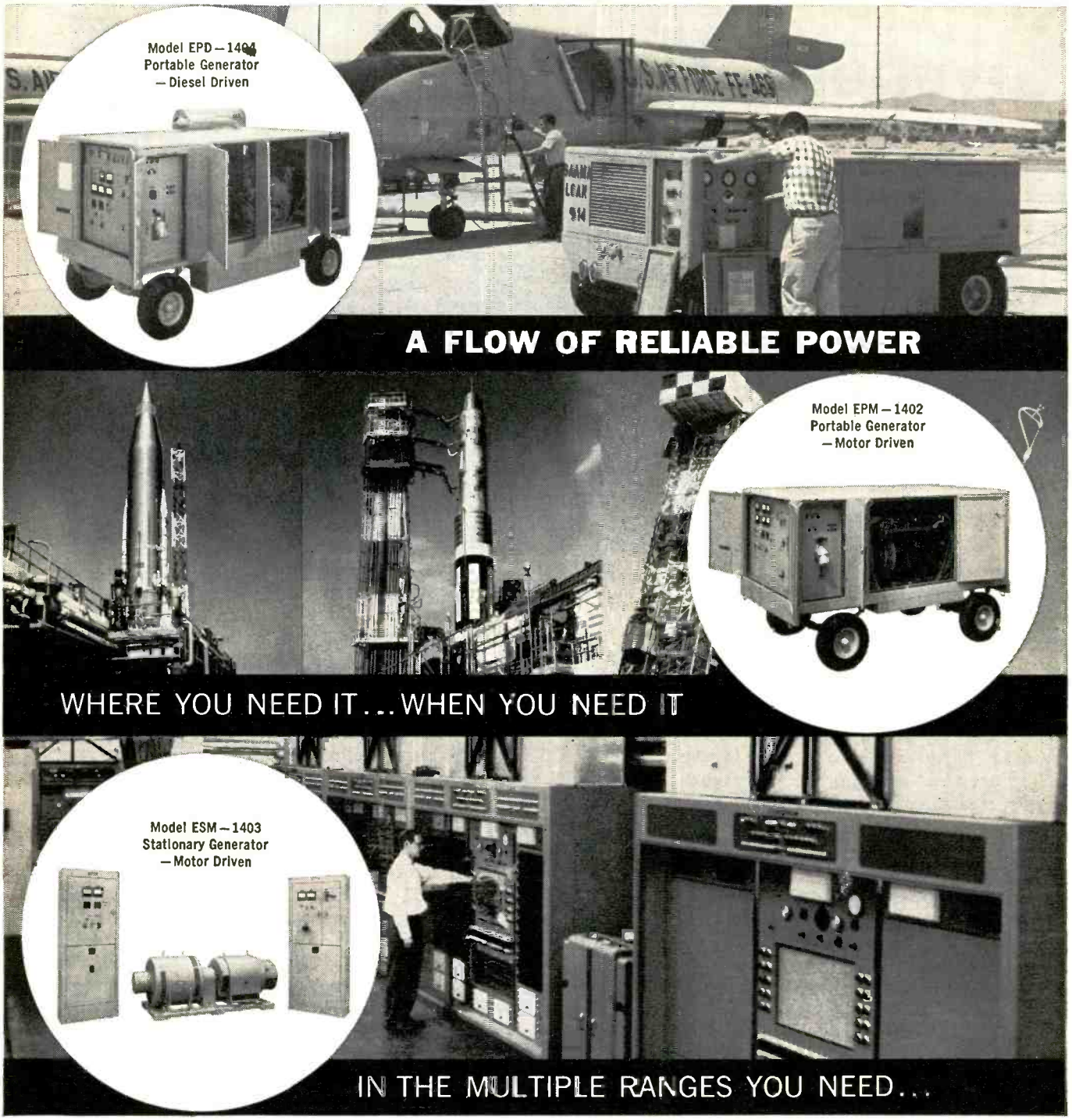
Two-Pronged Teaching

The Air Defense School at Fort Bliss, Tex., teaches both operation and maintenance for Nike-Ajax, Nike-Hercules and Hawk. Civilian instructors at Fort Bliss are prepared for their jobs at Western Electric's Winston-Salem, N. C., factory school.

The Army Artillery and Missile School at Fort Sill, Okla., teaches operation and maintenance of Corporal, Lacrosse, and Redstone. The school will soon handle instruction on Sergeant and Pershing.

Army Signal School at Fort Monmouth, N. J., teaches 11 weeks of basic electronics to missile crews. Soon the Infantry School at Fort Benning, Ga., and the Armor School, Fort Knox, Ky., will initiate an extensive instruction program on antitank guided missiles.

Factory courses include: Martin for Lacrosse; Firestone Tire and Rubber, Gilfillan, and LeTourneau for Corporal; and Raytheon for Hawk.



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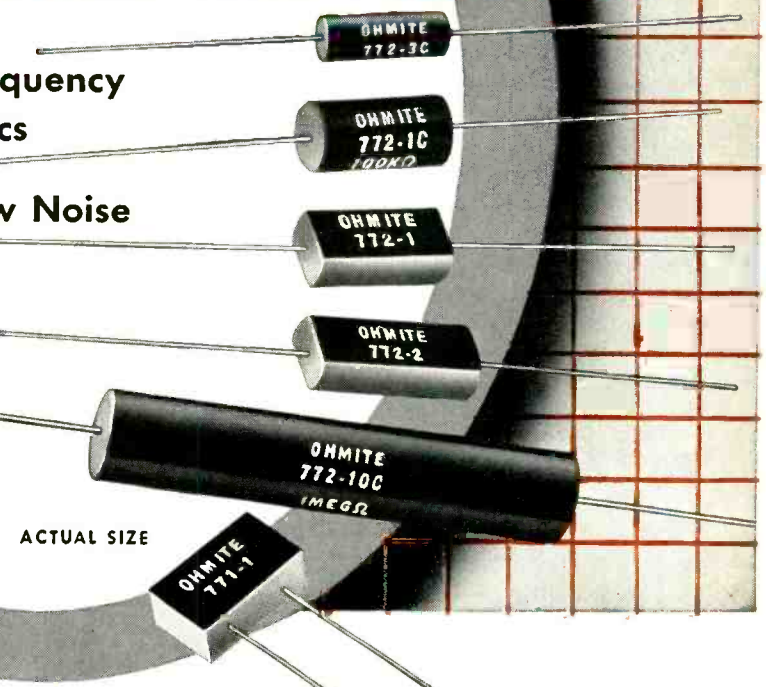

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Write for Bulletin 155

Ohmite Basic Style	MIL Sizes	Dimensions (Inches)		Full Wattage Rating at		Min–Max Ohms	Max Rated Volts
		Length	Diameter	125°C Amb.	150°C Amb.		
771-1	—	11/16	.400	½	¼	25-250K	350
771-2	—	⅞	.600	½	¼	251K-400K	350
772-3C	RN65* RI92†	⅝	15/64	¼	⅛	50-125K	300
772-3CJ	RI92†	⅝	15/64	½	¼	50-85K	300
772-1	—	⅝	21/64	½	¼	25-250K	350
772-1C	—	⅝	21/64	½	¼	25-250K	350
772-2	RN72* RI94†	13/16	21/64	½	¼	25-400K	350
772-2C	RI94†	13/16	21/64	½	¼	25-400K	350
772-2CS	RN70* RI94†	13/16	19/64	½	¼	25-350K	350
772-2J	RI94†	13/16	21/64	1	—	25-400K	350
		13/16	21/64	—	½	25-150K	350
772-2CJ	RI94†	13/16	21/64	1	—	25-400K	350
		13/16	21/64	—	½	25-150K	350
772-8	RI96†	1 3/32	13/32	1	½	100-1 meg	500
772-8C	RN75* RI96†	1 3/32	13/32	1	½	100-1 meg	500
772-10	—	2 7/32	27/64	2	—	200-2.5 meg	750
772-10C	RN80*	2 7/32	27/64	2	—	200-2.5 meg	750

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FAA to Test Blind-Landing

Companies are working on three new electronic systems designed to land airplanes safely in zero-zero weather. Here's a detailed roundup

WASHINGTON — ALL-WEATHER instrument-landing systems will be getting a lot of attention during the coming year from Federal Aviation Agency development people. Three electronic approaches to the old problem of bringing down an aircraft safely in zero-zero weather will be undergoing tests at National Aviation Facilities Experimental Center, FAA's big proving ground near Atlantic City, N. J.

Lack of a genuine and reliable all-weather landing system costs industry millions of dollars a year, according to aviation officials. The Allegheny Airlines plane that crashed early this month was attempting an instrument landing in snow, was pulling out of one attempt when it crashed. Military capability to meet enemy attack is also affected by the need.

Dependable—With Limitations

The instrument-landing system (ILS) has been in use for years, of course. Coupled with automatic pilot, it provides a reasonably dependable electronic pathway through murk and overcast.

A ground transmitter emits a single electronic glidepath and the pilot stays on this track—horizontally and vertically—by merely keeping two needles centered on the cockpit display. Or, in planes equipped with an autopilot, that system will keep him lined up horizontally with the runway.

However, the standard ILS has limitations. The system offers the pilot no information on how far he is from touchdown. And if he strays from the right track, he must either get back on quickly or pull up and go through the whole instrument approach sequence all over again.

More importantly, ILS is really only an approach system, not a landing system. It is not dependable enough below 200 ft to be an efficient guide, and the pilot himself must take over from that altitude.

As FAA deputy director James Pyle explains, "it was economically imperative that a solution be found. Cancelled flights because of weather difficulties, alternate landing necessitated by lack of visibility—all these have to be eliminated if the aviation industry is to continue its progress as a popular and dependable mode of transportation."

Solutions

Both long- and short-range solutions have been proposed. Top FAA officials are especially enthusiastic about the longer-range approach worked up under a development contract with Gilfillan Brothers. This refined ILS system is called REGAL and is meant to provide Range, Elevation, Guidance, Approach and Landing.

A ground transmitter—as close to the touchdown point as possible —emits a notched scanning beam. The airborne receiver, in effect, searches for the notch and translates the signal into information on how far and how high the plane is from touchdown.

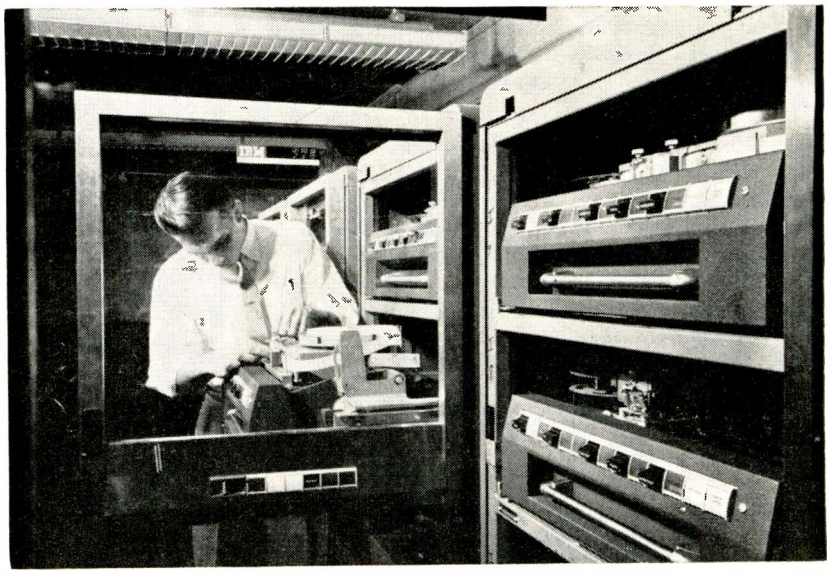
The second element in the system — control — is provided by an airborne computer which takes REGAL's altitude and distance data and translates them into commands to the autopilot. In the absence of an autopilot, the computer itself provides displays for pilot control.

If the system works according to plan, it will provide several advantages over ILS. First, it will take the plane all the way to touchdown on a blind landing. Further, it will give the pilot information on distance from touchdown. And if the aircraft is blown off the track, the computer should immediately and automatically give the autopilot a new track on glide slopes ranging from zero to 20 deg.

The REGAL system is off the drawing boards, and an experimental model will be delivered to NAFEC in January. Plans call for ground-testing the guidance elements early in 1960, with flight tests in July.

Sperry and Lear, which have con-

Aids Air Traffic Control



Federal Aviation Agency has tied in an IBM650 at Indianapolis Air Route Traffic Control Center with Univac File-Computers at Washington, Cleveland and Pittsburgh ARTCs. Paper tape equipment (pictured) provides multiple direct connections between wire links and the computer. Incoming message traffic is automatically edited, checked and sent to the computer; outgoing flight plans are devised and routed to proper adjoining centers. Boston and New York computers will join the network shortly

Gear

tracts for the computer and display elements of the system, are equipping a C-54 and a C-45 for the tests. The Air Force will provide a C-131 and a T-33.

If the initial experiments prove successful, then specifications will be drawn and FAA will buy a complete engineering model for further tests. It is hoped the system can be in operation within five years.

Short-Range Solution Needed

Even assuming the REGAL system lives up to its advance billing, there is one big customer which may not be willing to wait five years: the Air Force. Accordingly, FAA is going ahead at Atlantic City with tests of two other blind landing systems which are in a later stage of development.

These two were developed by Bell Aircraft and North American Aviation's Autonetics division, under Air Force-FAA contracts. Both are at the preproduction-test stage.

In the Bell Aircraft system, ground-based radar picks up an approaching aircraft, electronically records and analyzes distance and height from touchdown, and sends instructions to the pilot via the standard ILS system.

Autonetics' system combines an airborne radar altimeter with the ILS to give the pilot a programmed track below the critical 200-ft altitude and guide him on to touchdown.

Whatever system is finally adopted to succeed or complement ILS, a healthy new market awaits the electronics industry.

FAA is currently operating 173 ILS ground stations at airports within the U. S., and more are going in. Although any transition would be gradual, all are potential sites for a new system.

In the air, each of the 2,000-odd aircraft in common-carrier service represents potential sales. So does at least a small percentage of the 75,000 private and corporate aircraft in the country. But the biggest customer would be the Defense Department, with its total aircraft inventory of 35,000.

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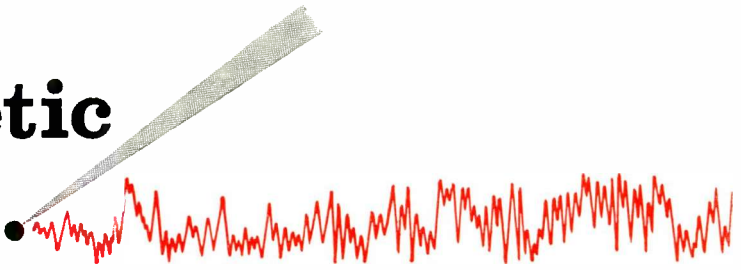

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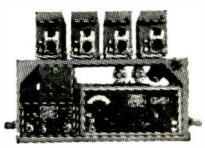

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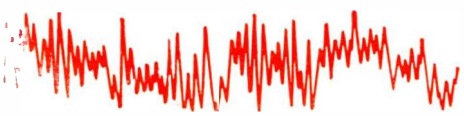

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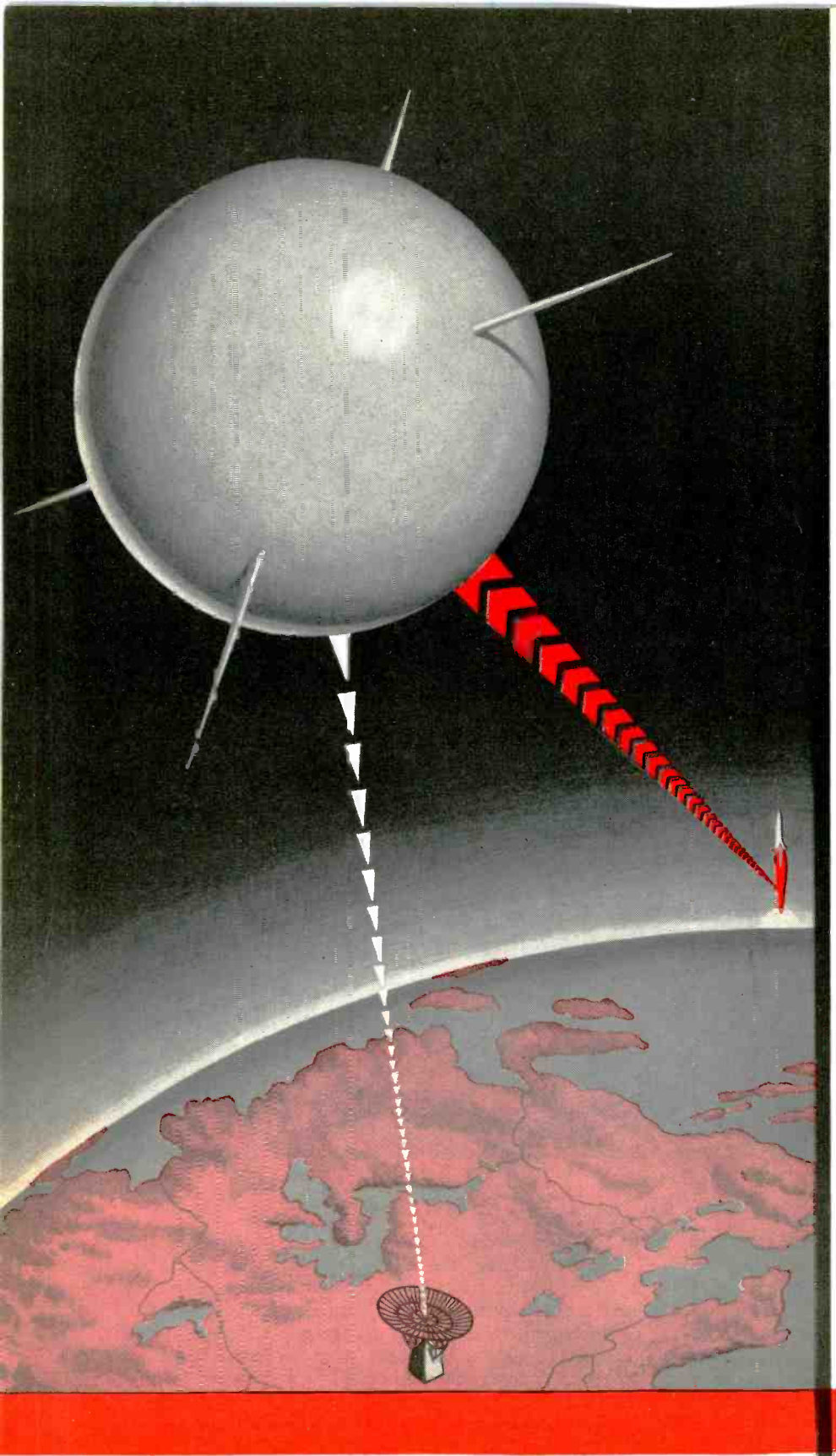

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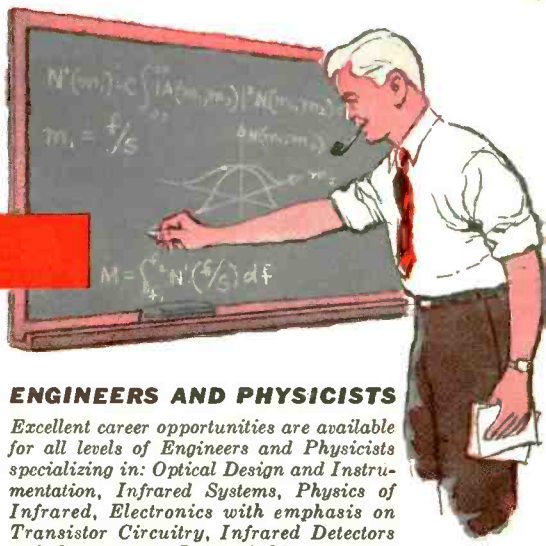
Infrared's singular use in World War II triggered a tremendous postwar effort to find other uses for its unique features. This effort, to which Avco's Crosley Division is a major contributor, has produced many applications in both industry and defense to which infrared is ideally suited.

Because they are so important to the national defense effort, most infrared research programs are classified as secret. But in general, Crosley's work in the field points toward new breakthroughs and conspicuous contributions in searching and tracking, anti-ICBM detection, airborne early warning and defense systems, reconnaissance, surveillance, anti-submarine warfare and passive ranging.

As a result of its progress in these areas, Crosley's team of infrared specialists—one of the largest in the country—is gaining the respect of a growing number of contractors.

For more information, write to: Vice President, Marketing-Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.



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Stratolab Looks at Venus

Navy balloon flight over midwestern states proves feasibility of using the gasbags to study atmosphere, stratosphere, near space

LATEST IN NAVY'S Stratolab flights took A. D. Little astrophysicist Charles B. Moore 81,000 ft aloft late last month, enabled him to get a good look at Venus from a higher vantage point than ever before and spectrographically analyze its atmosphere. The balloon went up from the Stratobowl, a natural depression in the Black Hills near Rapid City, S. D., stayed aloft 26 hours, came down with a bang near Manhattan, Kans.

One preliminary conclusion from the analysis: contrary to prior belief, there's water vapor in the Venusian atmosphere. How much, and what other components are present, had not been determined as ELECTRONICS went to press.

Flight was one of the first in a new program of balloon astronomy initiated by the Office of Naval Research and partly funded by National Science Foundation. Called Stratolab High IV, it is the fourth ONR closed-gondola flight to heights in excess of 80,000 ft. It was originally scheduled for this time last year to observe Mars, then was put off when a ground accident destroyed the balloon.

Navy plans to use Stratolab balloons to permit scientists to conduct astrophysical research while aloft in the stratosphere. Subsequent flights are planned to observe other planets and the sun, test feasibility of stratospheric and near-space monitoring platforms, and analyze upper-atmosphere winds and ionization.

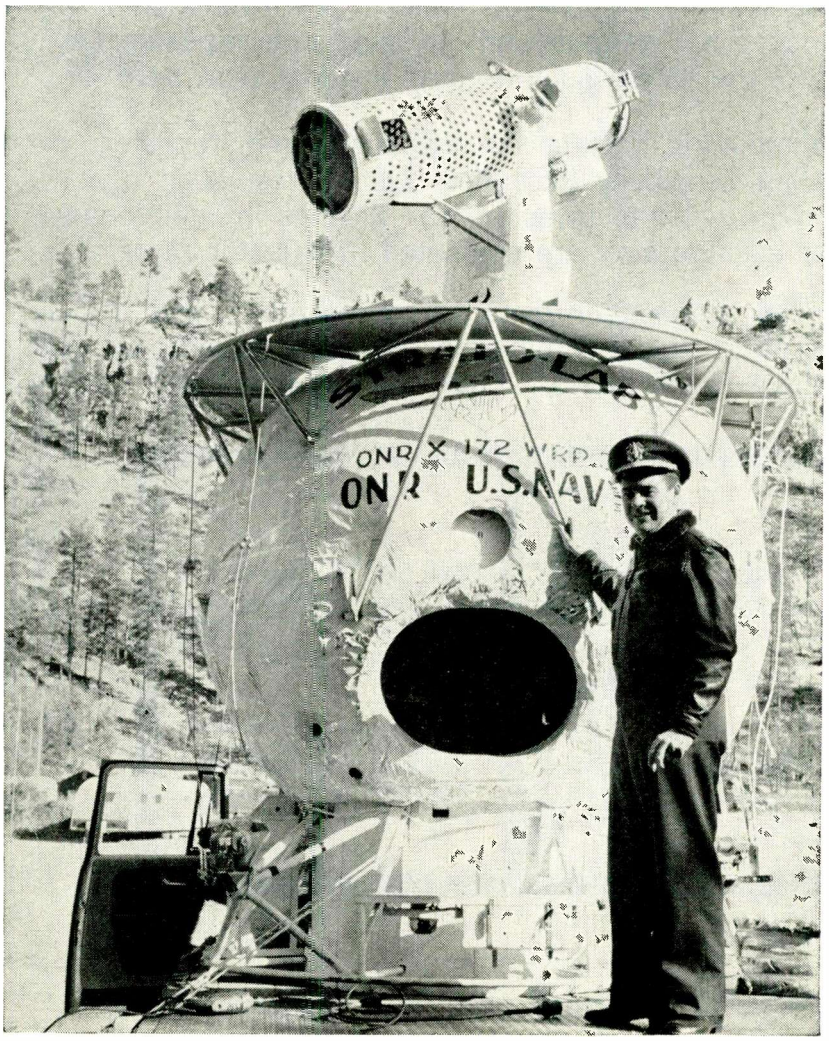
Weather Trouble

The 1959 flight was scheduled for Oct. 15, but a full night of unobstructed ground observation of Venus was required before the balloon could go up. Weather closed in prior to launch, and the flight was put off until Nov. 28.

Mounted atop the gondola was a 16-in. Schmidt-type telescope with a gold-coated spherical mirror and an aspheric correcting plate. It was designed and produced by Ferson Optical Co., Ocean Springs, Miss. A rough guidance system was used to bring Venus into the approximate telescope field; from there a Startracker made by Librascope of Livermore, Calif., took over to keep the image centered automatically throughout the flight.

Light from the primary optical system was relayed to a monocentric mirror and thence down to a spectrograph inside the gondola. The spectrograph was devised by John Strong and built at Johns Hopkins, where Strong is director of the astrophysics and meteorology labs. Prime detector in the spectrograph was a multiplier phototube developed by ITT's Fort Wayne, Ind., labs.

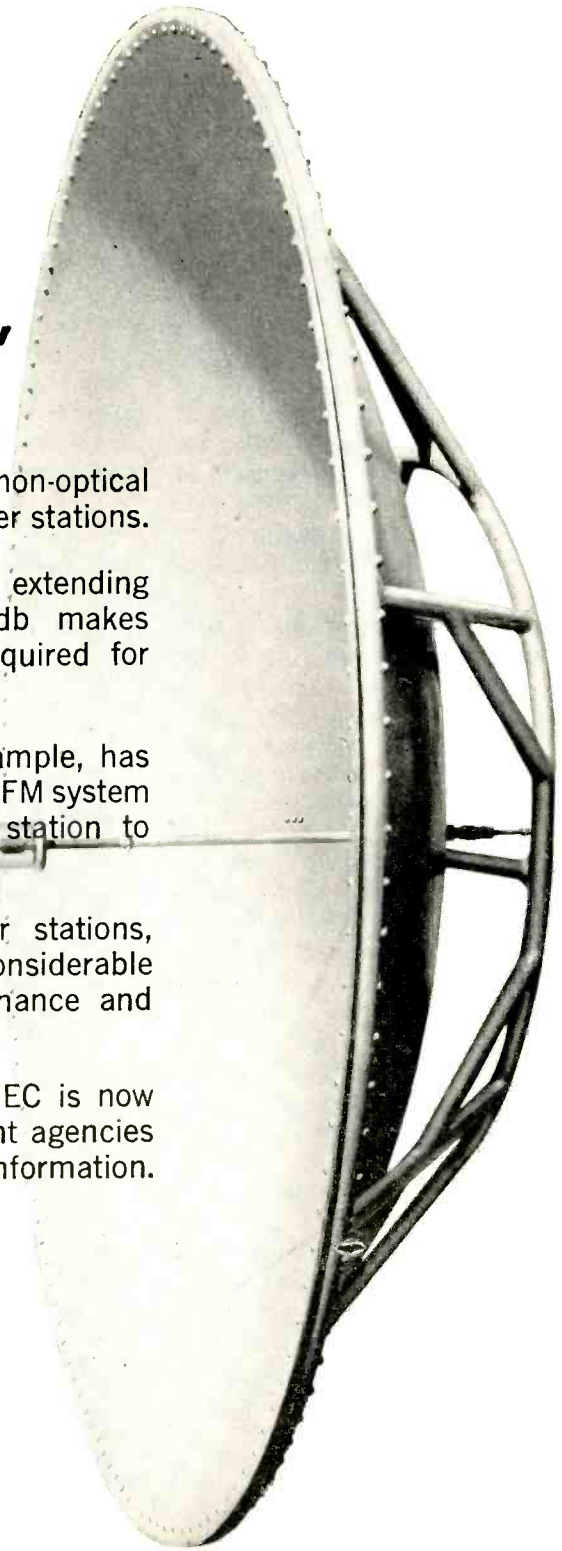
A telemetry-command system developed by Data-Control Systems, Danbury, Conn., provided 36 channels for telemetry and six command channels from ground to balloon. This system relayed inflight physiological data on pilot Malcolm Ross and flight scientist Moore to medical observers on the ground. Data recorders also kept permanent physiological records in the gondola, as well as recording data on inside and outside environment.



Schmidt telescope atop gondola tracked Venus, relayed light to spectrograph inside

New from Japan . . .

Important advance in short-haul, multi-channel communications



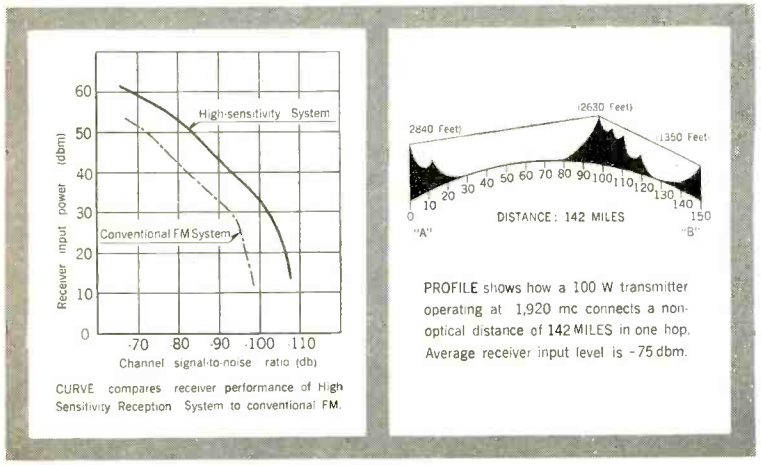
Microwave 60-channel voice transmission over a non-optical path up to 300 MILES is now possible without repeater stations.

NEC's High Sensitivity Reception System, by extending threshold level and improving S/N ratio 10 to 13 db makes this hop with only 1/20 of the power output required for conventional systems.

A 100 W transmitter in the 1,800-mc band, for example, has a scatter path of 100–150 MILES. A conventional FM system requires 2 KW output and at least one repeater station to connect the same distance over a non-optical path.

By eliminating high-power amplifiers and repeater stations, the High Sensitivity Reception System results in considerable reduction in initial investment. Savings in maintenance and power consumption are estimated at 40% or more.

Extensive propagation tests have been made, and NEC is now prepared to supply commercial users and government agencies anywhere in the world. Please write for detailed information.



CURVE compares receiver performance of High Sensitivity Reception System to conventional FM.

PROFILE shows how a 100 W transmitter operating at 1,920 mc connects a non-optical distance of 142 MILES in one hop. Average receiver input level is -75 dbm.

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Satellite Test Open

NASA announces timetable for Project Echo and invites outside scientists to join in

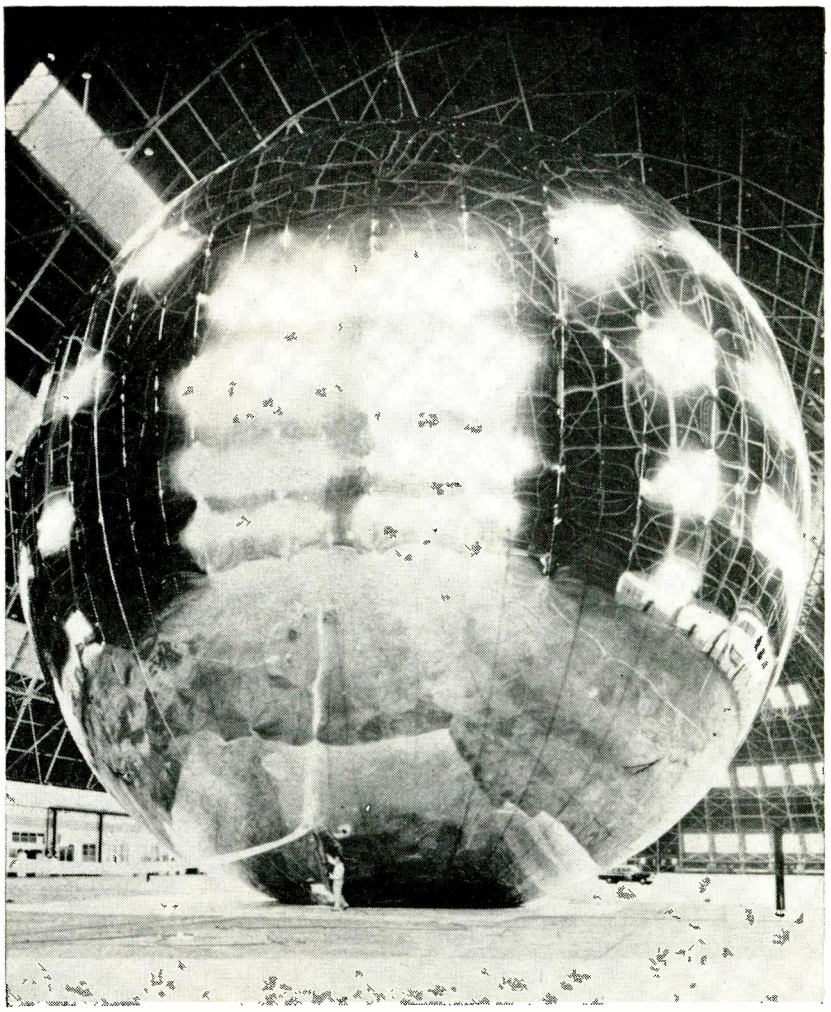
PROJECT ECHO—the experiment designed to launch into orbit early next spring a 100-ft inflatable sphere for use as a passive communications satellite—will be open to participation by American and foreign scientists in the communications field.

An invitation from the National Aeronautics and Space Administration extends to all scientists "who could make constructive use of experiments involving the sphere." This includes European scientists who have the necessary equipment. Some discussion is already reported to have taken place with scientists in Britain and West Germany.

Object of the satellite experiment, said NASA, will be "to test the feasibility of a passive reflector communications system on a global basis."

The NASA announcement cited "the intense interest expressed by the scientific community for volunteer participation by others than those who will participate on a contractual basis."

To give scientists sufficient notice to make necessary technical preparations, the agency said it was making an exception to its long-standing policy of not publicly reporting



NASA's 100-ft aluminized polyester film sphere will fold inside a 28-in. diameter container at launching of passive balloon satellite

to All

on space experiments until they have been performed.

The spring launching will be the first of three Project Echo satellites, each a NASA-developed 100-ft reflecting sphere fired into orbit by a Delta vehicle.

The aluminum-coated passive balloon satellite is expected to be launched into a 1,000-mi. altitude earth orbit in a northeasterly direction from the Atlantic Missile Range, with an inclination of about 50 degrees to the equator.

Orbit Over U. S.

NASA said the satellite would have a 120-minute orbital period and is expected to pass over every part of the U. S. except Alaska, permitting communications researchers to use the sphere for propagation experiments. Maximum time of mutual visibility between the East and West Coasts for any one pass will be about 16 minutes.

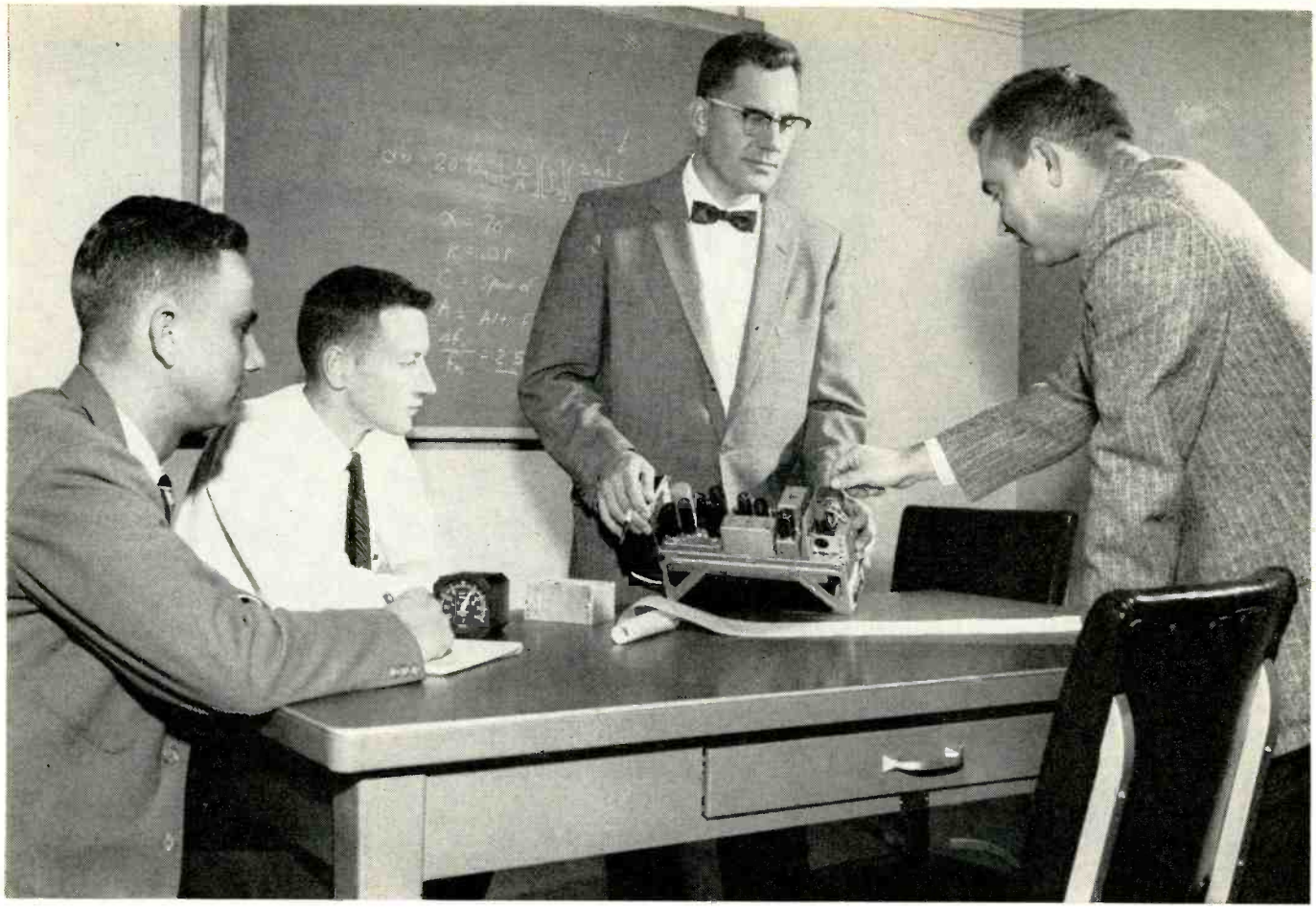
NASA reported that the inflatable satellite of 0.0005-in.-thick Mylar plastic coated with vapor-deposited aluminum would provide reflectivity of at least 98 percent up to frequencies of 4,000-mc per sec.

Interim Vehicle

The two major facilities involved in the experiment will be the NASA Jet Propulsion Laboratory's Goldstone Tracking station in California and a Bell Telephone Laboratories station at Holmdel, N. J. Goldstone will transmit a 2,390-mc signal for interception at Holmdel. The Bell antenna will transmit a 960-mc signal to Goldstone.

The Delta launching vehicle is an interim vehicle for use in 1960 and 1961. Three-stage configuration will be similar to Thor-Able but will have an improved inertial guidance system, and active control of longer coasting periods between second-stage burnout and third-stage ignition.

Vega, first of NASA's more advanced boosters, will not be ready for flight tests before late 1960. Eight are slated for production by the end of 1961 (ELECTRONICS, p 11, May 22).



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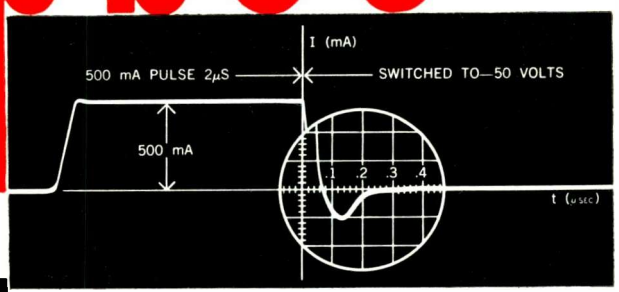

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. . . in a high-current silicon switching diode. The 1N920-1N923 series is the latest result of Sperry Semiconductor's unique developments for the computer field.

The most advanced addition to the industry's most complete line of high conduction fast recovery diodes, this series meets the severe requirements of high current pulse circuits for high speed computer switching, pulse clamping, gating, blocking, and diode logic circuits.

Designed for high temperature operation (to 175° C), the 1N920 series features high forward conductance (500mA at 1.0V.) and low leakage (50μA at 150° C). Peak dissipation is 800 mw.

All units feature a maximum recovery time of 0.3 microseconds to return to 10K ohms when switched from a forward current 2 microsecond pulse of 500mA to a reverse voltage of —50 volts (—30 V for 1N920), with a loop impedance of 1K ohms. Faster switching speeds are obtained at lower currents.

TENTATIVE DATA

Type	Working Inv. DC Voltage (Volts)	Max. Forward Voltage Drop at 25°C (V.)	Max. Inverse Current (μA) 25°C	Max. Inverse Current (μA) 150°C	Min. Saturation Voltage at 100μA 25°C	Max.* Recovery Time μsec.
1N920	36	1.0 at 500mA	.25	50 @ 30V.	40	0.3
1N921	70	1.0 at 500mA	.25	50 @ 60V.	80	0.3
1N922	100	1.0 at 500mA	.25	50 @ 90V.	120	0.3
1N923	130	1.0 at 500mA	.25	50 @ 120V.	150	0.3

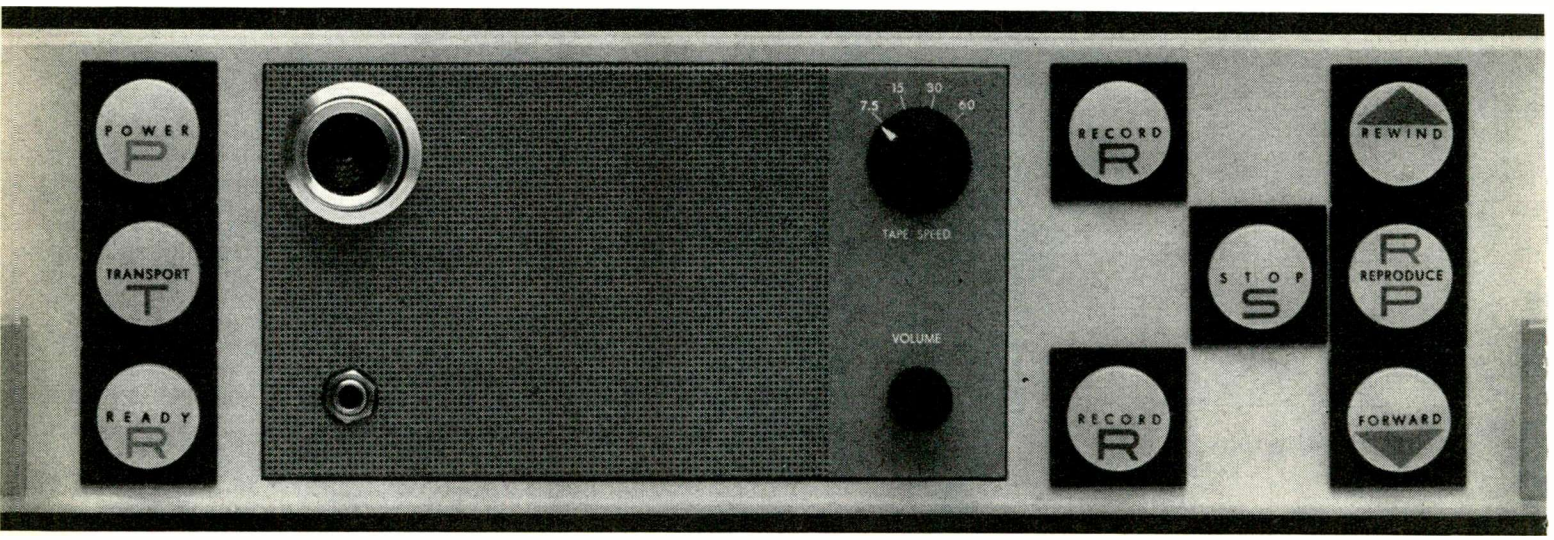
*Refer to Sperry Bulletin No. 2103

SPECIAL SAMPLE OFFER

Order a sample lot for your own application at the special price of only $50 for a lot of 10 1N921 diodes. Direct your order to the So. Norwalk plant or the nearest Sperry sales office as listed below.

SPERRY

SPERRY SEMICONDUCTOR DIVISION, *SPERRY RAND CORPORATION, SOUTH NORWALK, CONN.*
Call or write: *Sperry Semiconductor, Wilson Avenue, SOUTH NORWALK, Conn., VOlunteer 6-1641; in NEW YORK PLaza 2-0885; / 3555 W. Peterson Ave., CHICAGO 45, Ill., KEystone 9-1776; 2200 East Imperial Highway, EL SEGUNDO, Calif., ORegon 8-6226.*



push-button money saver

This control button cluster, designed for simple, error-proof operation, symbolizes the dozens of advanced engineering features that make the Ampex FR-600 the most time- and money-saving data recorder you can own. Here's why:

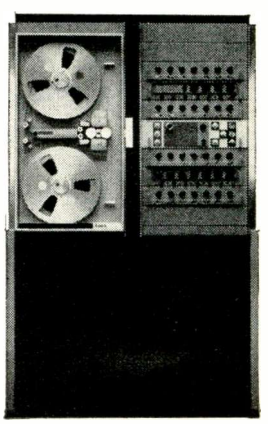
THE AMPEX FR-600 CUTS TAPE COSTS IN HALF — saves thousands of dollars a month in this way alone. How? By recording all standard IRIG channels at 30 ips instead of 60 (made possible by the FR-600's extra-wide bandwidth) you put the same data on half the tape required by other machines.

THE AMPEX FR-600 CUTS INSTRUMENTATION COSTS. How? By recording at 30 ips instead of 60, a 14-inch reel handles a full 48-minute data run — enough for most full missile flights including pre-launch time. Expensive dual-transport set-ups become unnecessary.

THE AMPEX FR-600 DOUBLES THE RECORDING TIME OF EXISTING INSTRUMENTATION RECORDERS. How? Because bandwidth is a function of the reproduce head rather than the record head, 100 KC channels to be reproduced on the FR-600 can be recorded at 30 ips on such equipment as the Ampex AR-200 airborne recorder, on earlier Model 800 recorders (with a simple bias change) and on many other compatible equipments. Recording time is doubled in space-limited airborne data acquisition.

THE AMPEX FR-600 RECORDS MORE DATA PER DAY. How? By cutting non-recording time needed for maintenance, warm-ups and calibration. Low-drift, solid-state electronics, for example, warm up in less than 10 minutes, maintain FM calibration within 1% for more than 24 hours as compared to 2 hours on most other equipment. One calibration instead of 12.

Need we say more? If so, a stamped, self-addressed boxcar will bring you our entire engineering staff. Lesser problems can undoubtedly be solved by a copy of the new AMPEX FR-600 brochure.



AMPEX DATA PRODUCTS CO. 934 Charter St., Redwood City, Calif.

AMPEX

Doctors Seek Pattern Detectors

Radiologist urges optical-electronic device for automatic analysis of human smear specimens

CHICAGO—A leading U. S. radiologist says the medical profession needs a high-volume, mass-screening unit for automatic optical-electronic analysis of human smear specimens.

Dr. Lee B. Lusted of Rochester, N. Y., made the statement here recently at the 45th annual meeting of the Radiological Society of North America.

Lusted thinks "a better understanding of the reasoning processes concerned with systematic decision-making may help to increase diagnostic accuracy."

Related to this, he adds, is development of electronic devices for establishment of "normal" or "abnormal" diagnostic conclusions, based on electronic screening of routine smear tests.

Scanner-Computer Unit

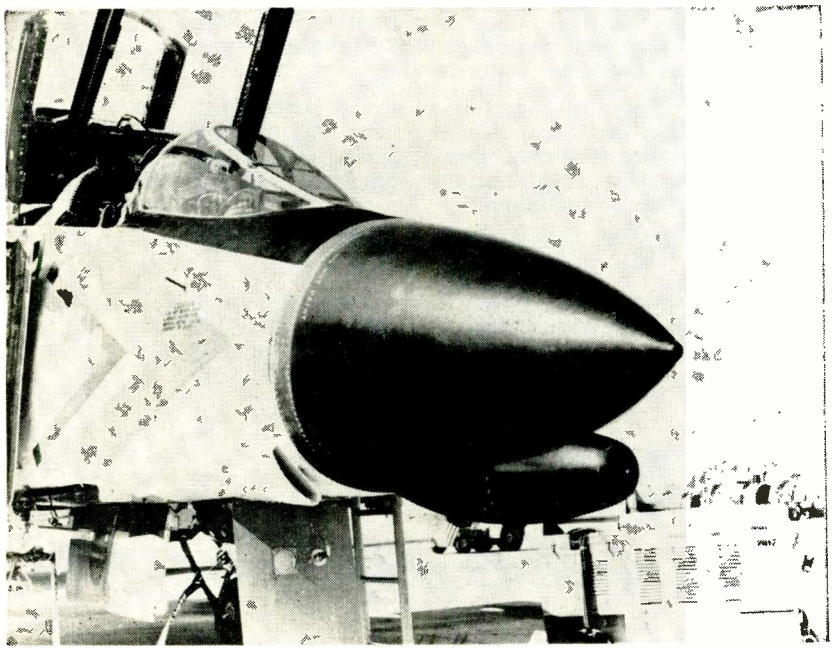
Lusted says the device deemed necessary for the medical profession would be an electronic scanner-computer combination. It would be used to look at chest photoflurograms and to separate clearly normal chest films from abnormal ones.

The abnormal chest films would be marked for later study by radiologists, he says.

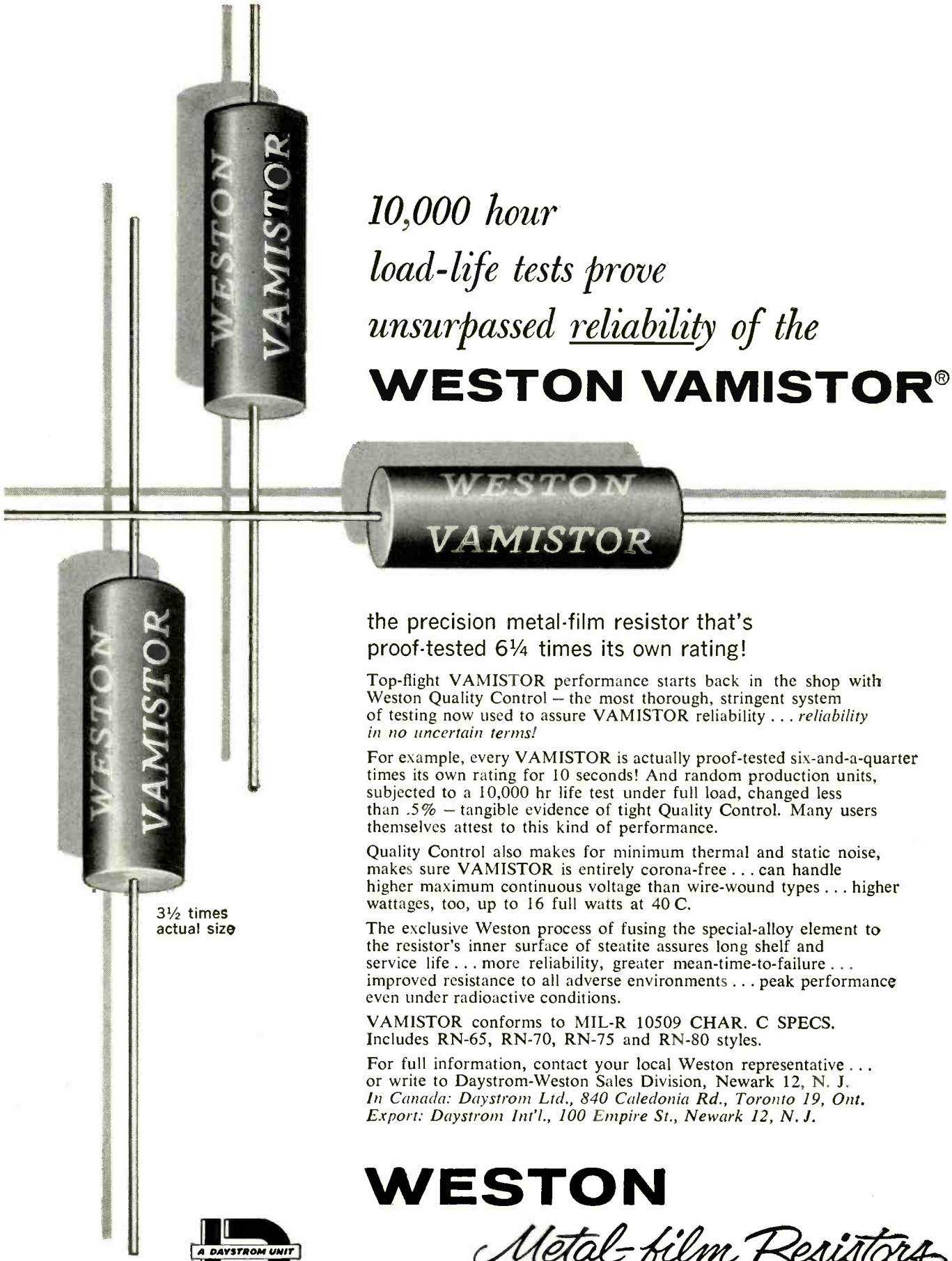
Lusted adds: "A challenging problem present in various scientific fields today concerns pattern detection and recognition. For instance, reading a psychometric test profile, a bone tumor analysis profile, or map reading where large surface areas have been surveyed—as in satellite mapping.

"The problems of pattern recognition for a lung lesion are difficult but the time required to solve them will be well spent. Here is a real challenge for a radiologist with firm grasp of principles in the disciplines of electronics, medicine, radiology, and visual physiology. Who knows, a radiologist could solve the problem of pattern recognition before the cartographers."

Infrared Dome for Interceptor



The small "chin" on the profile of the McDonnell F4H-1 houses an infrared detection system developed by Avion div., ACF Industries



3½ times actual size

10,000 hour load-life tests prove unsurpassed reliability of the

WESTON VAMISTOR®

the precision metal-film resistor that's proof-tested 6¼ times its own rating!

Top-flight VAMISTOR performance starts back in the shop with Weston Quality Control – the most thorough, stringent system of testing now used to assure VAMISTOR reliability . . . *reliability in no uncertain terms!*

For example, every VAMISTOR is actually proof-tested six-and-a-quarter times its own rating for 10 seconds! And random production units, subjected to a 10,000 hr life test under full load, changed less than .5% – tangible evidence of tight Quality Control. Many users themselves attest to this kind of performance.

Quality Control also makes for minimum thermal and static noise, makes sure VAMISTOR is entirely corona-free . . . can handle higher maximum continuous voltage than wire-wound types . . . higher wattages, too, up to 16 full watts at 40 C.

The exclusive Weston process of fusing the special-alloy element to the resistor's inner surface of steatite assures long shelf and service life . . . more reliability, greater mean-time-to-failure . . . improved resistance to all adverse environments . . . peak performance even under radioactive conditions.

VAMISTOR conforms to MIL-R 10509 CHAR. C SPECS. Includes RN-65, RN-70, RN-75 and RN-80 styles.

For full information, contact your local Weston representative . . . or write to Daystrom-Weston Sales Division, Newark 12, N. J.
In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont.
Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

A DAYSTROM UNIT

WESTON

Metal-film Resistors

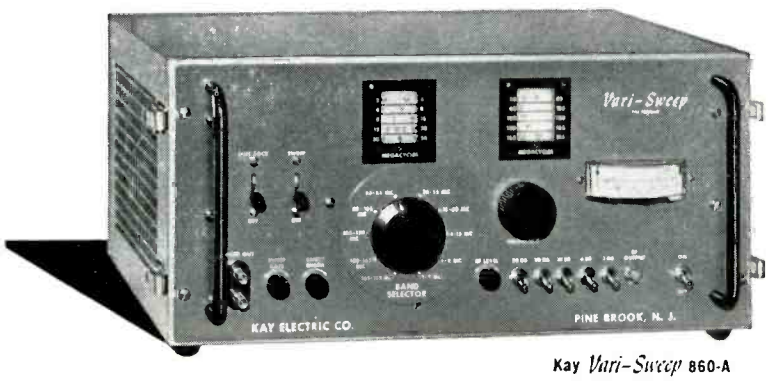
WORLD LEADERS IN MEASUREMENT AND CONTROL

AC Seeks and Solves the Significant—Because of GM's large contribution in the international race for technological superiority, AC accepts a challenge. AC Research is on a scientific quest for solutions to significant problems . . . for accomplishments even more advanced than AChiever inertial guidance for Titan. / We call this creative challenge . . . AC QUESTMANSHIP. It's an exciting quest for new ideas, components and systems . . . to advance AC's many projects in guidance, navigation, control and detection. / Right now Dr. Joseph F. Shea, AC's Director of Advanced Systems Research and Development, is drawing a group of competent men around him to build "the greatest R & D organization in the industry." And Dr. Shea adds strong support to the fact that AC offers "an excellent working atmosphere for a scientist or engineer who wishes to produce and progress." / You may qualify for our specially selected staff... if you have a B.S., M.S. or Ph.D. in the electronics, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

GUIDANCE/ NAVIGATION/ CONTROL/ DETECTION/ AC SPARK PLUG *The Electronics Division of General Motors*

SWEEPING OSCILLATORS for RADAR and TELEMETERING SYSTEMS ALIGNMENT 200 cycles-3800 mc

by KAY ELECTRIC



Kay *Vari-Sweep* 860-A

The Kay sweeping oscillators are a line of high level laboratory field test and production instruments designed for the alignment of radar and telemetering IF's and front ends, 200 cycles to 3800 mc.

- Wide Range, Wide Sweep
- High Output
- Fundamental Frequency
- Constant Output (Fast-Acting AGC)
- Continuously Variable Centers
- Fixed, Crystal-Controlled Markers
- All Electronic Operation

Instrument	Cat. No.	Range	Sweep Width	RF Output	Markers	Price†
Ligna-Sweep SKV	935-A	200 cycles-220 mc	2 kc-12 mc customer selected	1.0 V rms AGC'd, 70 ohms	customer selected	$995.
Vari-Sweep ®	860-A	2-220 mc (center)	Contin. Variable to 60% center freq. below 50 mc; 30 mc plus, above 50 mc.	1.0 V rms AGC'd, 70 ohms	None	$795.
Vari-Sweep Model IF	866-A*	4-120 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$985.
Vari-Sweep Model Radar	865-A*	10-145 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$985.
Vari-Sweep Model 400	867-A	15-470 mc in 10 bands	Same as above to 400 mc; 20 mc max. above 400 mc	1.0 V rms into 70 ohms to 220 mc; 0.5 V rms to 470 mc; all AGC'd	None	$850.
Mega-Sweep ®	110-A**	50 kc-950 mc	50 kc-40 mc	100 mv at 50 ohms	None	$575.
Kada-Sweep ®	380-A*	2 Switched bands 20-40 mc; 50-70 mc	2 Switched bands, Wide 20 mc, Nar. 3 mc	250 mv rms, 70 ohms	9 Fixed Crystals	$450. (with 4 crystals).
Kada-Sweep Sr.	385-A	1-260 mc (center) 6 Switched bands	Approx. 70% of center freq.	.5 V rms into 70 ohms	24 Fixed Crystals	$650.
Magna-Sweep	3500	5-1000 mc 2200-3800 mc	Full range of swept band	Low band: 0.1 V rms into 50 ohms; High: 1.5 V into 50 ohms	±0.1% accurate direct reading digital wavemeter	$4,950.

**Other Mega-Sweeps to 1200 mc; and with Markers.

*Wider sweep widths, additional crystal markers available on special order.

† All prices F.O.B. Pine Brook, N. J.

WRITE FOR NEW KAY CATALOG

KAY ELECTRIC COMPANY

Dept. E-12 Maple Avenue, Pine Brook, N. J. CApital 6-4000

FREEZE IT!

INHERENT STABILITY
Assured in a DALOHM MC Resistor

The freezing temperature of coils is mild by comparison with the temperature extremes at which Dalohm resistors can operate reliably.

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

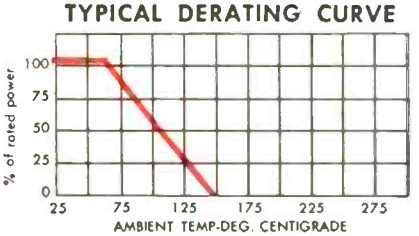
For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

DEPOSITED CARBON • MOLDED • MINIATURE
DALOHM TYPE MC RESISTORS

Made of pure crystalline carbon film with no binder or filler, these resistors offer excellent high frequency characteristics.

A molded housing provides complete electrical insulation and mechanical protection.

TYPICAL DERATING CURVE



- **Rated at** 2, 1, ½, ¼ and ⅛ watts
- **Resistance range** from 10 ohms to 50 megohms, depending on type
- **Standard tolerance** ± 1%
- **Temperature coefficient** 500 P.P.M. maximum
- **Smallest in size,** ranging from 9/64" x 13/32" to ⅜" x 2¼"
- **Full load operation** to 70° C., derating to 0 at 150° C.
- High heat dissipation
- Meet applicable paragraphs of MIL-R-10509C.

Write for Bulletin R-35, with handy cross-reference file card.

SPECIAL PROBLEMS?

You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1300 28th Ave., Columbus, Nebr.

MEETINGS AHEAD

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 1-4: Instrument-Automation Conf. and Exhibit, ISA, Sam Houston Coliseum, Houston, Texas.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Texas.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

Apr. 4-7: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

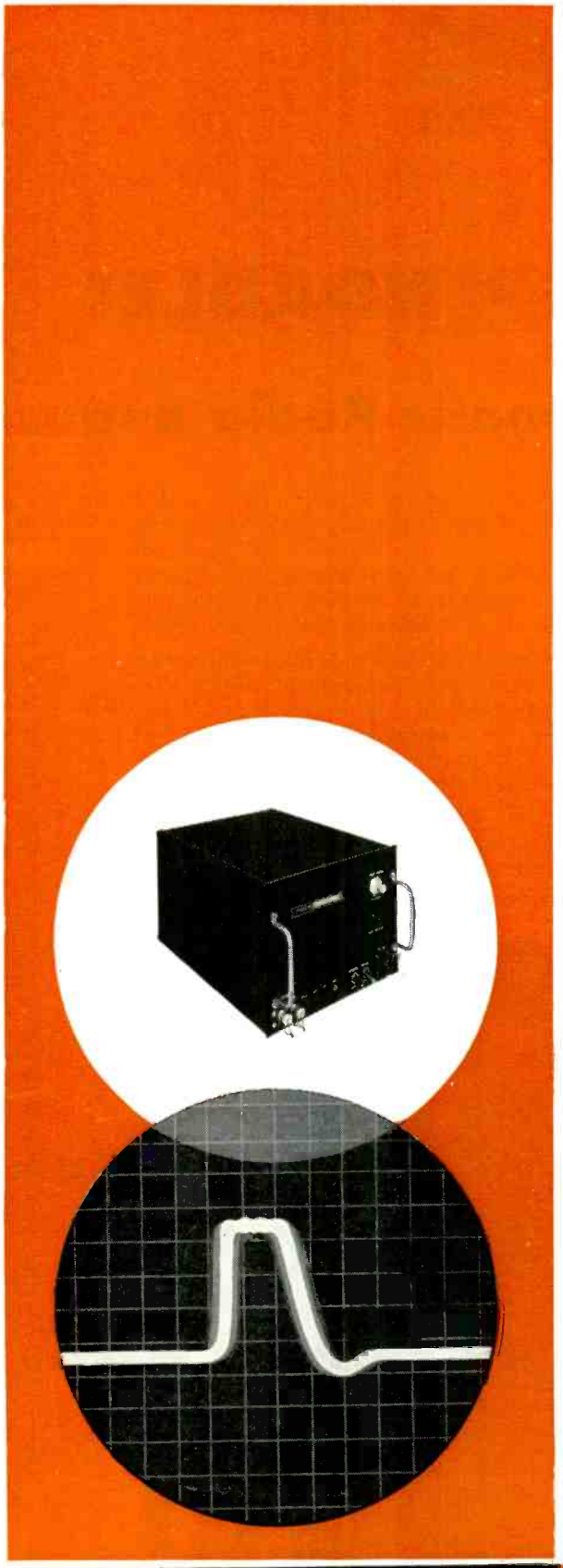
Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland, O.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., New York, City.

Aug. 23-26: Western Electronics Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 100.



HIGH RELIABILITY,
SMALL SIZE,
LESS THAN
50 MILLIMICROSECONDS
PULSE JITTER

A TRUE SOLID STATE RADAR MODULATOR

Temco Electronics has developed the first and only true solid state radar modulator for use in missiles, aircraft and ground equipment installations. Pulse jitter is minimum — it will not exceed 50 mμ sec.

Circuit efficiency is greater than in any comparable conventional modulator. It gains high reliability through the full use of solid state components as well as through the simplicity of design and circuitry. Use of solid state switching techniques rather than conventional thyratron switching also increases efficiency and reliability.

Temco's solid state modulator meets military specifications for shock, vibration and temperature environments. It needs no adjustment prior to or during operation, has automatic fault sensing and reset. Further advantages are small size and low operating voltage.

Temco has developed a family of solid state modulators suitable for a variety of military and commercial uses. One current application is in missile and airborne radar beacons. Further information is available from Temco on request.

TEMCO ELECTRONICS

A Division of TEMCO AIRCRAFT CORPORATION *P. O. Box 6191 • Dallas 22, Texas*

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CIRCLE 55 ON READER SERVICE CARD

AER -O- COM

DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon

Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

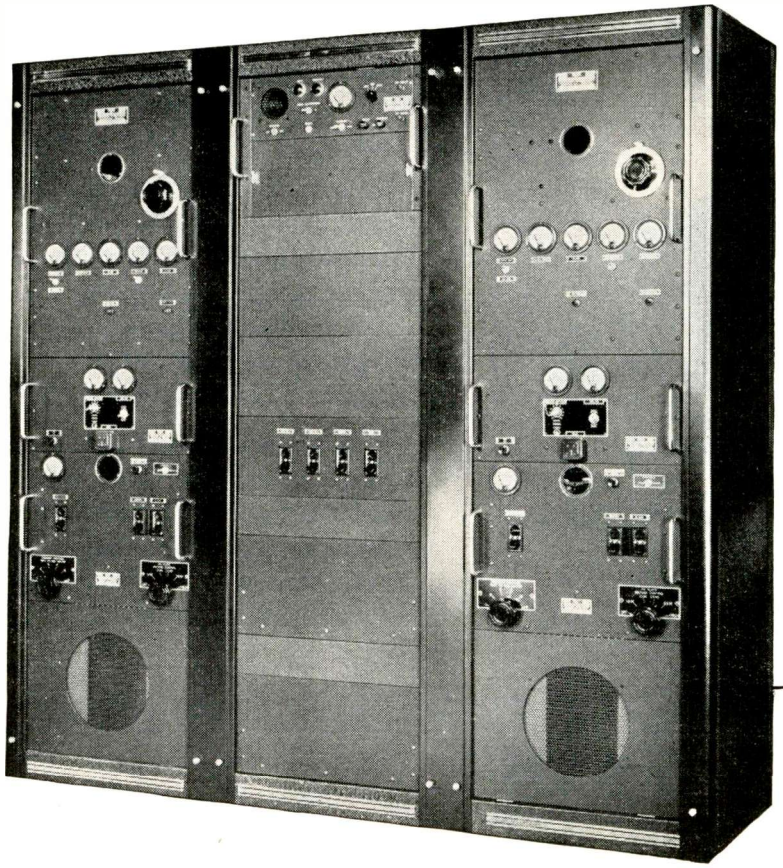
Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with 2 keyers, automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate fan ventilated rack cabinet, with controls in center rack cabinet.

Nominal carrier power is 1000 watts.

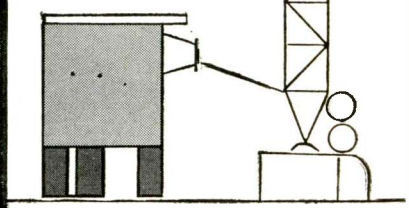
High level plate modulation of final amplifier is used, providing any desired level of modulation up to 100%. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from –35°C to 55°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone, or carrier frequency change of 5 kcs or more. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.



Also available in
50 WATT
100 WATT
400 WATT
and
4 KILOWATT
models



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AER -O- COM

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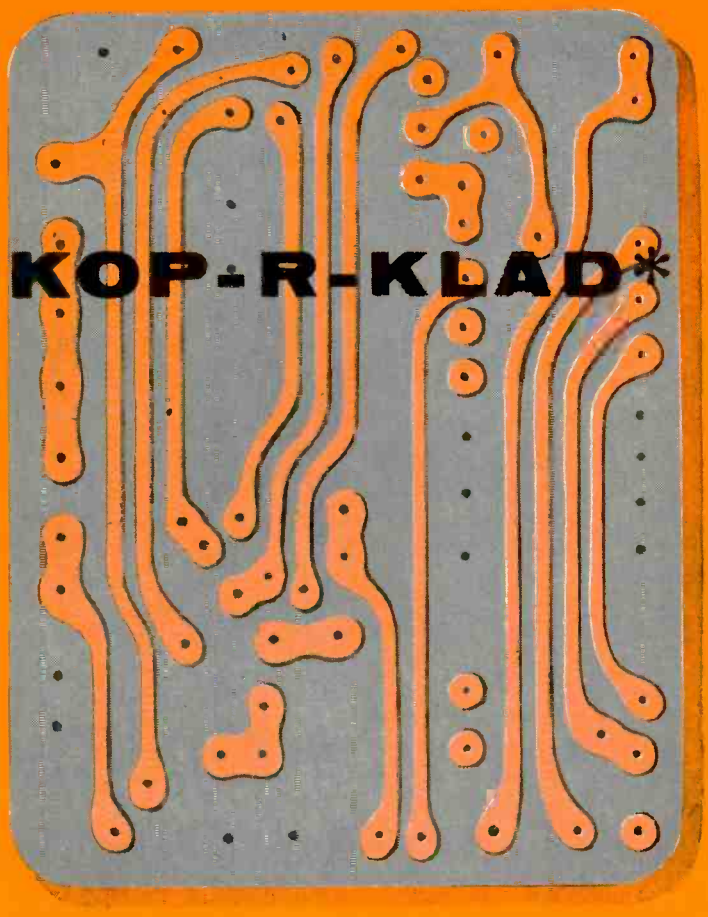
NOW SHAMBAN KOP-R-KLAD* printed circuit laminate

Here's an end to circuit unreliability caused by "leaking" printed circuitry. Unique bonding methods, developed by Shamban, bond insulator to copper **without compromising** the electrical properties of either. Even in extreme environments, there is no breakdown of strengths.



*Tradename of W. S. Shamban & Co.

A new, complete line of hi-temperature hi-dielectric strength laminates featuring:

* Maximum electrical properties
* Unique, optimum-performance bonding methods
* Highest commercial peel strengths
* Availability in sheets and continuous lengths
* Full range of types of constructions, sizes

New Shamban KOP-R-KLAD laminate presents several distinct advantages to the users of printed circuitry. KOP-R-KLAD offers a *complete line*, the right constructions for every application; *optimum electrical properties through proper bonding*, best volume, surface and insulation resistivity, highest dielectric strength; *highest peel strength*, for sharp bends, rugged environments; *continuous lengths*, for convenience of user, for wider application. KOP-R-KLAD is available in twelve different types, including copper to Teflon, to Teflon-glass, to Kel-F, and to FEP-fluorocarbon. Each type has specific advantages, all types have the advantage of absolute dependability and predictability within the limitations of the materials specified. KOP-R-KLAD is immediately available, dependent upon type, in widths up to 36", in lengths from 2" to continuous rolls. *Write or wire factory for complete data.*

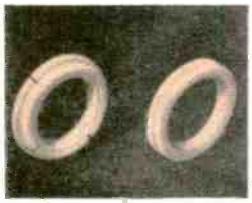
Engineered Plastic Products

W. S. Shamban & Co.

11617 W. Jefferson Blvd.
Culver City, Calif.
•Ft. Wayne, Indiana
•Floral Park, New York

SHAMCO

SHAMBAN PRODUCTS FOR ELECTRONICS



Snag-proof Teflon grommets. Non-abrasive, chemical resistant and very durable, Shamban snap-in and channel type grommets provide secure holding device.

Stand-off and feed-thru insulators. Absolute insulation for critical circuit tiepoints. Resists high frequency and voltage breakdowns.

Teflon and Nylon spaghetti tubing, standard and Microthin wall sizes. Available in all sizes, to meet every tubing need. Consistent quality.

NEW FROM NARDA

Wide Range

KLYSTRON POWER SUPPLY— $495.00

Model 438

Operates more Klystrons than any comparable unit!

This new Narda Wide Range Klystron Power Supply operates virtually all medium and low voltage Klystrons, as well as some high voltage tubes (at reduced power output). It literally operates more Klystrons, including Sperry and Varian tubes, than any other unit in its price range!

What's more, all components, including tube sockets, are operated within manufacturers' ratings. (Many other supplies exceed plate-cathode, cathode-filament or socket-ground voltage ratings.)

Want more information about this new Power Supply that gives you greater versatility and longer trouble-free service at lower cost? Then write us for complete spec sheets. Ask, too, for your free copy of our complete catalog. Address: Dept. E-6.

FEATURES

- **250-700 volt Beam Supply, 0-65 ma.**
- **0-1000 volt Reflector Supply**
- **Accurate Ten-Turn Dial Calibration**
- **5 mv max. Reflector Ripple**
- **Diode Protection Circuit**
- **Oil Filled Capacitors in High Voltage Filters**
- **Square Wave Modulation 0-150 Volts, 300 to 3000 cps.**
- **Saw Tooth Modulation 0-150 Volts, 30 to 180 cps.**
- **Sine Wave Modulation 0-150 Volts, 60 cps.**

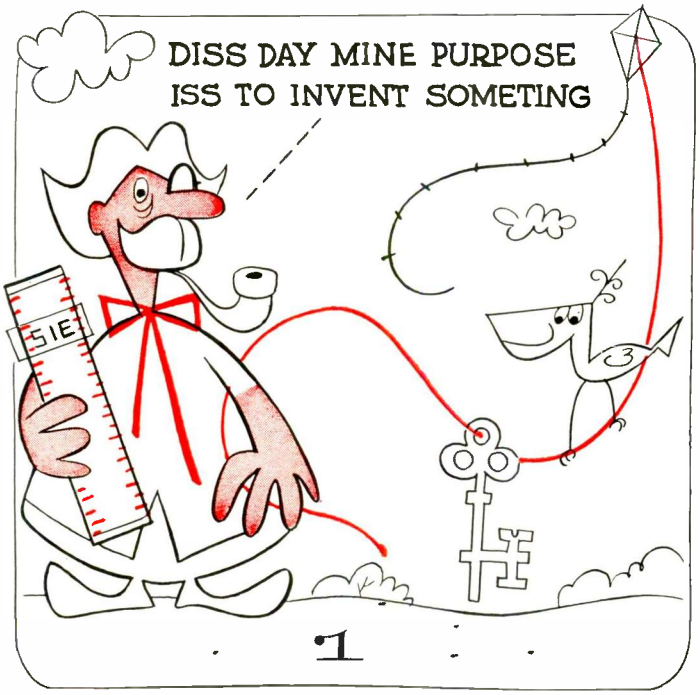
the narda microwave corporation

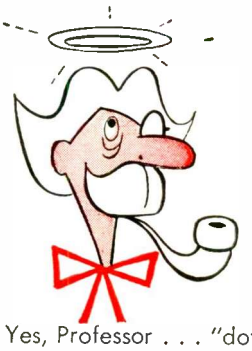
118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

PROFESSOR MIZZLE VON BOMB presents

Great Moments In Electronics

(Never Before Recorded)



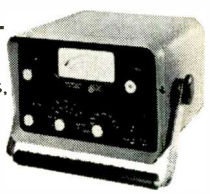


BUT
HERR FRANKLIN
VILL GET
DER CREDIT

Yes, Professor . . . "dot iss electricity" . . . discovered through bold research. And such research at SIE has produced the Model R-3 Transistorized Voltmeter, which combines more desirable features than any other instrument in its class.

AC: 1 mv to 1000 v full scale in 14 ranges
DC: 1 v to 1000 v full scale + or — in 7 ranges
Electrometer: 0 to 1 vdc + or —

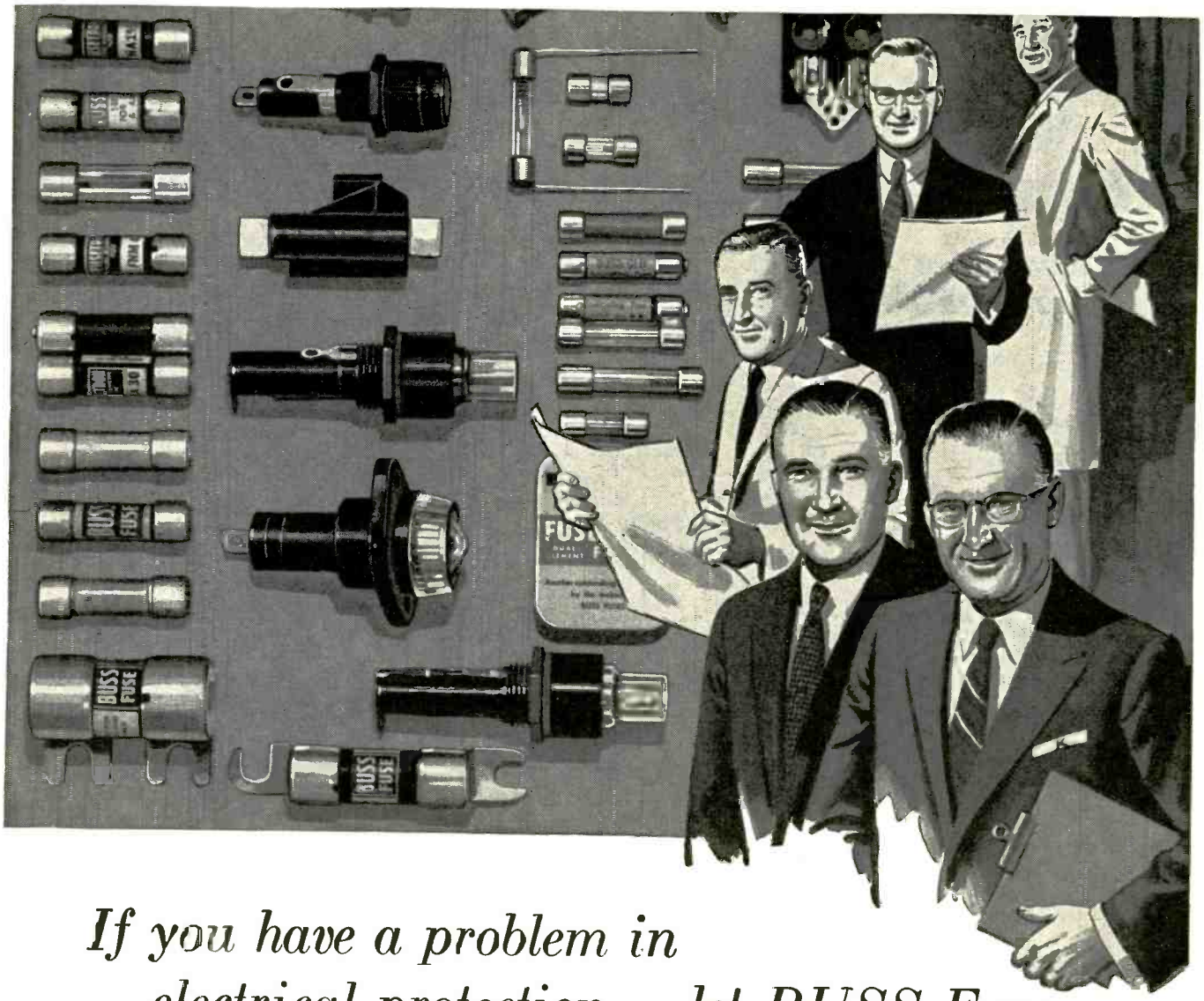
Ask your SIE representative to demonstrate the R-3 and the entire line of SIE Advanced Design Instruments. "Do itt zoon!"



Write today for prices and specifications.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
A DIVISION OF DRESSER INDUSTRIES, INC.
10201 Westheimer • P. O. Box 22187 • Houston 27, Texas • HOmestead 5-3471
CABLE: SIECO HOUSTON TWX: HO-1185



If you have a problem in electrical protection — let BUSS Fuse Engineers Help You Solve It.

If you have an electrical protection problem, the BUSS fuse research laboratory, and its staff of engineers are *at your service.* Our engineers will work with yours to help you find a solution — and so save you engineering time.

It is quite possible a fuse already stocked by local wholesalers will be your answer, so that the right fuse is readily available if your equipment needs service.

The complete BUSS and FUSETRON fuse line includes:

Single-element fuses for circuits where quick-blowing is needed, such as for instrument protection.

Single-element fuses for normal circuit protection.

Dual-element, slow-blowing fuses for circuits where harmless current surges occur.

Indicating fuses where signal must be given when fuses open — or to activate an alarm.

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion BUSS line of fuse clips, blocks and holders.

Dependability Always

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.

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V_{CEO}	25 v	25 v	25 v	25 v	40 v
V_{EBO}	20 v	20 v	10 v	10 v	10 v
I_{CO}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h_{FE}	18 min.	9 min.	——	——	——
f_{ab}(mc)	5 min.	2 min.	5 min.	2 min.	2 typ.
h_{fe}	——	——	18 min.	9 min.	6 min.

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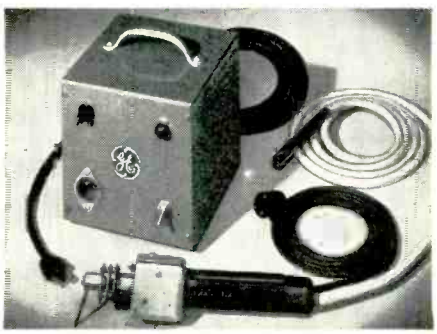

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Accuracies:—
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Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
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Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

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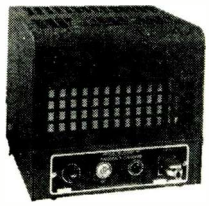

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

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TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
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R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
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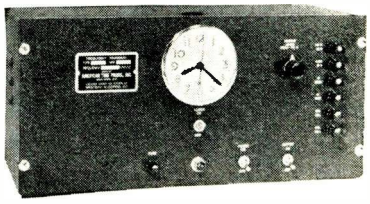

Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
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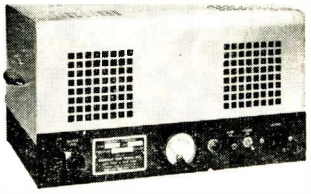

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
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L—For low frequencies
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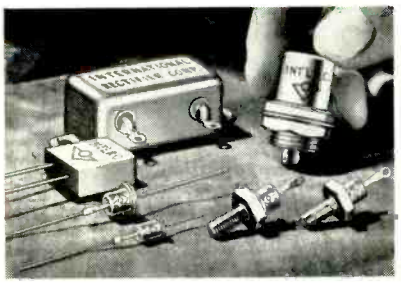

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Standard MIL Transformer Case

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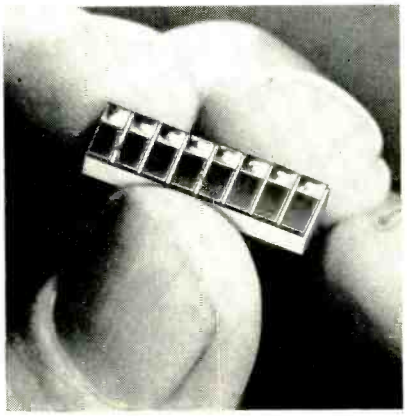

CIRCLE 252 ON INQUIRY CARD

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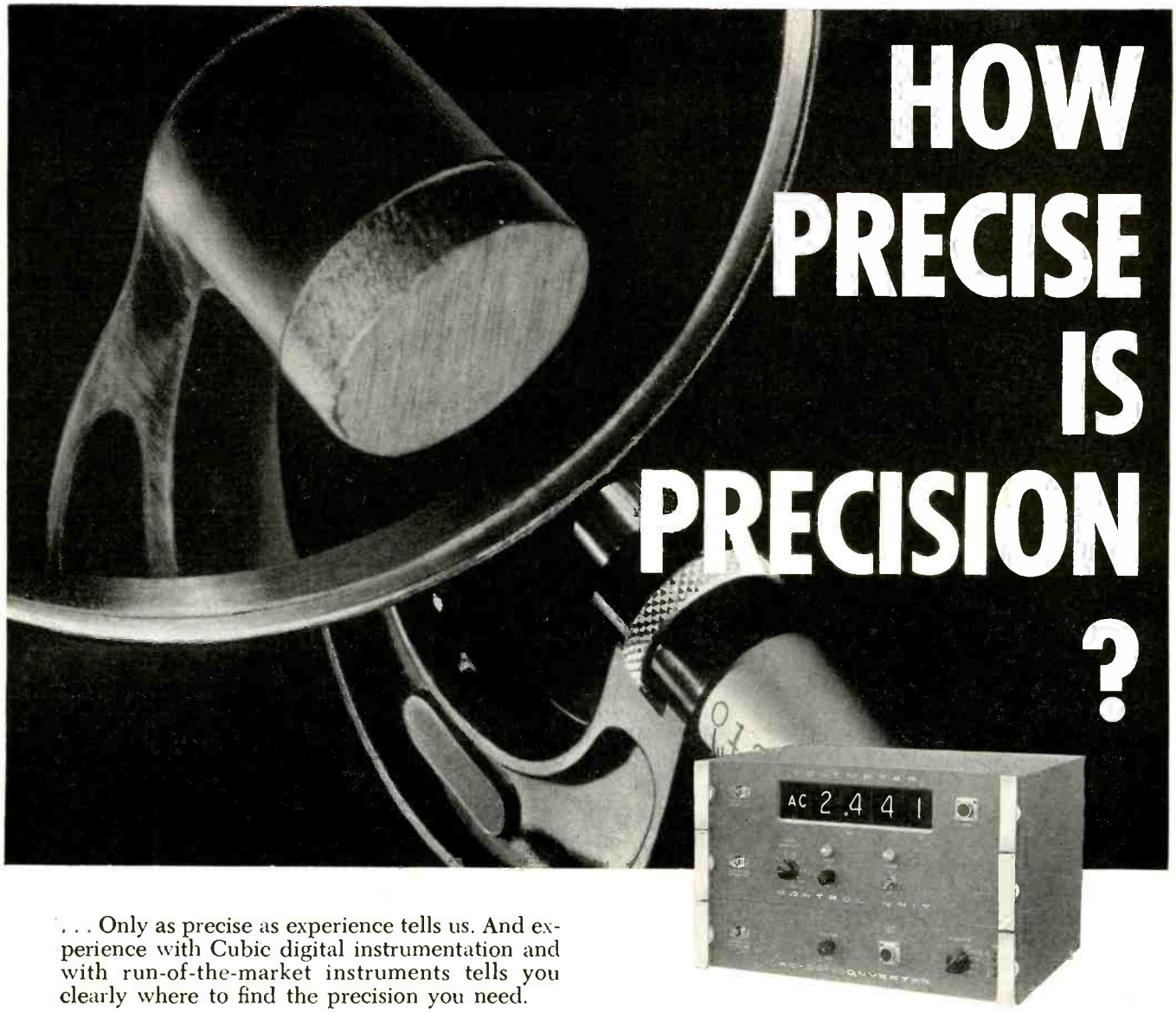

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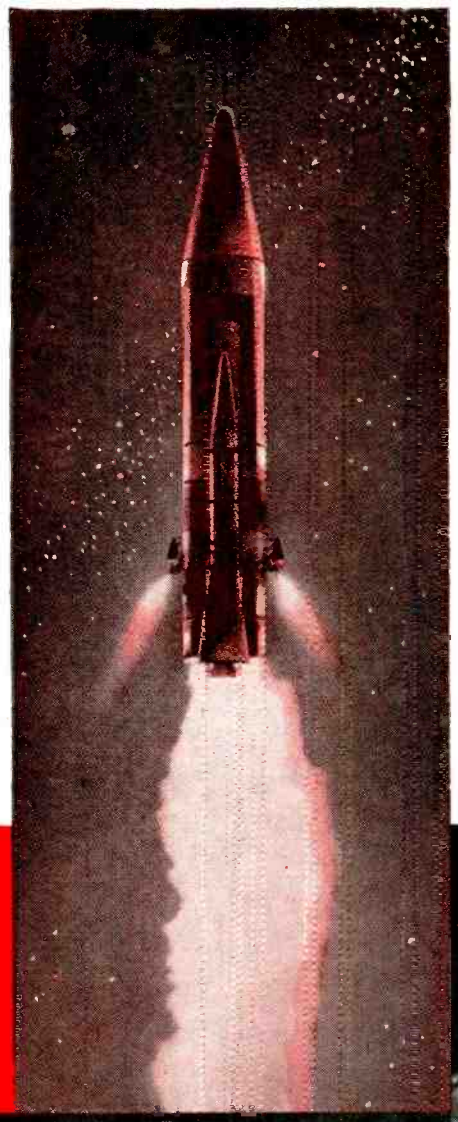

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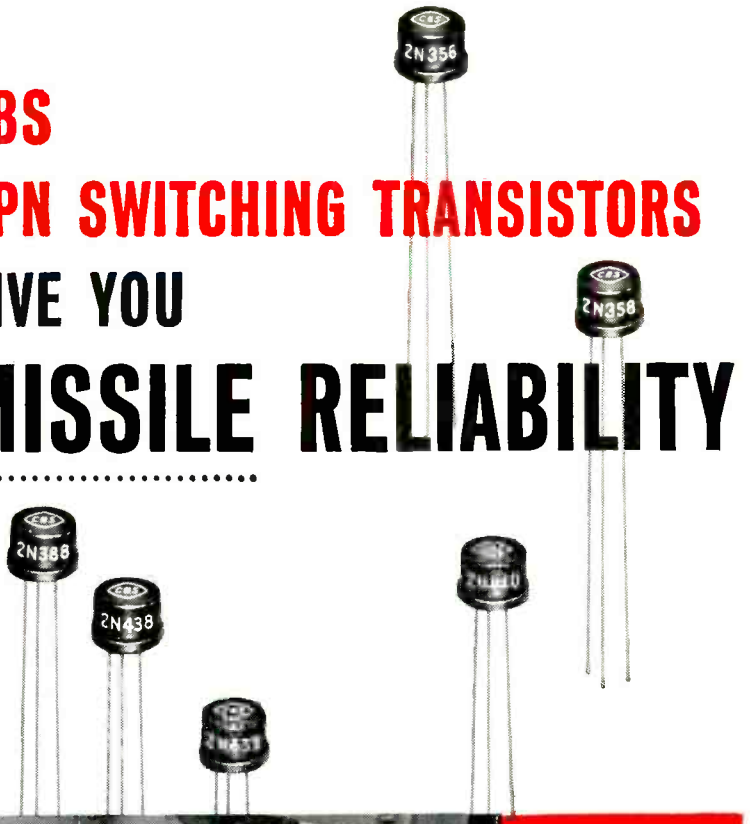

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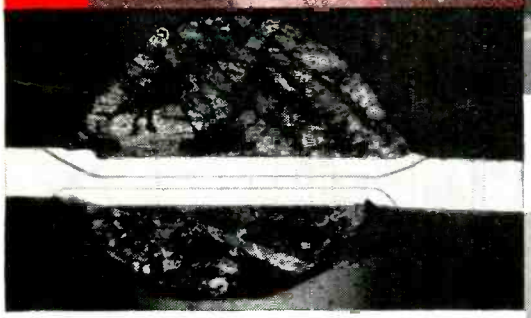

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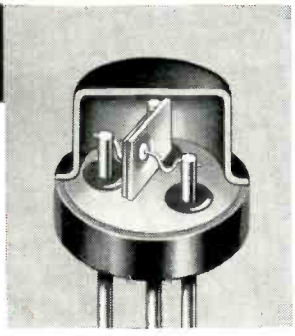

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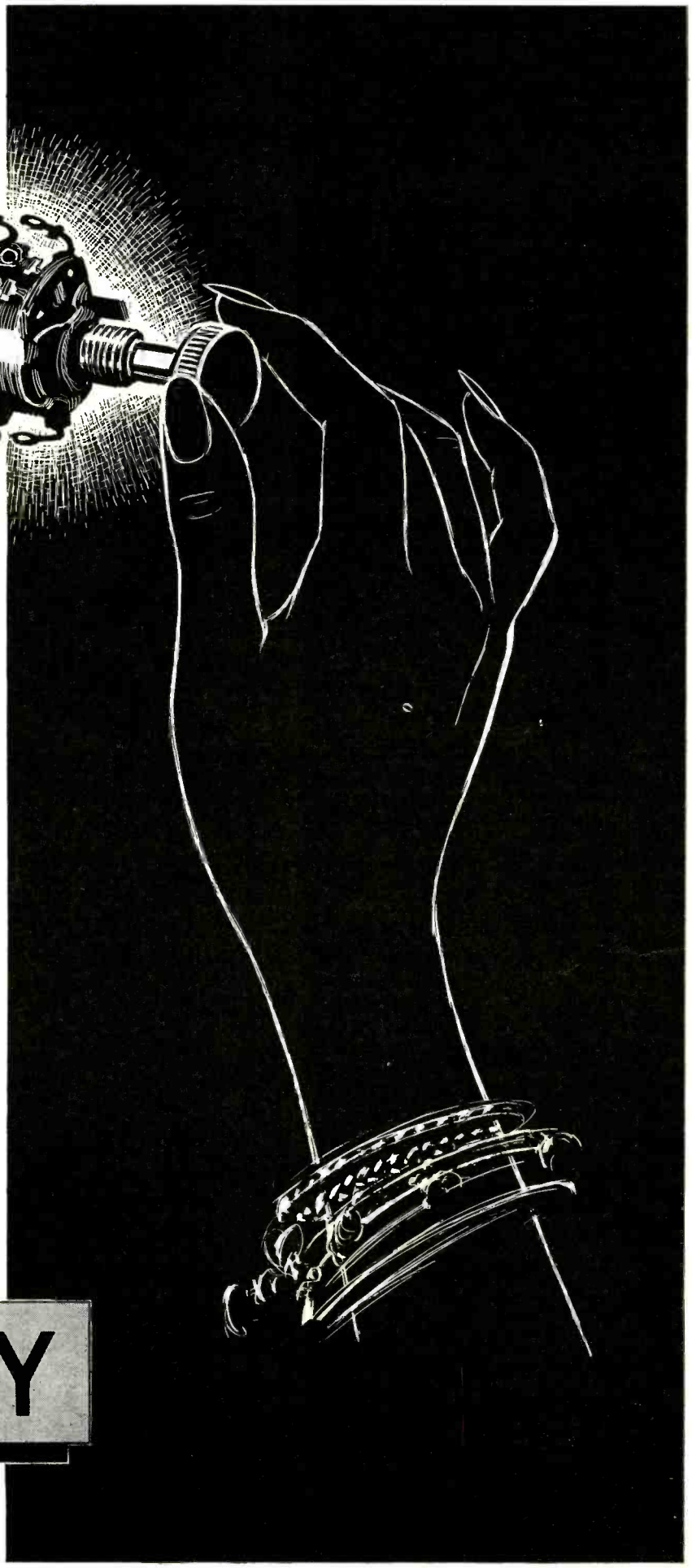

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DECEMBER 18, 1959

Electronics Assists in Highway Construction

A new family of instruments is being born to solve roadbuilding's unique problems. Experimental roadbeds are ironed out by latest electronic devices

By **HAROLD HARRIS,** Midwestern Editor

DURING THE NEXT 15 years, over one-hundred-billion dollars will be spent on highway construction in the United States. Electronics plays a very important role in the largest highway research project ever undertaken. This project is sponsored by the American Association of State Highway Officials, administered and directed by the Highway Research Board of the National Academy of Science.

Due to the unique requirements, much of the instrumentation had to be developed specifically for this research program. Instrumentation for a test highway (nine miles of four-lane highway divided into six test loops of portland cement and asphaltic concrete) serves several purposes. It measures the various effects of traffic on the test pavements and the environmental conditions such as moisture content and sub-surface temperature at the test site. It also speeds acquisition of the test data and reduces the volume of data to summary form to permit rapid engineering and statistical analysis.

Systems were classified into three categories. Those associated with pavement capabilities, those associated with pavement performance and those related to covariables.

PAVEMENT DEFLECTION—With strains in concrete pavements in the order of 20 to 50 microinches per inch, resolution of one microinch per inch was desired. Deflections (vertical movement) of the surface is to be measured to 0.001 in. with occasional

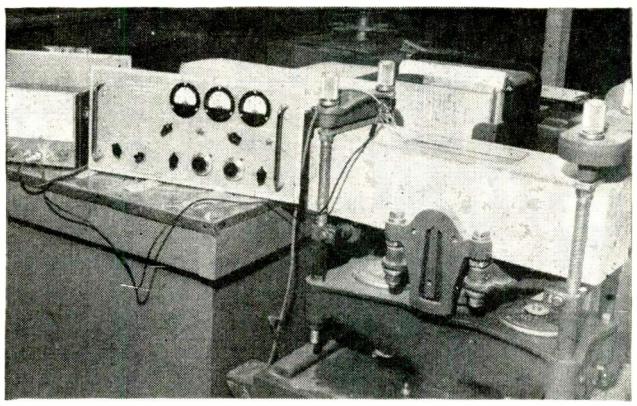


FIG. 1—Test setup checks strain gage by bending concrete beam in beam breaker that determines flexural strength

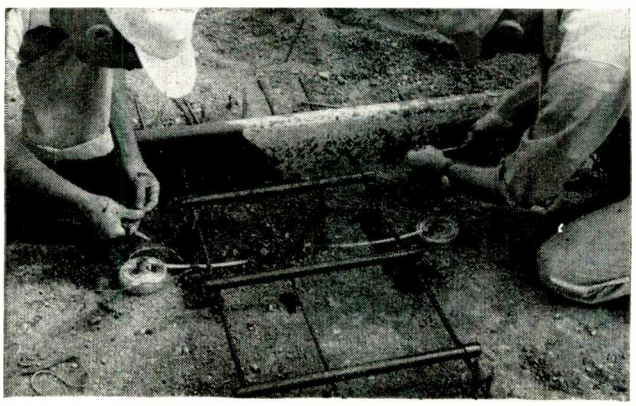


Fig. 2—Subbase contactors are installed prior to laying the pavement

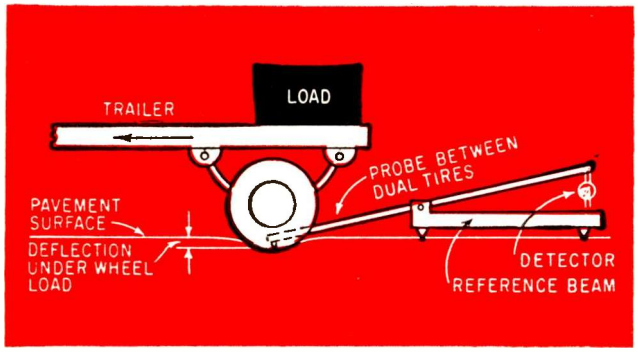


FIG. 3—Benkelman beam used to measure road distortion due to applied load as truck passes probe at creep speed. Road deflection is indicated on detector

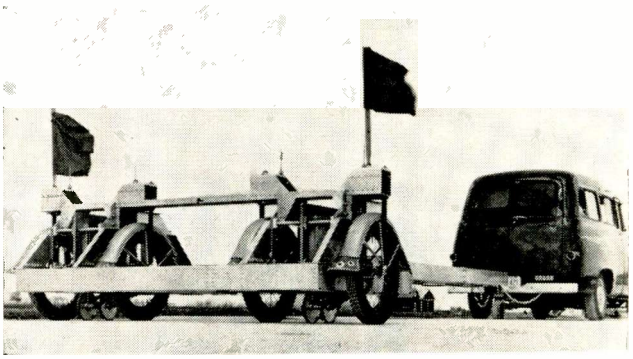


FIG. 4—Longitudinal profile of road is highly correlated with road performance. Slope-detecting wheels are located between the two pairs of large riding wheels

excursions exceeding 0.1 in.

Strains or deflections are half-wave transients with the passage of a truck wheel over a gage point. The strain or deflection assumes a shape similar to a heavily damped sine wave with half-cycle time approximately 100 milliseconds.

Strain gages for measurement of concrete strain were specially made to meet project requirements. Gages were etched foil on epoxy resin having a gage length of six inches. The foil gage was enclosed in a cover consisting of linen tracing cloth and epoxy resin covered with brass shim stock. Figure 1 shows a strain gage being tested in a beam breaker.

In operation, the gage is cemented to the concrete roadway with the leads kept under the surface and running to a junction box located alongside the test pavement.

Concrete pavement slabs warp when there is a temperature or moisture differential between the top and the bottom. Slab-subbase contact indicators are installed under the pavement to indicate whether or not the slab ends are in contact with the supporting subbase or whether the warp has broken the contact. The device is a simple pressure switch and is installed during construction as shown in Fig. 2.

The majority of deflections were measured with linear variable-differential transformers. The strain indicator, originally used by the U. S. Navy, met engineers' needs with a resolution of one microinch per inch without the need for primary calibration at each gagepoint and with extremely small error due to temperature variation or lead capacitance. These strain translators were used in all units using strain gages as transducers. These include curvature strips, direct strain measurements and the slope-measuring portion of the longitudinal profilometer.

Studies of pavements with asphaltic concrete surfacing were augmented by the use of a Benkelman beam. This device consists of a reference beam supported on the pavement surface outside the area influenced by the loaded wheel as shown in Fig. 3. Pivoted on this beam is a lever arm with one end resting on the surface. The probe is placed so that the contact end rests on the pavement in the area of load influence. The initial readings are made and the vehicle is driven away at creep speed. The operator then reads the maximum deflection value on the deflection gage attached to the free end of the lever arm.

PROFILOMETER—To measure variations of the riding surface of the road, both the longitudinal and transverse profiles are measured and recorded. To measure the longitudinal profile, a trailer similar to that shown in Fig. 4 is towed down the test highway at 5 mph. Two pairs of slope measuring wheels follow the traffic paths. Each pair of wheels is designed to provide a continuous voltage analog proportional to the slope of the angle between the road and the trailer. Another voltage, proportional to the angle between the trailer bed and horizontal, is generated and both sets of voltages are fed to the recording system shown in Fig. 5. Distance data consisting of voltage pips at each one-foot interval and additional pips to indicate start and finish of each test section are also supplied. A separate system, one for each wheel track, is provided so that a single pass of the trailer makes records for each wheel path.

The trailer horizontal reference must remain tangent to the surface of the earth despite earth rotation and must remain unaffected by acceleration. A free-spinning disk rotating on ball bearings which in turn rest on pressurized nitrogen gas was used. This almost frictionless bearing allowed the disk to spin for about one hour. Air friction existed primarily at the periphery of the disk. The disk center of gravity is a little below its support center. The disk showed some pendulum (with an 84-minute period) characteristics. The angle between disk and trailer was detected by a sensitive capacitance bridge.

As approximately 42 actual miles of charts will be generated by the longitudinal profilometer an automatic chart-reading device was developed. The oscillograph tape record is passed through a flying-spot scanner unit which reads the ordinate of the slope line at each one foot interval. The output of the scanner is digitized and punched into tape. The result is a foot-by-foot sample of analog record which can be summarized by a digital computer.

The transverse profilometer, shown in Figs. 6 and 7, consists of a truss bridging both lanes of pavement. Suspended from it are nine pneumatically operated probes that extend to, and contact, the pavement surface. At each probe, distance from

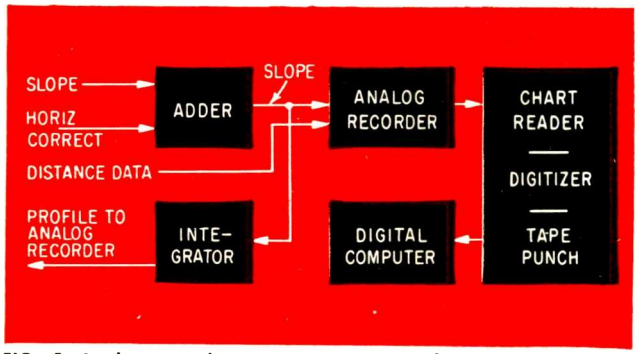


FIG. 5—Analog recorder accepts pavement slope signal which is digitized for summation purposes. Distance data and start and finish signals are also supplied

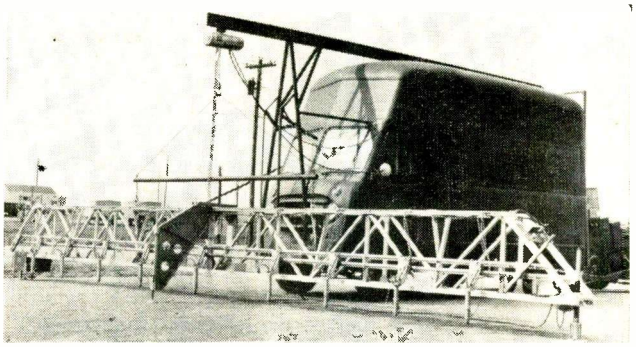


FIG. 6—Transverse profilometer truss can be quickly leveled and probes activated by equipment in truck. Motor-driven carriage (left bottom of truss) records analog of profile

pavement to truss is picked up by linear potentiometers within the probes and rut depths are sensed, digitized and punch taped. Provisions are made for an analog record of the transverse profile of the pavement under the truss.

NUCLEAR GAGE—The success of the test project rests to a large degree on the uniformity achieved in the construction of the test pavements. High uniformity in thickness, composition and condition of various test section components is desired.

In the construction of the various soil embankments, the uniformity of compaction of each 4-in. layer was checked by testing undisturbed specimens of material obtained by driven sampler tubes. Since this and any other conventional method, were not considered satisfactory for density determination of granular materials, a nuclear density-determination system similar to that shown in Fig. 8 was used.

A source of 3.5 millicurie of Cs^{137} and a halogen-quenched, neon-filled counter tube are mounted in a lead open-bottom container (Fig. 8). This surface gage is placed on the road surface and connected to a battery-operated counter and timer. During operation, the timer starts and stops the counter. With the source and the counter separated by a lead shield, the count is a function of the radiation reflected by the subsurface material. Calibration is accomplished by taking counts with the gage on blocks of materials of known densities.

HELP WANTED—The road engineering staff requires a non-destructive system for making accurate measurements, to one-percent of weight, of the moisture content of a thin (1-in.) layer of soil immediately under the pavement structure.

Among the systems tried were change in resistance due to moisture content and change in capacitance with change in dielectric (due to changes in moisture content). These have not worked with success and AASHO engineers hope that some ELECTRONICS reader may come up with an answer. Ideas would be welcomed by the Highway Research Board, National Academy of Science, 2101 Constitution Ave., Washington 25, D. C.

The author thanks W. N. Carey, chief engineer for research, AASHO, for his help.

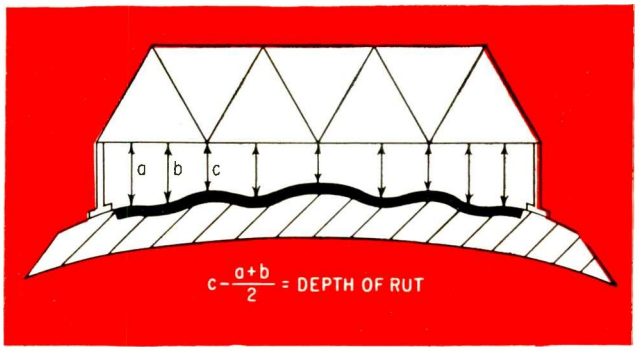


FIG. 7—To measure depth of rut, outputs of probes *a* and *b* are averaged then subtracted from output of probe *c*

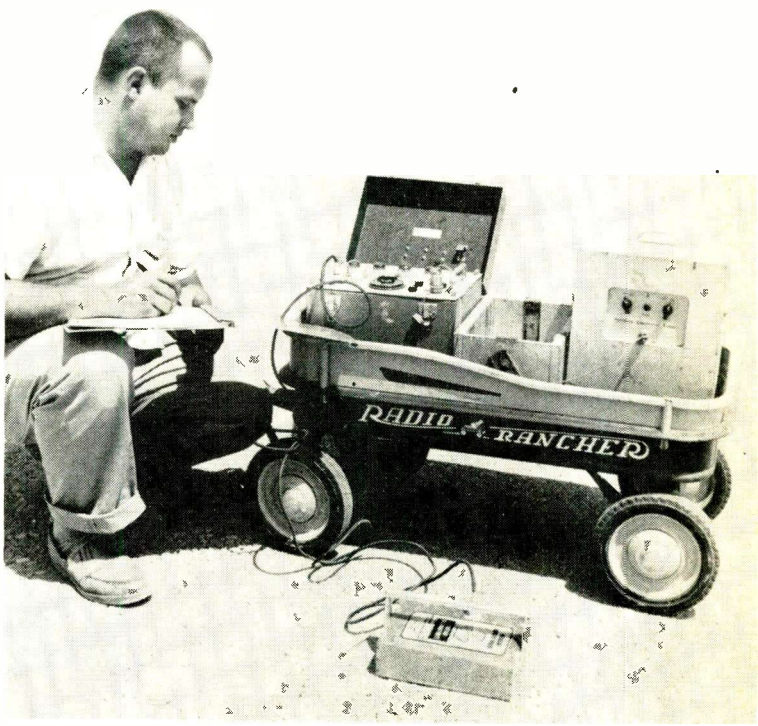


FIG. 8—Crushed stone base material density measured by backscatter from Cs^{137} source and indicated on wagon-mounted scaler

Recent Communications

Communications featured at Fall meeting of AIEE. Here's how some significant developments in microwave, telegraph and telephone systems are being used to meet some of these ever increasing requirements

By **M. M. PERUGINI,** Associate Editor

NEARLY ONE-FIFTH of the technical sessions of the AIEE Fall Meeting in Chicago were devoted to communications. Five papers, selected from over 40 presented at these communications sessions, are discussed. These papers cover microwave, telephone and telegraph systems.

Highlights of the papers were that microwave systems can handle all forms of signals used in electric power systems; undetected errors in a 5-level punched tape are reduced to only one error in 100 million characters by two error detection systems; a carrier telegraph system uses frequency-shift keying; and an economical detector makes it possible to use double-sideband, suppressed-carrier a-m in a telephone carrier system.

While four of these papers covered system descriptions, the fifth, on the use of microwaves by power utilities, stressed applications.

Microwave in Power Systems

Microwave communication systems using conventional multiplexing can handle all forms of signals normally used in the electric power business.[1] These signals include voice, telegraph, facsimile, supervisory control, load control, relaying, telemeter and alarms. There

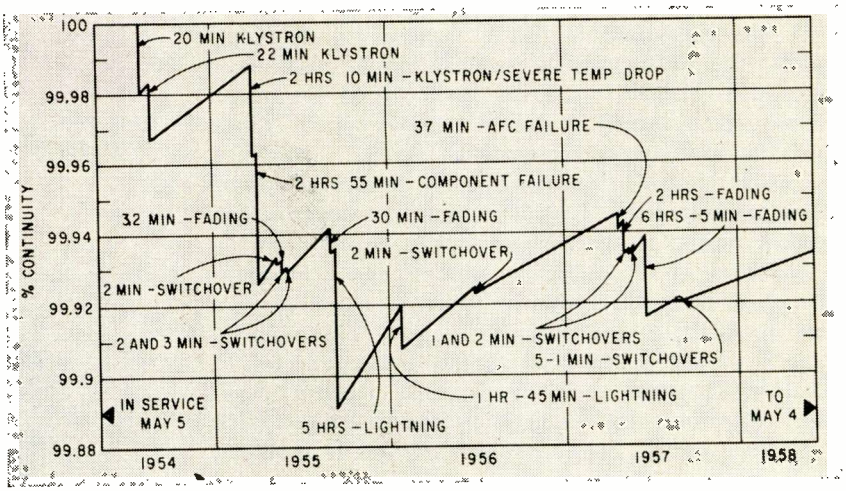


FIG. 1—Typical microwave system (Canton-Philo) provides reliable operation. Records show a continuity about 99.88 percent for the system or 99.97 percent per hop

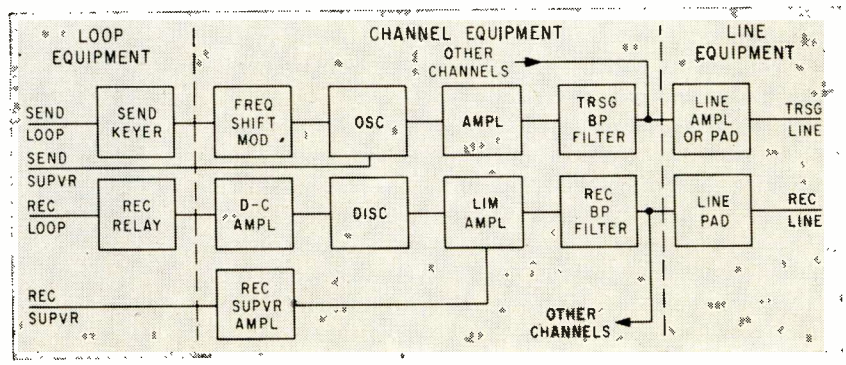


FIG. 2—Carrier frequency assignments of frequency shift carrier telegraph are coordinated with existing systems

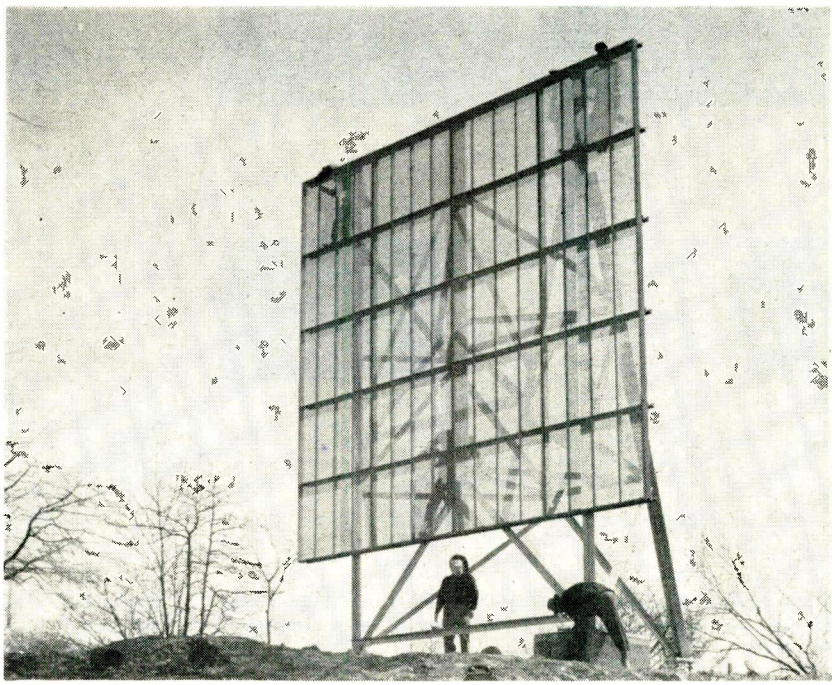
Systems Developments

seems to be no problem that will prevent the use of microwave in any future signal applications such as coded information for data processing.

Microwave circuits must compete on a cost basis with other types of communication systems used by power companies. Power line carrier, leased wires, private telephone line and carrier on private telephone line are some of these competing systems. When used for power utility operation, microwave systems have technical advantages over these alternate means of communication.

Higher intelligibility, better signal to noise ratio, lower crosstalk level, more flexibility and better continuity are some of these advantages. Figure 1 shows the continuity performance of a typical microwave system used by one power company. An additional advantage of microwave is the ability to restore zero dbm level.

By using it for long hauls, microwave can be made the backbone of power company communication systems. Local areas can then be fed by other communication methods. In this manner, the characteristics of each method are used to maximum advantage.



Large passive repeater located on Canton to Philo (Ohio) microwave system of the American Electric Power System

Telegraph System

A new 26-channel carrier telegraph system uses frequency-shift keying with transmission of one frequency indicating a mark and transmission of another frequency indicating a space.[2] Eighteen of the 26 channels are located in frequency band between 340 and 3,400 cycles while the other eight are located above 3,500 cycles. Maximum signaling speed of each channel is slightly more than 100 words per minute (80 bits per sec).

Transistorized circuits reduce heat problems in this system. A full terminal dissipates only $\frac{1}{15}$ the power of comparable vacuum tube equipment. A terminal of 18 channels occupies 7 ft of a standard 19-in. rack and has an overall depth of 10 in.

The system is divided into three functional groups as shown in Fig. 2. Use of this same division in the physical layout of the terminal has two advantages. The transistorized channel equipment is kept separate from the heat-producing loop equipment and flexibility of design and application is obtained.

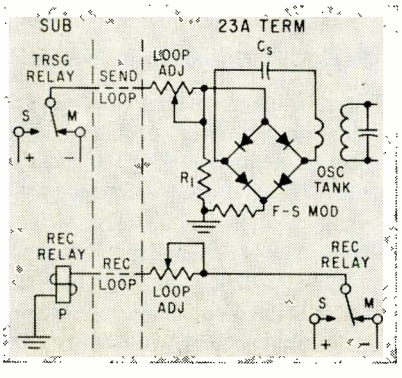


FIG. 3—Modulation arrangement for two-path polar loop uses diode bridge. Similar bridges are used for other types of loop operation

Loop Unit

When transmitting loop unit modulates the channel carrier oscillator in accordance with signals generated on the loop by a teleprinter. When receiving, the unit keys the loop in step with signals received from the distant transmitting equipment. How the loop unit functions in a two-path polar circuit is shown in Fig. 3.

The voltage developed across R_1 by the send loop current biases the diode quad. Marking current (from negative battery) biases the quad off, and C_s, the shift capacitor, is isolated from the main oscillator tank by a high impedance. Thus, the oscillator produces the high or marking frequency. Spacing current (plus battery) biases the quad

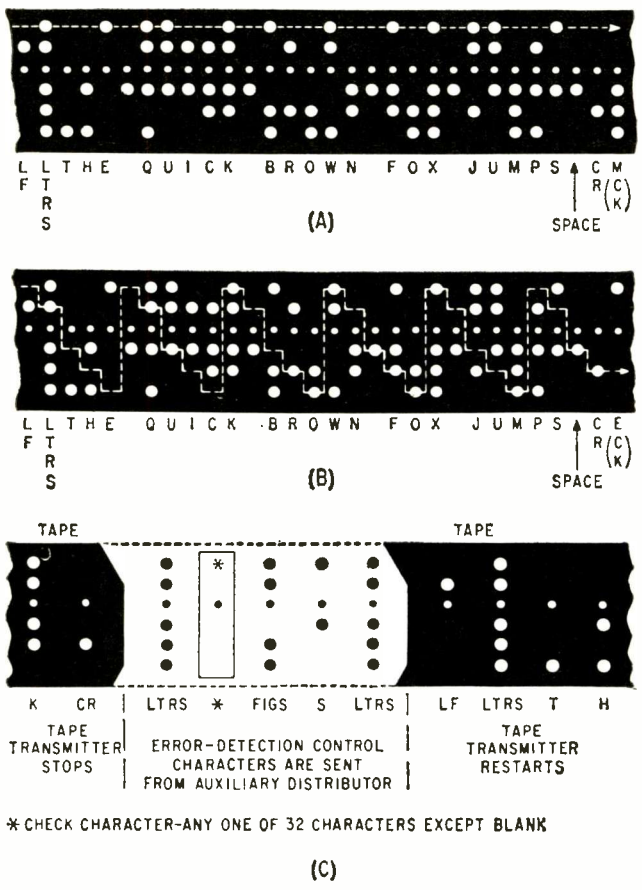


FIG. 4—Horizontal check line (A), spiral check line (B) and error-detection control characters (C) used in odd-even count error detection system

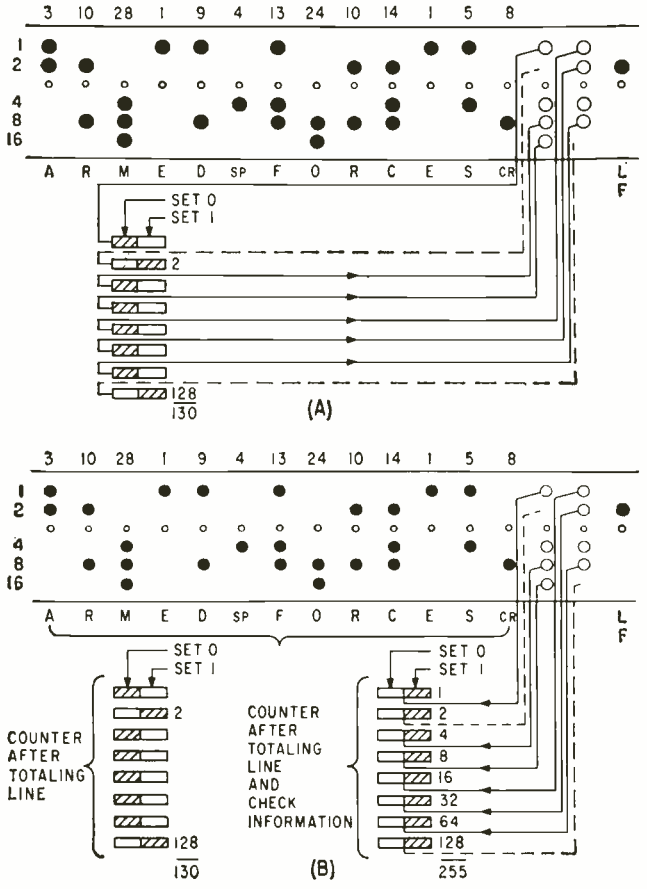


FIG. 5—Method of preparing tape at sending station (A) and checking tape at receiving station (B) in binary totaling error detection shows how characters are totaled

on, coupling the shift capacitor into the main oscillator tank. Under these conditions the oscillator produces the low or spacing frequency. On the receive side, polar signals are developed in the loop from the contacts of the receive relay.

To obtain good frequency stability as a function of voltage, a ferrite core inductor, resonated with a polystyrene film capacitor, is used in the oscillator tank. Because the core and capacitor have nearly equal and opposite temperature coefficients, this combination also gives good stability as a function of temperature. After measuring resonant frequency of the tank at room temperature and 50 C, any residual coefficient is reduced by padding the tank with capacitors of zero, negative or positive temperature coefficients as required.

Error Detection

Transmission of more numeric material (data) and the direct use of transmitted material in automatic computers without the material being read and checked by a human operator are becoming more common. These two trends have increased the demand for an automatic means of detecting transmission errors. Two error detection systems for 5-level punched tape use the common teleprinter code and add check characters to the data being transmitted. One method[3] uses odd-even counts to generate the check characters; the other[4] uses a binary totaling system to determine the check character.

Odd-Even Counting Principle

The odd-even count method adds, at the originating end, a check character after each typed line or portion of a line terminated by a carriage return (CR) signal.

When the transmitter senses a CR signal in the tape, it stops and waits while five error detection control characters, including the check character, are sent on the line from the error-detection circuit. The transmitter then resumes sending, the next character being the line feed (LF) character which advances the teletypewriter paper.

The check character is generated from five odd-even counts of the marking signal elements in five separate lines along the punched tape. Each counting line may be a horizontal line, Fig. 4A. An alternate form of counting line, Fig. 4B, shifts one level vertically for each character of horizontal advance.

Each of the five lines generates from its count a check bit. This check bit is a mark if there are an odd number of marks in the line, a space if there is an even number. The check bits are then used as the five signal elements of the check character, (CK) in Fig 4A and B.

Figure 4C shows the control characters that are inserted by the error-detection circuit at the sending end. These five control characters are sent over the line from an auxiliary distributor.

At the receiving end a new check character is generated from the received text by the same process as that used at the sending end.

This locally generated check character is compared to the character sent over the line. If the two do not agree, it indicates that an error has occurred in the preceding line of text. When a transmission error is detected, an identifying mark is made on the copy of the line in error.

Binary Totaling

Figures 5A and B illustrate the basic features of the two-character binary total error detection system. Each character in the text is considered a five-digit binary number with levels 1 through 5 having weights 1, 2, 4, 8 and 16 respectively. The characters in a variable-length line which does not exceed 72 characters are totaled up to and including the CR by a counter.

The counter has eight stages and can therefore total from 0 to 255. As the total for a line of 72 characters can be as high as 2,232, the counter cycles a number of times in totaling an average line.

At the end of the group the complement of the 8-digit binary total in the counter is punched in the tape as levels 1, 2, 4 and 5 in two characters. The third level of each of these characters is always punched to avoid the formation of control-character combinations used in switching systems.

The checking process at the receiving station consists of again totaling the characters in the group in a counter similar to the one in the sending unit. The eight binary digits in the two check characters are also totaled and if no errors were introduced in transmission this results in all eight stages of the counter being reset to 1.

If any of the bits in the block were reversed during transmission at least one of the stages in the receiving counter would be set on zero. When this happens, an alarm sounds and the text is marked in red.

Telephone Carrier

A new telephone carrier system provides up to 24 circuits on two cable pairs between offices where the attenuation of the trunks does not exceed 200 db at 480 kc.[5] Depending on the gage and capacitance of the cable pairs, this represents a distance of between 10 and 20 miles.

Based on double-sideband, suppressed-carrier modulation, this multiplex equipment uses a base group of 12 channel modulators (transmitters) operating at carrier frequencies between 292 and 476 kc and a corresponding base group of 12 channel demodulators (receivers) operating between 68 and 252 kc. Although each channel occupies 8 kc, the spacing between channels is 16 kc to permit interleaving of the two directions of transmission and to prevent crosstalk.

To close the transmission path between the 12-channel modulator group and the 12-channel demodulator group, it is necessary to translate (group-modulate or -demodulate) once. The system block diagram is shown in Fig. 6.

The channel modulator-demodulators (modem) contain the channel transmitters and receivers. They also provide the crystal controlled carrier supply for the transmitters.

Signal Supply

One signal supply provides 3.7- and 3.9-kc tones for 24 signaling units. The group modulator translates 12 high group transmitting channels to the low group spectrum and combines both groups. Separation of high group from the low group and amplification of the low group for channel detection is provided by the group receiver amplifier.

The group demodulator translates 12 high group receiving channels to the low group spectrum and amplifies the group for channel detection. The line amplifier boosts the channels to line level for transmission and provides span adjustment, equalization and amplification for received signals. It includes facilities for connecting repeater power.

Repeaters

Regulating and nonregulating repeaters are used. While both types furnish a normal gain of 25 db at the highest line frequency (480 kc), the regulating repeaters compensate for line variations of ± 8 db. Repeaters are installed at the same point for both directions of transmission with every third repeater being the regulating type. Power for the repeaters is fed over the same cable pairs on which they are installed. Ten repeaters can be used in a system without using an intermediate power source as up to five repeaters can be fed from each end.

This completely transistorized system uses plug-in units and module-type construction in both terminal and repeater equipment. Handles on the plug-in units assure easy removal of the units from the equipment.

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(2) M. L. Stephens, Lenkurt Electric Co., San Carlos, Calif., Design Features of a New Frequency Shift Carrier Telegraph System, 59-1111.

(3) P. H. Barry, Teletype Corp., Chicago, Ill., and A. L. Whitman, Bell Telephone Laboratories, New York, N. Y., An Error-Detection System for 5-Unit-Code Teletypewriter Transmission, 59-1106.

(4) R. Steeneck and H. F. Caley, Western Union Telegraph Co., New York, N. Y., Detection of Transmission Errors In 5-Level Punched Tape, 59-1147.

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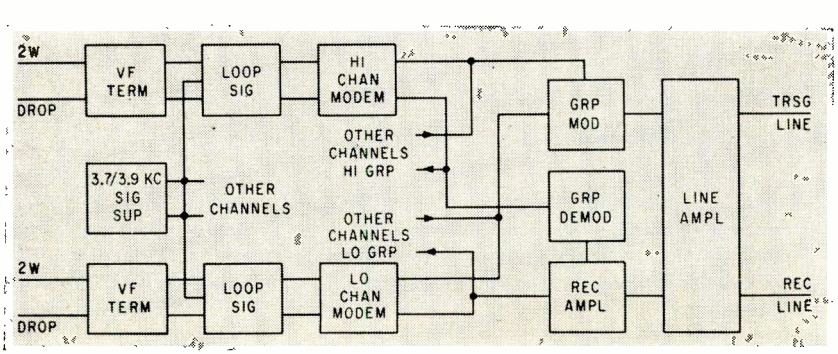


FIG. 6—Terminal of telephone carrier system. Four terminals can be mounted in one 11-ft, 6-in. bay

Typical High-Power

Table I—Characteristics of Typical Silicon Power Transistors[a]

Type	Structure[b]	Manufacturer[c]	V_{CEmax} (v)	I_{Cmax} (amp)	β_{min} (amp)	@ I_C	R_{Smax} (ohm)	t_r (μsec)	$f\alpha$ (kc)	R_{thmax} (°C/w)	T_j (°C)	$\frac{V_{CEmax}}{I_{Cmax}}$ (w)	$\frac{I_{Cmax}^2}{R_{Smax}}$ (w)
2N-1016-F	*npn*-F	WEC	300	5	10	5	0.50	20	300	0.70	150	1,500	12.5
2N-1015-F	*npn*-F	WEC	300	5	10	2	0.75	20	300	0.70	150	1,500	18.8
2N-1016-E	*npn*-F	WEC	250	5	10	5	0.50	20	300	0.70	150	1,250	12.5
2N-1015-E	*npn*-F	WEC	250	5	10	2	0.75	20	300	0.70	150	1,250	18.8
2N-1016-D	*npn*-F	WEC	200	5	10	5	0.50	20	300	0.70	150	1,000	12.5
2N-1015-D	*npn*-F	WEC	200	5	10	2	0.75	20	300	0.70	150	1,000	18.8
2N-1016-C	*npn*-F	WEC	150	5	10	5	0.50	20	300	0.70	150	750	12.5
2N-1015-C	*npn*-F	WEC	150	5	10	2	0.75	20	300	0.70	150	750	18.8
2N-1016-B	*npn*-F	WEC	100	5	10	5	0.50	20	300	0.70	150	500	12.5
2N-1015-B	*npn*-F	WEC	100	5	10	2	0.75	20	300	0.70	150	500	18.8
2N-1016-A	*npn*-F	WEC	60	5	10	5	0.50	20	300	0.70	150	300	12.5
2N-1015-A	*npn*-F	WEC	60	5	10	2	0.75	20	300	0.70	150	300	18.8
2N-1208	*npn*-D	TEC	60	5	15	–	1.5	0.25	12mc	0.50	200	300	37.5
ST-400	*npn*-D	TEC	60	5	15	2	2.5	0.25	6 mc	2.5	200	300	62.5
2N-1212	*npn*-D	TEC	60	5	12	–	2.5	0.25	2 mc	0.50	200	300	62.5
2N-1250	*npn*-D	TEC	60	5	15	...	....	0.25	6 mc	0.50	200	300	....
2N-1070	*npn*-D	STC/RCA	60	4	10	1.5	0.67	.....	1.2 mc	3.0	175	240	10.7
2N-1069	*npn*-D	STC/RCA	60	4	10	1.5	2.0	.....	1.2 mc	3.0	175	240	32
2N-1209	*npn*-D	TEC	45	5	20	...	1.5	0.25	12 mc	0.50	200	225	37.5
ST-401	*npn*-D	TEC	45	5	20	2	2.5	0.25	6 mc	2.5	200	225	62.5
ST-402	*npn*-D	TEC	60	3	15	2	4.0	0.25	6 mc	3.0	200	180	36
2N-424	*npn*-D	TEC/TII	80	2	12	1	10	0.70	6 mc	2.1	200	160	40
2N-1016	*npn*-F	WEC	30	5	10	5	0.50	20	300	0.70	150	150	12.5
2N-1015	*npn*-F	WEC	30	5	10	2	0.75	20	300	0.70	150	150	18.8
2N-1072	*npn*-D	WEST	75	2	..	...	....	.....	.....	....	175	150	....
ST-403	*npn*-D	TEC	45	3	15	2	3.0	0.25	6 mc	3.0	200	135	27
2N-389	*npn*-D	TEC/TII	60	2	12	1	5.0	.....	8 mc	2.1	200	120	20
ARA-46P	Composite	ARA	40	3	10,000	...	5.0	.....	.....	2.6	200	120	45

[a] V_{CEmax}—Blocking voltage capability; I_{Cmax}—Current carrying capacity; R_{Smax}—Collector saturation resistance; β—current transfer ratio; $f\alpha$—frequency response; t_r—switching time; R_{th}—thermal resistance; T_j—junction temperature

[b] F—fused; D—diffused

[c] WEC—Westinghouse Electric Corp; TEC—Transitron Electronic Corp.; STC—Silicon Transistor Corp.; RCA—Radio Corp. of America; TII—Texas Instruments Inc.; WEST—Western Electric Co.; ARA—Advanced Research Associates Inc.

Silicon Transistors

Properties of 28 commercially available high-power silicon transistors made by 7 manufacturers are listed. Article also gives indications of expected levels of performance of future devices

By **THOMAS P. NOWALK,** Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.

ADVANCES IN SILICON TECHNOLOGY over the past few years have generated a new family of power transistors. Silicon transistors for power applications of the several kilowatt range and higher are anticipated for the near future.

This article describes the present plateau of silicon power transistor development in terms of selected electrical characteristics. Primary data were obtained from specification sheets of commercially available units. Some developmental information is also included to indicate expected levels of performance of future devices.

The subject group of silicon transistors is loosely defined as high power. Limits of this category reflect the state of the art, among other things. Since current ratings are increasing in large increments, and thereby extending the range to very high values, the arbitrary minimum selected for this category is a collector current of two amperes.

Evaluation of high power transistors can be made in terms of several pertinent electrical and thermal characteristics. The common-emitter switching mode is assumed since the majority of applications employ this configuration. Moreover, it simplifies comparison of the devices in terms of power handling capability.

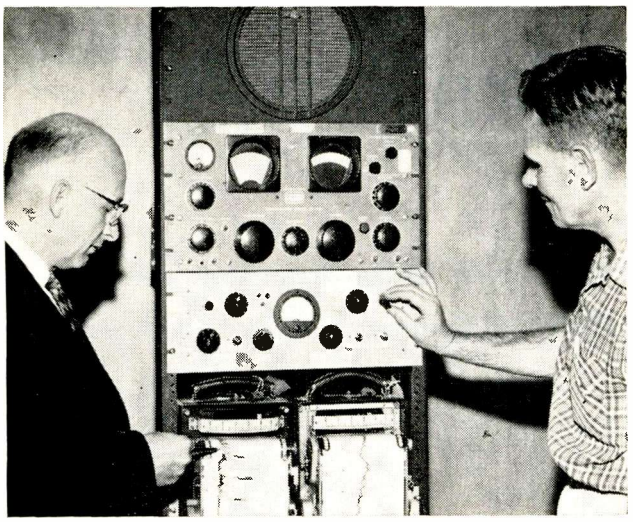
Data of typical commercially available units which satisfy the criterion of two amperes collector current, minimum, are given in Table I. The second column indicates a fused (F) or diffused (D) structure. The last two columns serve to compare devices in terms of power handling capability, defined as the product of V_{CEmax} and I_{Cmax} and power loss, defined as the product of I_{Cmax} squared and R_{Smax} (see footnotes of Table I). The importance of other listed characteristics is not meant to be minimized; rather, it is believed that the noted product expressions best summarize the relative merits of power transistors.

Interesting points arise, too, concerning the basic structures employed. Both utilize *p*-type silicon. The advantages include availability of high quality crystal and high minority carrier mobility. Electrically, the diffused structure is characterized by high current gains (and a flat β against I_c falloff), high frequency response and fast switching times. The fused structure is characterized by high blocking voltage and low saturation resistance (and, consequently, low power losses at equivalent output currents).

Table II includes available information on devices currently in development. The listing is by no means complete, since data are understandably sketchy in this area. The significant feature is the expected increase in current ratings. From this, one might extrapolate to future devices with current ratings in the range of hundreds of amperes. This is pure speculation in view of the tremendous difficulties which arise in the fabrication of large area devices.

Table II—Some Developmental Silicon Power Transistors

Manufacturer	Development
Pacific Semiconductors	10, 20, 50 and 100 ampere devices possessing high frequency characteristics
Texas Instruments	Several high current transistors to be introduced this year
Westinghouse Electric	30 and 50 ampere transistors with voltage ratings as high as 150 volts (V_{CE}) and saturation resistance less than 0.1 ohm at rated current
Westinghouse Electric	High gain (beta of the order of 1,000) cascaded transistors with voltage ratings as high as 150 volts and current ratings of the order of 10 amperes



Two of the authors demonstrate continuous fading rate recorder. Chart on left records radio signal fading rate

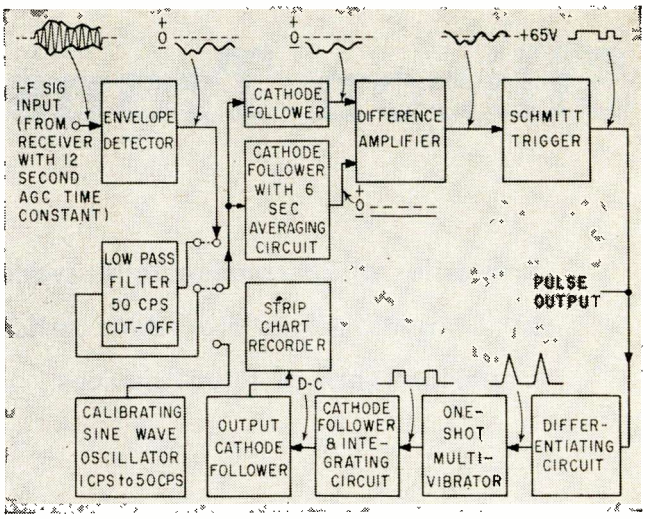


FIG. 1—This recorder diagram shows progressive transformations of i-f signal input

Fading Rate Recorder for Propagation Research

Continuous, simultaneous recordings of radio signal strengths and fading rates are needed in radio propagation research. This instrument provides strip-chart recordings of fading rates from almost zero cps up to 300 cps

By J. W. KOCH, W. B. HARDING and R. J. JANSEN,

Radio Communication and Systems Division, National Bureau of Standards, Boulder Laboratories, Boulder, Colo.

RECORDINGS of median strengths of received radio signals have been made at the Boulder Laboratories of the National Bureau of Standards for a number of years. Such recordings are used in radio propagation studies. Recently, the need for an instrument which would provide continuous, simultaneous recordings of both average fading rate and strength of radio signals at h-f and vhf led to the development of the strip-chart recorder shown in Fig. 1.

This recorder is an improved version of a previous design that records the number of times per second that the signal envelope crosses the average signal level with a positive slope.[1] The improved circuit allows faithful recording of fading rates down to almost zero cps and to as high as 300 cps.

Although it records the rate of average signal crossings rather than median signal crossings, and hence may not strictly agree with fading rates as frequently defined, this recorder does provide a convenient means for comparing average fading rates for various propagation conditions and transmission frequencies.

Input for this recorder (Fig. 1 and 2) is taken from the i-f output of a receiver that has a 12 second or longer time constant in the age circuit. A long time constant is necessary to maintain receiver gain at an approximately fixed value over the recorder integrating period.

Recording Range

The envelope detector and input circuits will handle intermediate frequencies in the range of 100 to 455 kc. The amplifiers feeding the diode detector have excellent linearity over the range of signal voltages used. An output voltage of 10

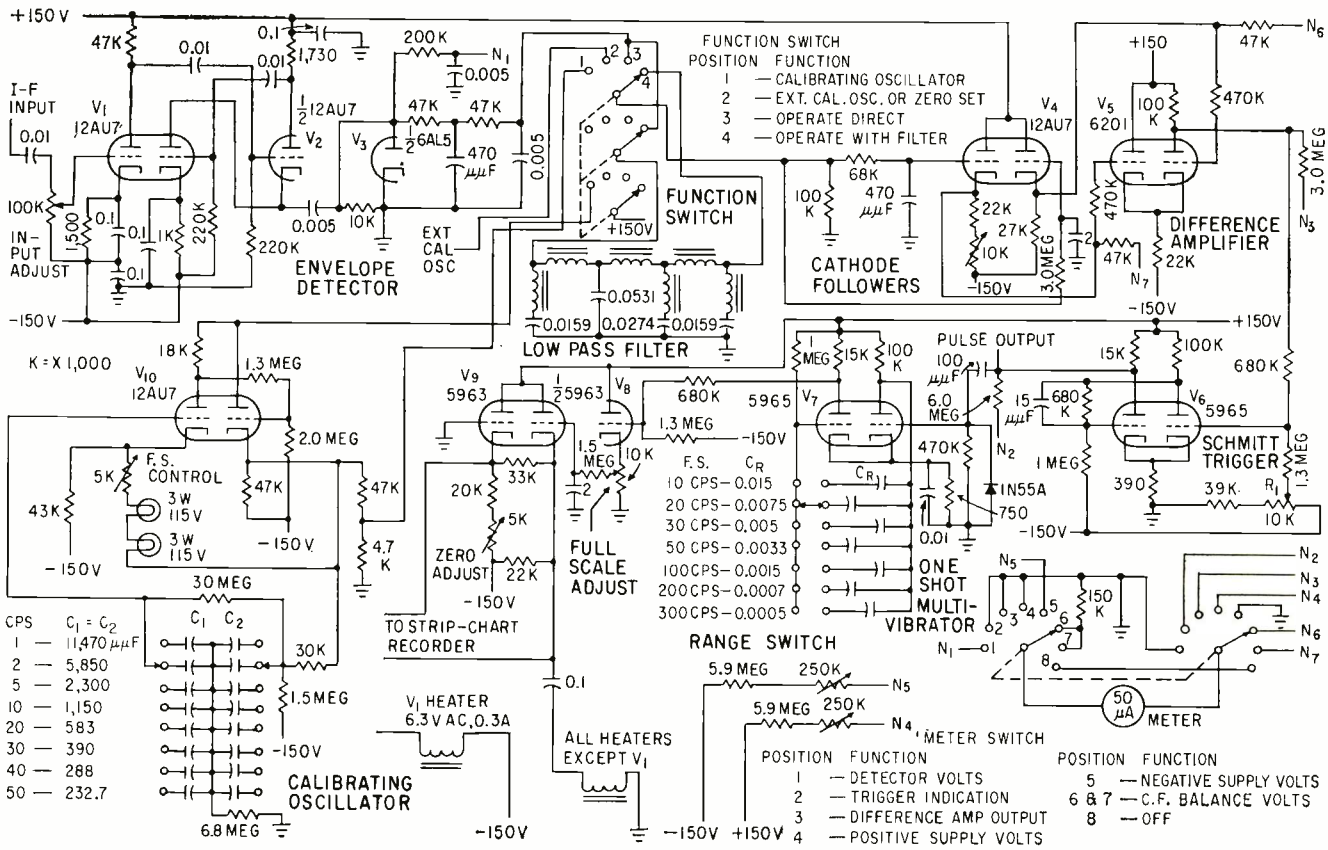


FIG. 2—Complete schematic of fading rate recorder. This unit records fading rates from less than 0.5 cps to 300 cps at receiver i-f frequencies from 100 kc to 455 kc

volts d-c is obtained for an i-f input voltage of approximately one volt rms.

Cathode Followers

The envelope detector feeds two cathode followers; the input circuit of cathods follower V_{4B} includes an integrating circuit with a six-second time constant. Average signal level is determined as the output voltage of the integrating circuit. Cathode follower V_{4A} has an adjustable cathode resistance which allows equalization of cathode voltages for zero input voltage.

The difference amplifier,[2] V_5, has a constant output plate voltage of approximately 64 v whenever the inputs to the two grids are equal. The performance of this stage may be expressed mathematically as

$$e_0 = \mu R_L(e_1 - e_2)/(2r_p + R_L) = A(e_1 - e_2)$$

where e_0 represents departure from the equal-signal plate voltage mentioned above, and e_1 and e_2 are the voltages on the two grids. The voltage e_2 is the integrated signal level, and e_1 is the instantaneous value of the signal envelope. Thus the output voltage changes sharply with variations of signal about the average value.

Schmitt trigger V_6 following the difference amplifier, is adjusted to switch ON and OFF respectively at one volt above and below the difference amplifier equal-signal output voltage. These two conditions correspond to a difference in the grid voltages of the two input cathode followers of about 0.07 v. The square-wave output of the Schmitt trigger is differentiated, and the resulting positive pulse triggers one-shot multivibrator V_7.

One-Shot Multivibrator

When the signal envelope crosses the average signal level with a positive slope, the one-shot multivibrator produces a rectangular positive pulse which has a peak value equal to the applied d-c plate voltage from a regulated power supply. The pulse width is short compared to the period of the maximum fading rate for which the instrument is calibrated.

For instance, when the instrument is set for a full scale fading rate of 10 cps, the pulse width at the output of the one-shot multivibrator is approximately 6 milliseconds. The pulse width is proportionately shorter when the instrument is set for higher fading rates with the range switch.

Cathode follower V_8, which is biased beyond cut-off, is connected to the output of the one-shot multivibrator. The cathode follower output is a constant-amplitude pulse, equal to the difference between the positive excursion of the applied pulse and the cut-off voltage of the cathode follower. This pulse output is integrated, and applied to the input of cathode follower V_9 which drives the strip-chart recorder. Output circuitry is so arranged that d-c drift is at a minimum. The voltage to the strip-chart recorder is proportional to the number of one-shot multivibrator pulses per second; hence the recorder indication is a linear function of the fading rate.

Sine wave oscillator[8] V_{10} facili-

tates calibrating the strip-chart recorder in fades-per-second. Output frequencies at discrete intervals are made available by switching capacitors in the bridged-T negative feedback network. Calibrating frequencies from 1 cps to 50 cps are used in the present unit. An external oscillator may also be used for calibrating to 300 cps.

Low-Pass Filtering

Inasmuch as the fade-rate recorder cannot distinguish between carrier fading and intended or incidental amplitude modulation of the carrier, it is desirable to filter out the amplitude modulation components. If fading rates no greater than 50 cps are expected, a low pass filter with a cut-off frequency of 50 cps may be inserted between the envelope detector and the inputs to the first cathode followers. The use of such a filter makes possible the recording of fading rates of the received signals from high-frequency broadcast stations.

With the filter, when the envelope detector average output voltage is 4 volts, 100 percent modulation at 103 cps would be required to cause the recorder to indicate. Inasmuch as high percentages of modulation are infrequent at low audio frequencies with normal program material, the use of the filter provides good protection from the effects of amplitude modulation.

A high attenuation factor at 60 cps has also been built into the filter to eliminate the effects of hum modulation, which is present on some carriers. Of course, where signal fading rates in excess of 50 cps are encountered, such as in propagation through disturbed ionospheric regions, the use of the filter is not practicable.

Adjustment Procedures

When the low-pass filter is used, the level control in the input circuit to the envelope detector is adjusted for an average value of detector output voltage of about 4 volts. This adjustment gives good protection against amplitude modulation effects, and will allow resolution of fades to 50 cps with a minimum total variation of 0.4 to 0.9 db. If the filter is not used the average detector voltage is reduced to about

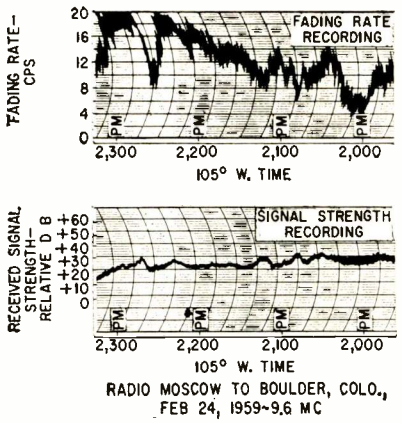


FIG. 3—Typical recording of fading rate and average signal strength

2.0 to 2.5 v to minimize the effects of noise. A resolution of fades with a minimum total variation of about 0.6 db will be obtained with this adjustment.

Even though the average signal level may vary diurnally over quite wide limits, the operation of the unit will not be seriously affected for considerable departure from the suggested values of detector output, as long as noise contamination of the signal is not great. A departure of plus or minus 30 db in received signal level from the adjustment value will not noticeably affect operation, assuming the receiver agc circuit is operating satisfactorily.

Schmitt trigger threshold is adjusted by placing the function switch and meter switch in the number 2 position, and noting the d-c voltage as threshold adjustment R_1 is moved. The control is set midway between the ON and OFF positions. The strip-chart recorder may then be calibrated with the oscillator. A zero adjustment and full-scale adjustment are available for setting the strip-chart recorder for the desired full-scale value. The range switch, which adjusts the pulse width of the one-shot multivibrator, must be set to a position corresponding to the full-scale fading rate. After calibration, the function switch is placed in the direct-operation or filter-operation position, as required.

Typical Results

The fading rate recorder has proved to be quite stable in operation after an initial warm-up period of 12 hours, when used with regulated positive and negative power supplies. A typical fading rate recording is shown in Fig. 3, along with a simultaneous recording of average signal strength. A 12 second time constant is used in the signal strength recording circuit.

Flutter fading at rates up to 20 cps occurs for paths through the auroral zone. Other recordings show a change in fading rate when rather sudden changes in signal level occur, probably due to propagation mode change at these times. Spikes caused by noise fluctuations appear on the fading rate records during transmitter OFF periods. Occasional noise spikes are noted on WWV recordings at times when the transmitter is not off; these are caused by impulse noise interference.

These continuous, simultaneous recordings of fading rate and signal strength should provide additional information for increased utilization of ionospheric propagation in communications. However, the user must exercise caution in applying the results of the fading rate recordings directly to communication problems, as the depth of fading and amplitude distribution of the signal envelope may vary considerably. This recorder gives no indication of these factors.

Also, the user must keep in mind that fading rate for this instrument is defined as the number of times per second that the signal crosses the average signal level with a positive slope. Despite these limitations, however, this fading rate recorder does provide a convenient method for comparing fading rates for various propagation conditions and paths.

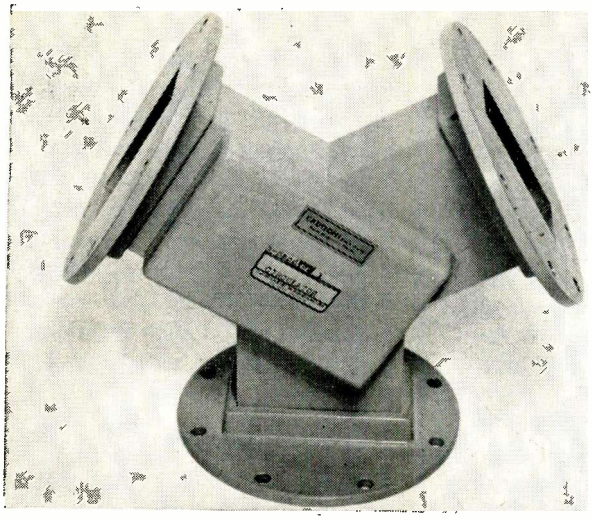
The development of the instrument was carried out in behalf of the U. S. Air Force, Wright Air Development Center, Wright-Patterson AFB, Ohio under Delivery Order (33-616) 58-16.

References

(1) Ben B. Balsley, A Device to Continuously Record the Rate of Fading of an Ionospherically Propagated Signal, Report in preparation for publication, NBS, Boulder Labs.

(2) G. E. Valley, Jr., and H. Wallman, "Vacuum Tube Amplifiers", McGraw-Hill Book Co., New York, N. Y., 1948.

(3) Peter G. Sulzer, A Note on a Bridged-T Network, *Proc IRE*, 39, p. 819, July, 1951.



Y-type circulator for S-band. See Fig. 8 for typical data

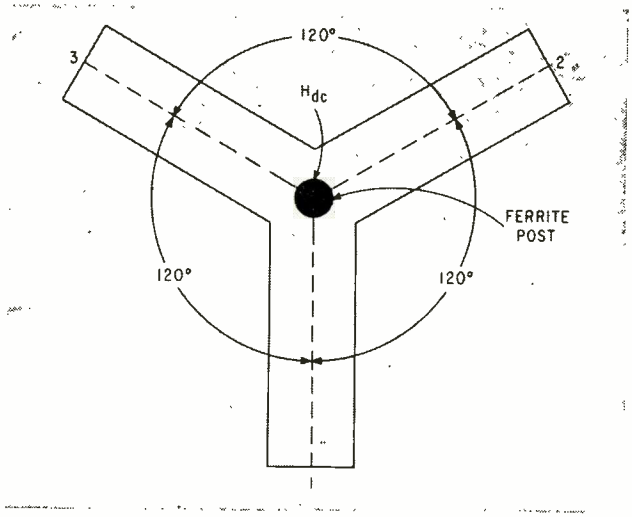


FIG. 1—Circulator's cylindrical ferrite produces transverse d-c field

New Microwave Circulators

These Y-type circulators have wide bandwidth and high power-handling capabilities

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THORNTON R. CURRY,
Naval Research Laboratory, Washington, D. C.

THE Y-CIRCULATOR consists of an H-plane junction of three identical waveguides joined to form a symmetrical Y-shaped figure. The region of the junction of the three waveguides contains a symmetrical distribution of ferrite which is transversely magnetized. Symmetry is three-fold, making the structure appear the same when looking into any one of the three waveguides (Fig. 1). Because of the geometrical symmetry, if all the power into one of the guides comes out an adjacent guide, the same will be true of all three guides; thus the device will be a circulator.

Since the magnetized ferrite is an anisotropic medium, this configuration is not electrically symmetrical even though it has geometrical symmetry. When waves propagate through a section of ferrite-loaded rectangular waveguide which is transversely magnetized, the r-f field distribution is asymmetrical even though the distribution of ferrite is symmetrical. This is shown in Fig. 2 for a rectangular waveguide filled with ferrite. Field distribution is asymmetrical because the r-f magnetic field is elliptically polarized in planes parallel to the broad faces of the guide, and is of opposite sense on either side of the guide. Since effective r-f permeability of the magnetized ferrite depends on the sense of polarization, the two sides of the ferrite-loaded guide are electrically dissimilar. This explains why all the power can be diverted into an adjacent waveguide in the junction by properly displacing the field to one side.

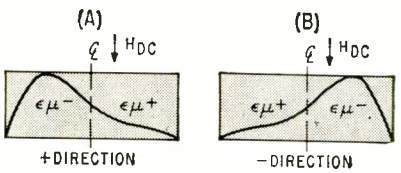
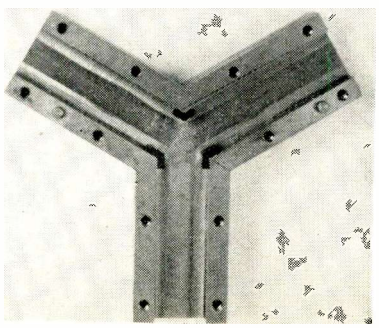


FIG. 2—R-f fields in positive (A) and negative (B) directions of wave travel

FIG. 3—Circulator has three V-shaped ferrite slabs against inside surfaces of waveguides



Power Guidance

Several methods of guiding all the power from one waveguide to an adjacent one have been tried. The method shown in Fig. 1 uses a ferrite post in the junction region. The ferrite post deviates the energy entirely into the adjacent guide; no energy is transmitted into the unwanted guide. This occurs because the dimensions and field are so chosen that reflections from the junction boundaries cancel the signal that might otherwise enter the third guide.

Another method uses slabs along

MICROWAVE CIRCULATORS

Circulators are of fundamental importance in the design of all types of radar systems. They can be used as passive duplexers, switches, modulators and isolators. When used as duplexers they eliminate problems created by the t-r and atr tubes (for example, the difficulty in seeing close-in targets, because of deionization time). Circulators used as switches are more reliable and faster acting than the mechanical switches they replace.

Since no large mismatch occurs during the switching cycle, there is less need for auxiliary equipment to protect the generator during the switching period. A circulator used to replace an isolator can be designed for high average power since absorbed power is dumped into a matched load instead of the ferrite itself, as occurs with conventional isolators. This is important if the isolator must dissipate all the incident power as happens when the load is short circuited.

The Y and T circulators depend on field displacement for their operation. Both are smaller, lighter in weight and less expensive to build than conventional differential phase shift circulators.

The Y circulator is symmetrical looking into any of its ports. If all the power into one of the guides can be made to come out of an adjacent guide, then this condition holds for all three guides and the device will be a circulator. This is not true of the T. Since the T is asymmetrical each of its ports must be separately matched to have the device operate as a circulator.

The Y will operate without any matching devices. Thus, the bandwidth of the Y is better than that of the T. The Y also has lower insertion loss and higher isolation for all ports than the T. Because the Y requires no matching, no large standing waves exist in the junction area. This makes the Y more suitable than the T for high-power applications. High-power models of the Y have worked at power levels up to 100 kw peak (100 w avg.). All available T circulators are low-power devices

each side of the three waveguides as shown on Fig. 3. Almost all of the energy is trapped in one of the slabs in the ferrite dielectric mode and is guided continuously by the slab from one waveguide into the adjacent one. Lax and Button have calculated the field distribution for symmetrical slabs of ferrite transversely magnetized in the same direction. If the ferrite slabs are sufficiently thick one slab guides a wave traveling in the forward direction and the other slab guides the wave traveling in the reverse direction. Figure 4 shows the r-f E and H fields under these conditions.

The first symmetrical configuration used experimentally consisted of a ferrite circular cylinder placed at the junction of three rectangular waveguides intersecting at 120 deg. Circulator action was obtained by choosing the rod diameter and by applying a transverse field. Rod diameters from 0.125 in. to 0.500 in. were tried. At 9,375 mc, the best results were obtained with a Ferramic R-1 rod 0.350 in. in diameter, which filled the 0.400 × 0.900-in. guide in height. The loss was less than 0.5 db and isolation and reflection were greater than 30 db over a 50-mc frequency band. The d-c field was about 120 oersteds.

Other configurations having three-fold symmetry were tried.

Circulator action was also obtained using ferrite slabs and wedges. Figure 5 shows a few ferrite configurations. Ferrite dimensions must be properly selected. The double-slab combination is most amenable to theoretical evaluation, but it is more lossy and has higher reflections than the post or wedge. This is probably caused by the large volume of ferrite material required. At 9,375 mc, slabs 0.125 in. or more were necessary to get circulator performance. It should be possible to get better loss figures and more bandwidth from the slab configuration by using ferrite material and special matching techniques.

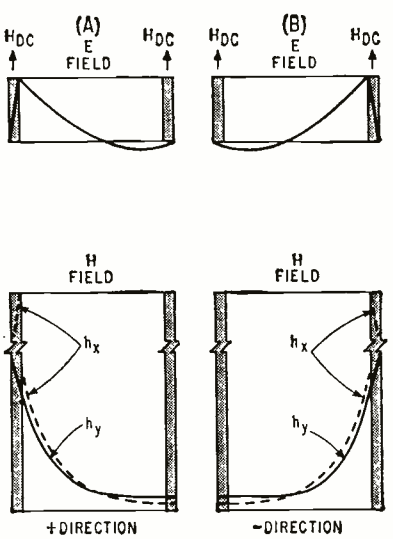
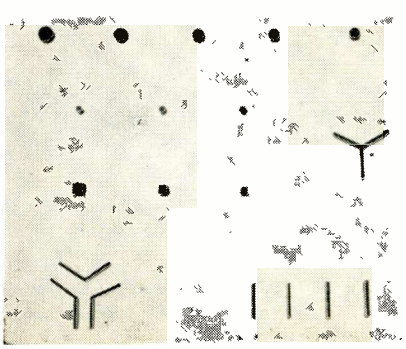


FIG. 4—Graphs of E and H-field distributions along two cross sections of waveguide in positive (A) and negative (B) directions

FIG. 5—Ferrite configurations for circulators



Test Data

Figure 6 shows a typical set of data using a wedge of Ferramic R-1, 0.400 in. on each side and filling the guide in height (0.400 in.). Loss is less than 0.75 db, and the reflection and isolation are greater than 20 db from about 9,200 to 9,500 mc. This frequency band can be shifted by either selecting different ferrite dimensions or changing the d-c field of 189 oersteds. Isolation and reflection of from 30 to 40 db are obtainable any place in the X band. Limited high-power tests of this unit indicate that it will operate without breakdown at 50 kw peak. However, the power absorbed increased to 1.3 db because of the nonlinear characteristics of the ferrite material.

Two of these three-port Y circulators can be connected in series to produce a four-port circulator. Such a circulator (Fig. 7) has its Y junctions separated by about one-half guide wavelength. The d-c field strength is 189 oersteds. Loss is less than 0.75 db and the reflection and isolation greater than 18 db

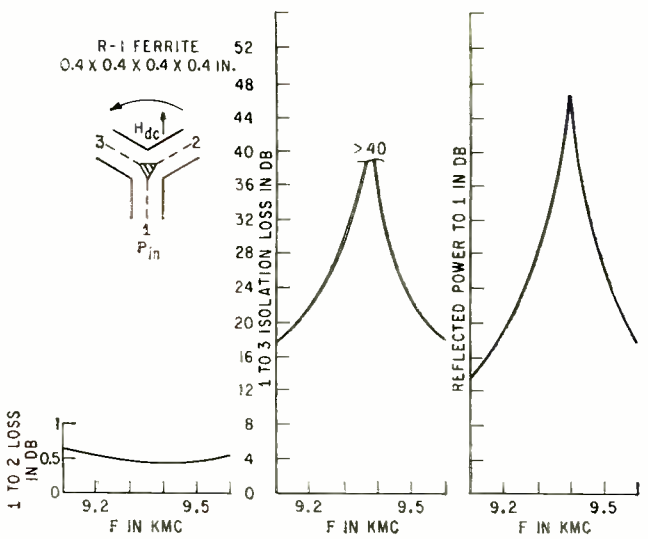


FIG. 6—Data for Y-type circulator. Wave travel is from port 1 to 2

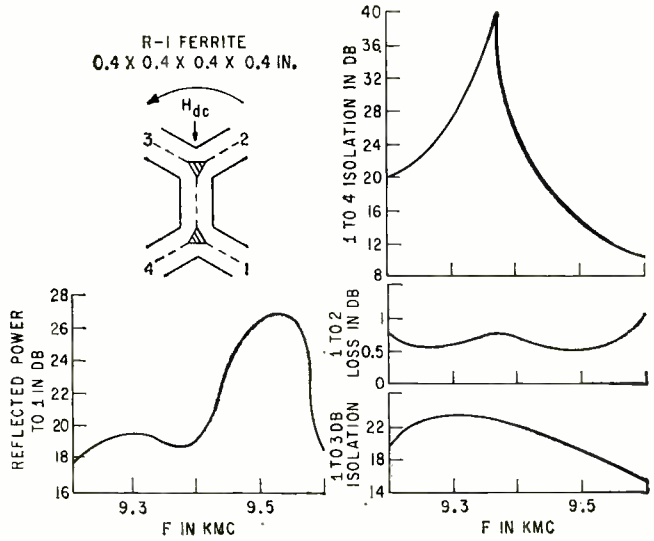


FIG. 7—Data for 4-port circulator. Wave travel is from port 1 to 2

from 9,200 to 9,400 mc.

Models of an S-band Y circulator have been built and tested. Figure 8 shows the results of some of these tests.

Applications

The junction-type circulator has several useful qualities. It is smaller in size and lighter in weight than the Faraday-rotation or rectangular-waveguide differential-phase circulators. It requires no expensive hybrids thereby making it cheaper to build than other types of circulators. Although its bandwidth is less than that of other circulators it is adequate for most radar applications. It should be possible to increase its bandwidth. Since this circulator is small and requires a low d-c magnetic field it should be useful in many antenna and fast-switching applications.

A number of these circulators arranged in series (Fig. 9A) can be used to produce a scanning array with separate control of the phase and amplitude of each radiator.

Shown in Fig. 9B is a scheme to control individually the positions of the transmitting and receiving beams of an antenna array. Phase shifters *A*, *B*, *C*, and *D* control the position of the transmitting beam while *E*, *F*, *G*, and *H* position the receiving beam.

These are just two of many possible applications for circulators in antenna systems. Y circulators should make schemes such as these more practical and feasible.

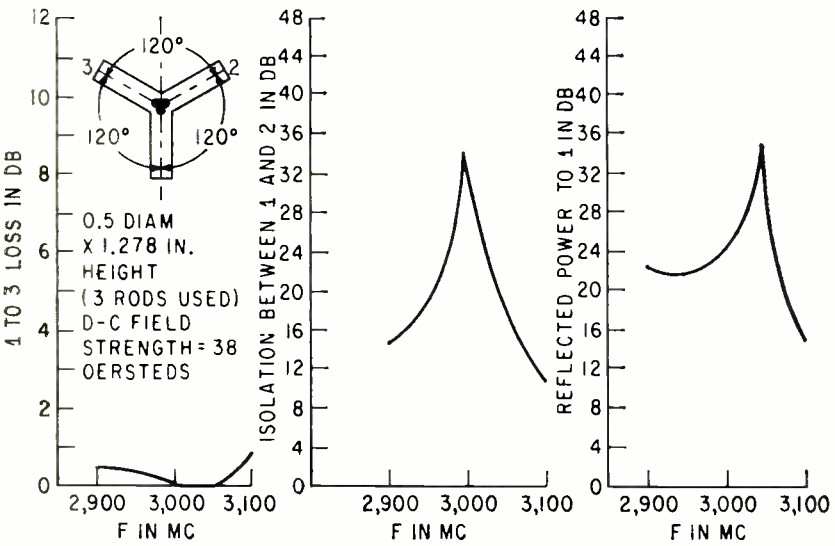


FIG. 8—Test data for S-band circulator whose wave-travel direction is from 1 to 3

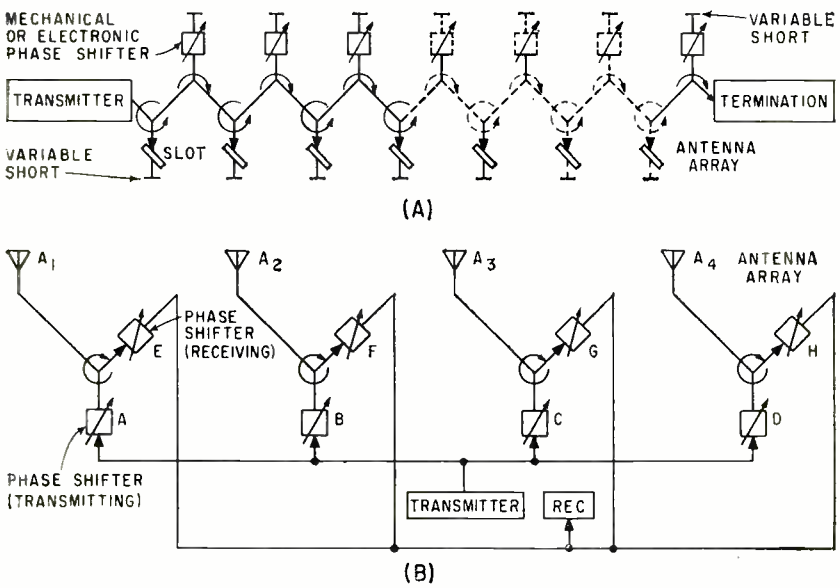


FIG. 9—Series-fed antenna array (A); parallel-fed antenna array (B)

Simplified Method for Harmonic Analysis

Here's a form that speeds the harmonic analysis of complex waves. Sample calculation and check are shown and explained in detail

By ERIK T. SOHLBERG,
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HARMONIC ANALYSIS OF a complex wave like the one shown in Fig. 1 can be simplified by using the form provided in Fig. 2. The amplitude and phase of the fundamental, second and third harmonics and the baseline location are determined from this form. It can also be extended to include fourth, fifth and sixth harmonics.

The harmonic analysis form may be used to analyze an oscilloscope display or to break down a recorded trace. It has been used extensively for finding the harmonics in error curves of aircraft instruments with 330 degrees of pointer rotation.

First step in using the form is to enter the amplitude and sense of the curve to be analyzed for every 30 degrees in the appropriate spaces in rows A and B. Note that the angle increases from right to left in row B. The indicated operations are then performed to complete the form. The entries in rows C and D come from row $A + B$ and those in rows E and F come from row $A - B$.

The values of a and b for each harmonic are obtained from the fL columns in the chart. Amplitude E is then found by computing $(a^2 + b^2)^{\frac{1}{2}}$ for each harmonic. The location of the first positive peak of each harmonic is obtained by calculating the angle θ. This angle is calculated with one of the four arctangent formulas in Fig. 2, depending on the signs of a and b. Only the magnitudes of a and b are used in the actual calculation of θ, however.

It is not necessary that a full 360 degrees of the curve be avail-

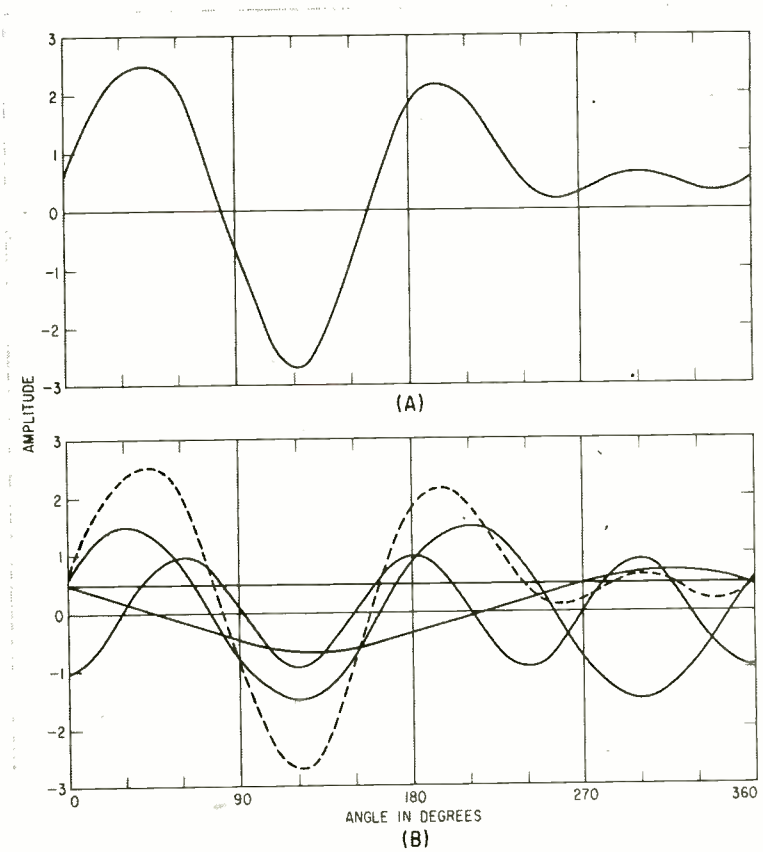
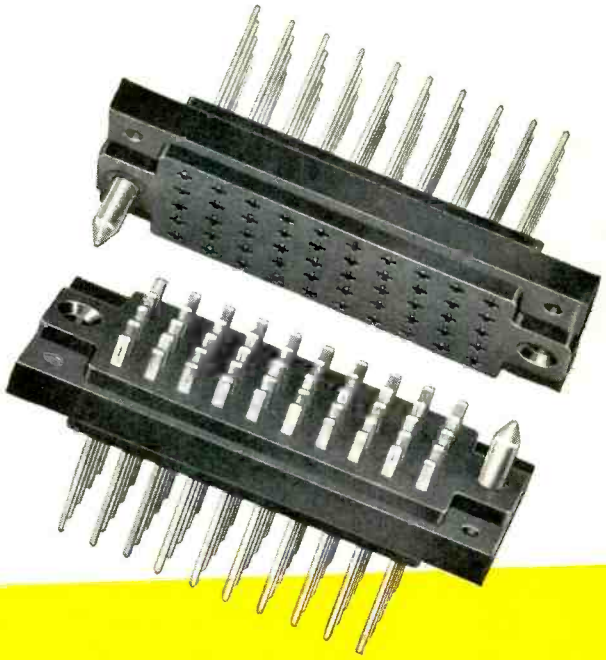
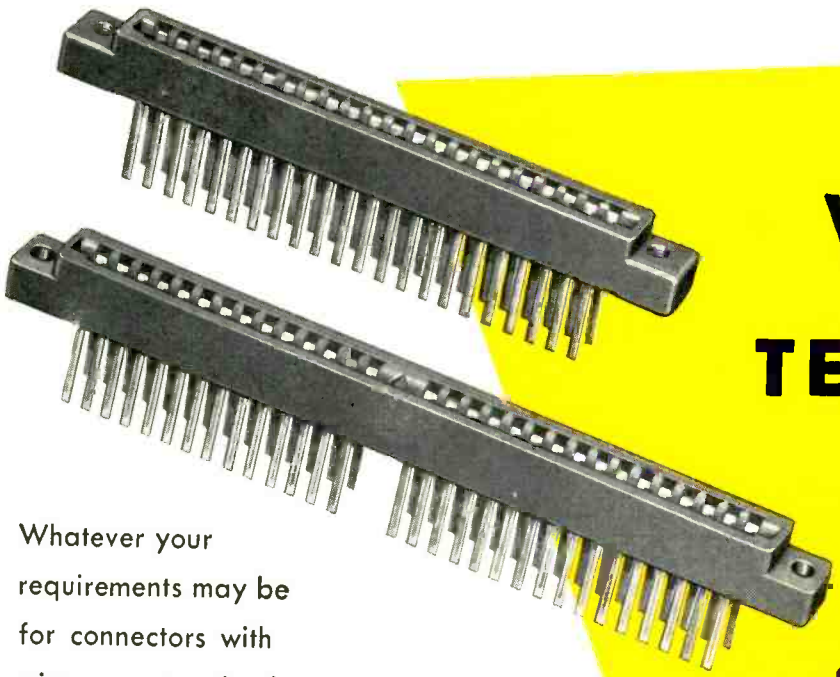


FIG. 1—Complex wave (A) is broken into its harmonics and baseline (B) by using form shown in Fig. 2. Dotted line shows check obtained by adding harmonics and baseline at each point

PLUG AND SOCKET TYPE, EDGE CONNECTORS, MODULE CONNECTORS, AND TERMINAL BOARDS--





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Whatever your requirements may be for connectors with wire wrap termination CINCH engineers will gladly assist in designing components to meet your specific need.

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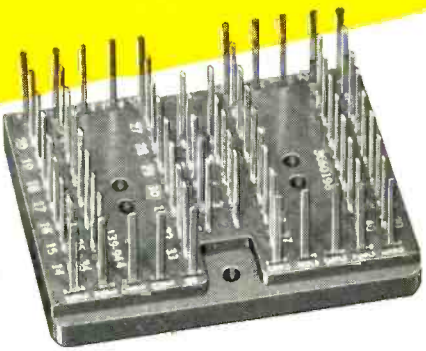

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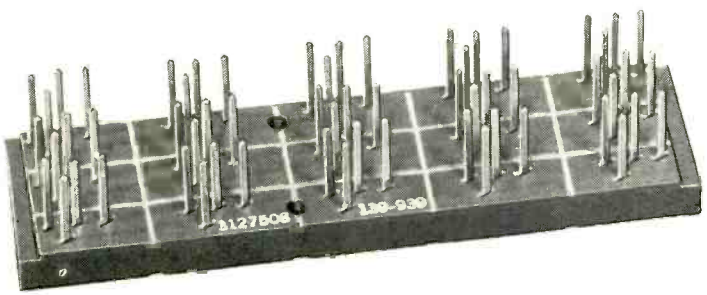

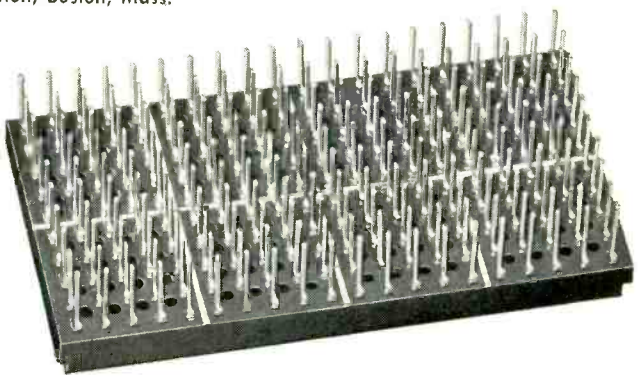

CIRCLE 85 ON READER SERVICE CARD

able if the missing 30-degree points can be estimated. Also, any suitable ordinate axis calibration can be used.

The author wishes to acknowledge the assistance of H. C. Wendt of General Electric Co. For the mathematical background of the form, refer to T. V. Karman and M. A. Biot, Mathematical Methods in Engineering, McGraw-Hill Book Co., 1940.

	AMPLITUDE AT INDICATED ANGLE						
	360	30 / 330	60 / 300	90 / 270	120 / 240	150 / 210	180
A		2.3	2.1	−0.7	−2.7	−0.9	1.9
B	0.6	0.3	0.6	0.3	0.5	1.9	
A + B	0.6 (0)	2.6 (1)	2.7 (2)	−0.4 (3)	−2.2 (4)	1.0 (5)	1.9 (6)
A − B		2.0 (I)	1.5 (II)	−1.0 (III)	−3.2 (IV)	−2.8 (V)	

C	0.6	2.6 (1)	2.7 (2)	−0.4 (3)
D	1.9 (6)	1.0 (5)	−2.2 (4)	
C+D	2.5 (w)	3.6 (x)	0.5 (y)	−0.4 (z)
C−D	−1.3 (W)	1.6 (X)	4.9 (Y)	

E	2.0 (I)	1.5 (II)	−1.0 (III)
F	−2.8 (V)	−3.2 (IV)	
E+F	−0.8 (m)	−1.7 (n)	−1.0 (p)
E−F	4.8 (M)	4.7 (N)	

f	BASE		SINE (a) 1 ST		SINE (a) 2 ND		SINE (a) 3 RD		COSINE (b) 1 ST		COSINE (b) 2 ND		COSINE (b) 3 RD	
	L	fL	L	fL	L	fL	L	fL	L	fL	L	fL	L	fL
0.50			m −0.8	−0.4					Y 4.9	2.5	x 3.6	1.8		
											−y −0.5	−0.3		
0.87			n −1.7	−1.5	M 4.8	4.2			X 1.6	1.4				
					N 4.7	4.1								
1.0	w 2.5	2.5	p −1.0	−1.0			m −0.8	−0.8	W −1.3	−1.3	w 2.5	2.5	W −1.3	−1.3
	x 3.6	3.6					−p 1.0	1.0			−z 0.4	0.4	−Y −4.9	−4.9
	y 0.5	0.5												
	z −0.4	−0.4												
SUM.		6.2		−2.9		8.3		0.2		2.6		4.4		−6.2
	1/12S	0.52	1/6S	−0.48	1/6S	1.38	1/6S	0.03	1/6S	0.43	1/6S	0.73	1/6S	−1.03

AMPLITUDE (E) = $\sqrt{a^2 + b^2}$

POSITIVE PEAK AT θ EQUAL TO:

b \ a	+	−
+	$\frac{\text{TAN}^{-1}\frac{a}{b}}{n}$	$\frac{-\text{TAN}^{-1}\frac{a}{b}}{n}$
−	$\frac{180° - \text{TAN}^{-1}\frac{a}{b}}{n}$	$\frac{180° + \text{TAN}^{-1}\frac{a}{b}}{n}$

WHERE θ = ANGLE
n = ORDER ORDER OF HARMONIC

$E_1 = \sqrt{(0.48)^2 + (0.43)^2}$

= 0.64

$\theta_3 = \frac{180 - \text{TAN}^{-1}\frac{0.03}{1.03}}{3}$

= 57.1 DEG

BASE	HARMONIC		
0.52	1	2	3
E	0.64	1.56	1.03
θ	−48.3	31.3	57.1

FIG. 2—Harmonic analysis form is used to analyze wave shown in Fig. 1. Solutions for amplitude of first harmonic (E_1) and angle of third harmonic (θ_3) are shown

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5 amp Relay

GENERAL FEATURES

Contact Arrangement:
Two pole double throw.

Contact Rating:
d-c non-inductive—low-level
up to 5 amperes at 29 volts.

a-c non-inductive—low-level
up to 2 amperes at 115 volts.

a-c or d-c inductive—1 ampere
at 29 volts d-c and 115 volts a-c.

Initial Contact Resistance:
.05 ohms maximum.

Minimum Operate Sensitivity
100 milliwatts with a contact
rating of 2 amperes non-inductive.

Ambient Temperature:
−65°C to +125°C.

Dielectric Strength:
1,000 volts rms at sea level.
450 volts rms at 70,000 feet.
350 volts rms at 80,000 feet.

Insulating Resistance:
10,000 megohms minimum.

Vibration:
5-28 cps at 0.5 inch double
amplitude and 28-2000 cps at 20 g.

Shock: 50 g operational. 100 g mechanical.

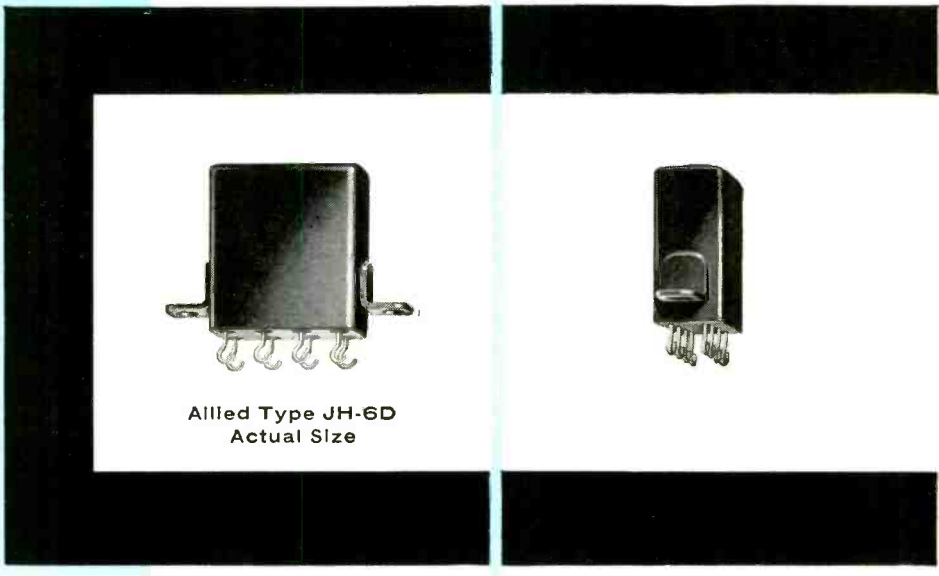
Operate Time:
10 milliseconds or less at rated voltage at 25°C.

Release Time:
5 milliseconds or less at rated voltage at 25°C.

Maximum Over-all Dimensions:
height 1.0" length 0.8" width 0.4".

Terminals:
0.2 inch grid spaced. Plug-in printed circuit
and hooked type solder terminals.

Weight: 0.8 ounces maximum.



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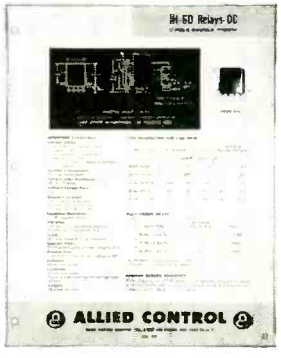
Actual Size



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Ferroelectrics Generate Power

FERROELECTRIC converters, which convert heat directly into electrical energy, can produce high-voltage d-c or a-c. Light weight and availability of thermal energy make them suitable for space applications.

Operating Principle

The ferroelectric converters developed by International Telephone and Telegraph are based on the fact that permittivity or dielectric constant of some ferroelectric materials varies with temperature. Main element is a large ferroelectric capacitor that is initially charged by a battery through a diode, as in Fig. 1. At Curie temperature, T_c, capacitance is maximum because of high permittivity, K_c, as shown in Fig. 2. Charge is $Q = C_c V_c$, where V_c is source voltage. Stored electrical energy is $W_c = \frac{1}{2} Q V_c$.

If the capacitor is cooled to T_a or heated to T_b, permittivity drops to K_a or K_b. Capacitance drops to $C_b = (K_b/K_c) C_c$. Since charge cannot decrease because of the diode, capacitor voltage rises from V_c to V_b by the factor K_c/K_b. Electrical energy also increases by K_c/K_b.

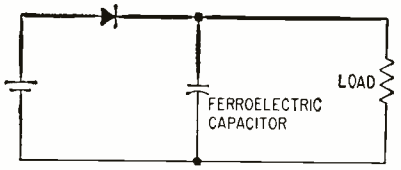


FIG. 1—Holding diode prevents capacitor from losing initial battery charge. Increase in charge results only from temperature change

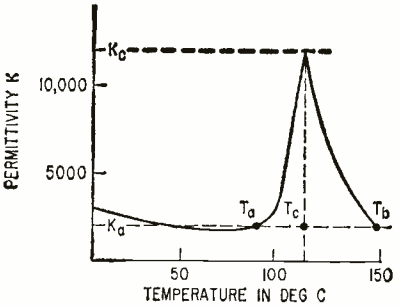


FIG. 2—Permittivity curve of barium titanate as temperature is varied around Curie point, T_c, applies only with low field strength

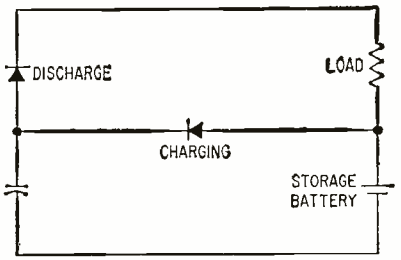


FIG. 3—Increased voltage across capacitor as temperature increases recharges storage battery through discharge diode

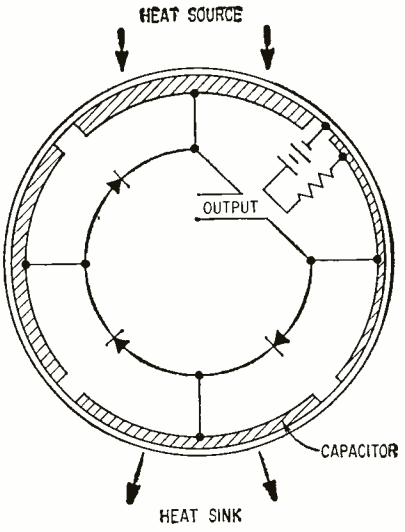


FIG. 4—Spinning satellite with four capacitors operating at different points in the cycle at the same time could generate high voltage

Permittivity in Fig. 2 depends on field strength, which changes during a temperature cycle, and the curve is applicable only with low applied field. Practical converters operate at higher field strength and permittivity does not drop below Curie temperature. They are therefore cycled between Curie point and a higher temperature.

One way of replacing dissipated battery power is to use a storage battery in series with the load, as in Fig. 3. The battery charges the capacitor through a diode, and the battery is recharged through the discharge diode and load.

High-Voltage Generators

Ferroelectric converters have inherently high output voltages. A high charging voltage and a material with a high K_c/K_b produce outputs exceeding 1,000 v.

Cascading stages so output of a preceding stage charges the following stage produces very high voltages. In Fig. 4, four converter capacitors are attached to a rotating body that forms a common electrode. The cylinder is heated at the top to T_b and cooled at the bottom by a heat sink or radiation to T_c. Optimum output voltage V_n of a converter with n stages is $V_n = V_c (K_c/K_b)^n$.

A device like that in Fig. 4 using solar energy might be suitable for

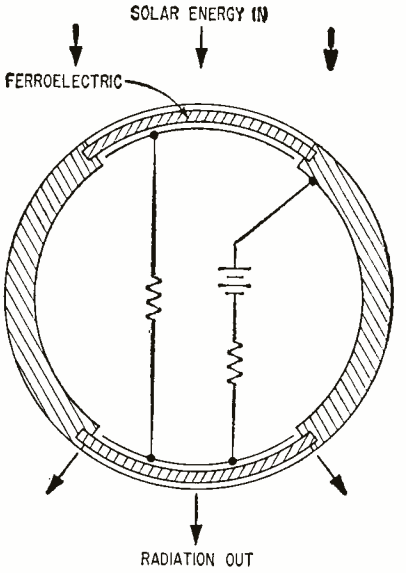


FIG. 5—Solar energy could be converted into a-c voltage with this arrangement

satellites or space vehicles that can be made to spin. The high voltage might be used for ion propulsion.

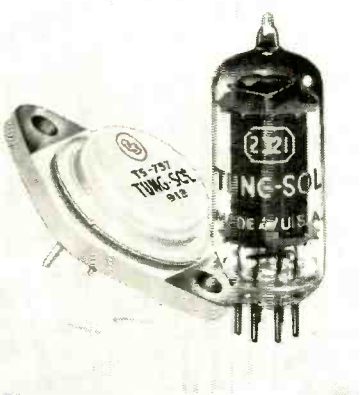
Generating A-C

A section through a rotating body, such as a spinning satellite, is shown in Fig. 5. One of two large ferroelectric capacitors on opposite sides of the satellite is heated by incoming solar energy while the other is cooled through radiation. The outside electrodes are common, and the inside electrodes are connected through a load.

The capacitors are charged ini-

End alternate chills and hot blasts. Shown in front of the thermistor wall unit and the furnace modulator valve are the tube type and transistorized amplifiers for the new Selectra home gas furnace control now in production at Maxitrol Company, Detroit, Michigan.

Tung-Sol tubes and transistors help MAXITROL provide non-cycling home heating



Maxitrol Company's new Selectra electronic gas furnace control does away with fluctuations in room temperature. It continually adjusts the burner flame to exactly compensate for the heat loss in the home and it responds to temperature changes as low as 1/10 degree F. Selectra controls are available with either tube type or transistorized amplifiers which boost the signal from a thermistor in the wall unit to selectively energize a solenoid in the furnace modulator valve.

Depending on their design some gas burners must be ignited at maximum flame. On such burners the tube type amplifier using a Tung-Sol 2D21 thyratron is recommended. The tube warm-up period provides a 10-15 second delay during which time the solenoid cannot be energized, insuring ignition at maximum flame.

Transistorized Selectra amplifiers are recommended for burners which can be successfully ignited at less than maximum flame. Since there is no warm-up delay with the transistorized circuit, ignition may occur as low as 1/3 of full fire. For this unit, Tung-Sol supplies TS757, a high power transistor selectively inspected to provide extremely tight characteristics. The high reliability of these Tung-Sol transistors, say Selectra's designers, was largely responsible for this type of control being in production.

Do you have an unusually demanding tube or transistor requirement? Tung-Sol applications engineers stand ready to help you. You'll get utmost benefit from their experience by consulting them while your equipment is in the planning stage. Just call or write: Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK193

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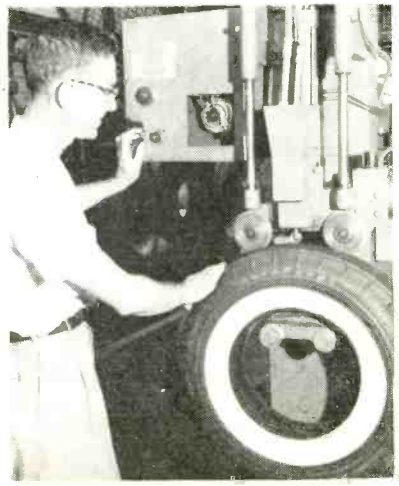
tially by a battery through a resistor. The charge oscillates through the load as the capacitors are heated and cooled. At Curie temperature, one capacitor accepts charge $Q_a = C_a V_a$, whereas the other at T_b accepts only $Q_b = C_b V_a$. Difference in charge oscillates through a small load twice per temperature cycle.

Control Instruments Add to Tire Life



Variations in tire tread thickness are recorded at Goodyear electronics laboratory

PRODUCTION control of automobile tires is becoming more complex. Higher auto speeds on smaller diameter tires, which must rotate faster for a given speed, require a high degree of dimensional precision. Durability, quiet operation and other characteristics depend on manufacturing control.

For these reasons, a six-million dollar instrumentation program has been instituted at Goodyear. Both electronic and atomic instruments are being used to maintain manufacturing tolerances.

Most widely used atomic instrument maintains uniform thickness of tire cord fabric as it is coated with rubber. Beta rays from strontium 90, or other radioactive by-products, pass through rubberized tire cord and are intercepted by an ionization chamber. Thickness of finished rubber sheeting is recorded by conversion of the beta rays to electrical signals.

X-ray and fluoroscope machines are used to spot check internal tire construction. A picture can be made

for short-time study on photosensitive metal plates that hold an electrostatic image when exposed to radiation. Permanent pictures are made on regular x-ray film.

An electronic scanner scans the rubberized tire cord and makes a continuous summary report on performance of other instruments.

After a tire is taken from a mold, it is checked for roundness on a machine that has three gage arms. Contact made at tire tread center and in the middle of each sidewall records tire shape as it is rotated. Dimensional variations exceeding 0.05 in. result in rejection.

The company claims that its electronically controlled production system results in tires one-fifth to one-fourth more durable than those built last year and more than 50 percent better than those produced five years ago.

System Will Monitor Low-Level Winds

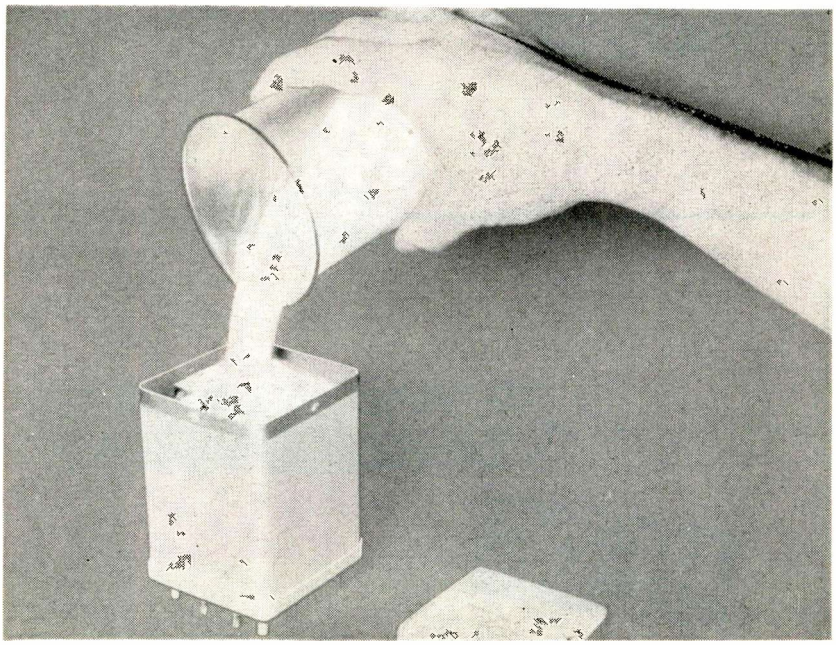
WEATHER transducers will soon be mounted on a 1,500-ft television tower shared by two Dallas television stations. Wind and temperature measurements will be made and recorded at a dozen altitudes starting from 30 feet. Although similar systems exist, heights usually only go to about 400 ft.

The system is being built for the Geophysics Research Directorate, Air Force Cambridge Research Center, by the University of Texas.

The fully automatic sensing and recording system will be used primarily for basic research. However, findings may benefit aircraft. The electronic instruments will be used to study an atmospheric characteristic known as low-level jet. This phenomenon is believed to result in a sharp increase in wind speed at a certain level, especially between midnight and sunrise. Forecasting the occurrence of this jet will be carried out this year.

Information will be recorded continuously on tape and forwarded once a week to University of Texas researchers. Should any unusual weather phenomena be recorded, instruments will send signals to the station and the information in turn will be dispensed to the public.

Alumina Powder for Potting: It Pours



Silicone treated alumina powder is poured into transformer assembly. Easily packed, the potting powder is enclosed in a metal-cased container

SEARCH FOR a new potting material (ELECTRONICS, p 78, Nov. 6) now uncovers the use of aluminum oxide, Al_2O_3, as a satisfactory potting or filling compound in metal-cased components and assemblies. The use of this material for potting was made known last week in a paper delivered at the National Conference of Electrical Insulation held in Washington, D. C.

Temperature Ranges

The report, written by L. W. Kirkwood and R. S. Key of Bell Laboratories, describes the use of specially-treated alumina powder as a potting material for electronic power transformers[1]. For this application the alumina is treated with silicone resin and xylene to overcome moisture and hence insulation resistance problems. The ability of this material to withstand temperatures in excess of 1,000 C gives the designer a single potting compound that covers the gamut of temperature ranges for insulation systems from Class O (90 C) through Class C (greater than 220 C) as defined in AIEE Standard I.

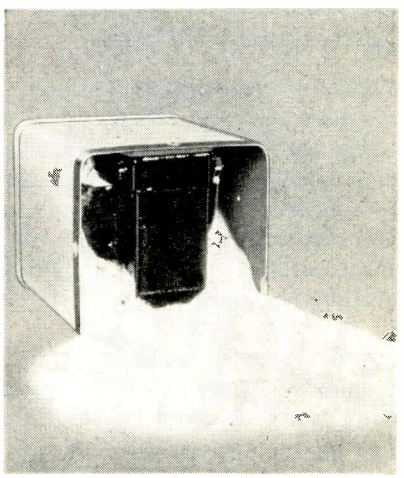
Transformer potting compounds previously used melt at relatively low temperatures and may expand, destroying the hermetic seal of the can. The alumina has no significant expansion-contraction characteristics and offers definite advantages as a transformer potting material.

No Strain

The material imposes no strain upon components and maintains its granular characteristics.

The paper put emphasis on the present use of this material in relatively low temperature applications, 105 C, 155 C and 180 C but in these temperature ranges the material performs at a fraction of its capabilities.

Aluminum oxide comes as a white, spherical particle powder of which two types are available from different suppliers: one type having particle sizes no larger than 15 mils, and the other type having particle sizes up to 200 mils in diameter. Both materials have a range of particle sizes down to about 5 to 7 mils or perhaps lower. That portion of material that will pass through a 40-mesh screen or in other words having particle size of about 17 mils in diameter or smaller, tends to be powdery but small enough to minimize the



Since the alumina powder maintains its granular characteristic, the component can be filled or emptied at will for repairs or changes

Table I—Characteristics of Some Potting Compounds[a]

Material	Density (g/cc)	Heat Diss Fact	Insul Resist (megohms)	Price ($/lb)	Price (cents/cu in)
Silicone Treated Al_2O_3	1.2	41	10^5	0.58	2.5
Sand Asphalt Compound	1.65	43	7×10^5	0.40	2.4
Epoxide Resin	1.64	54	$>10^6$	0.42	2.5
Wax	0.9	38	$>10^6$	0.23	0.8
Ceramic Encaps	2.4	45	$>10^6$	1.35	11.7

a—Data compiled by L. W. Kirkwood and R. S. Key, Bell Labs

a continuing series on technical topics of specific interest to engineers

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what is the difference between dissipation factor and power factor?

Approximations, to the engineer, are useful and necessary because the solution of an equation can often be made less laborious in its computation by knowing the weight of each factor and its effect in the final answer. Those factors having little weight can be eliminated and the solution is more easily and readily obtainable, although the answer is a "ball-park" figure. Sometimes one forgets the significance of equality and because approximations are made, quantities become equal to each other under *all* conditions with no limits. The set of conditions under which the approximations were made and for which the solution is valid is simply forgotten. Such is the case of Dissipation Factor and Power Factor with respect to capacitors.

By definition, the Power Factor of a capacitor is the ratio of the Equivalent Series Resistance (ESR) to the impedance (Z). In equation form it would be stated as:

$$\text{Power Factor} = \frac{R}{Z} = \frac{R}{\sqrt{X_c^2 + R^2}} \qquad \text{(eq. 1)}$$

Where: R = ESR in ohms

X_c = Capacitive reactance in ohms.

$$[X_c] = \frac{1}{2\pi fC}$$

f = frequency in cycles per second

C = capacity in farads

Also, by definition, the Dissipation Factor of a capacitor is the ratio of the ESR to the capactive reactance. In equation form it would be stated as:

$$\text{Dissipation Factor} = \frac{R}{[X_c]} = 2\pi fRC \qquad \text{(eq. 2)}$$

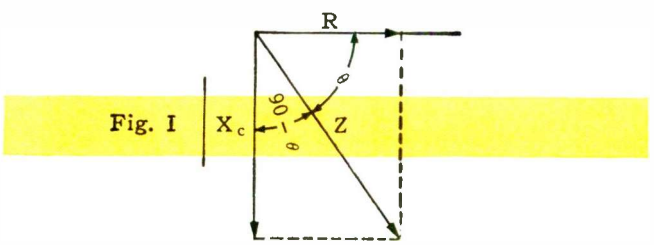


Fig. I

Comparing the two graphically (See Fig. I), several things are apparent.

1. Power Factor $= \frac{R}{Z}$ = Cosine θ; where θ equals the phase angle.
2. Dissipation Factor $= \frac{R}{[X_c]}$ = Tangent $(90 - \theta)$; where $(90 - \theta)$ equals the loss angle.
3. When θ approaches 90° and $90 - \theta$ approaches 0°, Z approaches $[X_c]$, and R approaches 0.

Now after examining the graphic analysis of Dissipation Factor and Power Factor, certain approximations can be made.

1. If when θ becomes very large, approaching 90°, and Z approaches $[X_c]$, then Z can be considered to be equal to $[X_c]$.
2. If this is assumed, then $\frac{R}{Z} \approx \frac{R}{[X_c]}$ and Power Factor $\approx$ Dissipation Factor.

When P. F. and D. F. are almost equal to each other, the cosine of θ and the tangent of $90 - \theta$) are almost equal to each other which can be seen by analyzing Fig. II. You will notice that when θ is large and $(90 - \theta)$ is small, the cosine of θ and the tangent of $(90 - \theta)$ are almost equal, but as θ decreases and the loss angle increases, the values depart from near equality. At this point, large values of dissipation factor differ appreciably from values of power factor — the limit being: tan 90° = ∞ Cos 0° = 1.

Let's consider a practical example of indiscriminate use of Dissipation Factor and Power Factor. Consider a 500 mfd. electrolytic capacitor rated at 25 WVDC that is being used in a filter circuit for 120 cps. The unit was checked for an ESR of 1.325 ohms and its dissipation factor calculated at .5 or 50%. The reactance at 120 cps. is 2.65 ohms. According to equation 2, D. F. $= \frac{1.325}{2.650} = .500 = 50\%$. The phase angle is then approximately 63° and the loss angle is approximately 27°.

If this same ESR were used to calculate Power Factor, equation 1 would yield:

$$\text{P. F.} = \frac{1.325}{\sqrt{(2.65)^2 + (1.325)^2}} = .447 = 44.7\%$$

Also, if ESR were calculated using equation 1 based on a dissipation factor of .5, the ESR would show a value of 1.530, whereas, the actual ESR is 1.325. Not too significant? Perhaps—but there is a difference.

Fig. II

Phase Angle θ	Cosine of Phase Angle θ	Tangent of Loss Angle $90 - \theta$	Phase Angle θ	Cosine of Phase Angle θ	Tangent of Loss Angle $90 - \theta$
89.0	.01745	.01745	59.9	.5015	.5797
88.0	.03490	.03492	59.8	.5030	.5820
87.0	.05234	.05241	59.7	.5045	.5844
86.0	.06976	.06993	59.6	.5060	.5867
85.0	.08716	.08749	59.5	.5075	.5890
84.0	.10453	.10510	59.4	.5090	.5914
83.0	.12187	.12278	59.3	.5105	.5938
82.0	.13917	.14054	59.2	.5120	.5961
81.0	.15643	.15838	59.1	.5135	.5985
80.0	.1736	.1763	59.0	.5150	.6009
79.0	.1908	.1944	59.9	.5165	.6032
78.0	.2079	.2126	58.8	.5180	.6056
77.0	.2250	.2309	58.7	.5195	.6080
76.0	.2419	.2493	58.6	.5210	.6104
75.0	.2588	.2679	58.5	.5225	.6128
74.0	.2756	.2867	58.4	.5240	.6152
73.0	.2924	.3057	58.3	.5255	.6176
72.0	.3090	.3249	58.2	.5270	.6200
71.0	.3256	.3443	58.1	.5284	.6224
70.0	.3420	.3640	58.0	5299	.6249
69.0	.3584	.3839	57.9	.5314	.6273
68.0	.3746	.4040	57.8	.5329	.6297
67.0	.3907	.4245	57.7	.5344	.6322
66.0	.4067	.4452	57.6	.5358	.6346
65.0	.4226	.4663	57.5	.5373	.6371
64.0	.4384	.4877	57.4	.5388	.6395
63.0	.4540	.5095	57.3	.5402	.6420
62.0	.4695	.5317	57.2	.5417	.6445
61.0	.4848	.5543	57.1	.5432	.6469
60.0	.5000	.5775	57.4	.5446	.6494

amount of free air between particles. It pours easily and packs easily with the use of a vibrating table or even by merely tapping the side of the can.

Table I presents a comparison of this treated alumina powder with some other potting compounds. Figures were taken from the Key, Kirkwood paper.

REFERENCE

(1) L. W. Kirkwood and R. S. Key, Alumina Powder as a Potting Material for Electronic Power Transformers, Paper delivered at the National Conference of Electrical Insulation, Dec. 8, 1959, Washington, D. C.

Tube Operates from Rocket's Exhaust Pipe

LAST WEEK ELECTRONICS reported news of the developmental RCA tube, mounted on a rocket flame pipe, that can produce current to operate the steering mechanism and electronic apparatus of a rocket (p 11, Dec. 11). This important announcement followed the great interest in the subject of thermionic generation of electricity as future power sources written up in ELECTRONICS last month[1].

Thermionics

A lightweight power source, operating from exhaust heat that is normally wasted, represents a long forward step in one critical area of missile and space technology, according to Karl G. Hernqvist of RCA. Conventional power supplies, such as chemical batteries, are heavy in proportion to their power output, and impose narrow limitations upon the payload carried by the rocket or missile. By using a lightweight thermionic generator it should be possible to increase the payload accordingly.

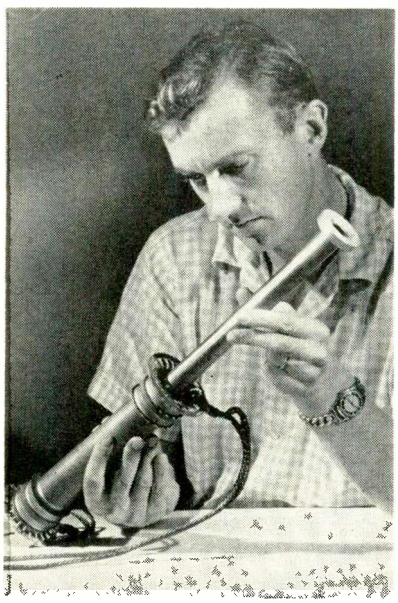
Gas Diode

The RCA tube bears a family resemblance to conventional two-element electron tubes, or diodes. The thermionic tube has a cathode from which electrons are activated by the application of heat, and another electrode to which these electrons flow to produce an electrical output.

In the experimental tube for rocket application, the cathode is

formed by the inner wall of the hollow cylinder, while the second electrode is formed by the outer wall. Between the two walls is a narrow space filled with cesium vapor.

When the cathode wall is heated by the burning rocket fuel in the flame tube, the electrons are boiled out of the cathode material and into the space between the two walls.



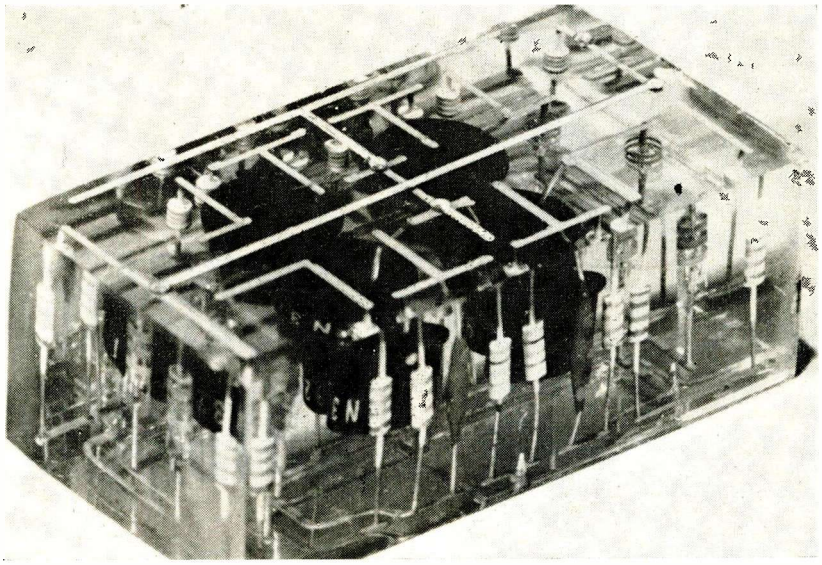
Electron tube in the shape of a hollow cylinder fits like a sleeve over the flame tube attached to a solid-fuel rocket motor. Heat from the burning fuel is converted directly into electricity by the thermionic generator tube which supplies power through wire leads

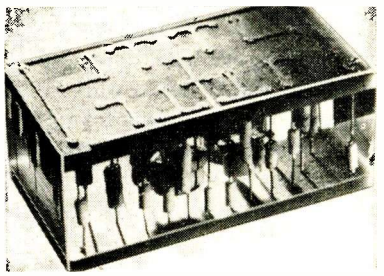
The cesium vapor that occupies this space becomes ionized upon contact with the hot cathode, and encourages the easy flow of electrons to the outer wall. The electrical power that is generated by this process is fed to the rocket steering control mechanism or to electronic apparatus by cables attached to the cathode and the second electrode.

The size and shape of the experimental tube were designed specifically for a Thiokol solid-fuel rocket motor. The operating principles of the tube are identical to those demonstrated in earlier experimental thermionic generator tubes developed at RCA for direct conversion of the sun's heat to electrical energy.

REFERENCE

(1). G. N. Hatsopoulos, J. Welsh and E. Langberg, Thermionic Engines: Future Power Sources?, ELECTRONICS, p 69, Nov. 13, 1959.





Encapsulated dual flip-flop with plated connections and etched wiring. Unit is 2 inches long

Encapsulated dual flip-flop with 2 layers of deposited wiring interconnected by drilled and plated-through holes

Connections Plated with Wiring

By E. A. GUDITZ, Staff Member, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass.

METHOD of plating both wiring and electrical connections[1, 2] is being developed. Advantages include low weight and volume, increased tolerance to temperature and vibration and the fact that connections are produced as part of the wiring.

The method is particularly useful for miniature assemblies. Connection densities are limited only by conductor or component spacing and photoetching resolution. Connections can be formed without subjecting components to temperatures above 100 C (encapsulating temperature).

Examples given are not comprehensive. New approaches to circuit and system packaging are possible. Total encapsulation of components is not necessary, allowing repairable packages. Any design which permits component leads to be faced off in an insulating surface can utilize plated connections.

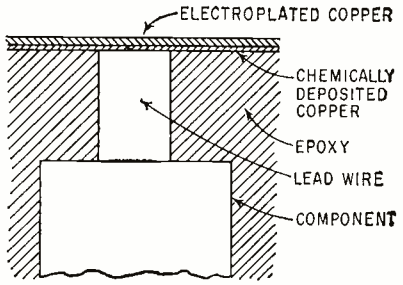


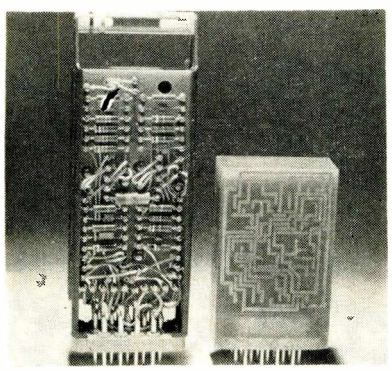
FIG. 1—Detail of plated connection

Fig. 1 shows details of the connections used with the flip-flop with etched wiring. The unit is lightly sandblasted. An initial layer of copper is chemically deposited less than 20 microinches thick from solution (Cuposit III, Shipley Co., Wellesley, Mass.). The electroplated layer is about 0.001 inch thick. The layers are deposited on both faces of the unit and selectively etched to form the wiring.

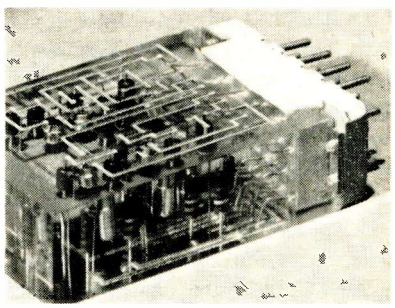
Plated connections have also been made with initial layers of silver, gold or nickel deposited from solutions. However, etching is simplified when only copper is used.

To make the flip-flop with deposited wiring, grooves are engraved in the surface of the encapsulant (grooves can also be molded during encapsulation). Leads are cut off flush with groove bottoms during engraving.

Copper is chemically deposited over the entire unit. Plating resist is rolled on the high surfaces, but not in the grooves. Copper is electroplated about 0.001 inch thick in the grooves and overplated with solder. The plating resist is removed and the chemically deposited solder is etched off by chromic acid, leaving the wiring pattern. The



Flip-flop with deposited wiring and plated connections (right) contains components identical to those in the conventional package



Transistor inverter package with deposited wiring and plated connections

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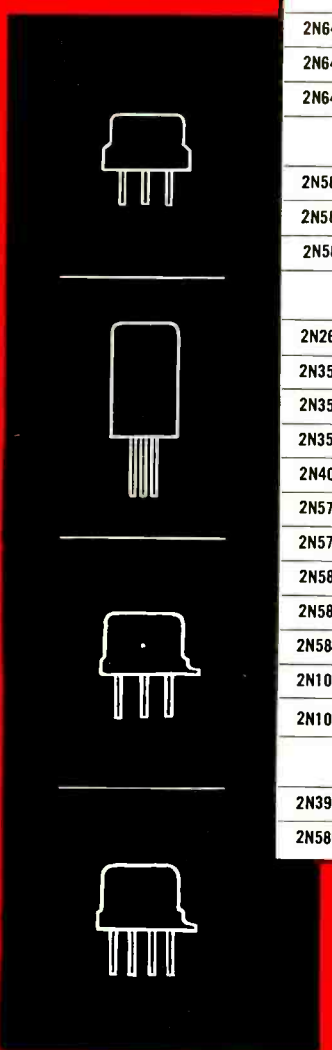


GERMANIUM TRANSISTORS

RCA TYPE	STRUCTURE	DIMENSIONAL OUTLINE JEDEC NO.	MAXIMUM RATINGS: ABSOLUTE—MAXIMUM VALUES				TYPICAL CHARACTERISTICS: AT AMBIENT TEMPERATURE OF 25°C		
			COLLECTOR-TO-BASE VOLTS	EMITTER-TO-BASE VOLTS	COLLECTOR MILLIAMPERES	TRANSISTOR DISSIPATION AT 25°C MW	D.C. CURRENT TRANSFER RATIO AT INDICATED COLLECTOR MILLIAMPERES	GAIN BAND-WIDTH PRODUCT MC	ALPHA CUTOFF FREQUENCY MC
Mesa High-Speed Switching Types									
2N1300	P-N-P	TO-5	−13	−1	−100	150	50 @ I_c = −10	40	—
2N1301	P-N-P	TO-5	−13	−4	−100	150	75 @ I_c = −40	60	—
"Drift" High-Speed Switching Types									
2N643	P-N-P	TO-33	−30	−2	−100	120	45 @ I_c = −5	30	—
2N644	P-N-P	TO-33	−30	−2	−100	120	45 @ I_c = −5	50	—
2N645	P-N-P	TO-33	−30	−2	−100	120	45 @ I_c = −5	75	—
High-Speed Switching Types									
2N580	P-N-P	TO-9	−20	−12	−400	120	45 @ I_c = −400	—	15
2N582	P-N-P	TO-9	−25	−12	−100	120	60 @ I_c = −20	—	18
2N584	P-N-P	TO-1	−25	−12	−100	120	60 @ I_c = −20	—	18
Medium-Speed Switching Types									
2N269	P-N-P	TO-1	−25	−12	−100	120	50 @ I_c = −12	—	12
2N356	N-P-N	TO-9	20	20	500	100	30 @ I_c = 100	—	3
2N357	N-P-N	TO-9	20	20	500	100	30 @ I_c = 200	—	6
2N358	N-P-N	TO-9	20	20	500	100	30 @ I_c = 300	—	9
2N404	P-N-P	TO-9	−25	−12	−100	120	50 @ I_c = −12	—	12
2N578	P-N-P	TO-9	−20	−12	−400	120	15 @ I_c = −400	—	5
2N579	P-N-P	TO-9	−20	−12	−400	120	30 @ I_c = −400	—	8
2N581	P-N-P	TO-9	−18	−10	−100	80	30 @ I_c = −20	—	8
2N583	P-N-P	TO-1	−18	−10	−100	80	30 @ I_c = −20	—	8
2N585	N-P-N	TO-9	25	20	200	120	40 @ I_c = 20	—	5
2N1090	N-P-N	TO-9	25	20	400	120	50 @ I_c = 20	—	7
2N1091	N-P-N	TO-9	25	20	400	120	70 @ I_c = 20	—	13
Low-Speed Switching Types									
2N398	P-N-P	TO-9	−105	−50	−100	50	60 @ I_c = −5	—	2
2N586	P-N-P	—	−45	−12	−250	250	55 @ I_c = −250	—	2

For technical information on these transistors and other semiconductor devices, telephone your RCA SEMICONDUCTOR DISTRIBUTOR, or write RCA Commercial Engineering, Section L-19-SD3 Harrison, N. J.

RADIO CORPORATION OF AMERICA

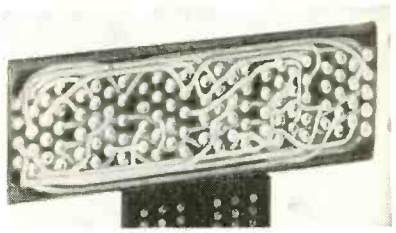
Semiconductor Products—Distributor Sales ***Harrison, N. J.***

electroplated solder serves as an etching resist.

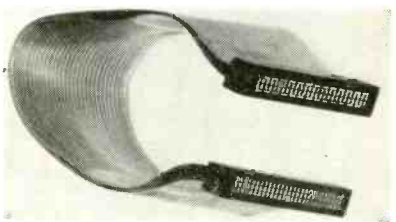
The rear of the transistor inverter package plug is cast first in resilient plastic after lead wires are attached. The plug and the other components are then cast in solid plastics. This procedure insures mobility of the plug pins.

Wiring can be made on several layers of plastic to facilitate point-to-point wiring. The flip-flop with 2 wiring layers uses the first layer to contact component leads. After the second layer of plastic is applied, tapered holes are drilled to pierce the first layer wiring. The copper deposited for the second layer's wiring forms plated-through connections to the first layer.

The back panel of the 3-stage binary counter has 3 wiring layers. Plated connections, formed as each wiring layer is deposited, join conductors to appropriate receptacle extension (pins) of 6 encapsulated sockets. A coating of plastic insulates each wiring layer and is the base of the next layer.

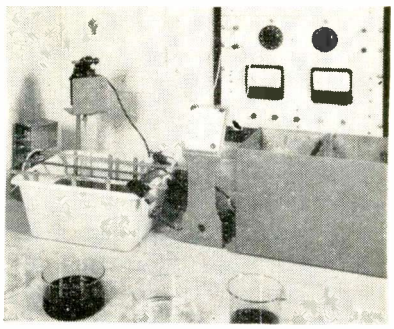


Inter-socket wiring of 3-stage binary counter has 3 layers of deposited wiring. Plated connections join layers to each other and to socket extension pins



Conductors of 6 layers of flexible cable connected in series by plating on encapsulated ends

The back panel can also be made without the pins, by using the plated-through connection method described above. If desired, a ground plane can be spaced between each wiring layer so that some of the wiring has transmission line characteristics. Characteristics would be determined by conductor



Laboratory setup for making plated connections

width, dielectric constant and spacing.

High density plated interconnections of ribbon conductors are expected to be very useful in coordinate-driven displays and memory devices. The ribbon cable ends are encapsulated and faced off to expose conductor cross sections. Copper is deposited and etched to form a pattern which connects all conductors in series.

Test Results

Plated connections have been evaluated by resistance measurements, temperature and vibration tests, and life tests while carrying 10 microamps to 3 amps, d-c.

Resistance measurements of 128 plated connections (0.025 inch diameter) in series yield an average of less than 1 milliohm. Plated connections have carried 3 amps d-c at 382 C (eutectic tin-lead solder melts at 183 C). Temperature tests have lasted from 8 hours to 840 hours, 4 to 120 connections per test.

The flip-flop with etched wiring was vibrated while in monitored operation for 5.5 hours without failure. Frequencies were 10 to 3,200 cps, force was increased by 5 g increments to 60 g and maximum peak-to-peak displacement was 0.2 inch at 75 cps. There were no operating errors or damage.

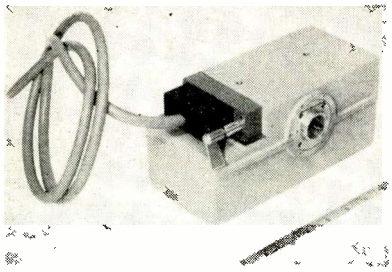
The work reported was performed at Lincoln Laboratory, operated by MIT with joint support of the U. S. Army, Navy and Air Force.

REFERENCES

(1) E. A. Guditz, Plated Component Connections for Micro-Miniature Circuits, p 166, Proc 1959 Electronics Components Conf, Philadelphia, 1959.

(2) N. J. Doctor and E. L. Hebb, Interconnection of Microminiature Electronic Assemblies, Proc Symposium on Microminiaturization of Electronic Assemblies, Diamond Ordnance Fuze Laboratories, Washington, D. C., Sept. 30, 1959.

On The Market



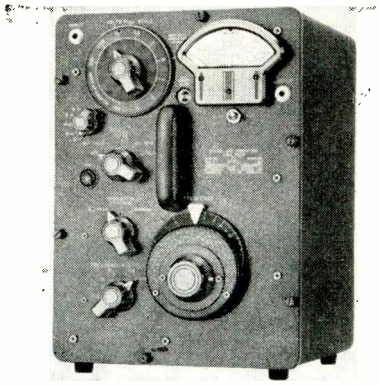
Converter
analog to digital

TELECHROME MFG. CORP., 26 Edison St., Amityville, N. Y. The Mem-O-Tizer features memory; ultra low torque, high accuracy; direct operation of external equipment through one ampere contacts; dynamic readout, "on-the-fly", readout up to 250 rpm. Among additional features are: no brushes; no contact of electrical circuit during rotation; no ambiguity; bidirectional operation; Chromector plug-in separable connector, completely sealed unit; and life over 20 million operations.

CIRCLE 301 ON READER SERVICE CARD

Analyzer
sound, vibration

GENERAL RADIO CO., West Concord, Mass., announces type 1554-A portable, wide-range (2.5 cps-25 kc) sound and vibration analyzer with a 10:1 span on each of four ranges, and featuring a ⅓-octave bandwidth (1.26:1), narrow bandwidth (8 percent, constant with frequency) and all-pass response. Unit can be used to measure not only line (single-frequency) components, but also continuous (noise) components. The instrument's narrow bandwidth is wide enough to embrace the small frequency fluctuations (or wow) arising from normal variations in speeds of engines, machines and appliances; 40-db discrimination obtains at one octave from selected frequency. The alternate, ⅓-octave bandwidth is available at low vibration frequencies.

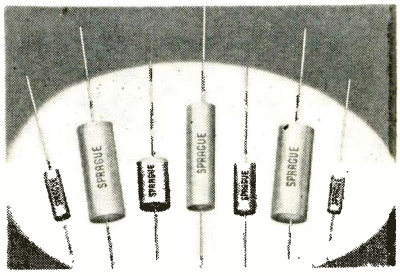


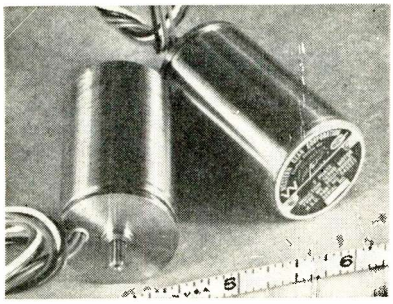
CIRCLE 302 ON READER SERVICE CARD

Film Capacitor
light-weight

SPRAGUE ELECTRIC CO., North Adams, Mass. Type 158P Yellow-Jacket Filmite E "wrap-and-end-fill" polyester film capacitor is designed for military and industrial electronics. Designed to withstand a 250 hr accelerated life test of 150 percent of the 85 C rated voltage impressed or the equivalent derated 125 C voltage with not more than 1 failure in 25 units tested, the capacitors also have very good resistance to humidity, vibration, and shock.

CIRCLE 303 ON READER SERVICE CARD





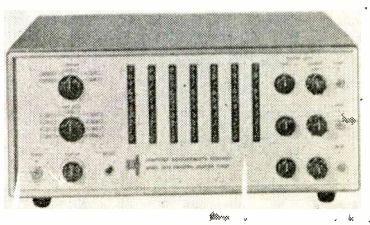
Servo Motor
and brake

WESTERN GEAR CORP., Electro Products Division, 132 W. Colorado Blvd., Pasadena, Calif., announces a new servo motor brake combination. Specifications include: stall torque motor alone 0.48 oz in.; brake range available 0.03-0.1 ± 0.01 oz in.; size 1 in. diameter by 1.85 in. long; designed to meet MIL-E-5272; 115 v, 400 cps, both phases; nominal impedance 1,450 plus j1,600; and the brake does not change linearity of the speed torque characteristics. Unit has a stainless housing, and can be produced with size 10, size 11, or 1-in. mounting.

CIRCLE 304 ON READER SERVICE CARD

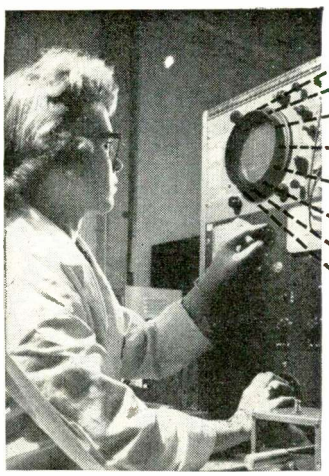
Counter-Timers
transistorized

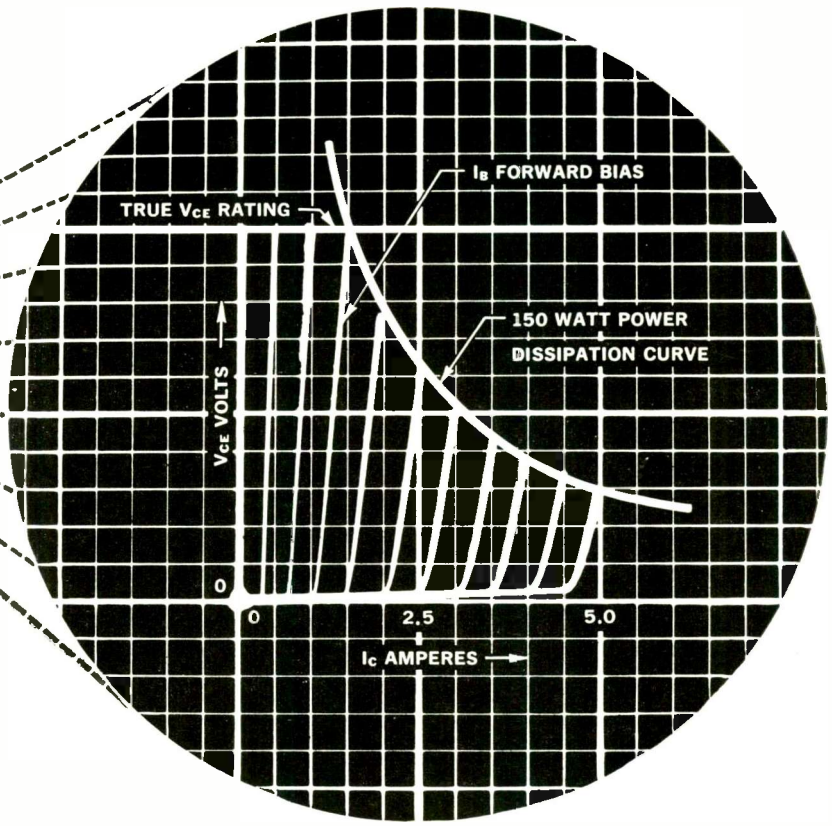
COMPUTER - MEASUREMENTS CO., 12970 Bradley Ave., Sylmar, Calif. A successful high frequency application of transistors to high speed circuitry equipment is found in three new all solid-state d-c to 10 mc counting, timing, and frequency measuring instruments. They are the model 727A universal counter-timer, the 707A frequency-period meter, and the 757A time interval meter. Power consumption of the 727A is 35 w and weight only 27



WESTINGHOUSE SILICON POWER TRANSISTORS

2N1015
2N1016





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This Power-voltage Test consists of testing the transistor in common emitter configuration under all bias conditions in the area defined by the *TRUE* voltage rating of the transistor (V_{CE}); the constant power dissipation curve for the transistor (150 watts); and its rated current (2 amps for 2N1015 and 5 amps for 2N1016).

The voltage at which alpha equals one, and other voltage ratings commonly given for transistors such as V_{CES}, V_{CER}, V_{CEX} and V_{CBO}, are *above* the voltage rating given to these transistors.

Each Westinghouse silicon power transistor has been completely tested throughout its rated voltage-power-current region before shipping. Thousands of transistors performing under all types of operating conditions have proved the validity of this method of *TRUE* voltage rating.

TRUE voltage ratings from 30 to 200 volts give you complete freedom in designing your equipment—you can operate Westinghouse silicon power transistors at the manufacturer's ratings without risking transistor failure. This *TRUE* voltage rating of Westinghouse silicon power transistors coupled with their still unequaled low saturation resistance and low thermal drop makes them an ideal first choice for military, industrial and commercial applications.

Type	V_{CE}*	B (min)	R_S (max)	I_C A (max)	T_j max. operating	Thermal drop to case (max)
2N1015 2N1015A 2N1015B 2N1015C 2N1015D	30 60 100 150 200	10 @I_C=2 amp	.75 ohms @I_C=2 amp I_B=300 ma	7.5	150°C	.7°C/W
2N1016 2N1016A 2N1016B 2N1016C 2N1016D	30 60 100 150 200	10 @I_C=5 amp	.50 ohms @I_C=5 amp I_B=750 ma	7.5	150°C	.7°C/W

*TRUE voltage rating (The transistors can be operated continuously at the V_{CE} listed for each rating.)

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Boston, Mass.

Oscillators—*A-F, Fork-Controlled*

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lb. Measurement ranges include 0.1 μsec to 10^7 sec for time interval; 0.1 μsec for period. Accuracy is ± 1 count ± oscillator stability. Sensitivity is 0.25 v rms; input impedance, 25 K ohms per v. Company offers these instruments with two-year free service warranties.

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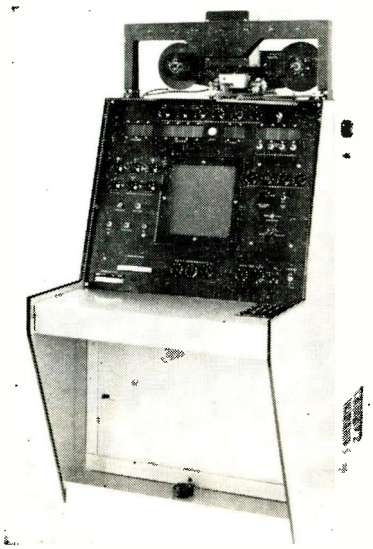

Angle Dial Reader
precision unit

PARABAM, INC., 13000 Yukon Ave., Hawthorne, Calif. New angle dial reader is designed for precision semiautomatic reading of elevation-angle and azimuth-angle dials on cinetheodolite and radar data film. By projecting the dials on a viewing screen and by utilizing a cross wire measuring system, the machine provides a rapid, accurate and efficient means for reading angle dials. An integral keyboard and selector switches are provided for entering additional data and the information is semiautomatically recorded on punched cards.

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Pulse Generator
high output power

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 3450C pulse generator provides high output power and fast rise time pulses at repetition rates to 2 mc. New features include wide range variable pulse delay and duration, high resolution controls, and automatic

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CIRCLE 103 ON READER SERVICE CARD 103

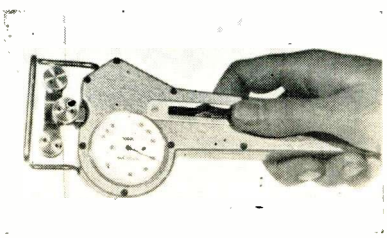
overload indication. Output amplitude is stabilized by power regulators and pulse output is presented d-c coupled with base line at chassis ground. Instrument is constructed entirely of plug-in printed wiring modules allowing extension to multiple pulse requirements and providing maximum accessibility for maintenance.

CIRCLE 307 ON READER SERVICE CARD

Servomotor
one-in. design

IMC MAGNETICS CORP., 570 Main St., Westbury, N. Y. A size 5 servomotor of only one-in. overall length is designed for use in extremely compact servomechanisms. It delivers a no-load-speed of 9,500 rpm; has a stall torque of 0.09 oz in. and a theoretical acceleration of 45,000 rad/sec². Total power input is 3.5 w. The 400-cycle unit will perform efficiently in a temperature range of −55 C to +150 C. It is completely encapsulated in epoxy. Weight is 0.68 oz; diameter, 0.5 in.

CIRCLE 308 ON READER SERVICE CARD



Tension Meter
precision device

ELECTROMATIC EQUIPMENT CO., 175 Fifth Ave., New York 10, N. Y. The Schmidt DXX20 tensiometer features front filament loading so that running filament is visible at all times, a thumb-operated ball bearing roller release to permit easy insertion and removal without stopping the manufacturing process and a special guide bar to assure proper alignment of material prior to roller engagement which virtually elimi-

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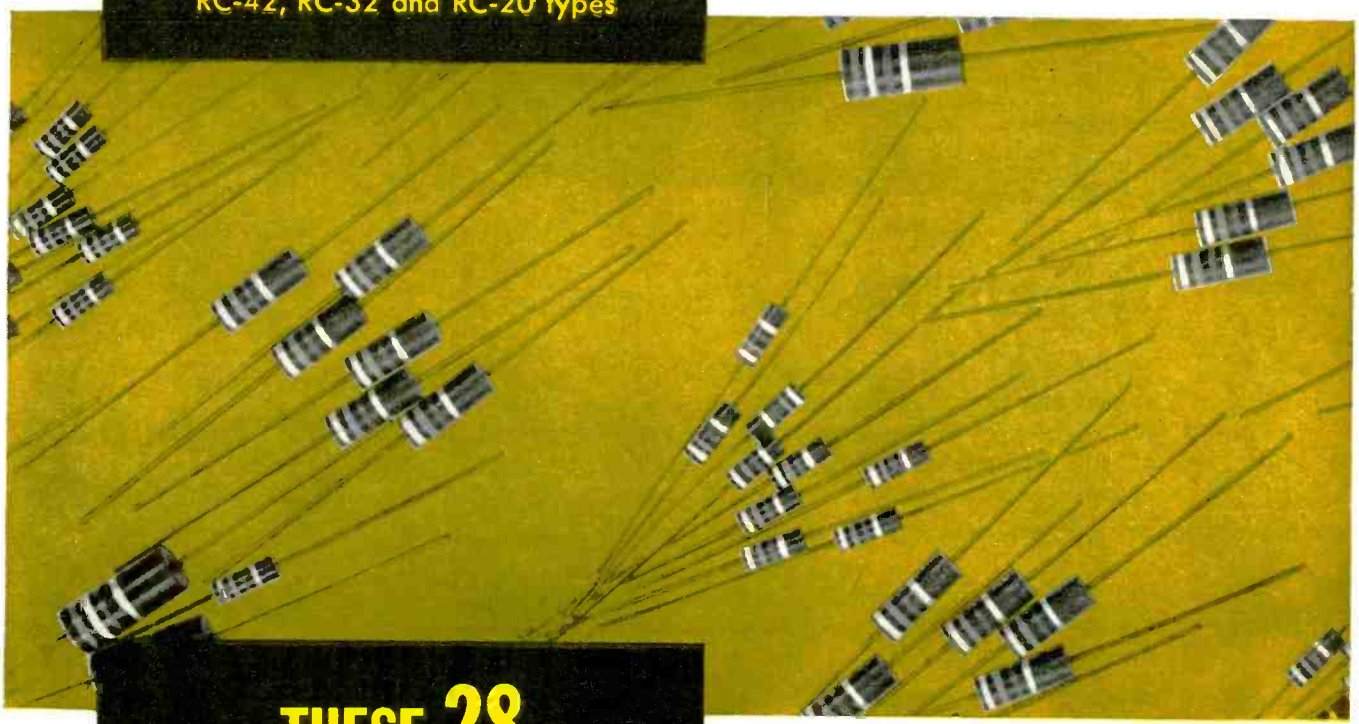

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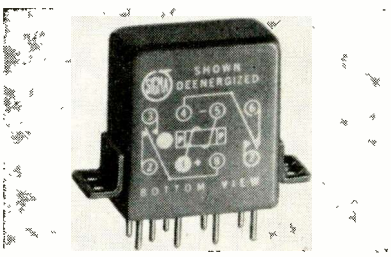
. . . and G-C/STACKPOLE, TOO!

Attractively packaged by G-C Electronics for service replacement uses, Coldite 70+ Resistors are also available through over 800 G-C distributors.

nates filament breakage of fine wire due to misalignment. Through the application of suitable rollers, the instruments can be used to monitor tensions of most engineering materials in various shapes and forms including copper and steel wire, filaments, bands and tapes of plastic, textiles and insulation sleevings. Tensions from 0.3 gram to 100 kilograms can be measured to an accuracy of 1 percent.

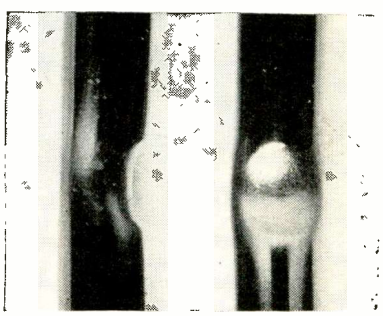
CIRCLE 309 ON READER SERVICE CARD



Polarized Relay subminiature

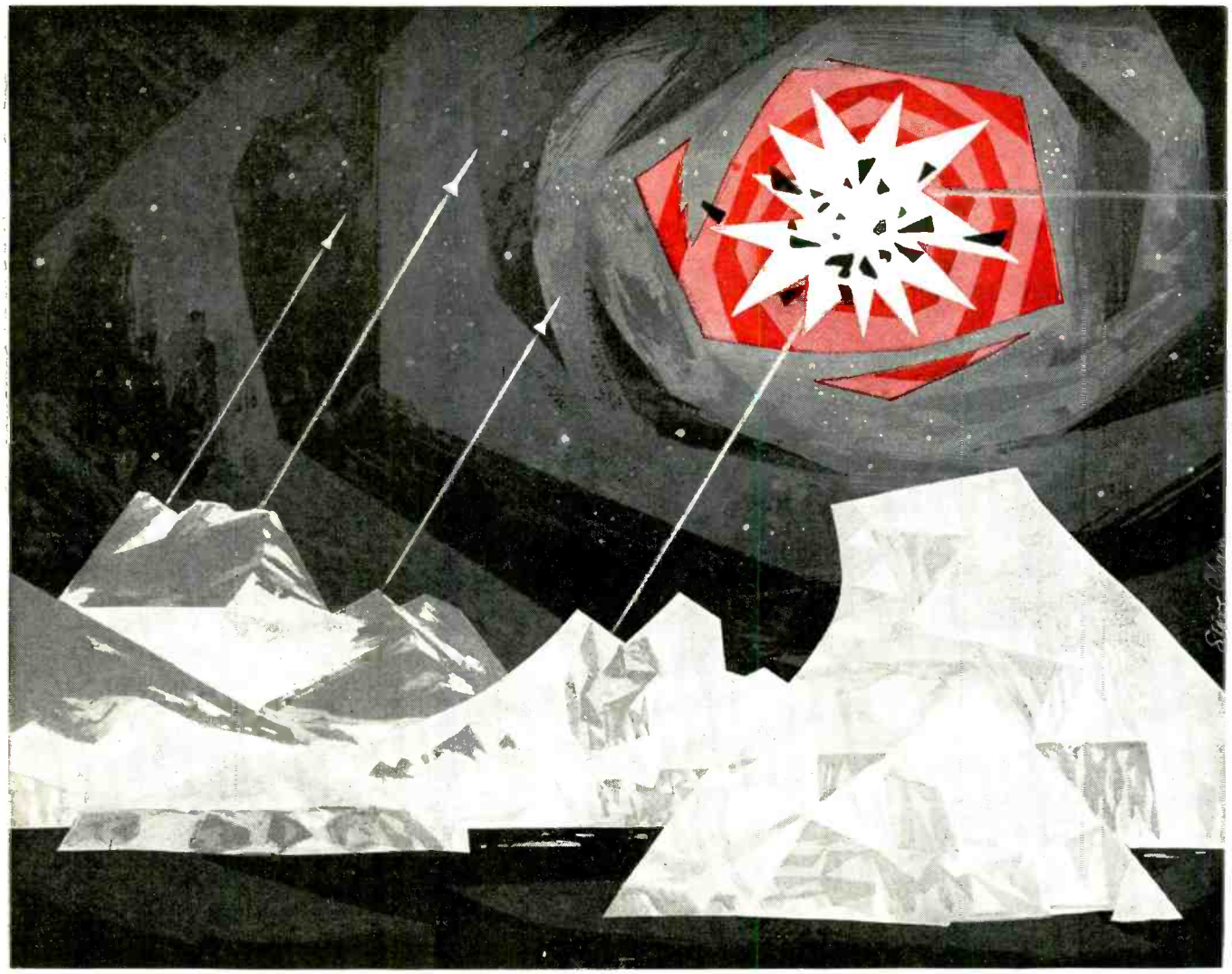
SIGMA INSTRUMENTS, INC., 170 Pearl St., So. Braintree 85, Mass., has available a subminiature polarized dpdt relay, only 0.800 in. by 0.400 in. by 0.900 in. high, with vibration immunity to 5,000 cycles at 30 g. The hermetically sealed series 33 provides 2-position, magnetically biased operation at a standard sensitivity of 200 mw within a temperature range of — 65 C to + 125 C. Shock and constant acceleration up to 100 g will not cause damage or open the contacts.

CIRCLE 310 ON READER SERVICE CARD



Hermetic Magnet Wire high stability

PHELPS DODGE COPPER PRODUCTS CORP., Inca Mfg. Division, Ft. Wayne, Ind. Hermeteze, a new hermetic magnet wire, is actually a Formvar material reacted for insolubility in Freon-22. Thus, it has



WITH ONLY MINUTES TO ACT

If America should be attacked . . . from bases around the world Strategic Air Command bombers, tankers and surface-to-surface missiles will rise to action. Minutes only will be available.

To integrate and control this assault requires accessibility and handling of a staggering volume of data. In the missile era, present methods of gathering and processing data will be inadequate. SAC is automating the system.

As systems manager, International Electric Corporation is developing and will turn over to SAC a world-wide electronic combat control system, an integrated complex of electronic subsystems. The system, employing digital techniques and equipment, will transmit, process and display information on a global basis . . . with only seconds involved.

Engineers whose interests lie in systems engineering, data processing and communications will find in this long-term project exceptional opportunity to exercise creative competence and individual initiative. For details of engineering assignments write B. J. Crawford, Director of Technical Staffing.

INTERNATIONAL ELECTRIC CORPORATION
An Associate of International Telephone and Telegraph Corporation
Route 17 & Garden State Parkway, Paramus, New Jersey

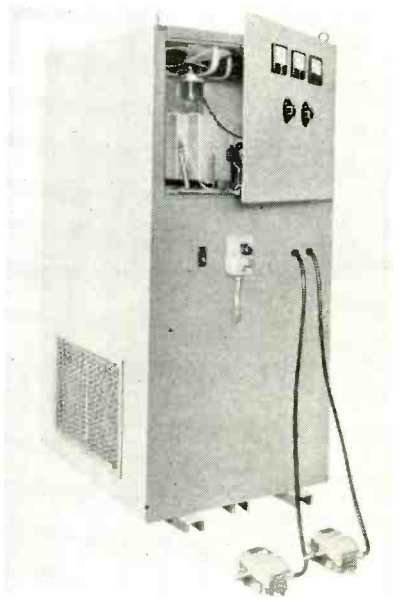
low extractions, excellent blister resistance, and does not soften in Freon-22. The high stability of the film eliminates the hydrolysis problem; it also gives Hermeteze more resistance to heat and pressure at crossovers as the illustration on p 106 indicates.

CIRCLE 311 ON READER SERVICE CARD

Capacitors
high reliability

VITRAMON INC., P. O. Box 544, Bridgeport 1, Conn. Type VK microminiature ceramic capacitors are available in ratings from 47 to 10,000 $\mu\mu$f, 200 v d-c without derating, −55 C to 150 C operation. They feature excellent environmental characteristics, conform to requirements of MIL-C-11015B.

CIRCLE 312 ON READER SERVICE CARD

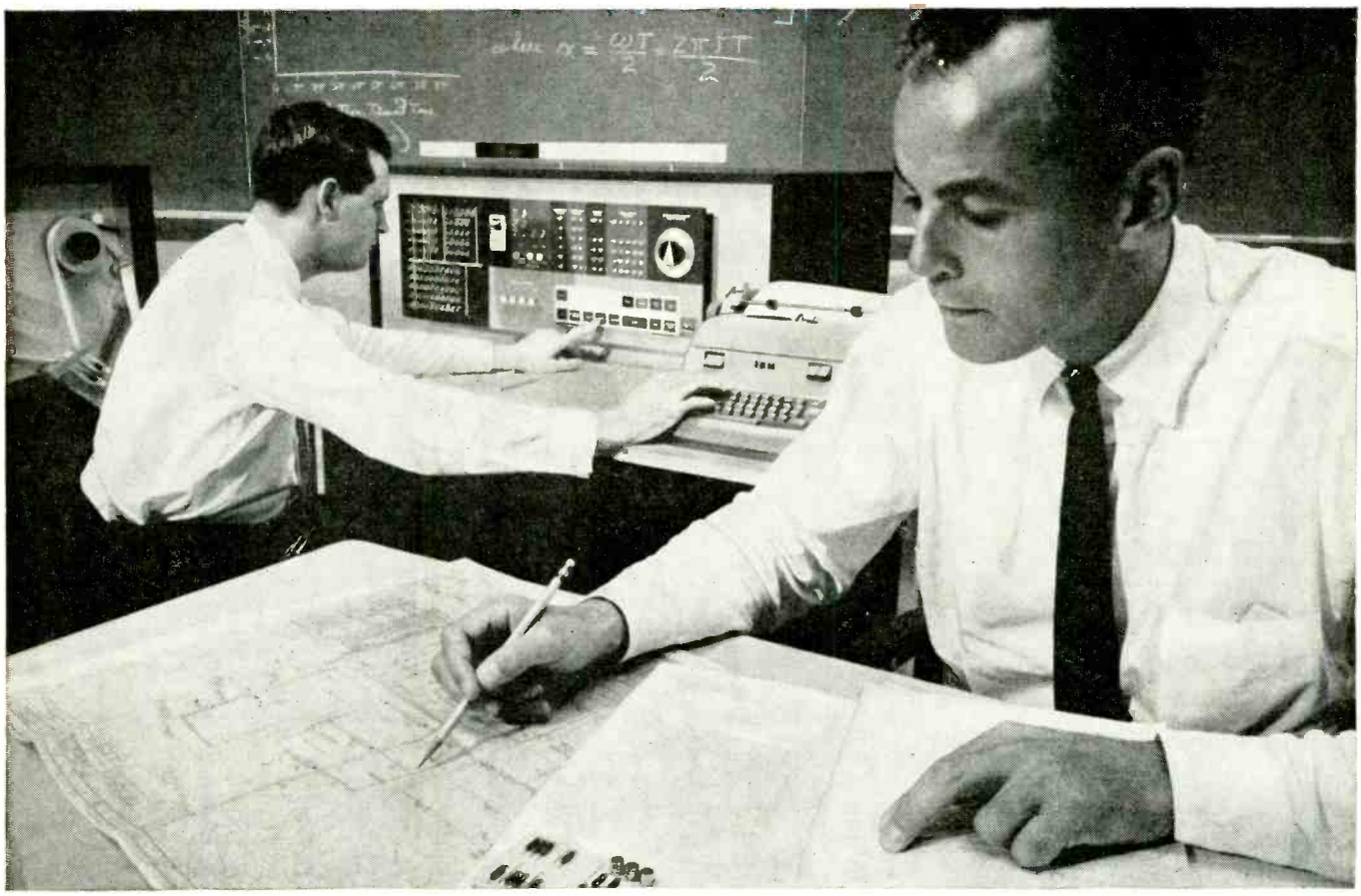


D-C Power Supply
sequence controlled

NOTHELFER WINDING LABORATORIES, INC., P.O. Box 455, Trenton, N. J. This unit is especially designed to produce a high magnetic field inside a high compression molding dye for the manufacture of magnetic ceramics. Output is 60 v, 1,000 amperes and ripple is less than 5 percent. Sequence timers and reversing switches, located internally, make the output positive or negative to produce magnetizing and demagnetizing fields as required. Output is varied over a wide range

IBM 1620 *data processing system*

...the most powerful engineering computer in its low price class



The new IBM 1620 is a desk-size engineering computer that offers you more computing ability per dollar than any system in its price class.

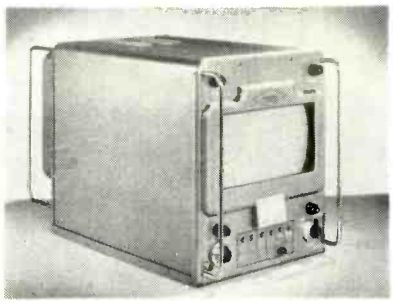
Transistorized throughout, the IBM 1620 has a 20,000-digit magnetic core memory with variable field length and immediate accessibility. Its input-output notation, on paper tape and console typewriter, is in convenient decimal arithmetic. It can perform more than 100,000 calculations a minute and is easily adapted to your engineering problems.

Easy to learn, easy to operate, easy to communicate with, the low-cost 1620 helps free your engineering talent for more creative work. And in keeping with our concept of Balanced Data Processing, the IBM 1620 is supported by extensive services. This includes a comprehensive library of mathematical routines and specific industry programs to permit you to put the 1620 to work without unnecessary delay.

Ask your IBM representative about the unique advantages of the IBM 1620. Like all IBM equipment, it may be purchased or leased.

balanced data processing IBM®

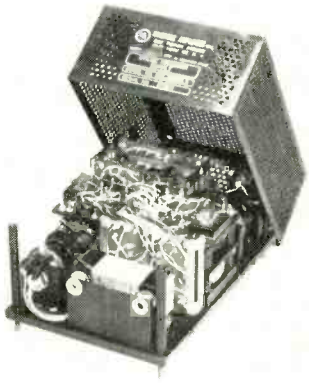
by a saturable core reactor. Detailed information may be obtained by writing the company.



Flaw Detector
ultrasonic

SPERRY PRODUCTS, INC., Danbury, Conn. Type UI Reflectoscope is suitable for both contact and immersed inspection. Use of printed circuits and transistors results in a versatile instrument with many capabilities that is yet small in size and easy to handle. It can be directly mounted on scanning bridges now in use in various plants. Designed for application in the lab or on the production line it features a large 12 in. dual trace display tube that is bright enough to be seen from a considerable distance, and a two-color display that enables flaw indications to be easily distinguished from range marks. Frequency ranges run from 1.0 to 25.0 mc.

CIRCLE 313 ON READER SERVICE CARD



Static Inverter
high temperature

MAGNETIC AMPLIFIERS, INC., 632 Tinton Ave., New York 55, N. Y. Model SIS-40613-S static inverter supply is a precision d-c/a-c power converter designed to operate from a nominal 28 v d-c source and to provide 26 v 400 cps 3-phase power

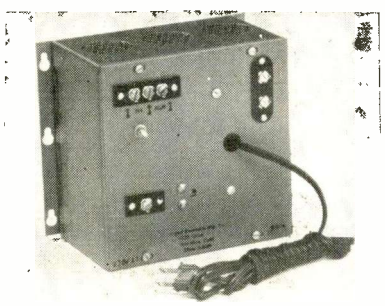
at 20 va per phase for a total of 60 va. Solid state components are used throughout. Unit is highly stable in frequency, phase and voltage, and will operate at base plate temperatures to + 100 C. It features automatic voltage regulation ± 5 percent no load to full load, short circuit protection with automatic recovery, and reverse voltage protection.

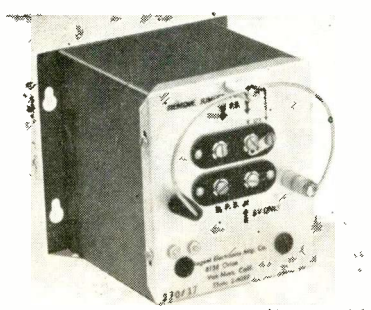
CIRCLE 314 ON READER SERVICE CARD

Rotator
medium duty

TELREX LABORATORIES, Asbury Park, N. J. Model 175-RIS rotator/indicator system provides over 1650 in./lb of rotating torque at 1.5 rpm, enough muscle to rotate and hold very large single boom Tri-Band arrays without damage or drifting in hurricane winds. Price is $198.50.

CIRCLE 315 ON READER SERVICE CARD



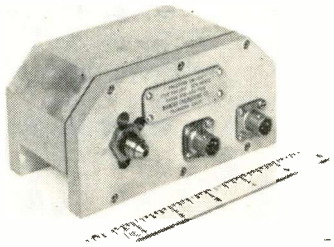


Receiver
and transmitter

REGENT ELECTRONICS MFG. CO., 15321 Rayen St., Sepulveda, Calif. Model RR-1 receiver and RT-1 transmitter provide pushbutton radio control of remote functions. Forty different frequency codes are provided to assure minimum interference and to provide maximum security. Transmitted signals con-

sist of a radio frequency carrier modulated with an audio frequency. Carrier frequency range is 250-290 mc; modulation frequency, 15 to 22 kc; carrier bandwidth, 6 mc.

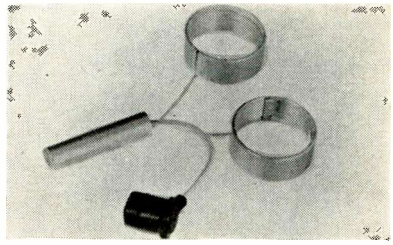
CIRCLE 316 ON READER SERVICE CARD



Pressure Switch
light-weight

WIANCKO ENGINEERING CO., 255 N. Halstead, Pasadena, Calif. The P36-1001 pressure switch combines a transducer, a solid-state carrier oscillator, ring demodulator, and switching transistor. D-C input voltage is converted to a-c for excitation of a variable reluctance magnetic circuit. Absence of mechanical contacts permits no chatter, or shift in the electrical output due to vibration. Range is 10 to 3,000 psig; maximum working pressure, 200 percent of nominal switch pressure; accuracy, ±1.5 percent of setting; switch pressure adjustment, ±16 percent of nominal switch pressure (adjustable).

CIRCLE 317 ON READER SERVICE CARD

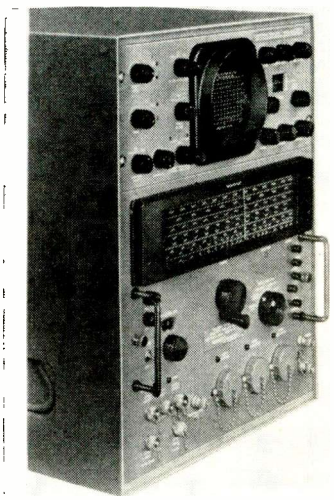


H-V Filter
anti-vibration

FILTRON CO., INC., 10023 W. Jefferson Blvd., Culver City, Calif. A high-voltage filter with a new method of keeping caps from shaking loose due to vibration plus special anti-corrosion treatment has been developed for use in military type systems. The filters are designed for 4,000 v; have special silver plating for anti-corrosion and conductivity with self-locking anti-

corona caps. All parts are formed or machined at a tolerance of 0.001, with screw-on connectors.

CIRCLE 318 ON READER SERVICE CARD



Spectrum Analyzer stable, versatile

PANORAMIC RADIO PRODUCTS, INC., 514 South Fulton Ave., Mt. Vernon, N. Y. SPA-4 spectrum analyzer has a usable sensitivity exceeding 100 dbm. It features 0-70 mc and 0-5 mc independent frequency dispersion ranges, with negligible internal frequency modulation; a variable 1-80 kc i-f bandwidth; precisely calibrated log, linear and power amplitude scales; a single tuning lead with a 10 mc to 44 kmc frequency range; and a self-contained marker oscillator for accurately measuring small frequency differences.

CIRCLE 319 ON READER SERVICE CARD

Digital Voltmeter high-speed

EPSCO, INC., 275 Massachusetts Ave., Cambridge, Mass. The DVM digital voltmeter is an all solid-state instrument for use in instrumentation. It is a multi-output data converter consisting of a voltage-to-digital converter and a digi-

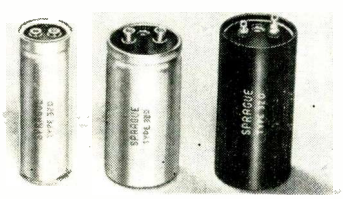
tal display. Unit measures bipolar d-c voltages ranging from 1 mv to 1,000 v. Accuracy is ±0.1 percent and speed is 100 conversions per sec. Output is automatically displayed as a 3-decimal digit readout plus an overflow digit, sign and decimal point. Electrical outputs include parallel BCD coded voltages and a serial pulse train for single wire telemetry use.

CIRCLE 320 ON READER SERVICE CARD

Autopilot Analyzer
fast and accurate

SERVO CORP. OF AMERICA, 111 New South Road, Hicksville, L. I., N. Y. New Servoflight autopilot analyzer, model 5800, provides a fast, accurate check of frequency response for advanced automatic pilot systems in commercial and military jets. It rapidly measures phase, gain, and transient response of both a-c and d-c automatic control systems. Direct setting for both amplitude and frequency assures more exact repeatability by eliminating any possibility of indicator reading error.

CIRCLE 321 ON READER SERVICE CARD



Aluminum Electrolytics
for power supplies

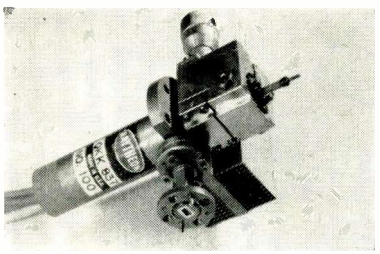
SPRAGUE ELECTRIC CO., North Adams, Mass. Type 32D Compulytic aluminum electrolytic capacitors are designed to meet 85C operating conditions as standard. In the largest standard case size, 3 in. diameter by 4⅝ in. long, it is possible to obtain them with a rating of 130,000 μf at 2½ v or 630 μf at 450 v. Capacitor banks as large as 1 farad of capacitance have been constructed using the type 32D. Expanded ratings and complete performance characteristics are given in engineering bulletin 3441A.

CIRCLE 322 ON READER SERVICE CARD

Radar Tubes
ultra-fast sweep

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. A line of radar tubes in 10, 12, and 16 in. sizes offer jump-sweep capabilities to meet modern radar read-out requirements including high resolution, deflection uniformity, and reduced deflection defocusing. The 16-in. tube has a minimum useful screen diameter of 14½ in. Typical operating conditions are accelerator voltage of 10,000 v, focusing electrode 3,000 to 3,500 v, grid No. 1,150 to 260 v, modulation 40 and line width 0.015 in.

CIRCLE 323 ON READER SERVICE CARD



Microwave Tubes
67,000-73,000 mc

RAYTHEON CO., Waltham 54, Mass. Types QKK837 and QKK838 are mechanically tuned velocity variation oscillators designed for operation in the 67,000 to 73,000 mc range with minimum output of 10 mw. The r-f output is through waveguide sealed by a mica window. The output flange mates with a standard UG385/U cover-flange.

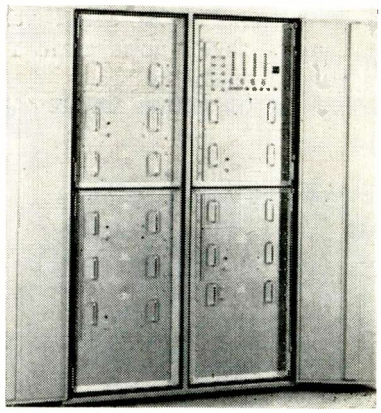
CIRCLE 324 ON READER SERVICE CARD

Magnetic Tape Eraser
weighs 26 lb

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston 19, Texas. The MTE-2 magnetic tape eraser is designed to provide clean demagnetization of either direct or f-m recorded tapes. The simple, lightweight unit allows

tapes to be erased without removing them from their containers. It can be used to demagnetize any magnetic tape that can be rolled to a diameter of 1½ in. Price is $195.

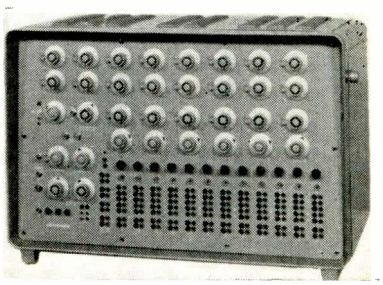
CIRCLE 325 ON READER SERVICE CARD



Reset Control System for steel mills

DATEX CORP., 1307 So. Myrtle Ave., Monrovia, Calif. Automatic digital control system will position the rolls of a hot strip mill and assure the desired thickness of sheet steel. The system resets the position of the screwdown rolls in accordance with directions obtained from an automatic gage controller. It includes five control channels to simultaneously reset the rolls of five stands, but can be designed to control any number of stands. The resetting is done to an accuracy of 0.001 in.

CIRCLE 326 ON READER SERVICE CARD

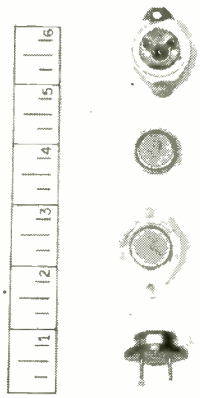


Analog Computer compact unit

BOONSHAFT AND FUCHS, INC., Hatboro Industrial Park, Hatboro, Pa. The AR-2 analog computer measures 35½ by 21 by 23 in. It is furnished complete with 12 amplifiers, 16 potentiometers, a pulse generator, and a stepping function generator. Six of the amplifiers can be used as integrators (with 3 dif-

ferent ratios of integration). Ease and speed of operation are achieved by an impedance matching design that eliminates the need to compensate for loading effects between amplifiers. The solution to physical and mathematical problems appears as a time-variable voltage curve that can be viewed on any d-c oscilloscope or a direct writing oscilloscope.

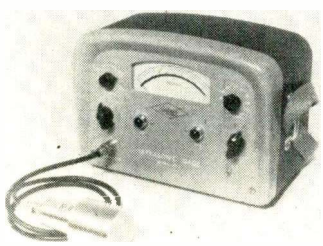
CIRCLE 327 ON READER SERVICE CARD



Switching Transistor
high-power

BENDIX SEMICONDUCTOR PRODUCTS, 201 Westwood Ave., Long Branch, N. J. The 2N1120 has been designed to meet MIL-T-19500/68 (Sig C). Its maximum collector current rating of 10 amperes d-c makes it particularly appropriate for high current switching applications, while a collector-emitter voltage rating of 70 v d-c suits it equally well to high voltage applications. The transistor will readily dissipate 45 w at a 25 C mounting base temperature.

CIRCLE 328 ON READER SERVICE CARD

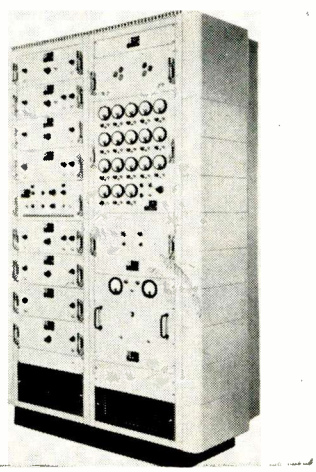


Ultrasonic Gage
compact, portable

SPERRY PRODUCTS, INC., Danbury, Conn. An ultrasonic gage weighing only 10 lb will be used for measuring thickness and inspecting corrosion in pipe, storage vessels, hull

plates and other applications. Since it uses transistors and 1-v batteries, it is explosion proof. Measurements may be read on a directly calibrated meter which eliminates the necessity of interpreting them through an oscilloscope and charts. Once the operator has adjusted the material dial for the metal being inspected, the instrument reads directly in inches. Accuracy in reading is 1 percent of full scale. Maximum thickness that can be gaged is in excess of 3 ft in aluminum and steel; minimum, 0.060 in aluminum and 0.070 in steel.

CIRCLE 329 ON READER SERVICE CARD



Checkout System for discriminators

DYNATRONICS, INC., Box 2566, Orlando, Fla. Automatic discriminator checkout system reduces calibration costs and eliminates human error. It operates in automatic, semiautomatic and manual modes and generates 18 RDB standard f-m/f-m subcarrier channels. In automatic mode, up to 18 discriminators can simultaneously be given an 11 point checkout in 11 sec, to an accuracy of better than 0.1 linearity.

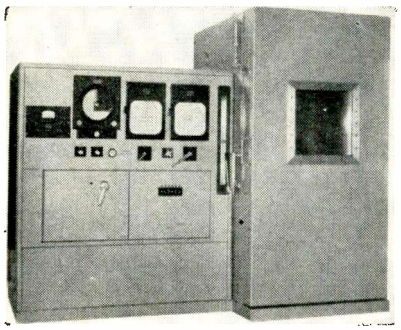
CIRCLE 330 ON READER SERVICE CARD

High-Meg Paints for lab, production

MICRO-CIRCUITS CO., New Buffalo, Mich. New ultra high resistance paints are for use in making individual, special resistors or larger quantities of low-cost, noncritical high meg resistors. The series of seven paints covers the resistance range from 10 megohms per square

through 10,000 megohms per square for which, the company says, no stock paints were previously available.

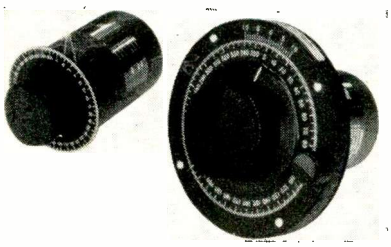
CIRCLE 331 ON READER SERVICE CARD



Test Chamber
temperature-altitude

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model FH-63-705-705 temperature-altitude chamber has a 7 ft high by 3 ft wide by 3 ft deep interior. Temperature range is −100 F to +300 F; altitude, to 200,000 ft. It features an electronic temperature recording controller with programming and automatic proportioning of heating and cooling, and recording and controlling of altitude conditions.

CIRCLE 332 ON READER SERVICE CARD



Phase Shifter
360 deg

THETA INSTRUMENT CORP., 520 Victor St., Saddle Brook, N. J. Employing a synchro resolver, resistors and capacitors, this phase generator provides continuous phase shift of a carrier without amplitude change. It is intended to be used as a single-frequency phase meter, reference for demodulator circuits, and a position-phase transducer. It conforms to MIL-D-8512 and MIL-T-945A. Phase accuracy is 30 min.; range, 360 deg; input voltage, 115 v; output voltage, 32 v.

CIRCLE 333 ON READER SERVICE CARD

Literature of

ENCASED TUBULAR CAPACITORS. The Potter Co., 1950 Sheridan Road, North Chicago, Ill. A 4-page folder describes a line of non-metallic encased tubular capacitors (200 v to 600 v).

CIRCLE 380 ON READER SERVICE CARD

SILICON POWER DEVICES. ITT Components Division, International Telephone and Telegraph Corp., P. O. Box 412, Clifton, N. J., has available a silicon buyer's guide covering a broad line of diffused junction power rectifiers and Zener diodes.

CIRCLE 381 ON READER SERVICE CARD

PULSE TRANSFORMER. ESC Corp., 534 Bergen Blvd., Palisades Park, N. J., has published a bulletin on a new microminiature pulse transformer with fractional μsec pulse width.

CIRCLE 382 ON READER SERVICE CARD

AUDIO SIGNAL TRANSISTOR. Bendix Aviation Corp., Red Bank Division, 201 Westwood Ave., Long Branch, N. J., has available a data sheet on the 2N1176, A,B "Yeoman" — a versatile, low-priced driver transistor.

CIRCLE 383 ON READER SERVICE CARD

PULSE WIDTH DISCRIMINATOR FILTER. Mini-Rad, Inc., 7416-E Varna Ave., North Hollywood, Calif. A 6-page technical brochure covers the pulse width discriminator filter which is applicable to a wide variety of pulse and video type electronic systems.

CIRCLE 384 ON READER SERVICE CARD

COIL WINDING EQUIPMENT. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill. An 8-page catalog illustrates and gives technical data on 5 coil winding machines for heavy duty transformers and field coils, 3 heavy duty tensions, and also has a page illustrating plant facilities.

CIRCLE 385 ON READER SERVICE CARD

ANALOG-TO-DIGITAL PROCESSOR. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Details of Micro-SADIC, a high-speed analog-

the Week

to-digital processor are presented in an illustrated, four-page bulletin.

CIRCLE 386 ON READER SERVICE CARD

ELECTRONIC MULTIPLIER. Computer Systems, Inc., 611 Broadway, New York 12, N. Y. A 16-page brochure describes the MC-701 a-m/f-m electronic multiplier which provides dynamic accuracy of ±0.05 percent of full scale at 500 cps.

CIRCLE 387 ON READER SERVICE CARD

DIGITAL TAPE HANDLER. Ampex Corp., Instrumentation Division, 934 Charter St., Redwood City, Calif., is offered a 3-color, 8-page brochure on the FR-400 digital magnetic tape handler.

CIRCLE 388 ON READER SERVICE CARD

MAGNETIC THYRATRON CONTROLS. Fairfield Engineering Corp., 934 Hope St., Springdale, Conn. Bulletin MTC558 gives operational data on a line of magnetic thyratron controls which give very fast response, precise power control and high efficiency.

CIRCLE 389 ON READER SERVICE CARD

SWEPT AUDIO MEASUREMENTS. Panoramic Radio Products, Inc., 514 S. Fulton Ave., Mt. Vernon, N. Y. Frequency response and distortion measurements of amplifiers, speakers and other high-fidelity equipment are discussed in issue No. 5 of The Panoramic Analyzer.

CIRCLE 390 ON READER SERVICE CARD

PRIMARY BATTERIES. Cook Batteries, 3850 Olive St., Denver 7, Colo. A 6-page illustrated brochure provides design details for over 20 new manual and automatically activated silver-zinc primary batteries.

CIRCLE 391 ON READER SERVICE CARD

ELECTRONIC GENERATORS. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., has available literature describing models 150 and 250 Powertron electronic generators, which provide output powers of 160 va and 250 va respectively.

CIRCLE 392 ON READER SERVICE CARD

GI Dedicates Space-Age Lab

GENERAL INSTRUMENT CORP. recently opened a new Advanced Development Laboratory (sixth unit in the company's Defense and Engineering Products Group) in Westbury Industrial Park, L. I., N. Y. The new facility is operated by Radio Receptor Co., wholly-owned GI subsidiary.

Housed in a modern, single-level building, the lab has an initial scientific and technical staff of 60, which is expected to be doubled within a year. The interior has been designed to provide spacious, air-conditioned offices for professional and technical personnel, complete design and drafting facilities, an extensive technical library, and large development and test laboratory areas. Also included are a fully equipped machine shop, an environmental test laboratory, model assembly shop, instrument room, and components test laboratories. ADL has been cleared by the Dept. of Defense for the handling of classified government contracts.

The organizational structure of General Instrument's Defense and Engineering Products Group enables the Advanced Development Laboratory to draw on technical facilities far greater than those actually installed at the Westbury lab. These include equipment, personnel and facilities available at the Newark, N. J.; Brooklyn, N. Y.; Chicopee, Mass.; and Woodbury, Conn., plants. Also available are the highly specialized functions of the Laboratory Groups of the General Instrument family, specializing in new products, ferrites, thermoelectric devices, capacitors, selenium, delay lines, semiconductors, and acoustic devices.

The new lab's management, scientific and engineering personnel are specialists in military electronics. The lab is under the direction of Ralph Mendel, vice president of Radio Receptor Co., Inc. Technical director is Arthur L. Rossoff, formerly chief engineer of Radio Receptor's Engineering Products division. Other key personnel include Harold Cohen, radar section head; Nathaniel L. Cohen, communication section head; and staff engineers Solomon A. Zadoff and Howard E. Lustig.

Aerojet Sets Up AETRON Division

AEROJET-GENERAL CORP., Azusa, Calif., developer and producer of rocket propulsion systems for the Space Age, has formed a new division which will integrate the company's skills in architectural engineering and electronics to develop facilities for the manufacturing, testing and development of weapons systems and space vehicles.

New division will be known as AETRON, and will combine Aerojet's Architect-Engineer unit with Electronic Design groups for more effective participation in the national effort to provide missile and space vehicle facilities.

Benjamin F. Rose, Jr., will manage AETRON. He has previously been associated with Douglas Aircraft Co. and Lockheed Aircraft Co. prior to joining Aerojet-General in 1947.

AETRON will maintain its office in its own plant in Covina, Calif. This plant contains 3.5 acres and at present houses 500 employees.

Warsher Enters Consulting Field

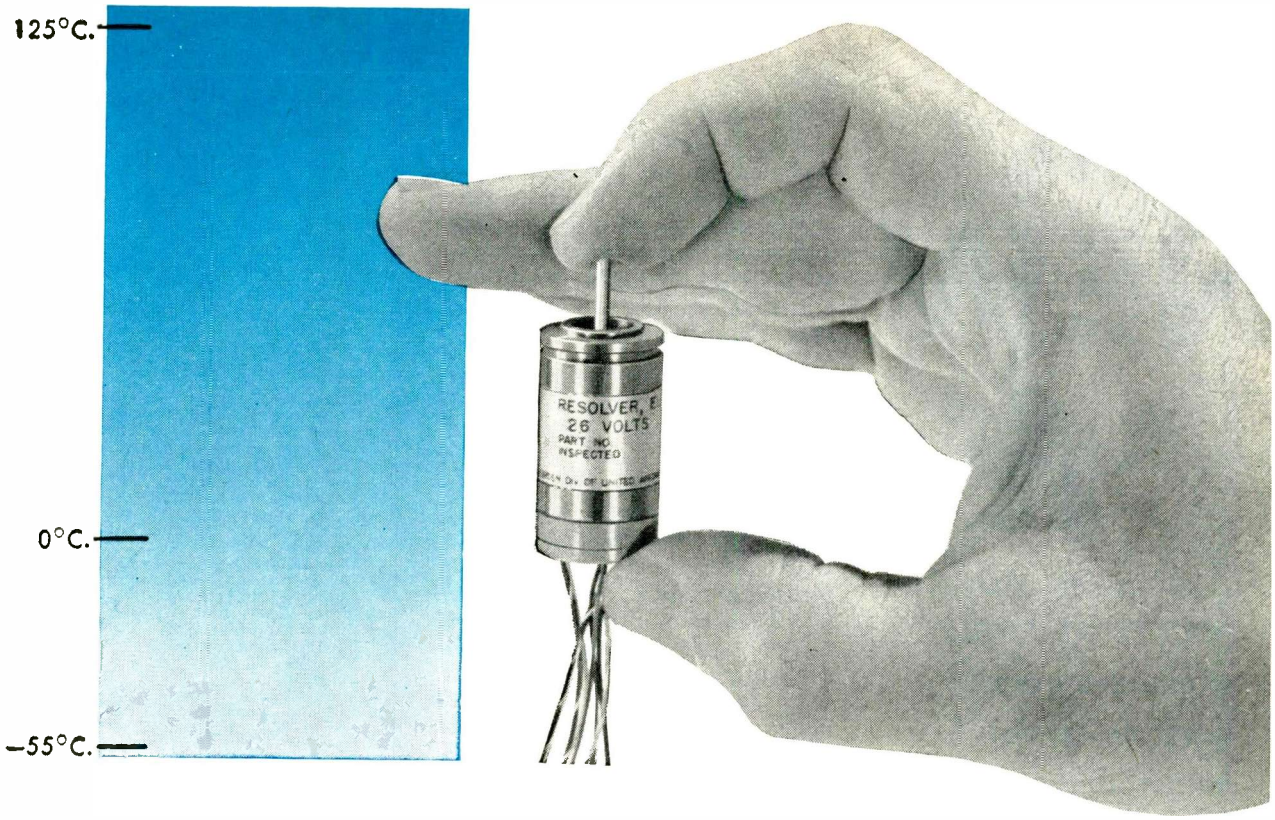
ADOLPH WARSHER announces that he is now engaged in a consulting practice specializing in reliability control engineering, with offices in Ridgewood, N. J.

Formerly manager of reliability control engineering at Bendix Aviation Corp.'s Eclipse-Pioneer Division, and chairman of the Bendix Corporate Interdivisional Reliability Technical Committee, Warsher was associated with Bendix since 1943. Previously he had been chief engineer of the New Republic Radio Corp., a subsidiary of Duro Test Corp., North Bergen, N. J.

IRE Announces Fellow Awards

SEVENTY-SIX leading radio engineers and scientists from the U. S. and other countries were recently named Fellows of the IRE by the board of directors, effective Jan. 1, 1960.

Presentation of the awards will be made by IRE Sections all over the world wherever the recipients reside. Recognition of the awards will be made by the president of the IRE at the annual banquet on March 23, 1960 at the Waldorf-



New size 08 Ketay Resolver is stable over entire temperature range

This new Ketay Resolver provides stability over the entire temperature range of −55°C to +125°C. This is accomplished without the size and weight of compensating circuitry.

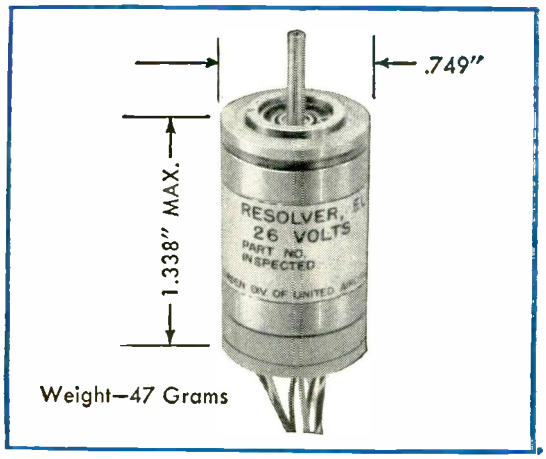
The Resolver has superior electrical characteristics:

- **High Input Impedance**—almost twice that of any existing unit.
- **Lower Phase Shift**—half that of existing units.

These features permit cascading twice as many resolvers with less degradation.

Resolver accuracy is now available in this small 08 size because of superior Ketay design. This Resolver meets or surpasses applicable military specifications for shock, vibration and humidity.

These typical specifications tell the story—



	At Room Temperature 25°C	MAXIMUM VARIATIONS Over Entire Temperature Range (Open Circuit) −55°C to +125°C
Input Impedance (ohms)	1010 ± 10% ∠79° ± 1°	± 10%
Transformation Ratio	1.059 ± 1%	± 1.0%
Phase Shift (lead)	6.0 ± 1°	± 2°
Null Voltage (total max.)	50.0 MV	± 15.0 MV
Rotor Interaxis Error (max.)	± 7′	± 2′
Stator Interaxis Error (max.)	± 7′	± 2′
Functional Accuracy (max.)	± 7′	± 3′
Frequency 400 cps		
Input Stator		
Number of Phases		
Rotor 2		
Stator 2		
Voltage Rating 26V AC		

Please write for detailed specifications and outline drawings.

KETAY DEPARTMENT

Norden Division of United Aircraft Corporation

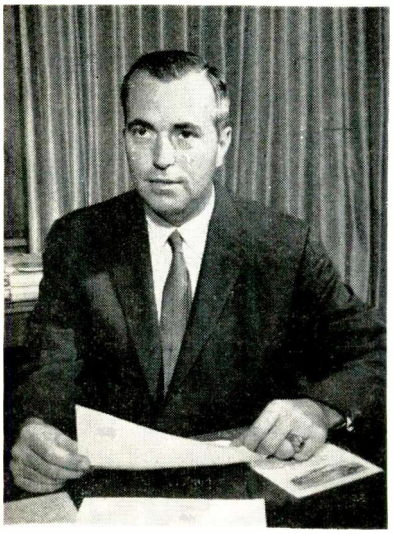
Commack, Long Island, New York

CIRCLE 125 ON READER SERVICE CARD 125

Astoria Hotel in New York City during the IRE International Convention.

Recipients of the award are as follows:

R. B. Adler, MIT, Cambridge, Mass.; H. H. Aiken, Harvard U., Cambridge, Mass.; H. O. G. Alfven, Royal Inst. of Technology, Stockholm, Sweden; W. M. Bailey, Cornell-Dubilier Electric Corp., New Bedford, Mass.; Rudolf Bechmann, Army Signal R & D Lab, Ft. Monmouth, N. J.; J. I. Bohnert, USNRL, Washington, D. C.; J. F. Calvert, U. of Pittsburgh, Pittsburgh, Pa.; D. K. Cheng, Syracuse U., Syracuse, N. Y.; Trevor Clark, Westinghouse Electric Corp., Baltimore, Md.; P. W. Crapuchettes, Litton Industries, Inc., San Carlos, Calif.; A. N. Curtiss, RCA, Los Angeles, Calif.; C. E. Dean, Hazeltine Research Corp., Little Neck, L. I., N. Y.; G. A. Deschamps, U. of Illinois, Urbana, Ill.; A. C. Dickieson, Bell Telephone Labs, Murray Hill, N. J.; Stephen Doba, Jr., Bell Telephone Labs, Murray Hill, N. J.; I. G. Easton, General Radio Co., West Concord, Mass.; P. G. Edwards, Bell Telephone Labs, North Andover, Mass.; J. H. Felker, AT&T, New York, N. Y.; G. J. Fiedler, Sverdrup & Parcel, Inc., St. Louis, Mo.; G. A. Fowler, Sandia Corp., Albuquerque, N. M.; D. W. Fry, United Kingdom Atomic Energy Authority, Winfrith, Dorset, England; R. W. Gilbert, Daystrom-Weston Divs., Newark, N. J.; G. S. Glinski, U. of Ottawa, Ottawa, Ontario, Canada; M. J. E. Golay, The Perkin-Elmer Corp. and the Philco Corp., Rumson, N. J.; Georges Goudet, Laboratory Centre des Telecommunications, Paris, France; W. J. Hamm, St. Mary's U., San Antonio, Texas; H. C. Hardy, Howard C. Hardy & Associates, Chicago, Ill.; R. A. Helliwell, Stanford U., Stanford, Calif.; R. K. Hellmann, Hazeltine Electronics Div., Little Neck, N. Y.; S. W. Herwald, Westinghouse Electric Corp., Pittsburgh, Pa.; W. H. C. Higgins, Bell Telephone Labs, Murray Hill, N. J.; C. L. Hogan, Motorola, Inc., Phoenix, Ariz.; J. M. Hollywood, CBS Labs, Stamford, Conn.; F. L. Hopper, Bell Telephone Labs, Winston-Salem, N. C.; P. W. Howells, GE Co., Syracuse, N. Y.; H. R. Huntley, AT&T Co., New York, N. Y.; E. O. Johnson, RCA Semiconductor Div., Somerville, N. J.; Harwick Johnson, RCA Labs, Princeton, N. J.; E. A. Keller, Motorola Military Electronic Center, Chicago, Ill.; C. L. Kober, AVCO Mfg. Corp., Cincinnati, Ohio; Harry Krutter, Naval Air Development Center, Johnsville, Pa.; J. G. Linvill, Stanford U., Stanford, Calif.; W. A. Lynch, Polytechnic Inst. of Bklyn, Bklyn, N. Y.; J. M. Manley, Bell Telephone Labs, Murray Hill, N. J.; M. A. McLennan, Wright ADC, Wright-Patterson AFB, Ohio; Doren Mitchell, Bell Telephone Labs, New York, N. Y.; J. P. Molnar, Sandia Corp., Albuquerque, N. M.; L. H. Montgomery, Jr., Vanderbilt U., Nashville, Tenn.; J. B. Moore, RCA Communications, Inc., New York, N. Y.; Theodore Moreno, Varian Associates, Palo Alto, Calif.; T. H. Morrin, Stanford Research Institute, Menlo Park, Calif.; Shogo Namba, Kokusai Denshin Denwa Co., Ltd., Tokyo, Japan; F. R. Norton, Denver Labs of Ramo-Wooldridge, Denver, Col.; Franz Ollendorff, Israel Institute of Technology, Haifa, Israel; R. L. Pritchard, Texas Instruments, Inc., Dallas, Texas; D. S. Rau, RCA Communications, Inc., New York, N. Y.; L. L. Rauch, U. of Michigan, Ann Arbor, Mich.; H. R. Reed, U. of Maryland, College Park, Md.; V. C. Rideout, U. of Wisconsin, Madison, Wisc.; A. W. Rogers, U. S. Signal Corps Engineering Labs, Ft. Monmouth, N. J.; V. H. Rumsey, U. of California, Berkeley, Calif.; W. T. Selsted, Ampex Corp., Redwood City, Calif.; Samuel Sensiper, Hughes Aircraft Co., Culver City, Calif.; William Sichak, ITT Labs, Nutley, N. J.; R. L. Sink, Consolidated Electrodynamics Corp., Pasadena, Calif.; P. T. Smith, RCA Labs, Princeton, N. J.; A. H. Sommer, RCA, Princeton, N. J.; R. C. Spencer, The Martin Co., Baltimore, Md.; W. E. Tolles, Airborne Instruments & Laboratory, Inc., Melville, L. I., N. Y.; L. G. Trolese, Smyth Research Associates, San Diego, Calif.; D. F. Tuttle, Jr., Stanford U., Stanford, Calif.; G. E. Valley, Jr., MIT, Cambridge, Mass.; J. A. Van Allen, State U. of Iowa, Iowa City, Iowa; E. A. Walker, Penn State U., University Park, Pa.; W. M. Webster, Jr., RCA Labs, Princeton, N. J.; and Louis Weinberg, Hughes Aircraft Co., Culver City, Calif.



Name Halligan Exec V-P and G-M

ROBERT F. HALLIGAN has been named executive vice president and general manager of The Hallicrafters Co., Chicago electronics development and manufacturing firm.

He joined Hallicrafters in 1950 and has served as an executive in purchasing, manufacturing, finance and engineering operations. In 1955 he was named vice president in charge of operations. Subsequently, he became a director of the company.

News of Reps

Chicago Dynamic Industries, Inc., Precision Products Division, Chicago, Ill., has appointed **Long & Associates** of Redwood City, Calif., to handle its line of removable wafer rotary selector switches and precision counters in northern California, and **Weightman & Associates** of Burbank for southern California sales.

Sierra Electronic Corp., Menlo Park, Calif., has appointed **Lee Mark Associates, Inc.**, as sales reps in Kansas, Missouri and southern Illinois. The Sierra account will be serviced at Lee Mark offices in St. Louis and Kansas City, Mo.

The **Munhall Co.** of Buffalo, N. Y., has been appointed by Bishop Mfg. Corp., Cedar Grove, N. J., as its sales rep in the western portion of New York State.

COMMENT

Reactor Control

Ref. ELECTRONICS May 22, the article "Transistor Amplifiers for Reactor Control," (pp 52-53) by Messrs. E. J. Wade and D. S. Davidson:

I found the article of considerable interest because of the combination of electrometer tubes with transistors which has several possible applications in the field of medical electronics. However, I would like to know if there is not an error in the circuit drawing, Fig. 1, where the collector of Q_1 is tied to the base of Q_5 through a 100-ohm resistor and a ground is also placed on the Q_1 collector.

Any comments on this circuit would be appreciated.

C. C. BATTERSON

DALLAS

The base of Q_5 is connected to a tap between a 22K resistor to 20 v and a 100-ohm resistor to ground. The Q_1 collector is also grounded. Author Wade comments:

With regard to the questions raised by Mr. Batterson, the circuit is correct as published. The collector of Q_1 should be grounded and the output is taken from the collector of Q_2 as shown.

However, in going over the circuit, I noticed some other errors which crept in when the circuit was redrawn for publication.

There should be a 680K resistor between −20 v and the common cathodes of V_1 and V_2. The 10K resistor shown between −20 v and the collectors of Q_3 and Q_4 should be 1K.

The heater of V_5 is not shown but is operated in series with heaters of V_1 and V_2. The diode in series between the emitters of Q_4 and Q_5 should be 1N450.

The unmarked resistor from the slider of the 10K potentiometer to switch 1A is 10^{11} ohms. The integrating capacitor between switch 1A and the output is 1 microfarad. The two other capacitors marked "1" are also 1 microfarad.

Perhaps you could publish a note in a forthcoming issue. . .

E. J. WADE

GENERAL ELECTRIC
SCHENECTADY, N. Y.

Small Problem

Recently you have been placing Financial Roundup back to back with Market Research.

Since we file each one, after clipping, in separate files, the back-to-back printing requires us to make copies to keep our files complete.

This is only a recent problem, so perhaps it can be rearranged to the former system. . .

DAVID L. KEITH
H. M. BYLLESBY & CO.
CHICAGO

We try to avoid "backing them up" and there will be few instances where this happens. However, we do sometimes get into a purely mechanical bind that requires it. Anyway, it's good to know that reader Keith's company, like many others, reads and files these business columns.

Germ Warfare

Your recent article on CBR warfare ("Germ-Gas Detectors Needed," p 34, Dec. 4) requires amplification.

You talk about influencing the reproductive rates of microorganisms with radio-frequency energy. Are you seriously suggesting that our Army Chemical Corps has devised a weapon that will selectively seed a pandemic under the influence of radio energy?

Seems pretty farfetched to me.

ROBERT HUTCHINSON
SALT LAKE CITY

It may seem farfetched, but our understanding is that both r-f and ultrasonic energy are being investigated, firstly as a countermeasure against bacteria seeded by an enemy and secondly as constituents of a retaliatory bacterial weapons system.

In the same issue, as reader Hutchinson may have noticed, we carried an article on new discoveries in this field ("New Bio-Effects of R-F Energy," p 38), in which we reported on research by other life scientists on the various ways in which microorganisms are affected by r-f energy. Control over rates of reproduction was one; artificial creation of mutations was another.

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Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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Used Test Cells ..... $1.95 ea. Postpaid
Brand New Cells ..... 2.95 ea. "
24 V Battery (20 cells) in metal case—used $40.00
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Plastic battery cases may have slight cracks-repaired easily or add 25¢ to price to insure uncracked case. *All cells guaranteed or money refunded (less postage).*

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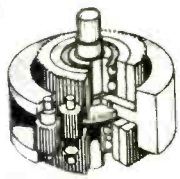

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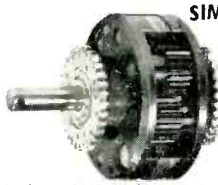
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. ¼" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115 ..... each $15.00



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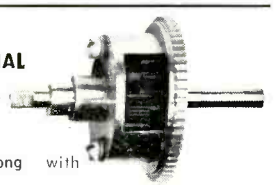
1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is ¾" thick, but the sun gears are spaced out so that they are 1½" apart. ¼" dia. shaft on each side is 23/32" long. OA length 3⅛". Requires 1-23/32" dia. to clear the body.
Stock no. A6-124 ..... each $4.50



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1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.
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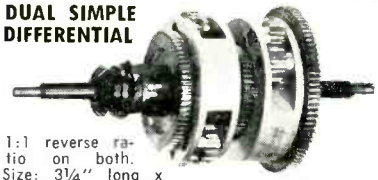

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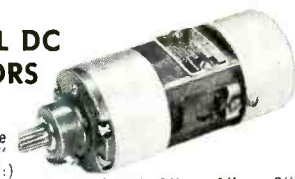

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115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°.
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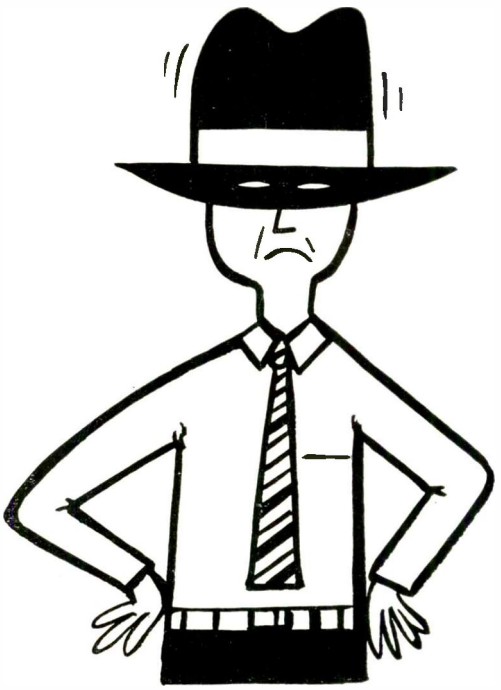
ADVERTISERS INDEX

• See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.



ARE YOU MAKING THE SAME MISTAKE IN DEPOSITED CARBON RESISTORS?

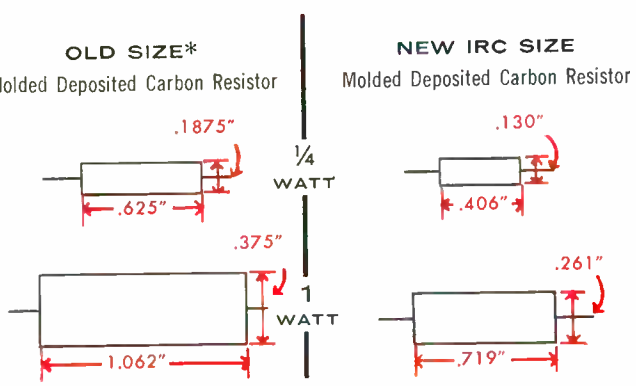
Switch to IRC Molded Deposited Carbon Resistors—"PRE-SHRUNK" for miniaturization.

If you have anything to do with miniaturizing components, be prepared for a pleasant surprise.

IRC has reduced the size of Molded Deposited Carbon Resistors in the 3 most popular wattage ratings at the same ambient, an improvement made possible through the use of a unique IRC alloy film and a new high-temperature coating.

This means that you can now choose a smaller unit with wattage equivalent to the one you formerly specified. Weight and space savings, as it happens, are especially significant in the most-used sizes.

COMPARE



*MIL NOMINALS

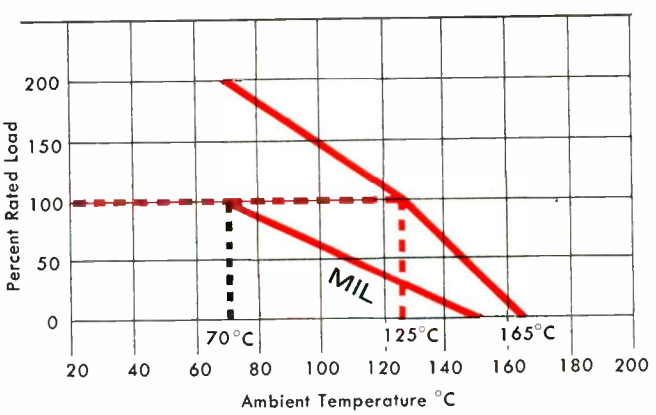
These SIZE REDUCTIONS also result in nearly corresponding weight reductions.

MIL Type	IRC Type	Length Nominal	Diam. Nominal	Min. Ohms	Max. Ohms	Max. Volts Continuous	WATTAGE MIL 70°C	WATTAGE IRC 70°C	WATTAGE IRC 125°C
RN60	MDA	.406	.130	10	5M	300	⅛	¼	⅛
RN65	MDB	.594	.203	10	5M	350	¼	½	¼
RN70	MDC	.719	.261	5	25M	500	½	1	½

IRC EXCEEDS MIL SPECIFICATIONS

IRC Resistors are designed for MIL-R-10509C Characteristic B requirements.

DERATING CURVE FOR IRC MOLDED RESISTORS



IRC HAS GREATER LOAD LIFE RESERVE

IRC Molded Deposited Carbon Resistors exhibit excellent heat dissipating characteristics. Size for size, IRC Resistors will run cooler under any load condition and take sudden overloads with very low permanent change. Load life is superior to that of hermetically sealed resistors which cost three times as much!

IRC HAS DOUBLE-BARRIER INSULATION

Resistance element is coated with a moisture-resisting material, then encased in a molded, break-resistant dielectric case which, though heavy-duty, is well within MIL size.

Write for Bulletin B-9C

INTERNATIONAL RESISTANCE CO., Dept. 379, 401 N. Broad St., Phila. 8, Pa. • *In Canada:* International Resistance Co., Ltd., Toronto, Licensee

Performance proved in street-light control

Day after day RCA-7163 meets the environmental challenge of street-light control with steady, dependable service. Unprotected exposure to weather conditions, winter and summer, make this a tough proving ground. Yet almost a quarter-million of these sturdy cells are now operating in this application.

Here is the secret of this remarkable performance record: *RCA-7163 is hermetically sealed.* Moisture—the worst enemy of a photosensitive material—cannot get into the cell to affect its operation. This means longer life and more reliable performance.

RCA-7163 is ideal for a wide variety of industrial light-operated relay applications. Its high illumination sensitivity permits direct relay operation on as little as one footcandle of light—making possible inexpensive, "minimum-circuit" designs. And the hermetic seal gives your equipment built-in reliability.

Investigate the advantages of RCA's line of high-quality hermetically sealed photoconductive cells. Get full details today from the RCA Field Office nearest you, or write RCA Commercial Engineering, Section L-19-Q3, Harrison, New Jersey.

RADIO CORPORATION OF AMERICA, Electron Tube Division, Harrison, N. J.

ANOTHER WAY RCA SERVES INDUSTRY THROUGH ELECTRONICS

Government Sales: **Harrison**, N. J., 415 S. Fifth St., HUmboldt 5-3900; **Dayton** 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366; **Washington** 6, D.C., 1625 "K" St., N.W., DIstrict 7-1260
Industrial Tube Products Sales: **Newark** 2, N. J., 744 Broad Street, HUmboldt 5-3900; **Detroit** 2, Mich., 714 New Center Building, TRinity 5-5600; **Chicago** 54, Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900; **Los Angeles** 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361