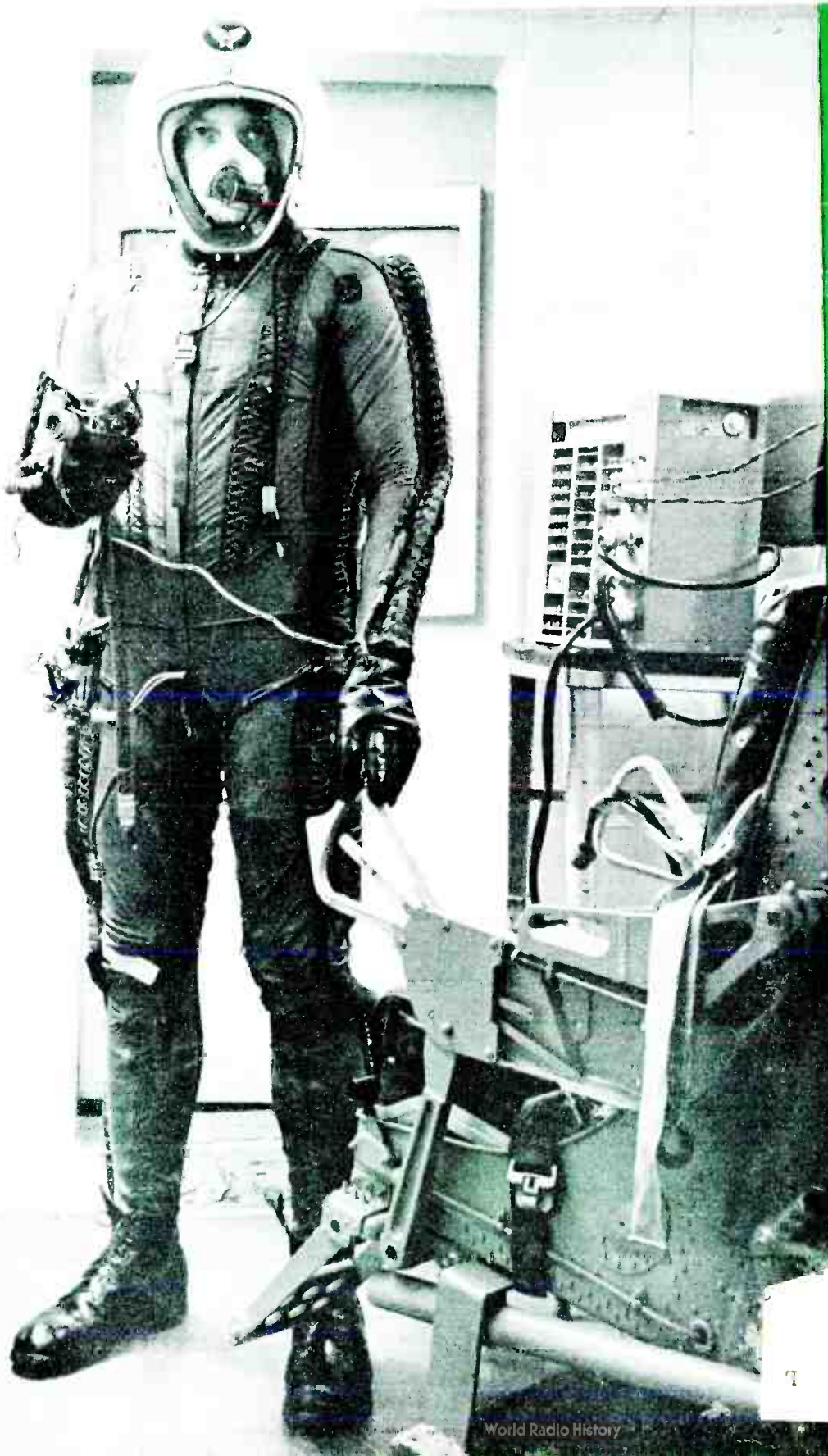
OCTOBER 16, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 42 PRICE SEVENTY-FIVE CENTS



Human Instrumentation for Space Flight ←

What Tomorrow's Computers Will Be Doing

Audio, telemetry and low frequency oscillators

Pictured here are six of the most widely used oscillators in electronics. All employ the highly stable, dependable, accurate resistance-capacity circuit. They require no zero setting. Output is constant, distortion is low and frequency range is wide. Scales are logarithmic for easy reading; all are compact, rugged and broadly useful basic instruments. Brief specifications are given below; call your hp rep for demonstration or write direct for complete data on any instrument.

Model	Frequency Range	Calibration Accuracy	Output to 600 Ohms	Recommended Load	Maximum Distortion	Max. Hum & Noise ¶	Input Power	Price
200AB	20 cps to 40 KC (4 bands)	± 2%	1 watt (24.5 v)	600 ohms	1% 20 cps to 20 KC 2% 20 KC to 40 KC	0.05%	65 watts	$150.00
200CD	5 cps to 600 KC (5 bands)	± 2%	160 mw 10 volts	600 ohms*	0.5% below 500 KC 1% 500 KC and above	0.1%	75 watts	$170.00
200J	6 cps to 6 KC (6 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.1%	100 watts	$300.00
200T	250 cps to 100 KC (5 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.03%	100 watts	$450.00
201C	20 cps to 20 KC (3 bands)	± 1%†	3 watts (42.5 v)	600 ohms**	0.5%‡	0.03%	75 watts	$225.00
202C	1 cps to 100 KC (5 bands)	± 2%	160 mw 10 volts	600 ohms*	0.5%§	0.1%	75 watts	$300.00

*Internal impedance is 600 ohms. Frequency and distortion unaffected by load resistance. Balanced output with amplitude control at 100. Use line matching transformer for other control settings. **Internal impedance approximately 600 ohms with output attenuator at 10 db or more. Approximately 75 ohms below 5000 cps with attenuator at zero. †Internal, non-operating controls permit precise calibration of each band. ‡0.5%, 50 cps to 20 KC at 1 watt output. 1.0% over full range at 3 watts output. §0.5%, 10 cps to 100 KC. 1.0%, 5 to 10 cps. 2.0% at 2 cps. 3.0% at 1 cps. ¶Measured with respect to full rated output.

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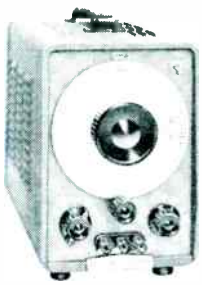
Field representatives in all principal areas

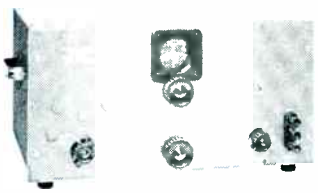
6036

200AB
Audio Oscillator



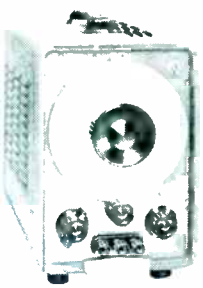
200CD
Wide Range Oscillator

200J
Interpolation Oscillator



200T
Telemetry Oscillator

201C
Audio Oscillator



202C
Low Frequency Oscillator

hp pioneered the world-famous resistance-capacity oscillator circuit

electronics

OCTOBER 16, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 42

Issue at a Glance

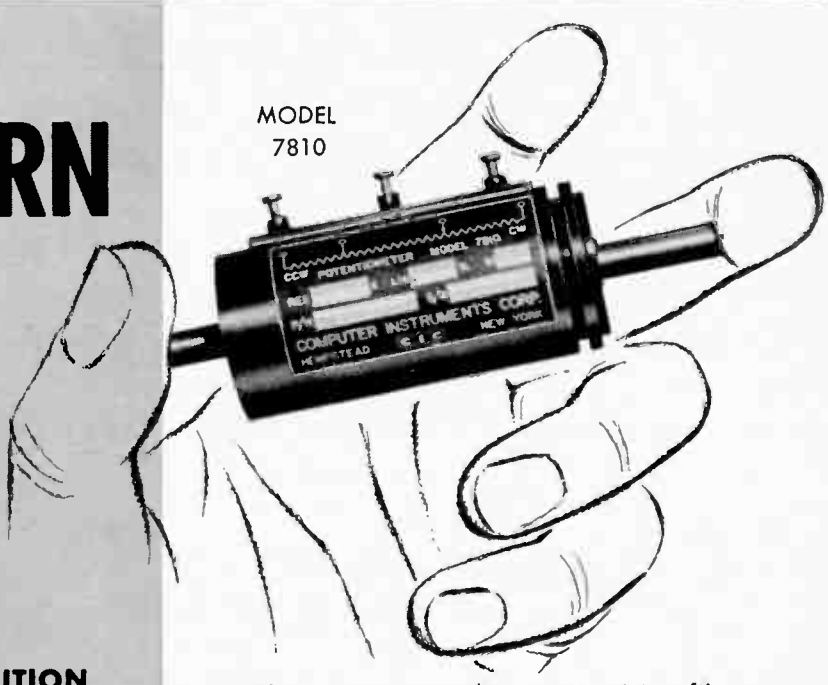
Business

Engineering

Departments

Now! CIC COMPUTER INSTRUMENTS CORPORATION FIRST AGAIN!

MINIATURE MULTI-TURN PRECISION FILM POTS



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  10,000,000 revolutions—500 rpm

EXCLUSIVE FEATURES:

- **NON-LINEAR OUTPUTS**
  No Tapping and Shunting
- **DUAL GANG—SINGLE GANG**
  SAME CASE SIZE!
  SAME STARTING TORQUE!
  SAME INERTIA!
- **ONE PIECE THROUGH SHAFT**
  Pot fits *anywhere* in your gear train
- **ONE PIECE, ALL METAL CASE**
  Machined-In, Stay-Put Accuracy

This miniature multi-turn precision film pot is not just better than wire-wound types—it brings a new dimension of performance and flexibility to your system. With SuperCon Film pots you can forget about the obsolete concepts of wire resolution, clumsy tapping and shunting to produce non-linear outputs, bulkiness in ganging, and loose-wire, glued-assembly construction. The ball-bearing supported, one-piece through shaft permits you to locate your pot *anywhere* in the gear train, freeing you to select the optimum ratios with the minimum components, to transmit torque through the pot, to miniaturize even more. SuperCon Film pots have the inherent accuracy and reliability to easily meet your requirements.

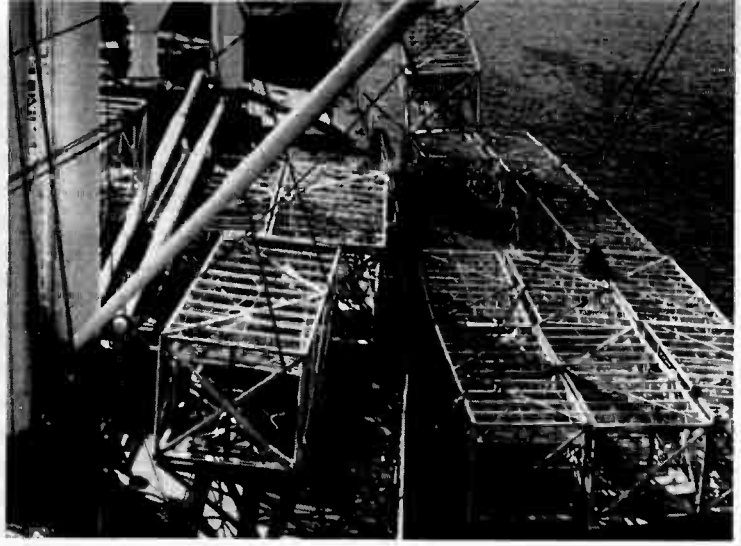
CIC is the largest manufacturer of Precision Film Potentiometers, having pioneered in their development, with a 10-year record of supply to all branches of the Armed Services and throughout industry. Our staff of technical specialists is ready to assist you with your potentiometer needs.

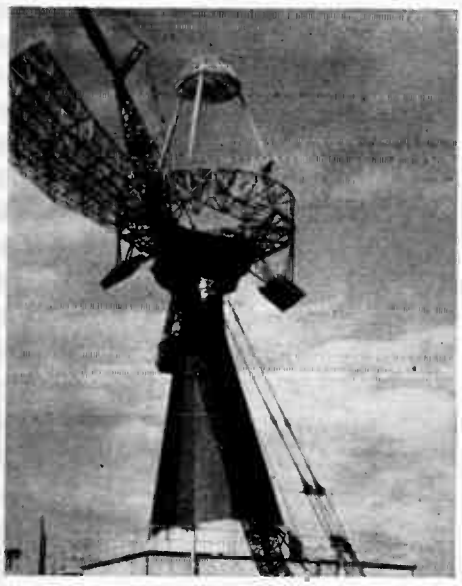
Write for our catalog. **FIRST IN FILM POTS**

92 Madison Avenue, Hempstead, L. I., N. Y.

CIC COMPUTER INSTRUMENTS CORPORATION

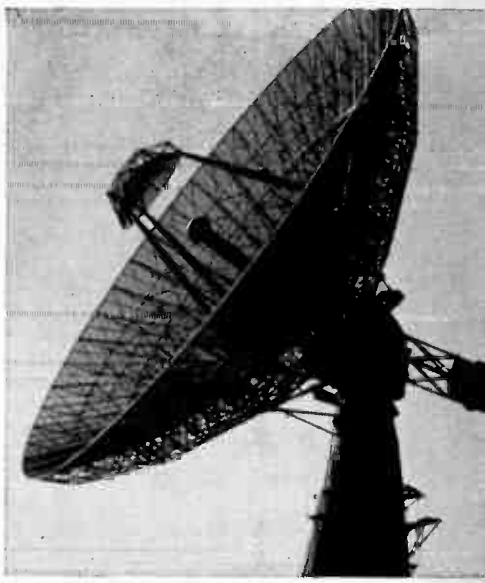
SINGLE TURN POTS | **SINE-COSINE POTS** | **LINEAR MOTION POTS** | **PRESSURE TRANSDUCERS** | **COMMUTATORS**

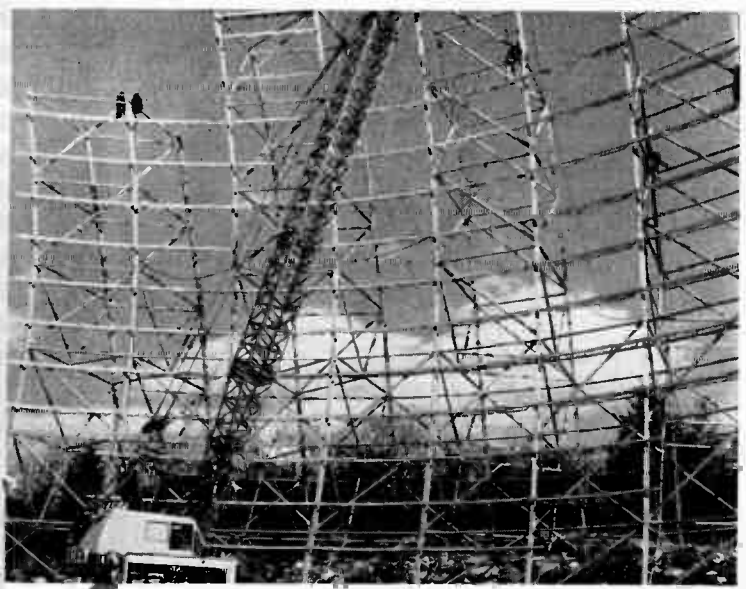


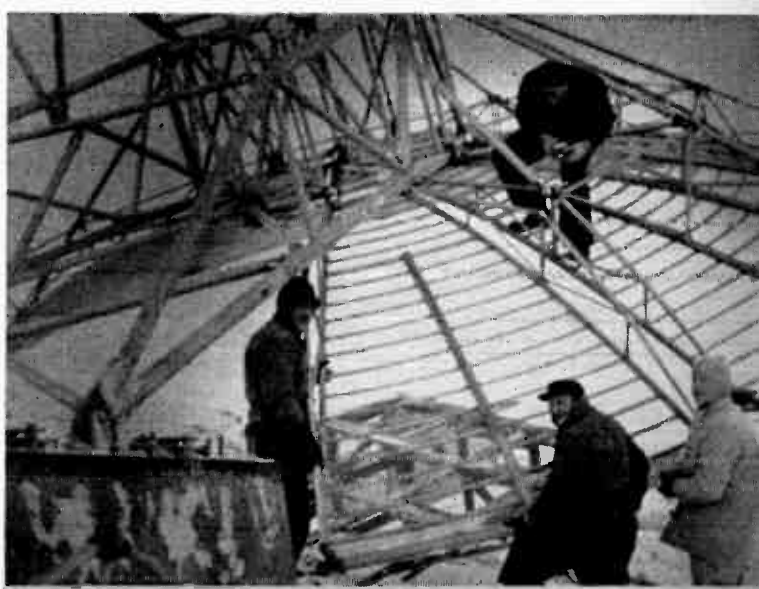


What you should know about

KENNEDY FIELD ENGINEERING SERVICE







OVER the years Kennedy has expanded its facilities to meet the needs of the antenna industry . . . and today provides a complete field engineering service geared to solve the complex problems of antenna systems installation.

This service, conducted by thoroughly experienced Kennedy field engineers and technicians, includes site selection assembly, erection, trouble shooting and checkout, customer liasion, and on-the-job training for systems personnel in operation and maintenance.

An important fact is underlined here: that Kennedy capability in antenna systems is *total* capability.

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electronics

October 16, 1959 Vol. 32, No. 42

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SHOPTALK . . . editorial

MILITARY DYNAMICS. Never before has our industry needed to be so alert to trends and shifts in emphasis. The international situation is changing rapidly. This, coupled with rising costs and closer scrutiny of defense expenditures, could add up to a tight situation. How to act intelligently in such a period and come out on top is a management challenge of the first magnitude.

In the backwash of the Khrushchev visit the concept of cold war, or at least its strategy, could change overnight. A major technical breakthrough could outdate one, two or more of our major weapons systems.

Even a relatively minor development could wipe out a subsystem representing $100 million of business.

Now as never before, timely and accurate knowledge is the key to success and indeed, even survival.

To serve the electronics business community in times like these takes not only national news coverage of our industry but also judgment of editors with long experience in the industry.

Sometimes, at a crucial turn in the road, intelligent coverage requires going to the top, asking the right questions of the right people. That's what Associate Editor Mason did last week. He spent the week in Washington; searching, probing, trying to find a road map for industry.

His story on p 46 tells some of the things you can expect to see and should not expect to see during the months to come.

Coming In Our October 23 Issue . . .

MODERN COMMUNICATIONS SYSTEMS. Not too long ago, what was called the electronics industry was in reality the communications industry. Since then, the technology has expanded to include control, computers, radar and the countless other areas of science which rely on electronics. These developments have somewhat overshadowed the substantial progress being made in communications—progress made possible by exciting breakthroughs in theoretical and practical concepts.

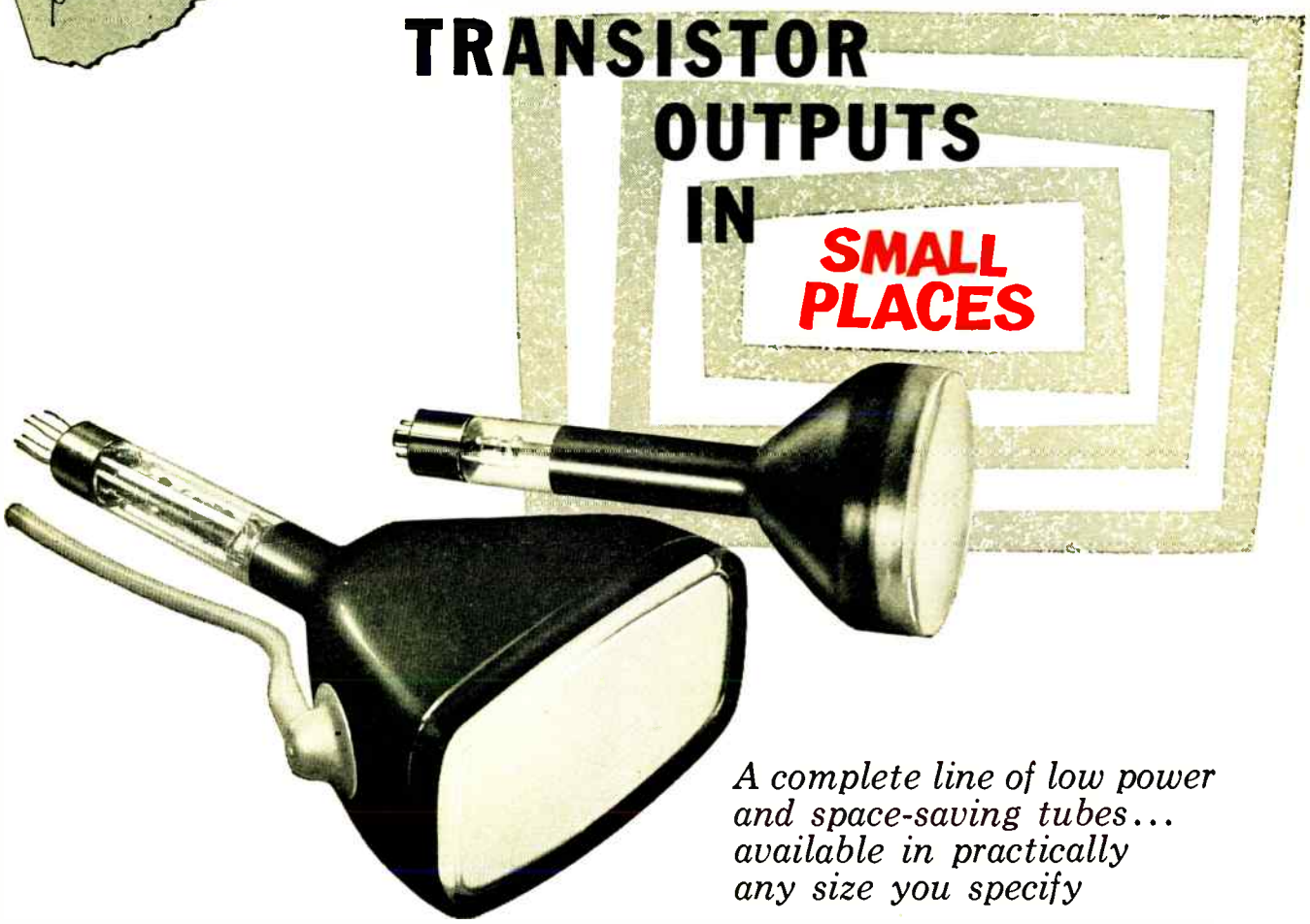
Next week, Associate Editor Weber's special report describes some of these new breakthroughs, which are helping to overcome the immense problems imposed by today's demands on world communications systems. You'll learn how economic, political, military and sociological considerations are increasing message traffic density beyond the capacity of existing facilities and how communications engineers are exploiting new mechanisms of propagation, new modulation schemes, new methods of transmission and detection to overcome the various obstacles imposed by natural and manmade interference.

You'll discover how the concepts of information theory are being incorporated into working systems and you'll be projected into the immediate future with design details of communications satellite programs now moving into the hardware stage. You won't want to miss this comprehensive report which was almost a year in preparation.

ALPHANUMERIC GENERATOR. A system for generating alphanumeric characters and special symbols for display on a cathode-ray tube is described by S. C. Chao of Link Aviation, Inc. in Palo Alto, Cal. The characters are generated by bombarding the crt screen with a predetermined sequence of overlapping dots, which are positioned by step deflection voltages derived from resistor summing networks. System offers high speed and readability.

product of the pioneer

OPERATION FROM TRANSISTOR OUTPUTS IN SMALL PLACES



A complete line of low power and space-saving tubes... available in practically any size you specify

FEATURES

- Designed for transistor operation
- Low grid drive
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- Excellent for high altitudes
- Eliminates bulky power equipment
- Compact and rugged
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- Resistant to thermal shock
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Low-powered enough to operate directly from transistor outputs, small enough for any space-hungry application, yet provides extra-high light output for use in high altitudes or any high-ambient light level. The low grid-drive and heater requirements of these tubes economize on space and weight by eliminating bulky accessory power equipment. Potted bases and high-voltage connectors, plus rugged construction, permit the utmost performance over wide temperature ranges and in the toughest of environmental conditions. Infinite in available sizes, shapes and ratings, infinite in capabilities.

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AEROCOM'S 1046 H.F. TRANSMITTER

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1000 WATTS WITH .003% STABILITY

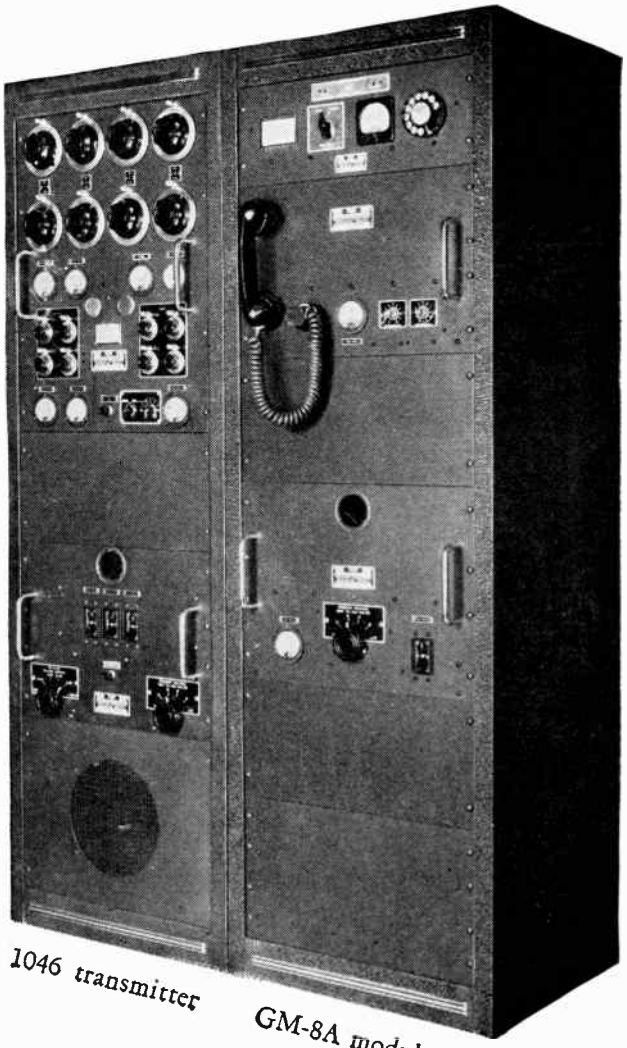
Rugged, versatile general purpose H.F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to +50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

Now! Complete-package, 192 channel, H.F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!

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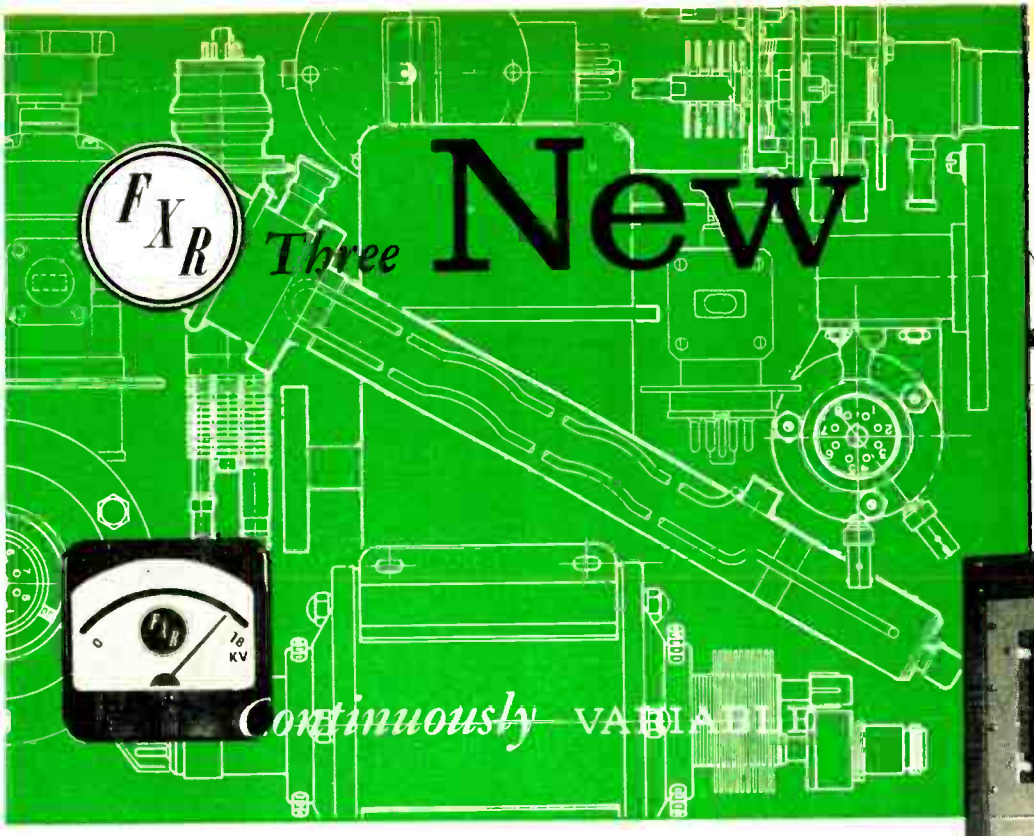

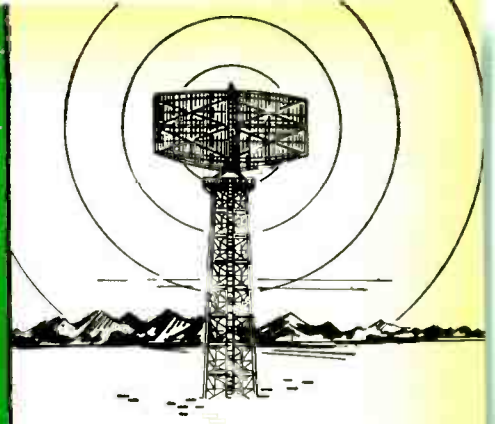

HIGH-VOLTAGE REGULATED POWER SUPPLIES *

- EXCEPTIONAL REGULATION — BETTER THAN 0.1% WITH A 10% FLUCTUATION OF PRIMARY POWER.
- LOW RIPPLE.
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- RF INSULATION TECHNIQUES INCORPORATED TO MINIMIZE PICK-UP AND CORONA NOISE.

1 *FXR Model Z850A*
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2 *FXR Model Z851A*
- 0 to 10 KV
- 250 MA
- Ripple, 5 MV

3 *FXR Model Z852A*
- 0 to 18 KV
- 1 AMP
- Ripple, 5 MV

* Newest representatives of FXR's commercial line of high-voltage power supplies.

shown here, FXR Model Z850A

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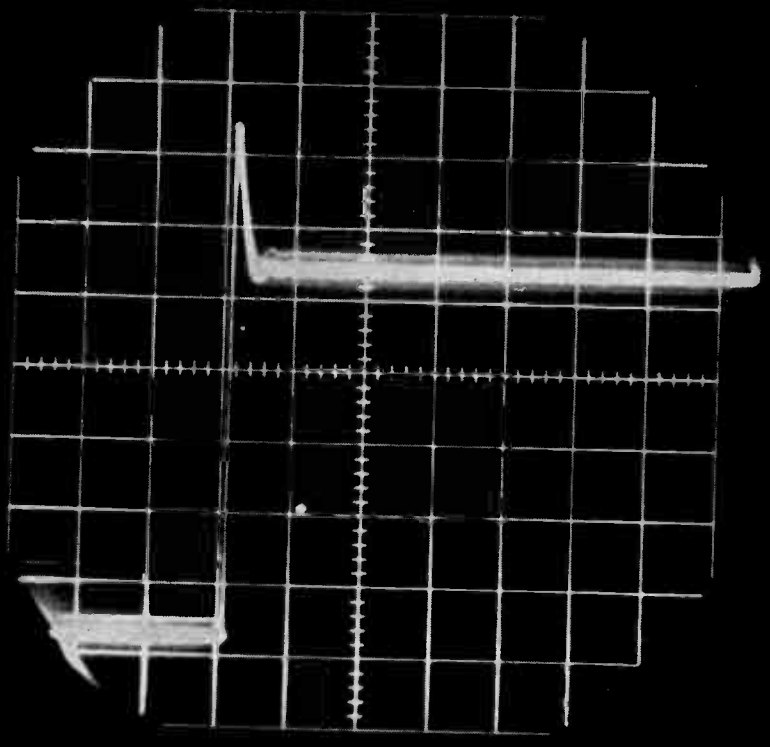
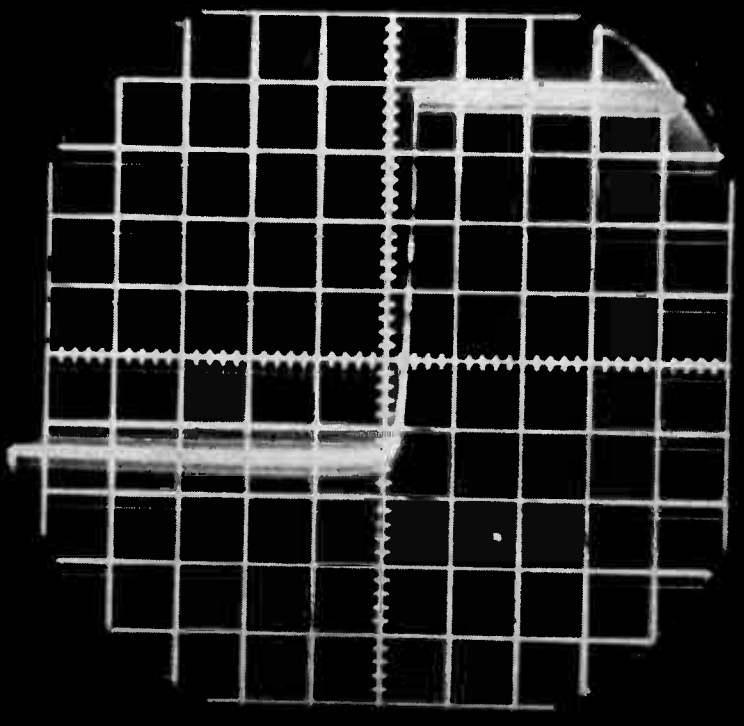


Actual photographs of power supply turn-on at 28v setting. Scope settings: 5v per cm vertical, 0.2 sec. per cm horizontal.

TRANSISTOR KILLER: THE VOLTAGE SPIKE...



TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For *complete* protection against line *and load* transients, use new Perkin MTR power supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation. Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant... even if an internal transistor fails, your Perkin MTR power supply *continues* to regulate smoothly and safely!

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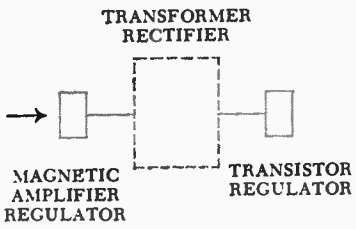
MODEL NO. MTR.-636-15



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES *prompt delivery*

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	± .2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	± .3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	± .2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	± .2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	± .4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	± .5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Overloads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

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Dallas, Tex.—FLeetwood 7-7080
Dayton, O.—CHapel 4-5551
Denver, Colo.—SUnset 1-7375
Detroit, Mich.—HOward 8-2461
Indianapolis, Ind.—STate 7-0009
Kansas City, Mo.—HEdrick 2-2528
Los Angeles, Calif.—HOllywood 9-7294
Minneapolis, Minn.—MIdway 6-2621
New York City, N.Y.—DIgby 4-2997
Orlando, Fla.—CHerry 1-2128
Philadelphia, Pa.—WAlnut 7-1820
Phoenix, Ariz.—WHitney 6-2111
St. Louis, Mo.—PArkview 1-6403
San Diego, Calif.—ATwater 3-2081
San Francisco, Calif.—EMerson 9-3354
Seattle, Wash.—PArkway 3-9000
Syracuse, N.Y.—GIbson 6-0220
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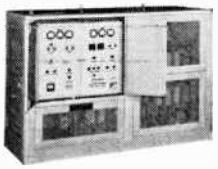
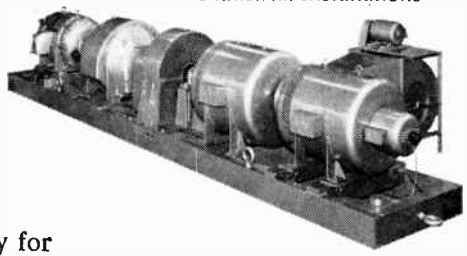
All your needs for dependable High Frequency Power Supplies can be found at *one source*—American Electronics' Electric Machinery & Equipment Division. Here engineering talent and manufacturing know-how have been pioneering new Rotary Power developments for over a decade.

Typical Generator for H-F Industrial Installations

FIRST to introduce a brushless, inductor type 400 cycle generator. Field windings are cast integrally with the rotor. Windings are practically indestructible.



FIRST to furnish 1200 cycle generators as the power source for industrial and medical X-Ray equipment – equipment recently used to check the atomic submarine NAUTILUS for perfection of hull weldments and seams.



Computer Check-Out Generator, 400 and 1600 Cycle

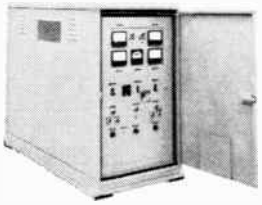
FIRST to meet the demands of the aircraft industry for 1600 cycle power to check out airborne computer systems.

FIRST to provide the high cycle generator as the power source for high speed routers for metal working.

Standard 2 Bearing Generator

FIRST to furnish power source for ultra high frequency lighting systems for more efficient lighting at lower cost.

Write or call for our new Rotary Power brochure, which gives the complete story on these and other power supply units.



AC-DC Supply for Production Check-Out Station

AMERICAN ELECTRONICS, INC.

ELECTRIC MACHINERY & EQUIPMENT DIVISION

2112 NORTH CHICO AVENUE, EL MONTE, CALIFORNIA • CUMBERLAND 3-7151

←CIRCLE 9 ON READER SERVICE CARD

CIRCLE 10 ON READER SERVICE CARD

ELECTRONICS NEWSLETTER

LUNIK DATA pieced together by ELECTRONICS during the first few days after the Soviets fired their moon station into orbit suggests the possibility that an instrument package may have been dropped on the moon. The orbiting "interplanetary station," as the Soviets call the satellite, could then be acting as a relay to transmit data from the far side of the moon to earth. Next week ELECTRONICS will publish information from Moscow and England's Jodrell Bank Observatory that lends credence to this theory.

SATELLITE MONITORING CENTER that will collect data for three military satellite projects is scheduled to be operational before June 1960. The projects are Midas, a ballistic missile warning satellite under development which uses infrared; Samos, the reconnaissance satellite known previously as Sentry; and the Discoverer satellites, forerunner to the Mercury man-in-space project. The Development Control Center is under construction at Sunnyvale, Calif., 250 mi from Vandenberg AFB and site of prime contractor Lockheed's Missile and Space division. Radiation, Inc. is supplying the center's display system, which will present information from at least five tracking stations. Center will monitor any signals from satellites by remote control and evaluate them; collect tracking data from round-the-world stations and command their equipment; receive corrections, program data to satellites and plot global weather and satellite positions. Closed circuit tv will connect the center to the Vandenberg AFB blockhouse.

Videotape recorder with one revolving head for recording both picture and sound is announced by the Japanese company Toshiba (Tokyo Shibaura Electric.) Firm expects to start production of the machine next month and sell it early next year.

ACTIVE COMMUNICATIONS SATELLITE system of 1,000 channels that would cover 3,000 land miles is "well worth pursuing." So says Dana W. Atchley, Jr., president of Microwave Associates, which is affiliated with Western Union. He said an active satellite system could be put into use by 1965 and would cost at least $100 million to develop. Atchley added that construction of the system with several ground terminals would cost about $7 million, which figures out to about $2.50 per voice channel mile. He cited a need for low-noise, long-life microwave tubes to operate around 10,000 mc, thinks one key receiver component will be a non-linear, junction-type diode (varactor).

Radiometric sextant miniaturized sufficiently to be installed in a submarine will be developed by AC Spark Plug division of GM under a $489,734 Navy BuShips contract.

DIGITAL READOUT of aircraft identification codes is reported possible with a device whose security wraps have just been taken off by the Air Force. Device, which combines optics and electronics to identify quickly any aircraft indicated on a radar screen, is intended primarily for air traffic control. It was developed by Radio Receptor's advanced development lab, Westbury, L. I., N. Y.

PASSIVE BALLOON SATELLITES will be tested for broadband radiotelephone relay use by Bell Telephone Laboratories and the National Aeronautics and Space Administration after an experimental facility is completed at Bell's Holmdel, N. J. lab. Signals will be transmitted and received by the Holmdel station and NASA's Jet Propulsion Laboratory tracking station, Goldstone, Calif. The used microwave signals will be analyzed to obtain data on transmission effects and the reflection characteristics of orbiting passive satellites. Bell is paying about 80 percent of the cost of the control buildings and two large antennas at Holmdel. A commercially available dish antenna will transmit the signals and a modified Bell horn reflector antenna will receive. Bell says a pair of parametric amplifiers, or a pair of masers, or one of each will be used in the receiving gear.

LOW LABOR COSTS for Japanese electronic products seem to be a two-edged sword for U.S. electronics firms. Cost factor permits competition with certain American-made products here but also allows some U.S. re-exporters to compete in Asian and European markets with Japanese-made goods. A case of the latter is reported this week from Tokyo: An unidentified U.S. firm flew some 8,500 Japanese-made transistor radios valued at $140,000 to West Germany for the Christmas trade. About 10,000 more sets will be shipped by sea.

Sign of the times in the steel industry: Allegheny Ludlum, Pittsburgh, has inaugurated a formal apprenticeship program for electronic maintenance men which calls for 1,000 hours of classroom and lab training over four years. Program has evolved from the steel company's interest in automatic control devices and data logging systems for steel rolling equipment.

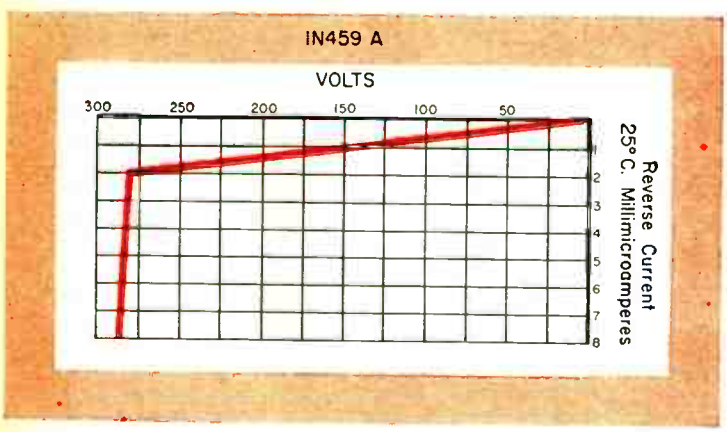
RADIATION TRACKING TRANSDUCER capable of detecting and resolving the angular position of light or other forms of radiation at angles of motion smaller than 0.1 second of an arc has been developed. Electro-Optical Systems, Pasadena, Calif., reports the thin semiconductor device, developed under contract from the Army Ballistic Missile Agency, can be aimed electrically. This makes complex mechanical apparatus unnecessary. Besides its use in tracking aircraft or other objects, says the firm, the device can also be used by the Army in celestial navigation and in certain missile and satellite applications.

MORE DIODE per dollar —from SYLVANIA

In Silicon Junction, Gold Bonded, and Germanium Point Contact types, Sylvania's complete mechanization assures EXTRA diode uniformity and quality control—at no extra cost.

Sylvania provides the design engineer with assurance of top-grade performance for its entire diode line. All Sylvania diodes in solder-sealed or all-glass packages are 100% tested for hermetic seals to assure maximum protection and reliability in any application—and particularly those where operating conditions are most severe.

Sylvania Silicon Junction Diodes are 100% tested on curve tracers for reverse characteristics—to eliminate such undesirable factors as soft breakdown, drift, flutter and creep.



Reverse characteristics of typical Sylvania Silicon Junction Diodes

A significant Sylvania EXTRA in automated diode quality control is the Sylvania-designed Digital Automatic Tester and Classifier. Here each unit is subjected to as many as 16 separate tests that can be programmed for an almost infinite variety of electrical characteristics. Accuracy of the automatic tester has proved to be better than 0.5 percent for every test.

In addition to 100% testing programs, all Sylvania diodes, through scientific sampling procedures, are thoroughly tested as follows:

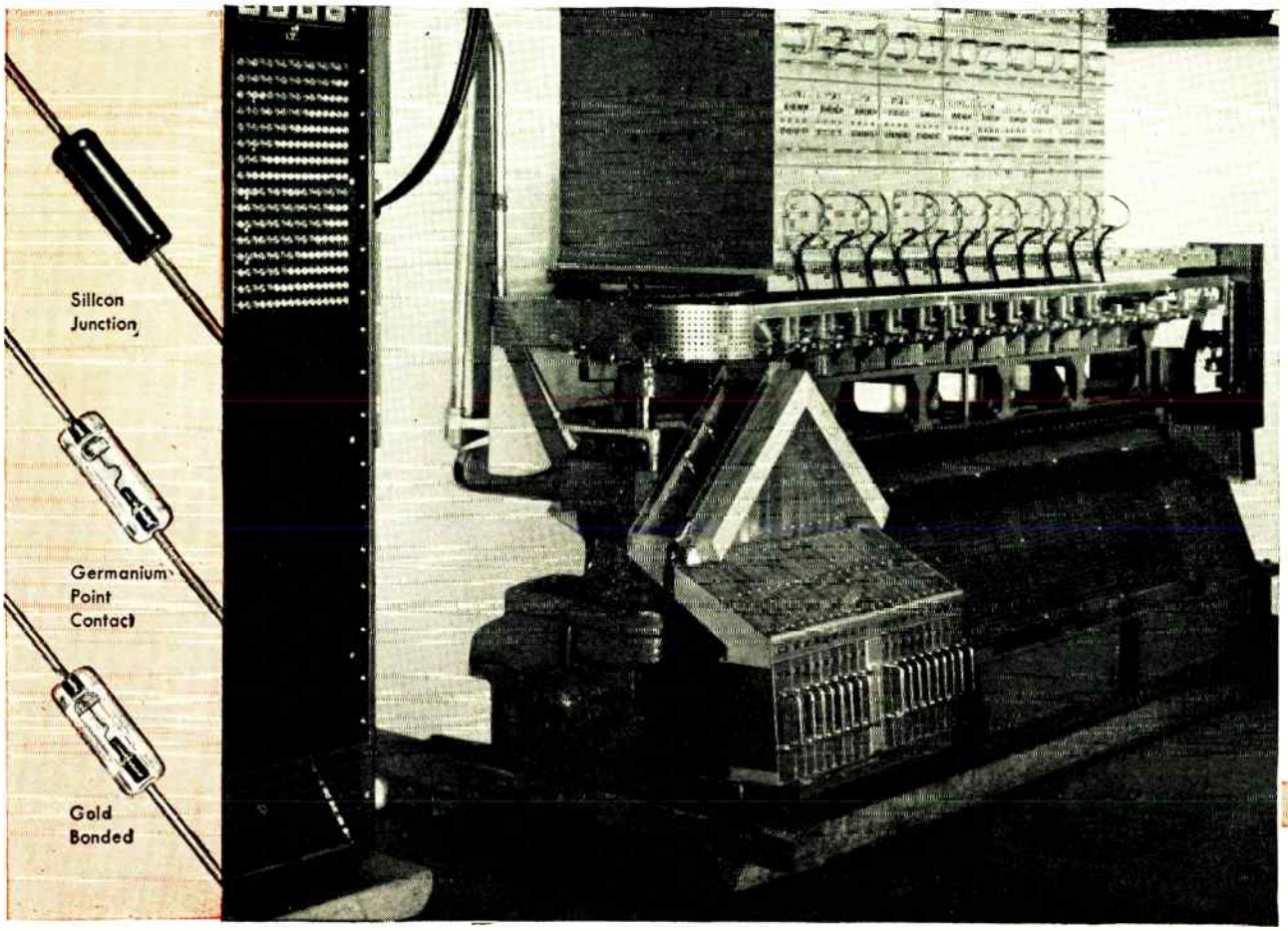
Extended Storage and Operating Life Tests—offer an extra safety factor, as they go beyond customer specifications.

Temperature Cycling Tests—ranging from —65° C to 200° C.

Lead Fatigue Tests—assurance of optimum mechanical stability.

Thermal Shock Tests—assure rugged seals.

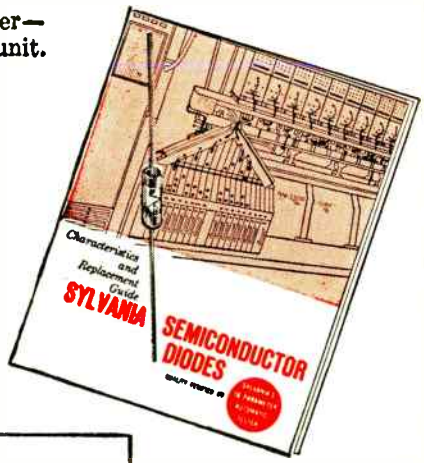
All of these mechanical and environmental tests are made in accordance with the most stringent specification procedures—military and non-military. In some cases, such as temperature cycling, the Sylvania limits exceed those of the specification.



Sylvania's Digital Automatic Tester and Classifier—performs up to 16 separate tests for each diode unit.

For the complete story on Sylvania Silicon Junction, Gold Bonded and Point Contact diodes, contact your Sylvania representative, or write the factory directly at the address below for a free copy of the new Sylvania 16-page diode booklet.

Write for your free copy of this new 16-page Sylvania Diode booklet.



POPULAR SYLVANIA MORE-DIODE-PER-DOLLAR TYPES

SILICON JUNCTION				POINT CONTACT		GOLD BONDED	
1N456,A	1N461,A	1N482,A,B	1N486,A,B,	1N126A	1N191	1N270	1N283
1N457,A	1N462,A	1N483,A,B	1N487,A	1N127A	1N192	1N276	D1165
1N458,A	1N463,A	1N484,A,B	1N488,A	1N128	1N198	1N279	D1248
1N459,A	1N464,A	1N485,A,B				1N281	

SYLVANIA GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

SYLVANIA ELECTRIC PRODUCTS INC.
Semiconductor Div.
100 Sylvan Road, Woburn, Mass.

WASHINGTON OUTLOOK

WASHINGTON—Imports of Japanese transistors, rectifiers and diodes will be "investigated" by Office of Civil Defense Mobilization to determine whether they are injuring national security.

The study comes under the so-called "defense-essentiality" section of the Trade Agreements Law, which provides for import restrictions on products which OCDM rules (1) are needed for defense mobilization, and (2) are being imported in quantities which threaten national security.

Electronic Industries Association petitioned the agency for the investigation. Under the trade laws which were tightened last year, the OCDM study follows automatically.

Of a handful of similar petitions which have reached a final ruling in the last few years, only imports of petroleum have been curbed under this provision. Last major petition to fail was one filed by National Association of Electrical Manufacturers seeking restrictions on foreign heavy electrical equipment.

OCDM will take statements and briefs from all interested parties through Nov. 17, rebuttals through Dec. 17, and all data and comments by Jan. 2, 1960.

Military requirements for transistors now total 10 million units annually, are expected to zoom to some 100 million units annually by 1965 as missile and space vehicle production starts to climb.

Commerce Department's Business and Defense Services Administration reports that Japanese exports of transistors to the U.S. multiplied from $7,000 worth last year to $521,000 worth in the first six months of 1959.

These figures, while reflecting dramatic increases, are less than the nearly 27-million unit figure which EIA reported Japan had shipped to the U.S. in transistors alone during the first quarter of 1959. The trade association later corrected its figures, explained that this was a production figure, not an export statistic.

- **Scientific development** through private enterprise—with government support—is the program laid out by the Republican party's committee on program and progress. The committee's science task force envisions a key role for communications in the next two decades with "automatic and simultaneous translation of languages in international calls, three-dimensional color tv, vhf radio and improved techniques for reproducing the printed word."

  The $10 billion the U.S. (both government and private) spends annually on scientific research and development should be stepped up to $36 billion by 1976, the group says. But the trend toward centralizing scientific work in federal laboratories must be reversed.

  The group strongly endorses federal support of basic research through the National Science Foundation utilizing private facilities, but wants commercial application left strictly to private industry.

- **An increase in sales** for communications equipment makers from this year's $2.65-billion level to some $4.65 billion in 1968 is forecast by the Commerce Department. The sums cover wire and microwave telephone and telegraph equipment used by common carriers. The forecast is based on an estimate that population growth, business expansion and other factors will boost the numbers of telephones in this country from 66.6 million to 110.7 million over the next decade.

BASIC BUILDING BLOCKS FROM KEARFOTT

Data Logging

Kearfott's broad line of test equipment includes the Scanalog 200-Scan Alarm Logging System which monitors, logs and performs an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. This precise data handling system is equipped with manual controls for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights correspond to specific points being maintained and provide a visual "off normal" display for operator's warning. System can be expanded to 1024 points capacity and 2000 points per second scanning rate.

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

Floated Rate Integrating Gyros

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/ hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to Anisoelasticity
Steady Acceleration:
.015°/hr./g² maximum
Vibratory Acceleration:
.008°/hr./g² maximum
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time:
.0035 seconds or less
Weight: 0.7 lbs.
Warm-Up Time:
10 minutes from −60°F
Life: 1000 hours minimum

BASIC BUILDING BLOCKS FROM KEARFOTT

Electrohydraulic Servo Valve

Kearfott's unique approach to electrohydraulic feedback amplification design has resulted in a high-performance miniature servo valve with just two moving parts. Ideally suited to missile, aircraft and industrial applications, these anti-clogging, 2-stage, 4-way selector valves provide high frequency response and proved reliability even with highly contaminated fluids and under conditions of extreme temperature.

TYPICAL CHARACTERISTICS

Quiescent Flow ..... 0.15 gpm
Hysteresis ...3% of rated current
Frequency Response
3 db @ 100 cps
Supply pressure....500 to 3000 psi
Temperature-Fluid & Ambient
−65° F to +275° F
Flow Rate Range .... .3 to 10 gpm
Weight ..... 10.5 ounces

Write for complete data.

Analog Digital Converter

20 Second Synchro

Integrator Tachometer

Engineers: Kearfott offers challenging opportunities in advanced component and system development.

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

EIMAC
is an electron tube specialist

EIMAC FINDS WAY TO END PREMATURE TUBE FAILURE

No matter how carefully you operate vacuum tubes, power overloads can't always be avoided. In most tubes, the resultant overheating produces vacuum loss or internal arcing. Tubes often fail immediately or fall off in performance.

To overcome this, Eimac developed a group of internal-anode radial-beam tetrodes with exceptional ability to withstand repeated power overloads and peak powers. Operated for millions of hours in every class of service, these rugged tetrodes have proved they last longer, *perform better*, than any comparable internal-anode tubes.

Their amazing reliability is due partly to Eimac's exclusive Pyrovac plate. This outstanding internal-anode material reduces internal arcing, actually absorbs gases which might ruin tube vacuum.

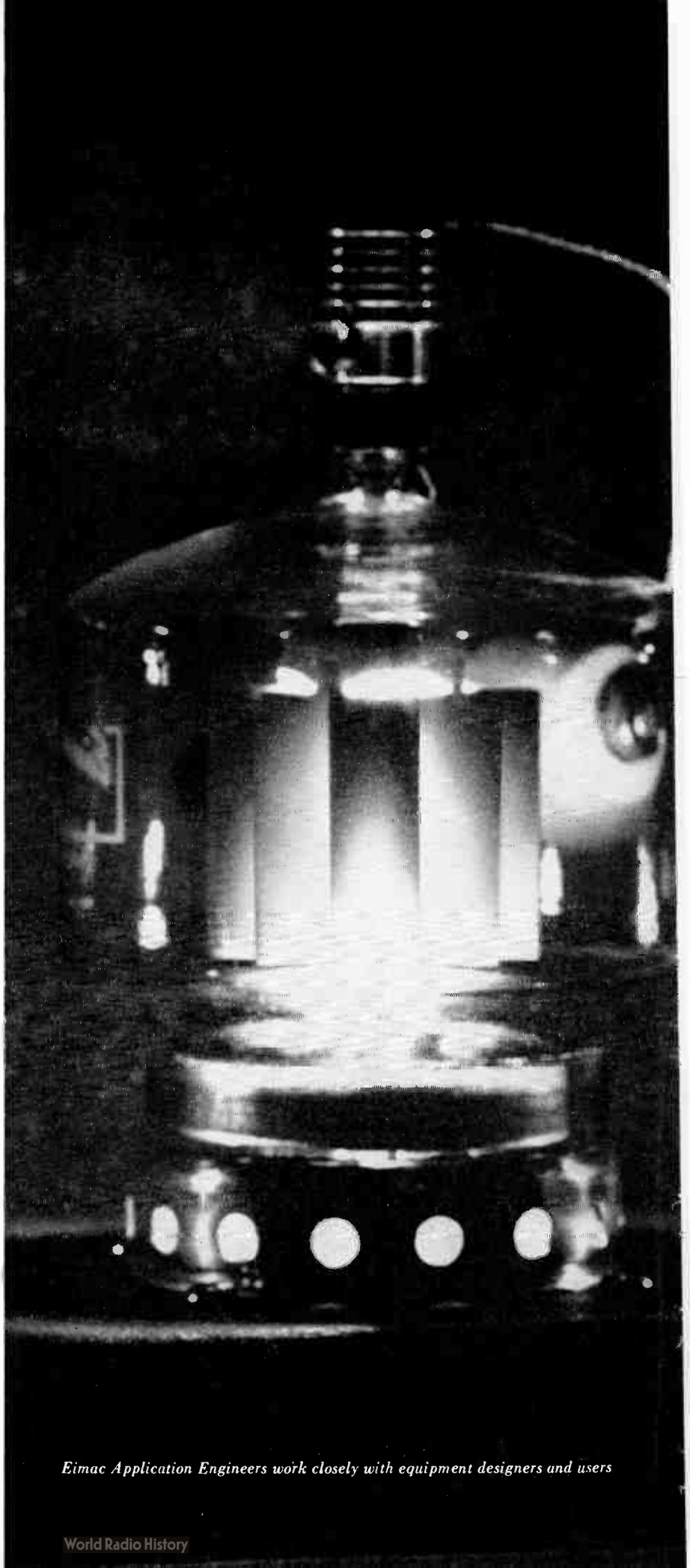
In these tetrodes, low inter-electrode capacitances and low lead inductances assure stable operation at high frequencies. Their high power gain and low driving power requirements simplify driver requirement and associated circuits.

For complete technical and application data on these outstanding tetrodes, see the attached Eimac Report to Design Engineers.

Eimac®

EITEL-McCULLOUGH, INC.
San Carlos, California

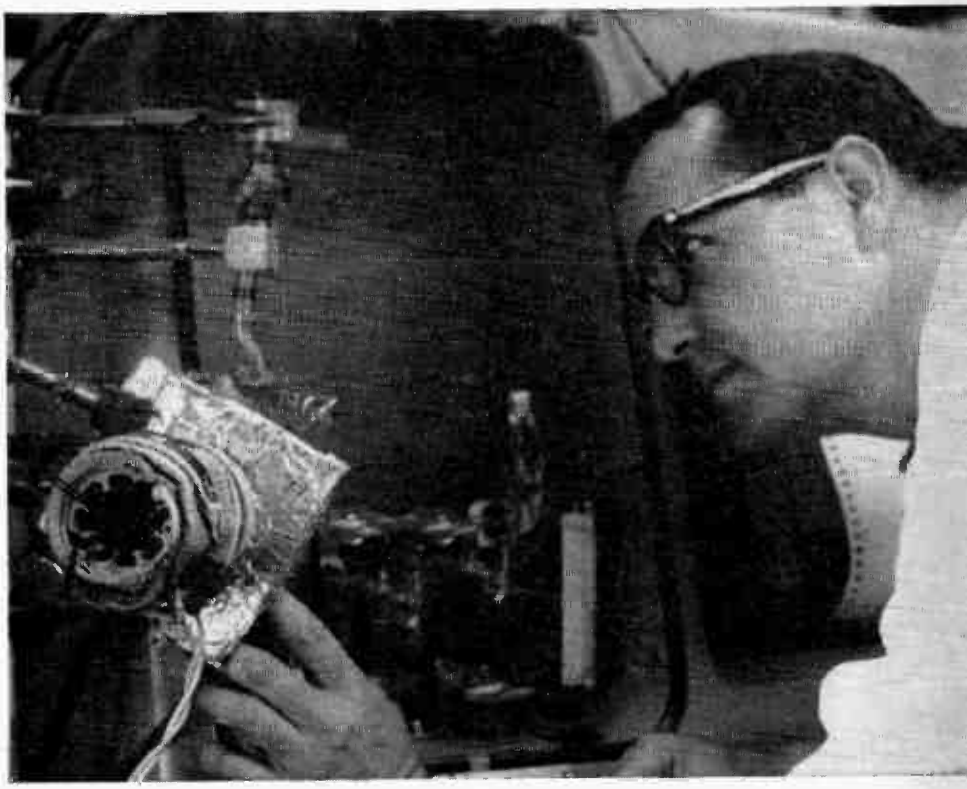
CIRCLE 16 ON READER SERVICE CARD



Eimac Application Engineers work closely with equipment designers and users

CLEANER, HARDER VACUUMS INCREASE TUBE LIFE

During production Eimac-designed rotary vacuum pumps evacuate gas at high temperatures. This, plus clean electrode design and non-emitting grids, helps make Eimac internal-anode tetrodes the most reliable available.



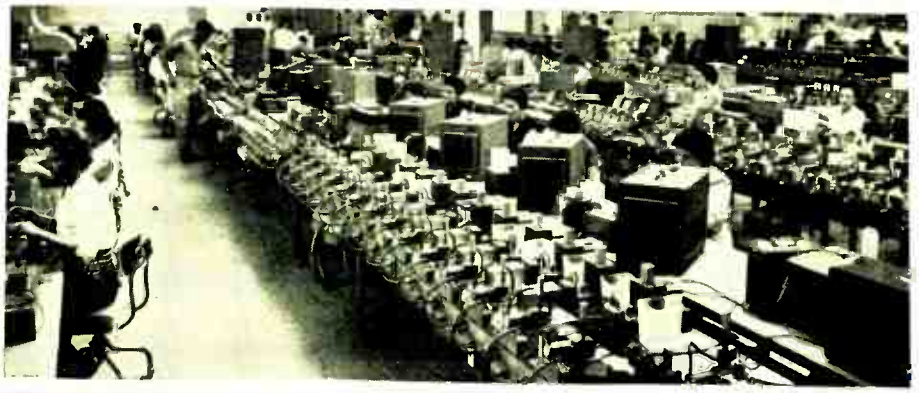
NEWEST TUBE TYPES, TUBE IMPROVEMENTS COME FROM EIMAC RESEARCH AND ENGINEERING

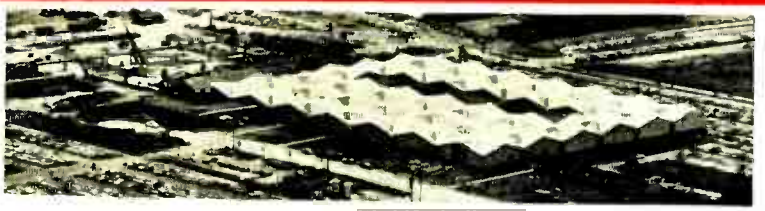
First to develop internal-anode tetrodes, Eimac is also the recognized leader in ceramic-metal vacuum tubes. With emphasis on new tube types, Eimac constantly improves conventional tube types, too.

TI 2N696 AND

100% DEVICE TEST WITH 'CAT' AUTOMATIC TEST EQUIPMENT

100% test of the performance and uniformity built into TI 'mesa' units is conducted automatically by CAT—Centralized Automatic Test equipments. Designed and built by TI, these machines each have a capacity of 40,000 units a day.





Currently doubling in size is the 310,000-sq ft TI Semiconductor-Components division plant, already the world's largest semiconductor facility.

TEXAS

2N697 MULTI-PURPOSE SILICON 'MESAS'

NOW MASS-PRODUCED BY WORLD'S LARGEST TRANSISTOR MANUFACTURER

MEDIUM-POWER AMPLIFIERS • SMALL-SIGNAL AMPLIFIERS • SWITCHERS

FEATURE:

- **Diffused-base 'mesa' construction**
- **2-w maximum power dissipation at 25°C**
- **DC betas of 20-60 and 40-120**

Available now in production quantities . . . TI 2N696 and TI 2N697 multi-purpose silicon 'mesa' units for amplifier, switching and medium-power applications.

Produced by the pioneer of the diffused-base process, these highly reliable 'mesa' units feature . . . *2-w maximum power dissipation . . . beta spreads of 20-60 (TI 2N696) and 40-120 (TI 2N697) . . . 10-ohm maximum saturation resistance.*

Your full-year guarantee is backed by TI's proven production capabilities (largest in the world and currently being doubled) and a stringent quality assurance program.

Check these specs and contact your nearest distributor or TI sales office for *immediate* delivery.

electrical characteristics at 25°C ambient

(unless otherwise noted)

	PARAMETERS	TEST CONDITIONS			min.	max.	unit
I_{CBO}	Collector Reverse Current	V_{CB} = 30v	I_E = 0		—	1.0	μa
	at 150°C	V_{CB} = 30v	I_E = 0		—	100	μa
BV_{CBO}	Collector-Base Breakdown Voltage	I_{CBO} = 100μa	I_E = 0		60	—	v
BV_{CER}	Collector-Emitter Breakdown Voltage	I_{CER} = 100ma	R_{BE} = 10 ohms		40	—	v
BV_{EBO}	Emitter-Base Breakdown Voltage	I_{EBO} = 100μa	I_C = 0		5	—	v
h_{FE}*	D-C Forward Current Transfer Ratio	I_C = 150ma	V_{CE} = 10 v	(2N696)	20	60	—
				(2N697)	40	120	—
$V_{BE(sat)}$*	Base-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma		—	1.3	v
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma		—	1.5	v
h_{fe}	A-C Common Emitter Forward Current Transfer Ratio	I_C = 50ma	V_C = 10v	f = 20mc	2.5	—	—
C_{ob}	Collector Capacitance	I_E = 0ma	V_C = 10v		—	35	μμf

*Pulse conditions: length = 300μs; duty cycle < 2%.

maximum ratings at 25°C ambient

Collector-Base Voltage	60v
Collector-Emitter Voltage (R_{BE} = 10 Ω)	40v
Emitter-Base Voltage	5v
Total Device Dissipation	0.6w
Total Device Dissipation at case temperature 25°C	2w
Storage Temperature Range	−65°C to +175°C

INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 • DALLAS, TEXAS

Write on your company letterhead describing your application for specific details on TI products.

CIRCLE 27 ON READER SERVICE CARD

Voting Today on Merger Plan

BEING VOTED ON TODAY are merger plans concerning **Consolidated Electronics Industries Corp., Philips Industries** and **Central Public Utility Corp.** (see ELECTRONICS, p 21, Aug. 14). To become effective, the merger will require approval of two-thirds of all stockholders involved. If approved, the new corporate entity, Consolidated Electronics Industries Corp., will have total assets of more than $74 million, net current assets of $33 million and sales and revenues of more than $87 million. Each firm involved in the merger will continue in its special field of electronics, pharmaceuticals and electricity, respectively.

• **Universal Winding Co.**, Cranston, R. I., reports stockholders approve changing its corporate name to **Leesona Corp.** Also approved are two changes in the company's capital structure. The firm's $5 par common stock authorization will go from 1 million to 2 million shares, and all 90-cent cumulative convertible preferred stock is being recalled and cancelled. The company's capital now consists solely of 2 million shares of common stock. Company officials say coil winding machine sales were abnormally low in 1958 and in the early part of this year. A marked upturn has been in effect since April, however, and incoming orders have increased 100 percent.

• **Marshall Industries**, San Marino, Calif., announces purchase of the entire assets, lease holdings and inventory of **Electron Products Co.** for about $400,000. EPC manufactures miniaturized capacitors and radio interference and noise filters. Marshall Industries is a firm recently formed through the merger of three companies bearing the generic name of **G. S. Marshall Co.**, manufacturers representatives, the **Wahlgren Electric Manufacturing Co.**, and **Electro Physics Laboratories, Inc.** The newly acquired firm, which has a current sales rate of more than $1 million annually, expects a 50-percent increase will be recorded in the coming year.

• **Tenney Engineering, Inc.**, Union, N. J., reports acquisition of the copper and aluminum coil division of **Kirsch Co.**, Sturgis, Mich. Tenney plans to utilize this division's know-how and facilities in connection with environmental test equipment manufacture. Sales of the newly acquired division are expected to double by the end of 1960 reaching a volume of about $3 million. Facilities will be housed in a new location currently being sought. Indications are that Wilmington, N. C., is a likely site for the operation, which will use about 75,000 sq. ft. Also in the Tenney expansion program is a licensing arrangement concluded with the West German firm, **Deutsche Waggon und Maschinenfabriken**, to manufacture and sell Tenney equipment in the European market.

25 MOST ACTIVE STOCKS

WEEK ENDING OCTOBER 2

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	600	13⅛	12⅛	12⅜
Elec & Mus Ind	568	7¼	7	7⅛
Sperry Rand	558	22⅝	21⅞	22⅛
Int'l Tel & Tel	553	34⅜	33¼	33½
Gen Elec	537	79½	77	79⅛
RCA	466	59⅝	55¾	57
Univ Control	420	17¼	16¼	16⅜
Texas Inst	388	135⅞	128¾	131¾
Du Mont	377	8½	6⅜	8¼
Gen Dynamic	372	48¼	45⅛	45⅞
Gen Tel & Elec	363	69⅞	68⅞	69½
Westinghouse	311	91½	88½	91¼
Raytheon	280	47¾	44½	45
Burroughs	275	31½	30⅜	30⅜
Ampex	256	83¾	78¼	82¾
Siegler Corp	246	29¼	25¼	29¼
Zenith Radio	220	97¾	94⅛	95½
El-Tronics	194	1⅜	1¼	1⅜
Int'l Bus Mach	185	426½	411½	419¾
Reeves Sndcrft	175	8⅝	7¾	8
Gen Transistor	174	34⅜	31⅜	33½
Beckman Inst	159	53⅞	50¾	52⅝
Emerson Radio	147	15⅞	14⅝	14¾
Lear	147	13⅞	12⅝	13¼
Philco Corp	146	25⅜	23¼	24¼

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.

NEW PUBLIC ISSUES

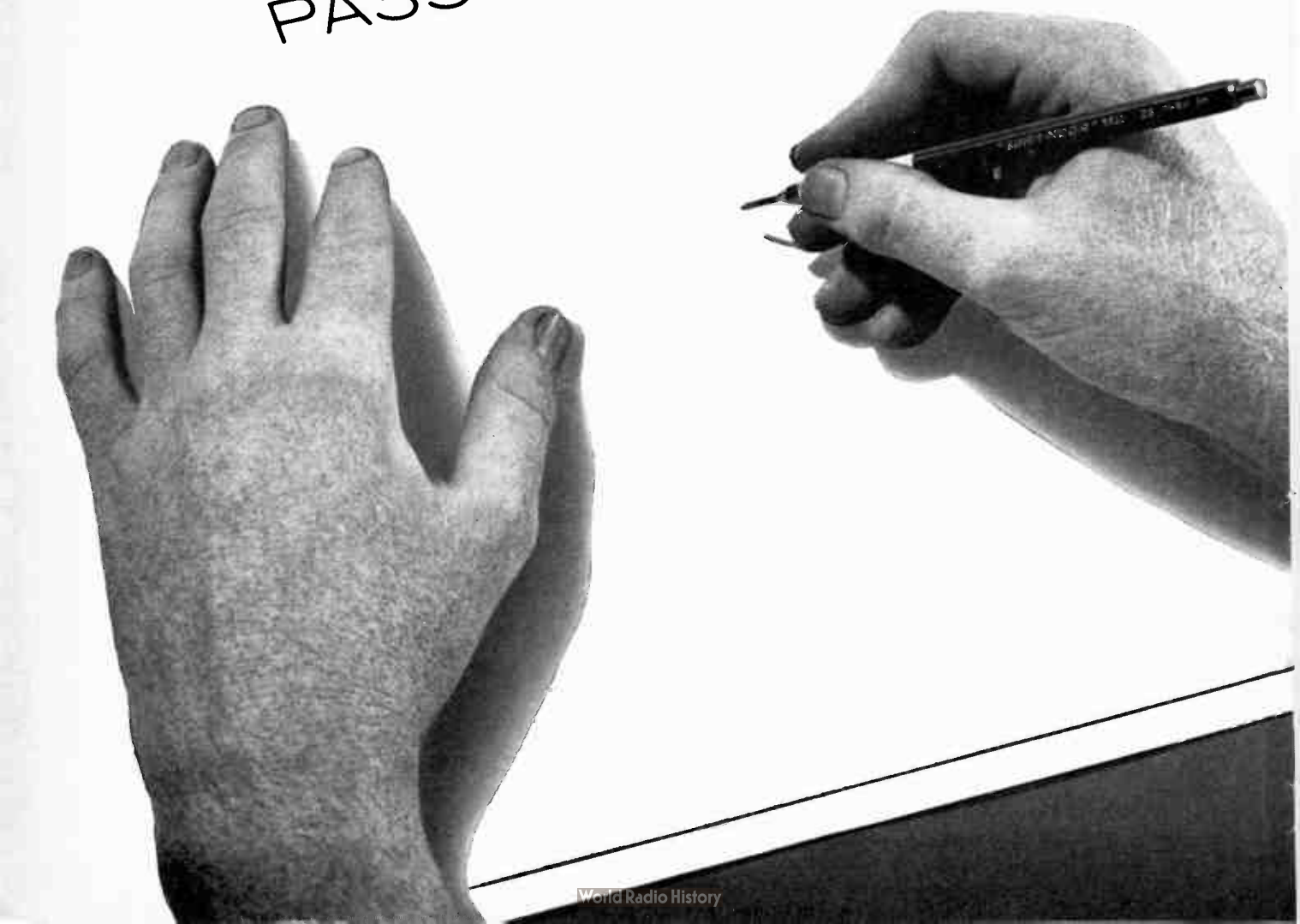
	No. of Shares	Issue Price
Allied Radio	333,335	16*
Radiation Dynamics	25,000	12½
Rek-O-Kut	142,666	3½
Technical Materiel	80,000	12

*approx

NEWLY IMPROVED

WHATEVER IS IMPORTANT TO YOU IN AN INTERMEDIATE

IMPROVED VAPO-VEL PASSES EVERY TEST!



POST VAPO-VEL

Here's a sepia intermediate that handles just like the best vellums

As a result of The Frederick Post Company's long and intensive research in intermediates and coating technology, there is now available a dramatically improved sepiatone vellum. POST Vapo-Vel (209) combines *every* important feature you've been looking for in a transparentized paper-base print—top drafting qualities, superior shelf-life and filing characteristics, and outstanding printback speed. An extra dividend: Vapo-Vel's cost per print is surprisingly economical compared to other types of intermediates.

To the man on the board, this newly improved Vapo-Vel is a real find. It has all the drawing and transparency features of a top-notch vellum, even that crisp vellum "feel." Vapo-Vel's easy-to-read dark brown image and outstanding transparency eliminate eyestrain in modification work on the back of reverse-reading prints. The surface takes pencil and ink without feathering. Pencil erasing characteristics of this strong 100% rag premium paper are truly outstanding, while eradication of print images is easily accomplished.

You check it! Whatever your special interest, test 209 Vapo-Vel ammonia process prints for factors most important in your own operations. Whatever your prime requirements may be, POST welcomes a comparative evaluation of diazo-type sepia papers for each and every one of these prime characteristics:

PASSES EVERY TEST!

Image Density—Visual
Drafting Qualities
Line Contrast
Readability thru Back
Eradication
Filing Characteristics
Image Density—Actinic Opacity (Printback)
Quality of Reprint
Image Bleed on Aging
Background Stability
Shelf-Life

Write today for your copy of the POST Vapo-Vel Kit. It contains sample prints to examine and test, a Print Characteristics Checklist, a Data Sheet and a copy of POST's popular booklet "11 Ways to Save Drafting Time." To keep up-to-date with the latest, just write Frederick Post Company, 3660 North Avondale Avenue, Chicago 18, Illinois.

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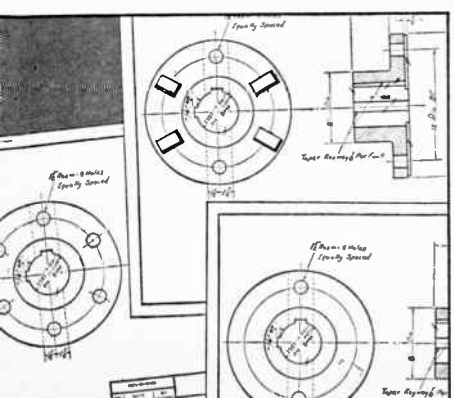
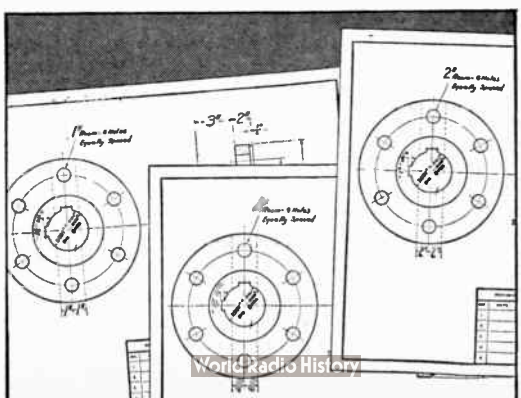
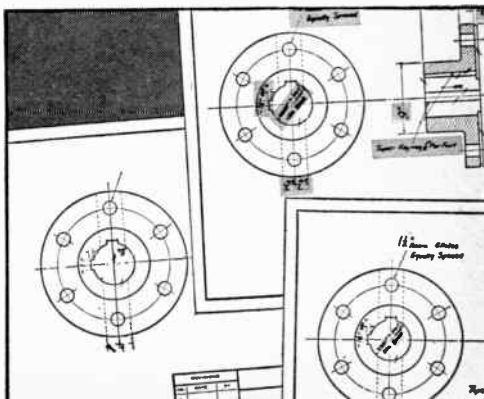
From this . . . to this WITH NO ERASURES! When a large element in your original drawing requires modifications, simply cut it out of the first Vapo-Vel print. Draw in the changes on a second Vapo-Vel print . . . and you have a new master.

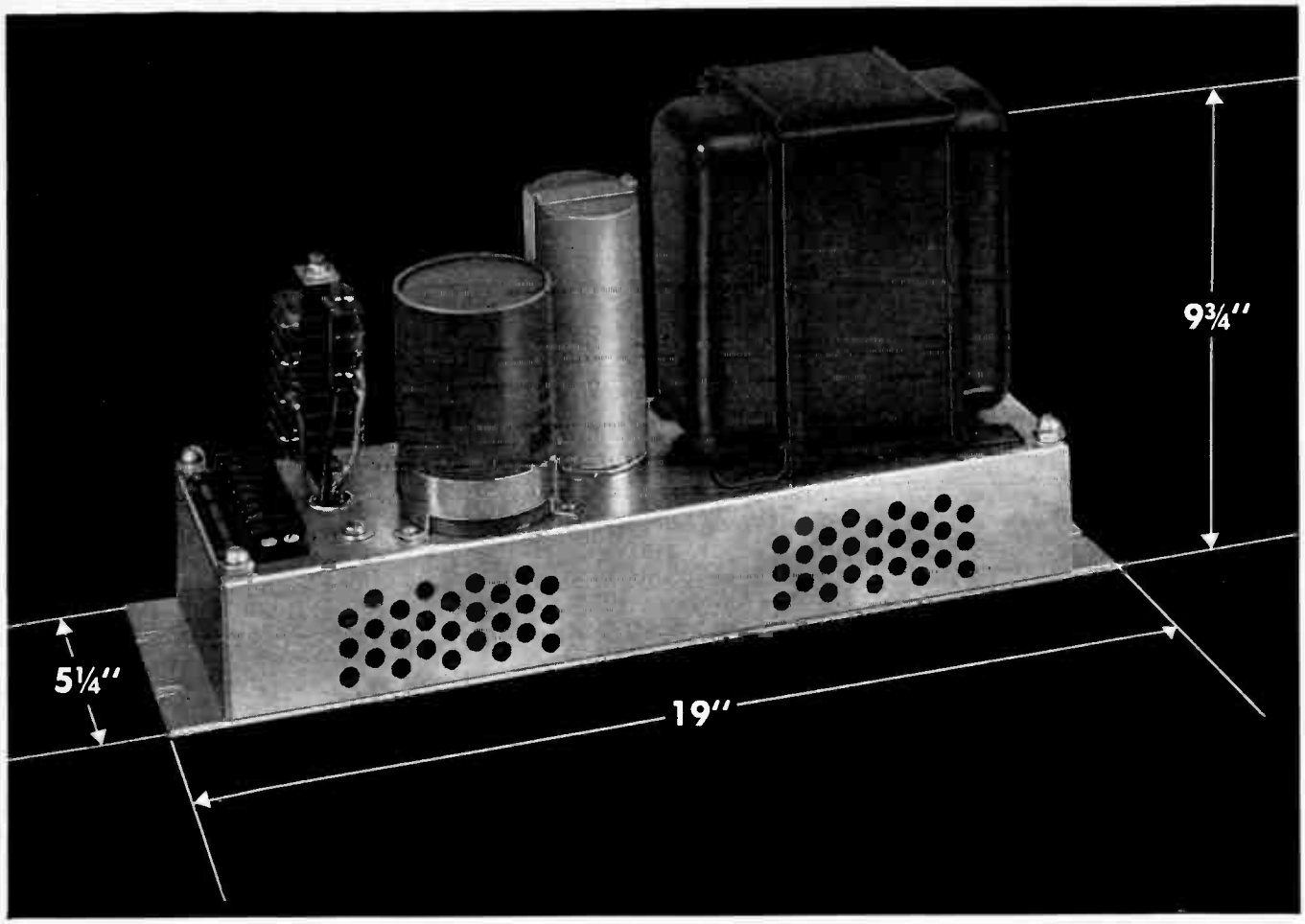
Make quick corrections over scattered areas. When small patches of your original drawing need alterations, make a Vapo-Vel intermediate. Then eliminate the unwanted lines with POST Eradicator Fluid and redraw.

Add variable data with transparent matte tape. It is often economical to maintain standard drawings without dimensions and other variables, adding this information on transparent matte tape, as needed to specific orders. A subsequent Vapo-Vel print then supplies the completed drawing.









Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-amperage loads.

Sola packs 6 amps of 300-watt regulated dc power into 5¼ inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within ±1% even under a ±10% variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.

How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

For complete data write for Bulletin 7J-CV-235

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

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REGULATED DC POWER SUPPLIES


MERCURY LAMP TRANSFORMERS


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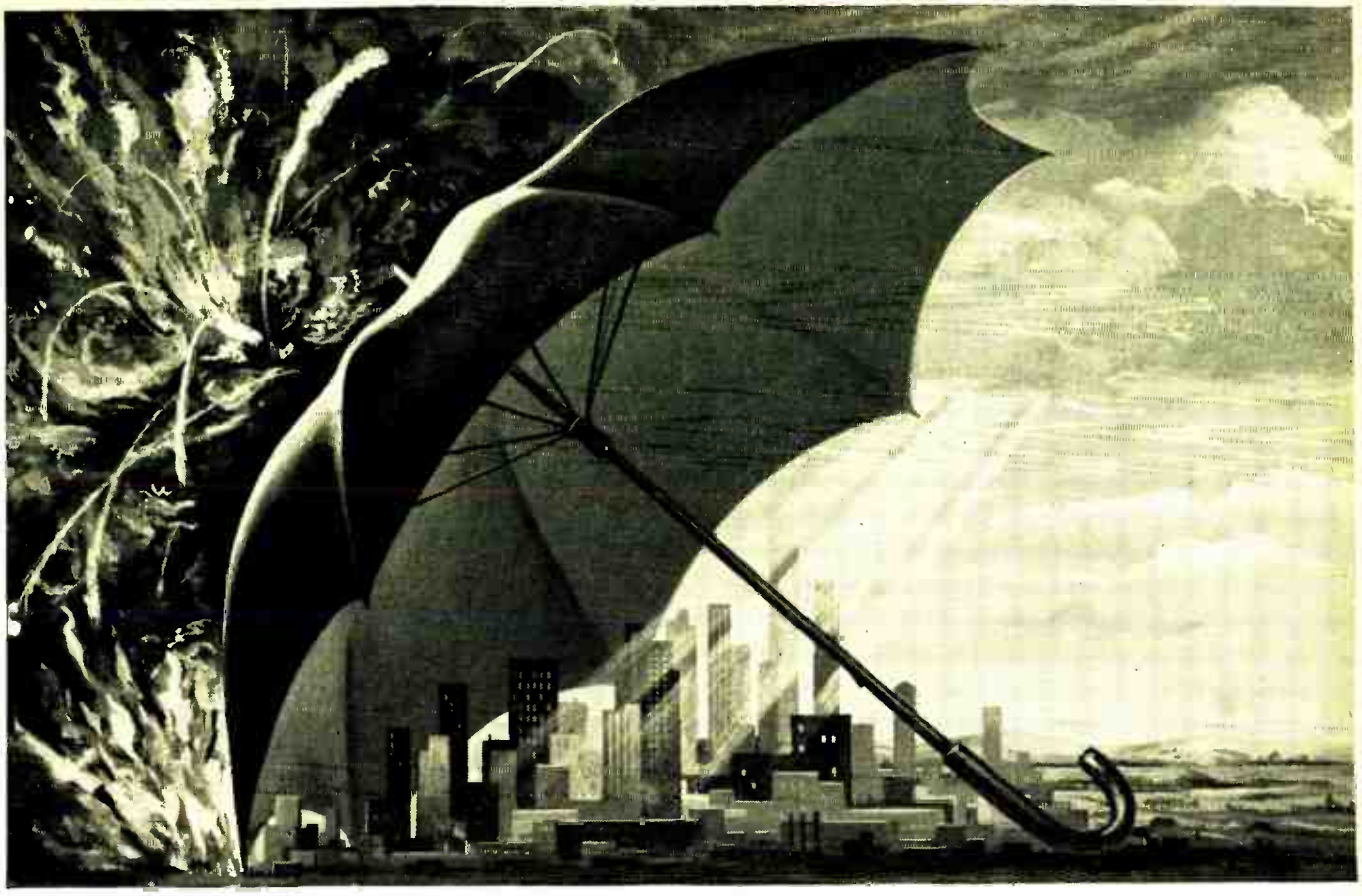
←CIRCLE 31 ON READER SERVICE CARD

CIRCLE 32 ON READER SERVICE CARD



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For over seven years, the Hallicrafters company has been answering this urgent need with QRC—Quick Reaction Capability.

For your electronic requirements . . . from single circuit to complete system . . . for application on land, sea, air or space . . . Hallicrafters QRC can provide you with this unique design and production service in electronics.

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MILITARY ELECTRONICS DIVISION CHICAGO 24, ILLINOIS

URGENT PROBLEMS RELIABLY SOLVED

Microwave Sales to Rise

POINT-TO-POINT microwave equipment market will grow rapidly over the next four years, with sales multiplying four to five times their present volume.

That's the opinion of electronics manufacturers, industry consultants and investors' groups who are intensively studying the microwave picture.

Combined military and industrial point-to-point microwave business for 1959 amounts to $40 million to $50 million, including about $25 million from industry and business. By 1963, annual volume of the combined market is expected to jump to about $200 million, with military orders accounting for the bulk of the sales.

What's Included

These sales estimates include the electronic receiving and transmitting equipment used in point-to-point microwave systems, but exclude the towers. Both ground and satellite microwave systems figure in the military portions of the estimates, while tv repeater stations, private industrial and common-carrier systems fit into the industrial picture.

Both large and small microwave equipment manufacturers should enjoy the fruits of this market. Large manufacturers may have advantages in obtaining big military and industrial ground-to-ground installations. Some observers see small companies doing well in competition for satellite microwave communication business where emphasis for a number of years will probably be on prototype construction, research and development.

Big military sales push will come from expanded use of microwave links in air defense systems where ability of microwave systems to operate despite enemy jamming efforts is an important factor. Military will also try to extend microwave communication distances by use of orbiting satellites as relay stations.

In the industrial and commercial field microwave experts look to more use of microwave relay stations for intercity communications by common carriers as a big source of future business. Private industrial microwave systems and tv repeater stations also play a growing role.

Manufacturers of klystrons, magnetrons, traveling-wave tubes, backward wave oscillators and many other components stand to benefit.

Total microwave tube market was about $100 million in 1958, according to statistics reported by Electronic Production Resources Agency.

The market for some 50 other microwave components, including microwave ferrite devices, is estimated at around $200 million. Industry will have a better picture of this market in a month or so when the Business and Defense Services Administration's Electronics Division is expected to release results of its survey of non-tube microwave components.

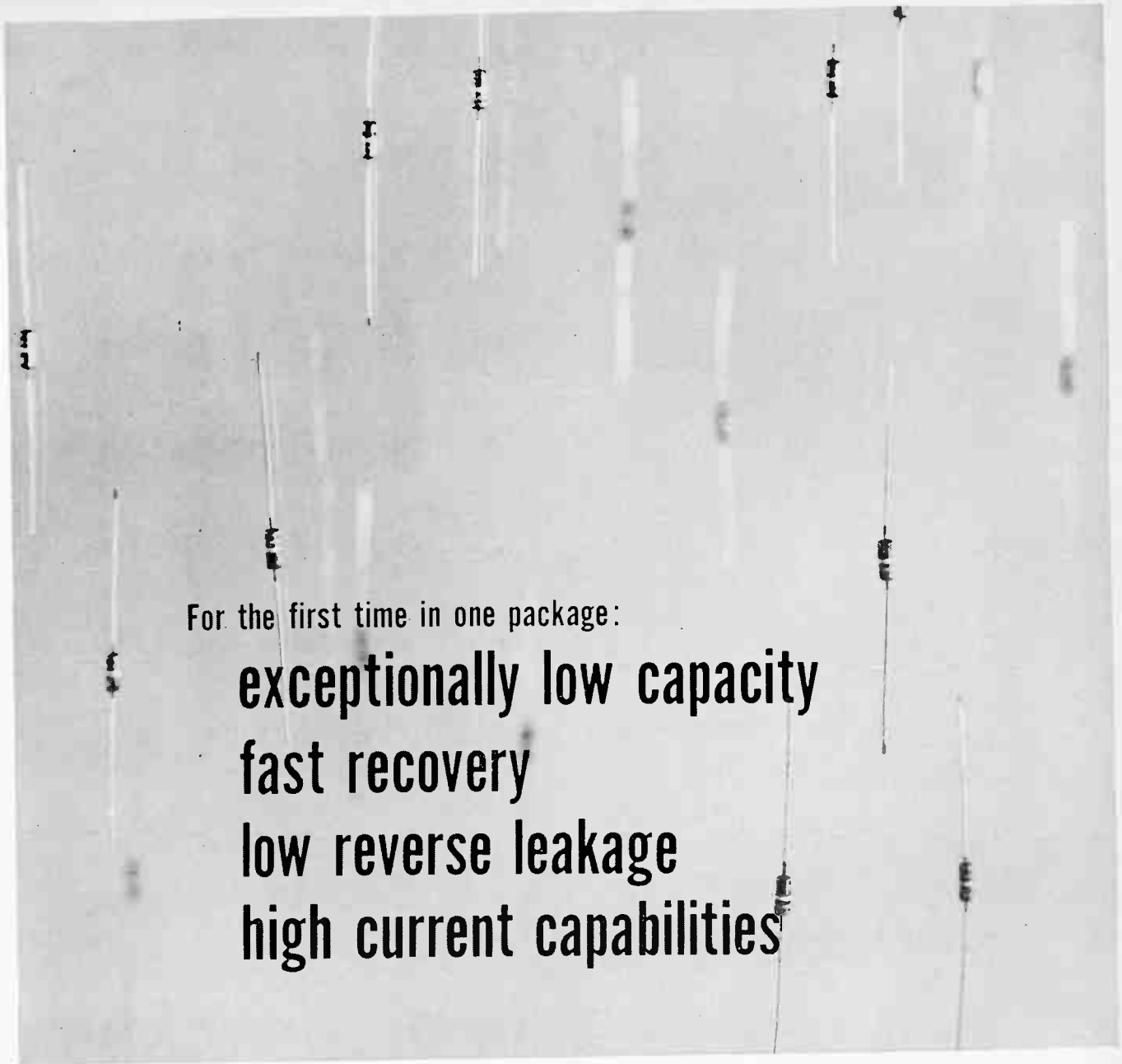
BDSA survey will show total shipments for each of some 50 specialized microwave components in units and in dollars. Breakdown of shipments to military and non-military users will be reported.

• **Bench mark** for estimating sales of analog computers has been established by Bureau of the Census, which states that value of shipments of analog computers at factory prices in 1958 was $9.067 million, representing 267 analog units. Manufacturers' estimates of current year value of analog shipments range around $12 million to $15 million. However, most electronics manufacturers in the past have found it extremely difficult to make a reliable estimate of the analog market. Bureau of Census information is contained in the Bureau's latest Facts for Industry report on Office, Computing and Accounting Machines.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Sept. 25, 1959	Aug. 28, 1959	Change From One Year Ago
Television sets	183,441	142,162	+42.9%
Radio sets, total	411,956	287,977	+35.0%
Auto sets	146,979	87,951	+45.2%



For the first time in one package:

exceptionally low capacity
fast recovery
low reverse leakage
high current capabilities

100 mA Min. @ 1V Forward Current...0.3 μsec recovery...4 μμf at −2V... that's what you get with the new Hughes computer diodes. With these characteristics, *these diodes will cover practically every major computer switching requirement.*

You can always count on them for top performance. Hermetically sealed in glass envelopes, these Hughes computer diodes have been engineered for extreme reliability under adverse environmental conditions.

For additional information concerning these unique Hughes diodes call or write the Hughes sales office nearest you. They are located at:

***Boston,** 4 Federal Street; Woburn, Mass.; WOburn 2-4824*
***Newark,** 80 Mulberry Street; Newark 2, N. J.; MArket 3-3520*
***San Francisco,** 535 Middlefield Road; Palo Alto, Calif.; DA 6-7780*
***Syracuse,** 224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163*
***Chicago,** 6120 West North Ave.; Chicago 39, Ill.; NAtional 2-0283*
***Philadelphia,** 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365*
***Los Angeles,** 690 N. Sepulveda; El Segundo, Calif.; OR 8-6125*

Or write, Hughes Products, Marketing Department,
SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

TYPICAL SPECIFICATIONS:

Type	Min. E_S (@ 100μA)	Min. Forward Current (@ 25°C (@ +1.0V)	Max. Reverse Current (μA) @ 25° C	@ 100° C	Reverse Recovery* Reverse Resistance (R) (ohms)	Maximum Recovery Time (μsec)
1N840	50	150	0.1 @ 40V	15 @ 40V	400 K	0.3
1N837A	100	150	0.1 @ 80V	15 @ 80V	400 K	0.3
1N841	150	150	0.1 @ 120V	15 @ 120V	400 K	0.3
1N843	250	150	0.1 @ 200V	15 @ 200V	400 K	0.3
1N844	100	200	0.1 @ 80V	15 @ 80V	400 K	0.5
1N845	200	200	0.1 @ 160V	15 @ 160V	400 K	0.5

*Measured in JAN test circuit and switched from 30mA forward current to −35V.

TYPICAL CAPACITANCE: C_{-10}=2.2μμf $C_{-1.5}$=4.4μμf C_{-0}=9.0μμf

Operating Temp. Range: −65°C to +150°C Storage Temp. Range: −65°C to +200°C

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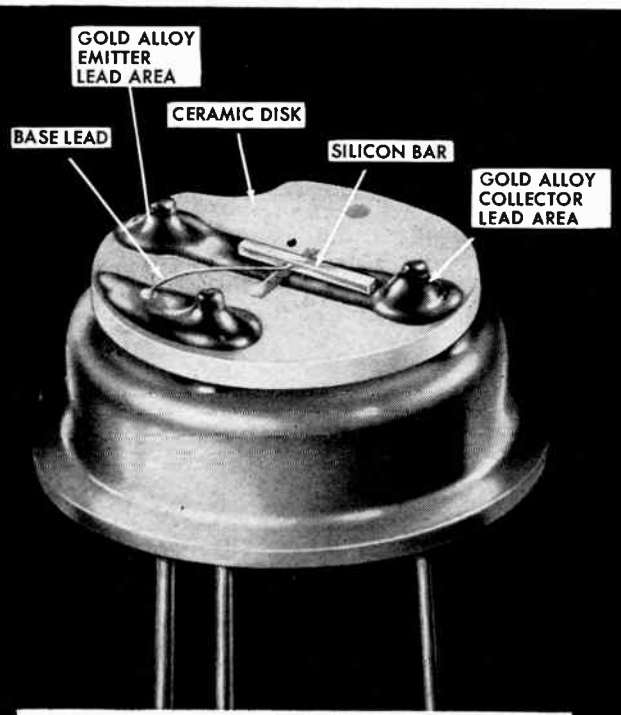
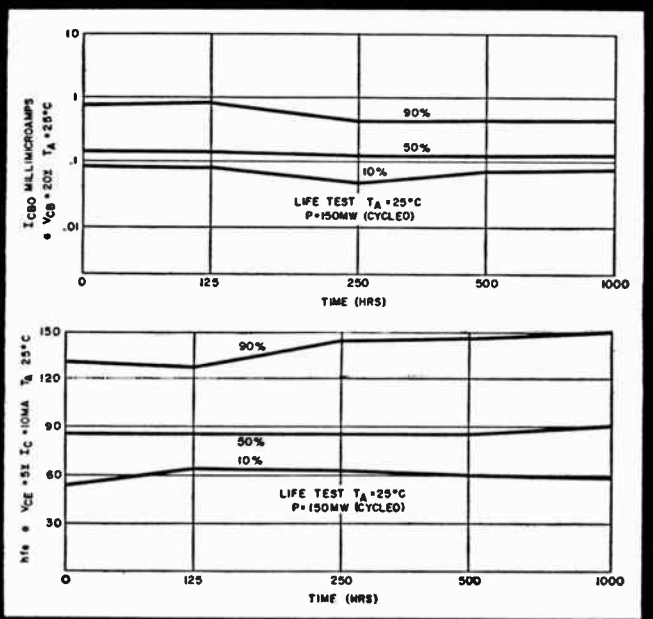
New life test data prove superior



Magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration.



Charts show extreme stability of performance throughout 1000 hours of life for beta and I_{CBO}. Test conditions were 150 mw at 25°C, 200°C storage and 25 mw at 125°C. Drift rates were substantially the same under all conditions.

New NPN Tetrodes: Higher gain at high temperature and low current

LARGE QUANTITIES OF TYPES 3N36 AND 3N37 TESTED AND PROVED, HIGH RELIABILITY THE RESULT OF TWO YEARS OF MANUFACTURING EXPERIENCE*

Mechanical Reliability Test	Results	% Survival
3-ft drop-shock (2500 G's. Mil St'd calls for 500G's)	2 out of 595 did not survive	99.66
Temperature cycling (−55°C to 100°C)	1 out of 375 did not survive	99.78
Life Test Reliability		
Cycled power @ 50 mw (device rated at 30 mw)	6 out of 500 exceeded parameter limits at 1000 hours	98.8
Oven @ 85°C	17 out of 500 exceeded parameter limits at 1000 hours	96.8
Shelf	No parameter failures of 500 units at 1000 hours	100.0

*General Electric's rigid standards call for only a slight shift in parameters to be a "failure." Many of these "failures" are still within EIA limits.

Here are two new germanium transistors that operate on lower voltages, require less current and are more rugged (see box below) than any other transistors that perform a like function. Furthermore, they deliver a high and constant gain at various voltages and at low power dissipation levels. Therefore, they are not only useful at high temperatures, but they also simplify circuit design and eliminate the need for close voltage regulation.

Features: Maximum gain at 1 ma, 5 volts or 5 mw. Flat gain noise factor from 1 ma to 5 ma. *Where to use them:* Mobile communications (made possible the first transistorized portable receiver). Wide band amplifier, oscillator and switching applications for radar and video at frequencies to 200 mc. *Availability:* Now . . . from your General Electric Semiconductor Sales Representative and in stock at your G-E Semiconductor Distributor's.

Absolute Maximum Ratings (25°C)	2N36	2N37	
Collector voltage to base 1 or base 2 (V_{CB})	+7	+7	V
Emitter to base 1 ar base 2 (V_{EB})	+2	+2	V
Collector current (I_C)	+20	+20	ma
Emitter current (I_E)	−20	−20	ma
Base 2 current (I_{B2})	2	2	ma
Total Power dissipation	30	30	mw

Electrical Characteristics (25°C)			
Output capacity (C_{ob})	2	1.5	μμf
Noise figure (NF)	11	11	db
Input impedance (h_{ie})	100-j27	80-j10	ohms
Current transfer ratio (h_{fe})	$2.2\angle -81°$	$1.1\angle -100°$	
Common base cutoff frequency (f_{ab})	50 MIN.	90 MIN.	mc
Common Emitter power gain (G_e)	11.5	9	db
Measurement frequency	60	150	mc

stability of G-E silicon transistors

Uniform characteristics out to 1000 hours exhibited by silicon transistors featuring Fixed Bed Construction

Comprehensive tests performed on General Electric silicon transistors show remarkably stable performance throughout 1000 hours of operation at high temperatures. Each test was run on seven lots of fifty Type 2N337 or 2N338 transistors (part of the series 2N332 through 339). These are the results:

350 units were given a 150 mw operating test at 25°C.

Only two units exceeded parameter limits, a successful performance rate of 99.4 percent.

350 units were given a 200°C storage test.

Only three units exceeded parameter limits, a successful performance rate of 99.1 percent.

Fixed Bed Construction, plus stabilized processing makes these results possible. No fluxes, resins or solders are used — only a gold alloy which forms an integral bond between all parts.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

Electrically and mechanically, this series of transistors is the most thoroughly tested and proved today—your assurance of high stability and reliability. Call your General Electric Semiconductor Representative for further details.

ABSOLUTE MAXIMUM RATINGS AT 25°C

	2N332-6	2N337-8	
Collector to base voltage	45	45	volts
Emitter to base voltage	1	1	volt
Collector current	25	20	ma
Collector power dissipation	150	125	mw
Operating temperature	−65°C to 175°C	−65° to 150°C	

Now available—4 new NPN alloy transistors

Absolute Maximum Ratings at 25°C	
Collector to base voltage	20 volts
Emitter to base voltage	15 volts
Collector to emitter voltage	20 volts
Collector current	300 ma
Base current	50 ma
Emitter current	300 ma
Storage temperature	85°C to −65°C
Operating junction temperature	85°C
Power dissipation	150 mw

Four new germanium switching transistors, made by the highly controllable NPN alloying process, are now being warehoused by General Electric and its distributors. The four transistors, Types 2N634, -5, -6 and 2N388, feature extremely consistent parameters. I_{CO} for instance, multiplies up in a normal fashion, so that higher temperature I_{CO} may be predicted from low temperature readings.

The transistors provide 150 mw power dissipation. They are useful in emitter-follower applications in computers, high current flip-flops, and are ideal as complementary devices to PNP computer transistors, such as the 2N396.

For complete information call your General Electric Semiconductor Sales Representative, your G-E Semiconductor Distributor, or write Section S25109, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York.

GENERAL ELECTRIC

Semiconductor Products Dept., Syracuse, New York

HOW DEPENDABLE IS DEPENDABILITY ?

. . . As dependable as the engineering and construction effort that goes into the product. Just as *dependability* is built into precision wrist chronometers — dependable as time itself — so reliability engineering and careful attention to construction detail are two important components of every Cubic digital instrument.

Your requirement for dependable digital systems is Cubic's greatest concern . . . and each precise detail of design and construction receives Cubic's constant attention. *Dependability* and reliability are "built in" with such features as "controlled drive" stepping switches, in which the switch turns off the drive circuit part way through its cycle, ending overdrive and eliminating impact wear. Other unique design features provide extra-long lamp life in the ultra-brilliant readout display, sturdy cabinet construction, transistorization for longer instrument life — with all components of highest quality and maximum reliability.

Unit construction with standard dimensions provides Cubic digital "systems that design themselves." Instrumentation for monitoring, control, check-out, inspection, calibration, research and development is provided by simple combination in standard racks of DC Voltmeters, Control Units, DC Pre-Amplifiers, AC Converters, Ohmmeters, Scanners, Ratiometers, Printer Controls and Chronometers. And a new dimension in instrument readout is offered by the Cubic Vocameter, the meter that talks! Throughout Cubic's complete line of digital instruments, *dependability* is an "off-the-shelf" item.

The skill and experience responsible for the superiority of Cubic's Space Age electronic tracking systems are also important engineering and production components of Cubic digital instruments — yours for an easier job . . . done faster . . . better . . . and with greater assurance.

CUBIC CORPORATION

5575 Kearny Villa Road, San Diego 11, California

Electronic Engineering With a Dimension for the Future

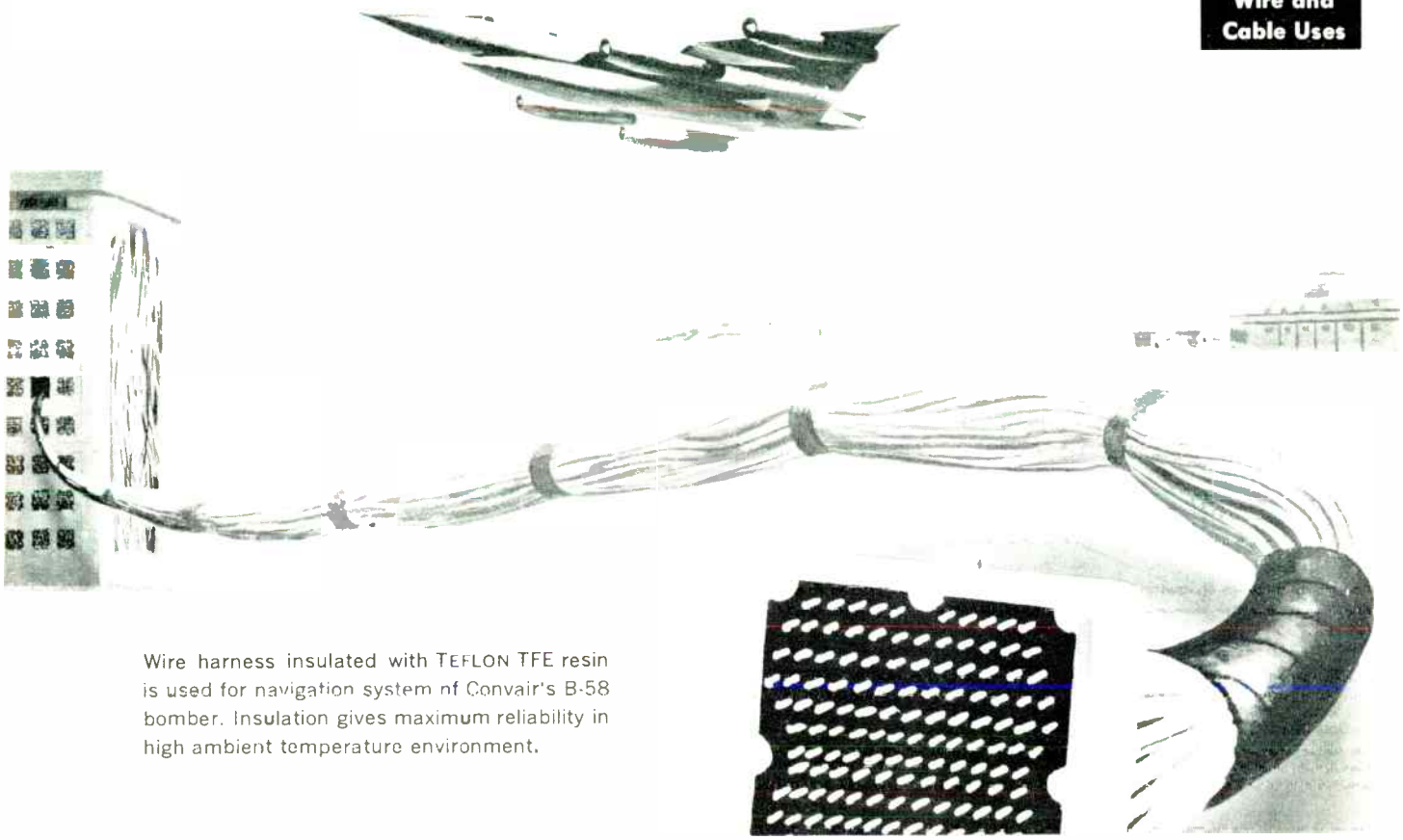
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number E-6 in a series
ELECTRICAL DESIGN
Wire and Cable Uses



Wire harness insulated with TEFLON TFE resin is used for navigation system of Convair's B-58 bomber. Insulation gives maximum reliability in high ambient temperature environment.

Wire and cable insulation of TEFLON® fluorocarbon resins gives maximum reliability

IN LATE 1959 . . .

A NEW MELT-PROCESSIBLE "TEFLON" RESIN. This plant in Parkersburg, W.Va., begins production of TEFLON FEP-fluorocarbon resin in late 1959. For more on this new product of Du Pont research, see the following pages.

TEFLON fluorocarbon resins are unique as dielectric materials. No other wire and cable insulations can offer such outstanding resistance to so great an extreme of conditions. No other insulations can provide such excellent electrical properties in the face of widely different operating requirements.

In the next three pages you will see how TEFLON resins can help you overcome your tough design problems—with savings in weight, space and costs!

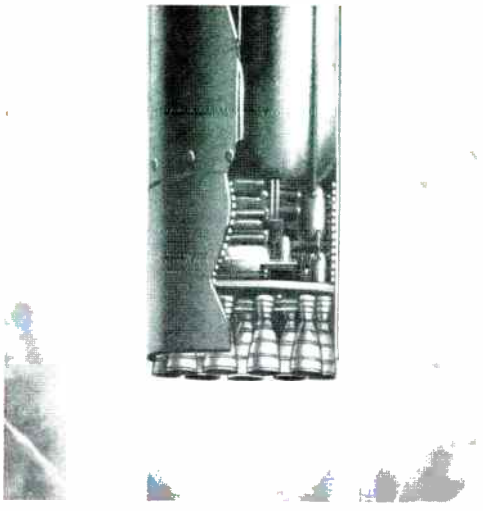
DU PONT

BETTER THINGS FOR BETTER LIVING THROUGH CHEMISTRY

OVER

DUPONT

Insulation of TFE resins gives the utmost in heat-resistance

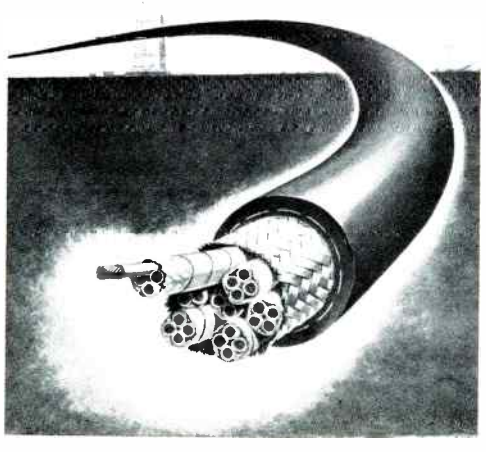


Insulation of TFE resins insures against high-temperature overloads

Wire insulated with TEFLON TFE resin is used for maximum reliability in Rocketdyne engines for the Thor and Atlas missiles. In this application, the insulation must withstand high-temperature overloads, possible exposure to corrosive or reactive missile fuels, the severe cold of liquid-fuel temperatures, and extreme vibration and shock.

TFE resins are capable of continuous service to at least 500°F. They can be used at much higher temperatures for short periods, providing an important margin of safety in emergency conditions. TFE resins retain appreciable mechanical strength and exceptional dielectric properties at such temperatures.

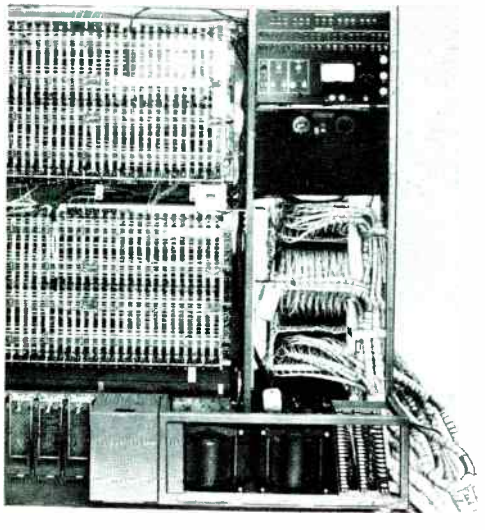
Photo courtesy of Rocketdyne, a division of North American Aviation.



TFE resins lead all organic insulations in resistance to heat aging

For the Titan ICBM, the Martin Company specifies, among others, wire insulated with TEFLON TFE resins at the launching pad. TFE resins are used for insulation of the thermocouple conductors and, in special cases, for coaxial and triaxial leads. The insulation resists the extreme heat of the rocket blast, and provides minimum cable capacitance in the signal circuits. Overload of one wire does not burn or fuse adjacent wires insulated with TFE resins. Conductors are protected from the corrosive effects of missile chemicals and solvents.

The outstanding dielectric properties of TFE resins remain virtually unchanged over extremely broad ranges of temperature, frequency and time.



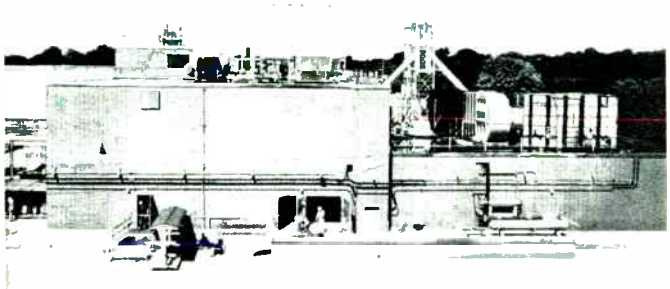
TFE resins save space . . . increase reliability of data-processing equipment

The exceptional electrical properties and heat resistance of TEFLON TFE resins enable the manufacturer of this data-processing equipment to save space and increase over-all reliability. Thinner insulation can be used with TFE resins because of their low capacitance and dissipation factor. This permits considerable reduction in outside diameter of the cable and provides important space savings. The heat resistance of TFE resins prevents migration of the center conductor under high power loads.

Another reason for selecting a TFE resin for this application is the fact that the center conductor can be soldered directly to the pins without an adapter. TFE resins are unaffected by soldering-iron temperatures.

Photo courtesy of International Business Machines Corp.

Melt-processible TEFLON FEP resin brings new design opportunities

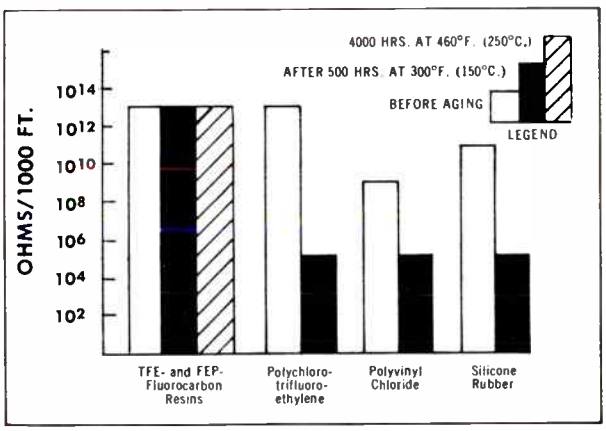


TEFLON FEP-fluorocarbon resin goes into commercial production in late 1959

New Du Pont facilities are being completed at Parkersburg, W. Va., for the production of TEFLON FEP-fluorocarbon resins. This new member of the family of TEFLON fluorocarbon resins, fluorinated ethylene propylene, can be extruded and injection-molded on conventional thermoplastic processing equipment. Thus, it brings the exceptional properties of fluorocarbon resins to many uses not now feasible with TFE resin . . . jacketing for wire and cable, thin wire coatings, easily fabricated complex shapes.

This full-scale commercial plant for production of FEP resin will go onstream in late 1959. Limited quantities of material are available for development purposes at this time.

INSULATION RESISTANCE AFTER ACCELERATED HEAT AGING*



*Measurements made on hookup-wire samples

New FEP resin is excellent dielectric at all frequencies . . . chemically inert

FEP resin has a fully fluorinated structure. Thus, it has outstanding electrical properties over a wide range of frequencies and temperatures, excellent mechanical properties and chemical inertness. Its dielectric constant of 2.2 is flat over the frequency range of 100 cycles to above 100 megacycles. Its dissipation factor is less than 0.0003 at 100 cycles to a maximum of 0.0007 at 1 megacycle. Insulation resistance is so high, it is above the measurable range . . . and this property is not affected by heat aging.

FEP resin is capable of continuous service at 400°F. It is easily pigmented. It can be extruded as a high-quality, chemical-resistant jacket in long, continuous lengths. It does not become embrittled on heat aging.

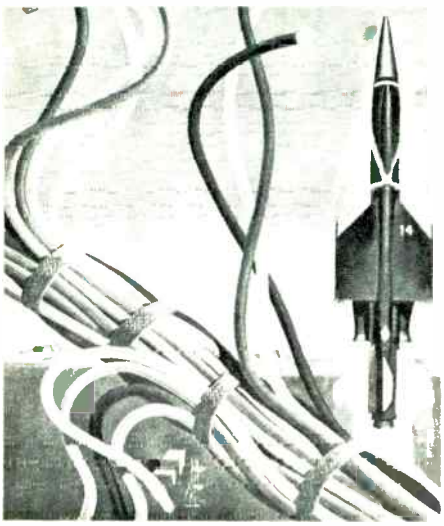
Early development work shows FEP resin to be excellent jacketing material

FEP resin has been made into a number of wire and cable constructions. This multi-conductor cable used on the North American A3J bomber has primary insulation of a TFE resin, and an outer jacket of FEP. The use of TFE resin for the primary insulation permits a weight saving of 8 pounds per 1,000 feet of cable. The tough, heat-resistant jacket of FEP resin gives extra reliability.

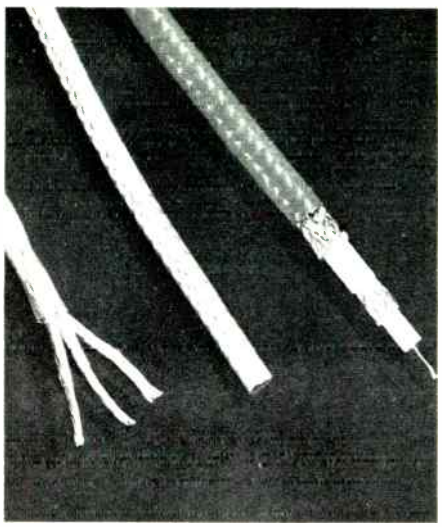
Other anticipated uses for wire constructions of FEP resin are shipboard cable, ground control cable, power cable, industrial control cable, and oil-well cable . . . or any installation where weather resistance, chemical resistance, heat resistance and exceptional reliability are required.

OVER

In late 1959 . . . TEFLON TFE and FEP resins for electrical and electronics engineers



PROTECTION AGAINST SURGES of extreme heat is given by insulation of TFE resins. The interconnecting wire used in the Bomarc IM-99 Interceptor Missile is insulated with a TFE resin for this important reason. Design specifications involving cramped spaces, tight wiring and high ambients are often best met by wire insulated with TFE resins. Signal and power are delivered with minimum transmission losses.



CABLE JACKETING OF FEP RESIN promises to be an important use for this new product of Du Pont research. The three-wire twisted cable at the left has a primary insulation and jacket of FEP. It is economical to make because FEP is easily extruded. The coaxial cable (center) has a jacket of FEP to ward off chemicals and moisture. The complex triaxial cable has two pigmented jackets of FEP resin.

INJECTION-MOLDED COMPONENTS are also possible with FEP resin. Insulators, coil forms, tube sockets and bases, and a variety of other intricate electrical components can be easily produced in quantity to close tolerances. Thus, exciting new opportunities for improved design and greater reliability are opened by the availability of TEFLON fluorocarbon resin in melt-processible form.

Now, more than ever, it is important that designers of electrical and electronic equipment become familiar with the properties of TEFLON fluorocarbon resins. And it is essential that specifications involving TEFLON resins state whether a TFE or FEP resin is desired. In many instances, different fluorocarbon resins will be employed for individual elements of the same construction.

TFE (tetrafluoroethylene) resins are the established standards where reliability over a wide range of severe conditions is important. TFE resins are rated for continuous service at 500°F.

FEP (fluorinated ethylene propylene) resin is the new melt-processible member of the family of TEFLON fluorocarbon resins. Because FEP resin is a true thermoplastic, it can be molded and extruded like nylon, polyethylene and other resins familiar to industry. It is capable of continuous service at 400°F.

When FEP resin becomes a commercial product in late 1959, it is expected to join TFE-fluorocarbon resin as a design standard where extreme environmental conditions are encountered in service or in storage. And even for service where ambient conditions are not strenuous, TEFLON fluorocarbon resins deserve consideration because of their non-aging characteristics. For reliable, trouble-free service, wire and cable insulated with TEFLON fluorocarbon resins are your best bet.

FOR MORE INFORMATION

If you would like further design and end-use information about Du Pont TEFLON resins, contact your supplier of TEFLON fluorocarbon resins (listed in the Yellow Pages under "Plastics—Du Pont"). For any unanswered technical questions about these resins, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room T-1510 Nemours Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal Quebec.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins.

TEFLON®

FLUOROCARBON RESINS

DU PONT

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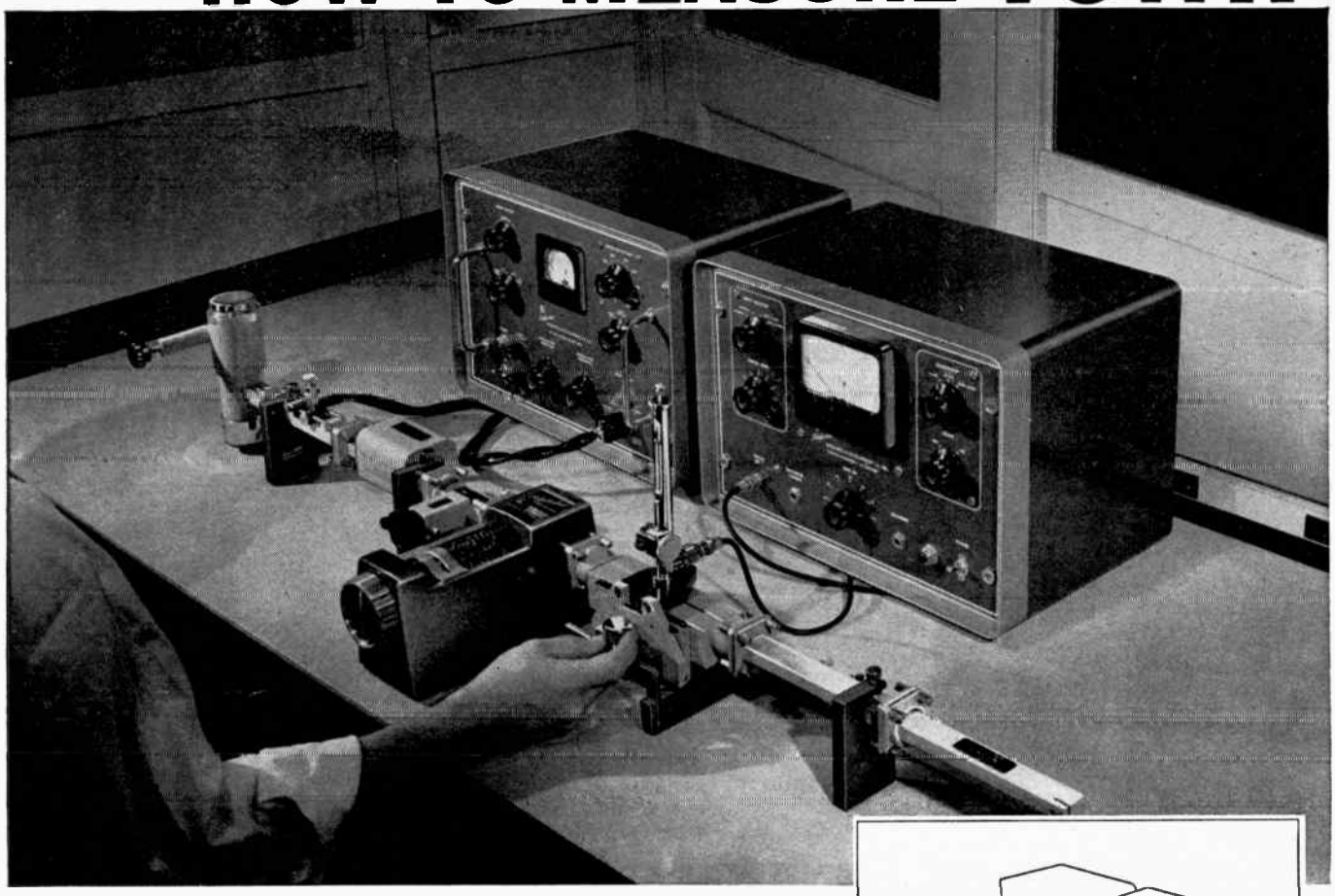
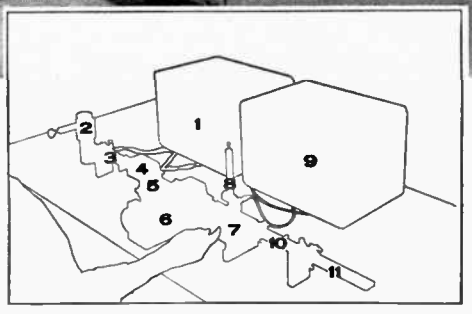
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

HOW TO MEASURE VSWR





This microwave measurement bench is for the determination of Voltage Standing Wave Ratio using the slotted-line technique. Other systems utilizing directional couplers or magic tees for measurement of VSWR are known, but the use of the Slotted Section assures maximum accuracy.

Regardless of the technique used, accurate readings depend on the precision of the test instruments involved. When it comes to microwave test instruments PRD produces the widest range of the most precise equipment available anywhere in the world.

You will notice in the measurement bench shown that there are four test components separating the klystron tube mount from the Slotted Section. These are: A Slide Screw Tuner, ferrite Isolator, Level Set Attenuator, and a broadband direct reading Frequency Meter. THE USE OF THESE FOUR COMPONENTS IN THE TEST LINE IS MANDATORY FOR PRECISE VSWR MEASUREMENTS!

The reason for this is clear when you consider the interrelationship between VSWR, power, and frequency.

The Slide Screw Tuner is used to match the klystron output to that of the tandem test line, thereby maximizing its output and increasing its stability.

The use of the ferrite Isolator assures klystron frequency and power stability by shielding the source generator from changes in impedance further down the line. It accomplishes this with negligible attenuation of the incident power. The Level Set Attenuator is used to adjust the amount of power feeding the remainder of the test line.

The reaction Frequency Meter accurately monitors the output of the klystron by a resonant dip on the Standing Wave Amplifier.

A Slotted Section, tuned Broadband Probe, Standing Wave Amplifier, and matched Termination complete the precision waveguide, X-band, VSWR bench. A Klystron Power Supply to provide the signal source with power and modulation and a Fixed Waveguide Attenuator to simulate the unknown are also shown.

Special problems in VSWR and other related measurements? — Contact our Applications Engineering Department.

We at PRD have pioneered the development of precision microwave test instruments . . . PRD is the only pioneer company today producing microwave test instruments exclusively. In fact, we're just about the largest microwave company in the world . . . our cable address is MICROWAVE, New York, USA.

For technical details and specifications covering products shown write:

TEST INSTRUMENTS USED IN THIS X-BAND VSWR BENCH

1—809 Klystron Power Supply, catalog page F-10
2—703 Shielded Tube Mount, catalog page F-8
3—303-A Slide Screw Tuner, catalog page B-14
4—1203 Isolator, catalog page A-21
5—159-A Level Set Attenuator, catalog page A-17
6—535 Frequency Meter, catalog page D-12
7—203-D Slotted Section, catalog page B-11
8—250-A Broadband Probe, catalog page B-12
9—277-A Standing Wave Amplifier, catalog page E-7
10—UNKNOWN—represented by a 140 Fixed Waveguide Attenuator, catalog page A-11
11—116-A Waveguide Termination, catalog page A-19

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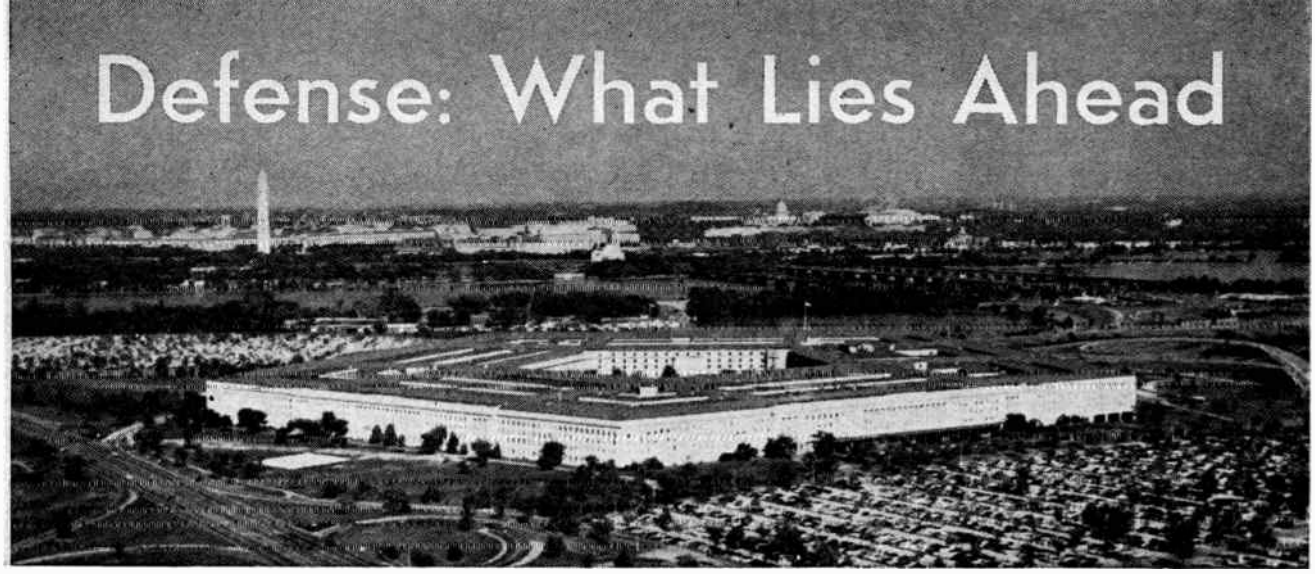
West Coast Office: 2639 So. La Cienega Blvd., Los Angeles 34, California. Telephone: UPton 0-1940

Defense: What Lies Ahead



Never before have knowledge and judgment been so vital in steering a successful defense course. Here's what Pentagon officials are saying

By **JOHN F. MASON,** Associate Editor

WASHINGTON, D. C.—A recent series of personal interviews with top Defense Department policy makers and military officials turns a bright light on a number of dark spots in the road ahead for the electronics industry.

Here are some of the problems and conflicts facing the DOD, how they are apt to be resolved, and what effects these solutions will have on our industry:

Despite Khrushchev's disarmament proposal, U. S. Treasury dilemmas, and a now-operational ICBM, the Defense budget appears to be set close to $41 billion a year for the next three to four years.

A heavy Congressional foot on the budget lid immediately presents the problem of how to meet the rising costs of increasingly complex weapons systems. Abandoning limited war requirements in favor of preparing against a total push is not being considered as a solution. Both brush-fire and all-out threats will be met with continued buying of hardware for each.

Financial ends will be forced to meet in other ways.

How DOD Will Cut Costs

At the first signs of obsolescence —technological or tactical—systems under development will be cancelled without delay. Long drawn-out debates on relative merits of similar weapons will be brought to a money-saving halt by the office of Herbert F. York, Pentagon's Director of Research and Engineering. Congressional proddings to keep constituents back home in business will also have less appeal.

Greater selectivity will be exercised before starting new programs. The DOD will not translate service desires into service needs as easily as in the past.

Though fewer systems will be developed, electronics' portion of the total dollar market will increase. One reason systems are costing more is the added automation made possible by electronics.

How this greater selectivity will affect our industry, however, will lie in the greater concentration of prime contract awards among fewer companies. More subcontracting will be ensured due to urging by Congress, efforts of the Small Business Administration and services themselves.

More Subcontracting

More big companies will work as subs to other big companies and to small firms as well. Nearly half of the prime contract funds awarded to the top 100 prime contractor firms in 1958 went to subcontractors. This percentage will go up.

USAF assures more subcontracting by its "make-or-buy" clause: On signing a contract, joint buyer-contractor determinations are made as to which components the contractor will build in his own plant or buy outside. Later changes in original plans must be justified on the grounds of better quality, faster delivery, or greater economy.

This plan is intended to prevent the prime from expanding into new areas of production where adequate subcontracting capability already exists. Along with this same thinking, is the DOD's intention to restrict further government financing of industrial facilities. This, too, will increase subcontracting work.

The subcontractor is likely to find himself in closer contact with the government than he has been before. As a result of the General Accounting Office's recent claims that primes had overcharged the DOD, prime contractors and first-tier subs, where sums over $100,000 are involved, will have to sign certificates of accuracy. Subs can expect DOD inspectors directly checking their books, quality control techniques, and other areas heretofore left up to themselves.

Kinds of Contracts

Whenever possible, the DOD awards a fixed price-price redetermination contract. The incentive to cut costs is built in. However, if the redetermination of price is not checked frequently, the final cost is higher than expected and the end result may, in effect, turn into a cost-plus-fixed-fee type contract.

Use of the CPFF, or the CPIF (cost plus incentive fee), is definitely on the rise (38.2 percent of all dollars awarded during July-Dec., 1958, were by cost-plus con-

tracts. Greater use of cost plus results from an increase in development contracts for new systems for which the cost is unknown. Kinds of incentives for which the contractor is rewarded have broadened to include performance awards.

BuShips has started using a value engineering clause which soon will be extended throughout the other Navy bureaus. Contractors, on reviewing design, development and production methods, may recommend cost savings to the Navy. On acceptance, the contractor is allowed a share of the savings.

After the CPFF is far enough along to estimate costs, the DOD likes to convert to a fixed-price agreement.

Other types of contracts currently in use include: Cost contracts for non-profit organizations; cost sharing (when the product has high commercial potential the government will share the cost with the contractor, letting the contractor wait for profit from the commercial market); time and material contracts, for repair work; fixed price plus labor escalator clauses, etc.

The DOD is very anxious to come up with a completely new, cure-all-evils kind of contract. However, no one seems to know at the moment what form this panacea would take.

Letter Contracts

Letter contracts—a headache for the DOD and industry alike—will probably be made definite more quickly in the future. Costs go unmonitored by the DOD during these letter-contract interims and the contractor suffers from uncertainty. As long as a letter contract is in effect, the contractor is paid 70-percent progress payments. However, when the contract is finally drawn up—if it is a cost-type contract—the contractor gets 80 percent of the allowable items of cost.

Average profits on government contracts, as revealed by the individual services, show:

Army: Normal range of profit for cost; for R&D, 4 to 9 percent. 7 to 10 percent of estimated cost; for R&D, four to 9 percent. These Army figures do not include contracts awarded after formal advertising since such contracts do not permit a review of pricing details.

Navy: Fees paid for R&D work

(Continued on p 51)

Largest selection

Trimpot®

the original leadscrew-actuated potentiometer

More engineers specify Trimpot because:

Trimpot line is complete

Bourns offers you the largest selection of leadscrew actuated potentiometers... 20 basic models—4 terminal types—three mounting methods.

Trimpot is small

Space saving size and rectangular shape permit the installation of 12 to 17 units in one square inch of panel area.

Trimpot is accurate

Multi-turn screwdriver adjustment provides 9000° of rotation...you can make and repeat the finest adjustments.

Trimpot is stable

Adjustment shaft is self-locking...settings are virtually immune to severe acceleration, vibration and shock.

Trimpot is fully tested

All instruments are 100% inspected before shipment to assure you of reliable performance.

Trimpot is proved

It is used in more military and commercial equipment than any other leadscrew actuated potentiometer.

Only Bourns Trimpot potentiometers give you these outstanding features

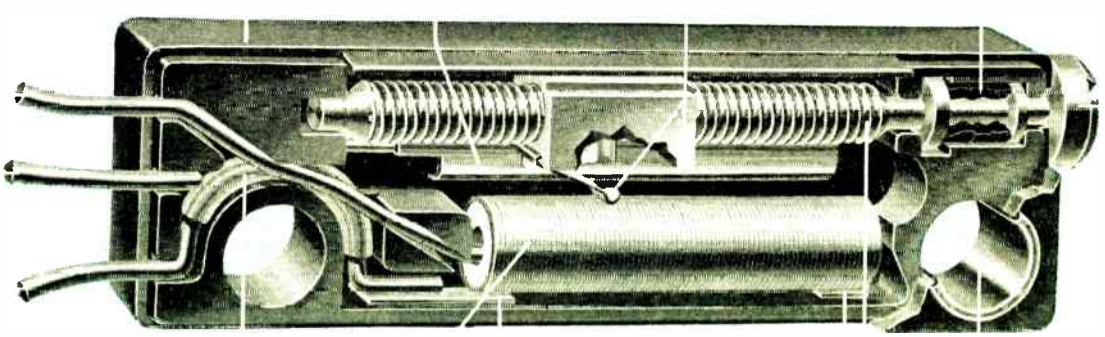
BODY—High-temperature, thermosetting plastic body is sealed, enabling potentiometer to meet Mil-Specs for humidity, sand, dust, fungus, salt spray, etc.

COLLECTOR BAR—Precious metal collector bar provides positive electrical contact, improves potentiometer performance and reliability.

WIPER CARRIAGE—Special high-temperature plastic carriage with precious metal contact spring permits exact settings and stability under severe environmental conditions.

SHAFT HEAD—Stainless steel with machined slot for screwdriver adjustment. Meets military salt spray requirements.

O-RING—Silicon rubber O-ring seals potentiometer against humidity, withstands high temperature.



TUBING INSULATION—Tubing around terminal eliminates possible short or electrical cross-over.

SILVERWELD* TERMINATION—This exclusive Bourns feature is unequalled in ruggedness. There is a metal-to-metal bond from the terminal to the resistance wire.

EYELETS—Stainless steel eyelets are set on ¾" centers and provide easy mounting with 2-56 screws.

TERMINALS—Three terminals are gold-plated copperweld wire or Teflon-insulated leads.

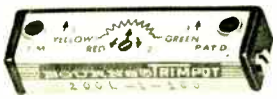
ELEMENT—Special ceramic mandrel is precision wound with low temperature coefficient resistance wire.

LEADSCREW—Stainless steel leadscrew is corrosion resistant, withstands salt spray.

* TRADEMARK

This cutaway of Model 220 is typical of the design of all Bourns Trimpot potentiometers though some features may vary from model to model.

Longest record of reliability



General Purpose Wirewound Trimpot—Model 200. Operates at 105 C / L,S,P terminals / 1/4 watt / 10 ohms to 100K. Available as rheostat, Model 201.

High-Resistance Wirewound Hi-R® Trimpot—Model 207. Operates at 175°C / L terminal / 2 watts / 100 ohms to 100K. Available as rheostat, Model 208 Hi-R Trim R®.

Dual-Element Wirewound Twinpot®—Model 209. Operates at 105°C / L terminal / 1/4 watt / 10 ohms to 20K. Two potentiometer outputs with one adjustment shaft.

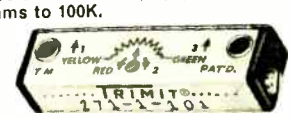
General-Purpose Carbon Trimpot—Model 215. Operates at 125°C / L,S,P terminals / 1/4 watt / 20K to 1 Meg. Available as Mil-Spec humidity-proof unit, Model 235 (1K to 10 Meg).

Subminiature Wirewound Trimpot—Model 220. Operates at 175°C / L & W terminals / 1 watt / 100 ohms to 20K. Meets Mil-Specs for humidity.

High-Temperature, Humidity-Proof Wirewound Trimpot—Model 224. Operates at 175°C / L,S,P terminals / 1 watt / 100 ohms to 100K. Meets Mil-Specs for humidity.

Humidity-Proof Wirewound Trimpot—Model 236. Operates at 135°C / L,S,P terminals / 0.8 watt / 10 ohms to 100K. Meets Mil-Specs for humidity.

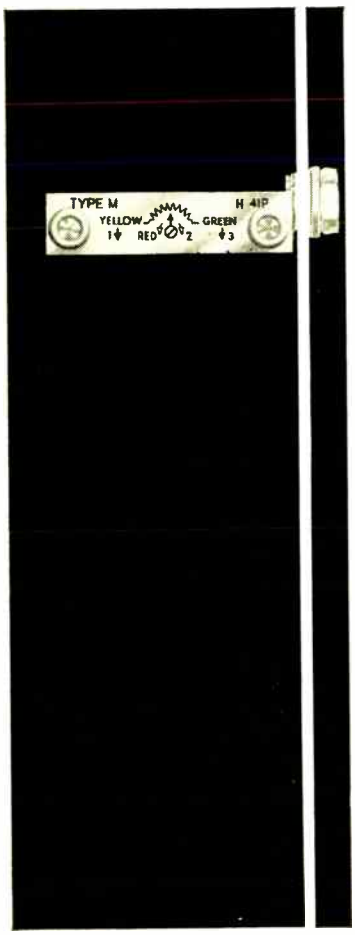
High-Temperature Wirewound Trimpot—Model 260. Operates at 175°C / L,S,P terminals / 1 watt / 10 ohms to 100K.



High-Quality Commercial Wirewound Trimit®—Models 271, 273, 275. Operates at 85°C / L,S,P terminals / 1/4 watt / 100 ohms to 10K.

High-Quality Commercial Carbon Trimit—Models 272, 274, 276. Operates at 85°C / L,S,P terminals / 0.2 watt / 20K to 1 Meg.

Low Cost Commercial Wirewound E-Z Trim®—Model 277. Subminiature—1" x 17/64" x 5/16". Tapered all-purpose lug terminals / 1/2 watt / 100 ohms to 10K. For computers, test equipment, industrial control systems, etc.



Panel-Mount Trimpot

All models are now available with the added convenience of panel mounting. Unique design permits quick factory attachment of rugged panel-mount assembly to standard "on-the-shelf" Trimpot potentiometers. The Panel Mount Trimpot takes as little as 1/12 sq. inch of panel space, meets Mil-Specs for vibration, shock, salt spray, etc. Recessed head prevents accidental changes of setting. Silicon rubber O-ring and Teflon washer provide moisture barrier.

Key to terminals

L — insulated stranded Leads

S — Solder lugs

S — Solder lugs (Model 224 only)

P — Printed circuit Pins

W — uninsulated Wires

Standard resistances (ohms)

10	50	200	1K	5K	20K	100K	500K
20	100	500	2K	10K	50K	200K	1Meg

other Resistances Available

Write for detailed specifications and list of stocking distributors.

BOURNS Inc.

P.O. Box 2112r, Riverside, California

Plants: Riverside, California and Ames, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

PROGRESS IN PLASTICS

THE TROUBLE WITH PRINTED CIRCUITS— AND HOW CDF WORKS TO SOLVE IT

The honeymoon is long since over; suppliers and manufacturers are engaged now in the humdrum activity of making printed circuits *work*. The industry found in time that there was still a long way to go before the *magic* of printed circuitry was proved incontrovertibly in practice. The truth: Too many mass-produced printed circuits simply were no good. Why?

The trouble was not in the theory. Or in approved manufacturing techniques. It lay—and still lies—in raw materials, primarily in the consistency of quality of base laminates.

We're not here to say that CDF has a totally rosy record in this field. No, we've had our share of failures along with our many triumphs. In fact, our failures during the early years of copper-clad laminates taught us certain important things that our competitors have yet to learn.

But we do emphasize this: We've made—and are still making—great progress at CDF in licking problems that have beset the printed-circuit producer and the printed-circuit user in obtaining top-quality laminates on every order, regardless of grade.

Here, for example, are a few areas where CDF R&D has been particularly active:

1. Consistent quality. A major cause for printed-circuit rejects has been delamination and blistering of the base laminates when subjected to high temperatures in processing. New developments in CDF raw-materials control promise a heartening break-through in this respect. Also, CDF technical personnel are engaged in counseling circuit manufacturers in optimum handling and processing techniques.

2. Foil-bond strength. Certain metal-clad laminates seem to pass the most rigid laboratory tests, only to fail at the end of manufacture when dipped in solder or when put through long-term operational tests at elevated temperatures. The foil-bonding strength of CDF Di-Clad® laminates, however, is recognized throughout the industry as superior in every grade.

Nevertheless, improvements are being made daily in foil adhesives and bonding methods at CDF, and bond strengths are being increased—not only in number of pounds required for foil separation, but in length of safe solder-immersion and high-temperature operation time.

3. Range of selection. CDF has consistently offered the widest range of metal-clad grades—in phenolic and epoxy paper-base, epoxy-glass, and Teflon*-glass. And CDF Di-Clad Teflon-glass grades remain the only laminates of their kind approved by the military. CDF Technical Bulletin 11,900 gives the latest information on all Di-Clad printed-circuit grades.

* du Pont's TFE fluorocarbon resin

4. Flexible grades. Newly-perfected *flexible* grades of CDF Di-Clad promise the designer even greater freedom. One of the headaches in the use of printed circuits has been their rigidity. They tend to hamper independent movement and vibration of connected systems. They occasionally dictate inconvenient housing shapes. Flexible printed circuits, however, overcome these objections and provide many additional benefits of their own. Details on how CDF flexible Di-Clad materials can help see you out of a printed-circuit problem can be obtained from your CDF sales engineer. Look up his phone number in the Product Design File (Sweet's), Electronics Buyers' Guide, or your own CDF catalog. Or send us your print or your problem, and we'll return recommendations based on your individual needs.

NEW CDF LITERATURE

Information on new grades, special applications, and outstanding properties of CDF insulating materials is made available regularly through CDF Technical Bulletins and Folders. The following literature is new. For copies of any bulletins listed, send the coupon below.

CDF Di-Clad Laminates—
Bulletin 11,900

CDF Skived Tapes of Teflon—
Bulletin 97

CDF Pressure-Sensitive Tapes of Teflon
Bulletin 102

CDF Grades Meeting NEMA, ASTM, Federal, and Military Specifications—
Bulletin 10,100

CDF Dilecto® Paper-Base Laminates—
Bulletin 11,110

CDF Dilecto Epoxy Laminates—
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U.S. Defense . . .

(Continued from p 47)

under CPFF contracts average about 6.5 percent. The final pricing of fixed-price incentive-type contracts shows a profit range of from 8 to 15 percent of the costs.

USAF: Air Research and Development Command's contracts resulted in profits from 4 to 10 percent, with an average of 6.1 percent. Records kept by Air Materiel Command on 90 percent of the dollar volume of R&D contracts showed a profit ranging from 4 to 7 percent.

Renegotiation Board

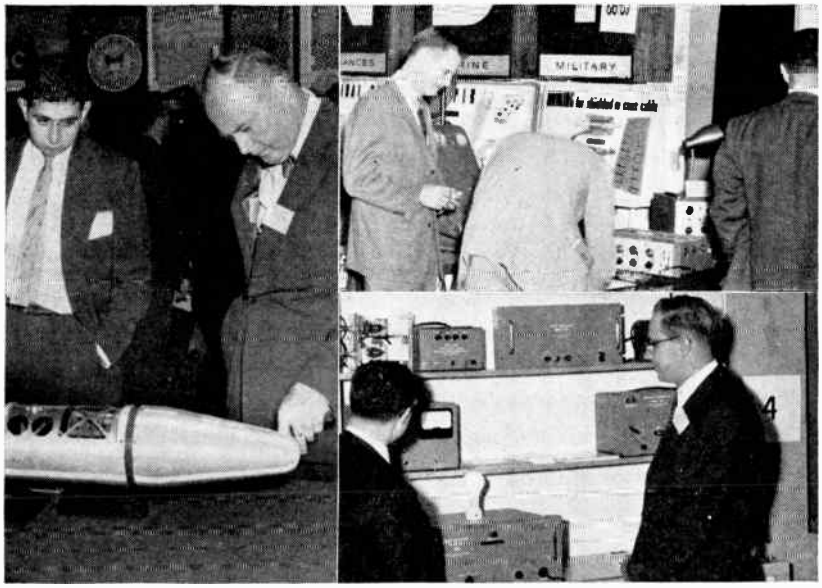
All companies doing over $1 million in business with the government—whether by prime, sub or supplier contracts—must file with the Renegotiation Board. A number of factors are taken into consideration besides just the percentage of profit. These may include risk involved, performance of the end product, delivery date, etc. Though Congress continues to fight for competitive bidding—which by law calls for formal advertising—as opposed to contract by negotiation, the records show poor returns for its efforts.

During the last half of 1958, 24-percent of money contracted by the Navy was by formal advertising. About 25 percent was by negotiation after competition between two or more suppliers. And the remaining 49 or 50 percent was negotiated with one firm which has been selected after design competition among several prospective producers.

USAF, during fiscal year 1958, negotiated 95.3 percent of its U. S. business.

How to Succeed

Many small companies continue to make the grade, however, and come out with big profits and growth. How can a commercial electronics firm best get into government business? Several budget and procurement policy officials answered this question the same way: "Hire inventive design engineers and maybe a few college professors and come up with a new system. A new and good idea puts the smallest company on a par with the biggest."



More than 13,000 engineers and businessmen visited 282 booths at NEC this week

NEC Program Makes Big Hit

Adaptive servomechanisms hold interest at 15th National Electronics Conference

CHICAGO—ONE TOP TECHNICAL subject at the 15th annual National Electronics Conference held here earlier this week was adaptive servomechanisms.

According to NEC program chairman M. E. Van Valkenburg, the heavy turnout for this session was reminiscent of a similar turnout for the same subject at an Air Force meeting at Wright-Patterson AFB. The subject of adaptive servomechanisms has been crystallized in recent years by the use of digital computers in feedback control systems.

Over 13,000 engineers and businessmen registered for NEC. They chose from among 125 papers presented at 28 technical sessions and visited 282 exhibit booths.

Lively interest was apparent at Monday evening's panel discussion on recruiting scientific personnel. The panel was moderated by John D. Ryder of Michigan State University. One NEC executive remarked the subject should have been called "recruiting and pirating of scientific personnel."

Receive Awards

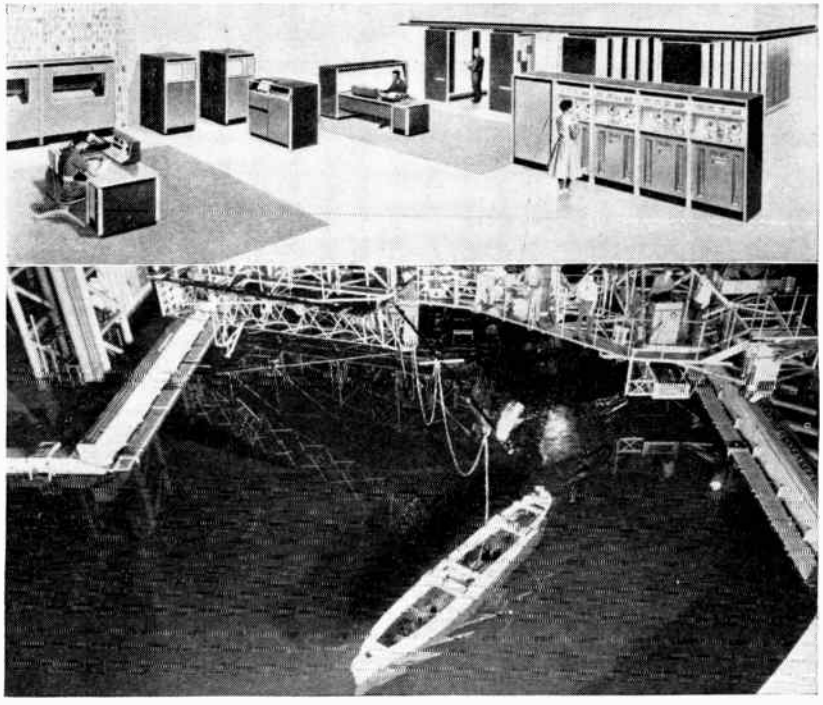
Technical sessions on perception and recognition, information theory, navigation and guidance, and parametric amplification were all well attended. Strong interest was shown in a talk on the exploding problem of information and data-handling, by John G. Green of the Dept. of Commerce.

A. J. Buxton and M. O. Felix, both of Canadian Westinghouse, received the NEC Conference Award for their joint paper, "The Performance of F-M Scatter Systems Using Frequency Compression." The award honored their coinvention of a method to improve scatter communications systems by reducing undesirable noise. The scatter system is used for long-range, beyond-the-horizon transmission of voice, television, teleprinter, facsimile and telemetering signals over hops of 100 to 200 mi. Canadian Westinghouse is currently working on scatter projects for the Royal Canadian Air Force, U. S. Air Force and in addition, Supreme Headquarters, Allied Powers in Europe.

The 1959 NEC Fellowship Award to promising graduate student in electronics was given to William Alonzo Porter, student at the University of Michigan's Rackham School of Graduate Studies. Porter, working toward a doctorate, is specializing in noise problems as related to servomechanisms and inertial guidance systems.

Computers: New Jobs,

Today one system handles the housekeeping, the other concentrates on processing data



Hydrodynamic analysis at Navy's Taylor Model Basin will be one of first jobs given to Larc, new giant computer

ANNOUNCEMENT late last month that Remington Rand Univac's Larc (Livermore Atomic Research Computer) will be offered in the commercial market marks the debut of another second-generation computer.

Besides the installation at Livermore Atomic Laboratory in California, scheduled to undergo acceptance test next month, a Larc will be installed at the Navy's David Taylor Model Basin, Carderock, Md. Beyond that, Univac officials confidently predict a market potential of at least 50.

Larc, which is priced at upwards of $6 million, could open new markets by opening new approaches to data-handling.

Second-generation computers augment data-processing capacity by several orders of magnitude. Principal reason: complete rethinking of computer functions. "We used to build a fairly sophisticated computer and then make it waste 80 percent of its time controlling input-output gear, or doing other housekeeping," says one executive. "Now we're making two systems, one to handle the housekeeping, the other to concentrate on processing."

New logical concepts are not solely responsible, of course. New components, better circuits, more capacious and more easily accessed memory systems, better tape units and new approaches to programming have all had a hand in multiplying the speed and efficiency of the new machines.

Technical Details

The Larc is a solid-state computer, 30 percent magnetic amplifiers, 70 percent transistors, with a score of highly reliable tubes in the clock. Information rate is 2 mc.

Logical design permits optimum routing of data and some new manipulation techniques. Multiplication, for example, is accomplished by a combination of matrix lookup (as in a multiplication table) and repeated addition.

Core storage of 97,500 12-digit words is augmented by high-speed drums storing up to 6 million words, and can be further supplemented by up to 40 tape units.

Individual synchronizers in the

Abilities

separate input-output processor control all reading and writing operations. They can be made to work with any type of available auxiliary unit. Transfer speed is 400,000 digits a second.

Markets

Small, medium and large computers are working today in everyday business tasks of accounting and recordkeeping. Every day, business management somewhere finds a new task, departing from the conventional jobs that now take the bulk of computer attention.

In the not-too-distant future, predicts one business executive, small computers will be talking to each other through the medium of paper tape over telegraph lines.

S. M. Humphrey, partner in the consultant firm of Booz Allen & Hamilton, thinks that computers may ultimately replace "our present system of using cash with a truly universal credit-card system." Humphrey adds that "a long and arduous educational process" will be needed to change the conventional attitudes of people towards such a system.

Bank systems will become more common. Systems based on magnetic-ink character recognition (ELECTRONICS, p 40, May 29 and p 46, Sept. 25) are only one step in reducing bankers' problems. On-line computer installations have been tried in savings banks, and may ultimately take over some demand-deposit (checking account) work.

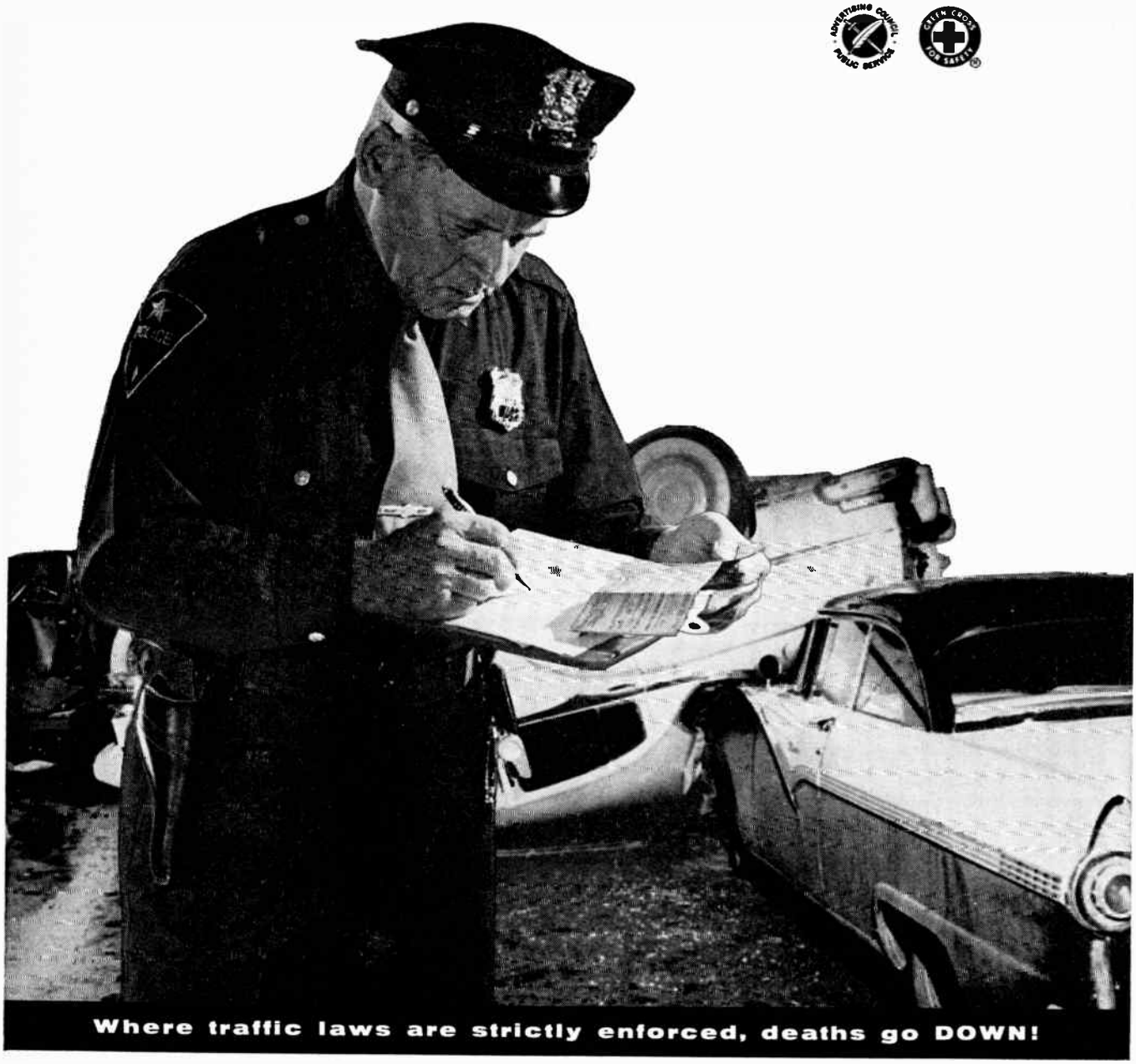
Tomorrow's computer will be more and more adaptable to control of industrial production processes. Continuous-process industries—notably petrochemicals—are already putting their 24-hr-a-day plants under digital-computer supervision. Other industries are experimenting.

Development of control computers like Larc's input-output processor is a big step forward in this area of the technology. Such units are designed to accept sense information and operate effectors—the necessary functions of a process-control computer.

Last year, traffic accidents killed 37,000, injured 1,400,000

. . . and they wasted Five Billion Dollars!

Traffic accidents' human toll is so tragic we sometimes overlook their staggering economic waste. Five Billion Dollars in lost wages, medical expenses, insurance costs and property damage! Your business—every business—shares in this loss. So you have a double interest in helping reduce traffic accidents. And you *can* help! Drive safely and obey the law yourself . . . certainly. But go further. Use your influence to promote safe driving and urge strict law enforcement. To make your efforts more effective, join with others working actively to reduce traffic hazards in your community. *Support your local Safety Council!*



Published in an effort to save lives, in cooperation with the National Safety Council and The Advertising Council.

RCA-7360

RCA's New Beam-Deflection Tube Revolutionizes SSB Design!

RCA-7360 **First tube specifically developed for single-sideband applications...reduces tube and component requirements...its inherent long-term stability assures top performance of balanced circuits**

Now you can design low-cost balanced SSB circuits around a single tube...RCA-7360. This unique tube makes possible one-tube balanced-modulator, balanced-mixer, and product-detector circuits. As a balanced modulator, it will deliver push-pull output from single-ended input...*and can provide stable 60-db carrier suppression*. When used as a self-excited balanced mixer, it can provide *oscillator-signal suppression of at least 40-db*. Other features include large signal-handling capability (up to 8 volts peak-to-peak mixer input), high transconductance, high input impedance, high deflection sensitivity, and extremely effective isolation between inputs. All these features make the 7360 the most significant electron-tube development for SSB design.

RCA-7360 contains two plates and two deflecting electrodes together with a cathode, a control grid, and a screen grid. Its inherent long-term stability is the result of electron flow to both plates from a single beam of electrons. Total beam current is determined by the voltages on grid No. 1 and grid No. 2 as in conventional pentode tubes, while the portion of the total beam current collected by each plate is determined by the *voltage difference* between the deflecting electrodes. Thus the output is a product of two input voltages.

The unique features of RCA-7360 enable you to design simpler, less-costly balanced SSB circuits with excellent long-term stability. Get full details now from the RCA Field Office nearest you.

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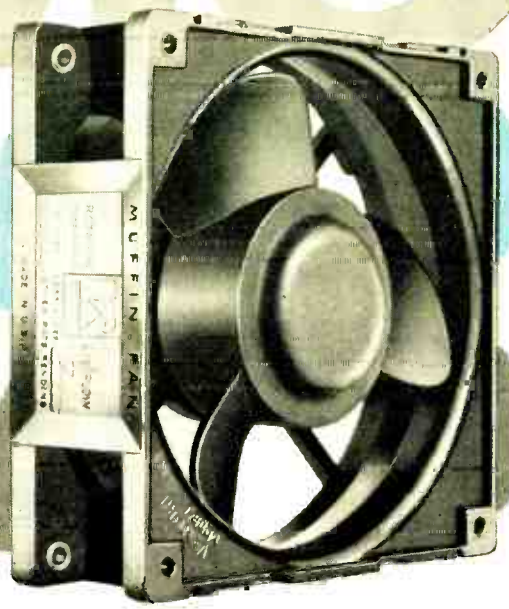
RADIO CORPORATION OF AMERICA
Electron Tube Division **Harrison, N.J.**

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

MOST MOST MOST



most economical,
most compact, most efficient
cooling fan of its size!

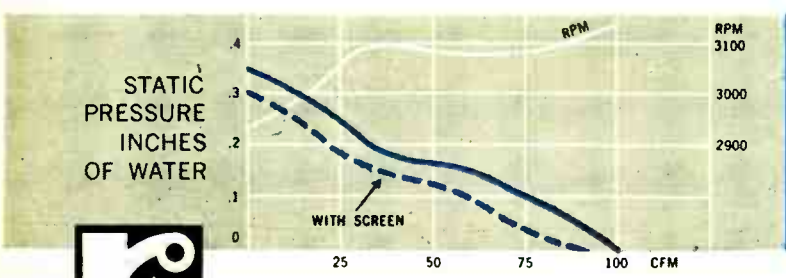
ROTRON **MUFFIN®** FAN

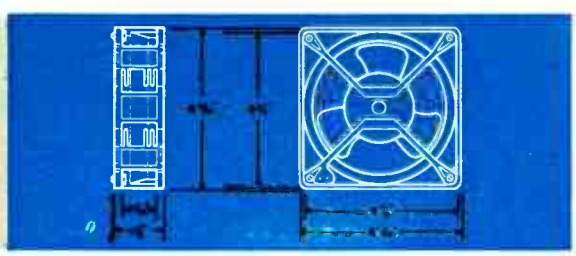
Unlike conventional or phonograph motor assemblies, the MUFFIN FAN boasts a high air performance of 100 CFM free delivery from a basic package only 4-11/16" square and 1½" deep and weighing just 1.2 pounds.

Power requirement is 105 to 120 VAC, 60 cycles, single phase. Electrical connections made to convenient terminal lugs accepting standard 18 gauge lamp cord. Completely original aero-dynamic design permits operation through a dust filter and tightly packed electronic equipment. Airflow instantly reversible by turning fan end-for-end.

The MUFFIN FAN is a completely integrated cooling unit consisting of propellor, stator assembly and venturi block. It is also available in combination with a grille assembly and all-purpose mounting clips to form a **complete** package. Unbelievably thin, the MUFFIN FAN can be installed in seconds in cabinet cutout, imposing practically no space requirement within the enclosure.

Cool economically... the MUFFIN FAN can be supplied at a price less than $8.00 per unit in quantity. The low cost, high performance, compact size and maintenance-free design provide efficient air cooling previously unobtainable. Write for complete details...





ROTRON® **ROTRON** mfg. co., inc.

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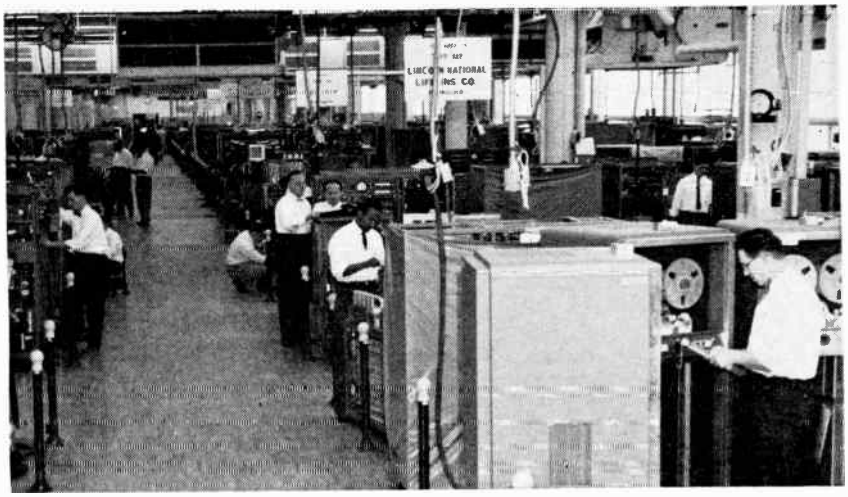

In this IBM assembly plant, a visitor doesn't notice some employees are disabled, but . . .

"They Also Serve . . ."

Handicapped workers prove their value by performing a wide variety of specialized tasks

THIS WEEK a skilled technican will return from vacation to his job of assembling clutch mechanisms for computers. A glance shows no difference between him and other assemblers, but a difference exists . . . he cannot hear or speak.

The electronics industry and the disabled worker are becoming increasingly aware of each other's value. This is seen in the rehabilitation program of the Institute for the Crippled and Disabled.

The Institute's vocational rehabilitation program, which evaluates the vocational potential of disabled persons in 13 major occupational categories, includes several areas of testing applicable to the electronics industry. Special training in such areas as cable harness assembly, precision soldering and skilled metal crafting are included in the program, plus clerical work for the electronics industry.

Institute surveys indicate that about 27 percent of the jobs offered by the electronics industry are in non-production areas such as clerical and administrative. This, coupled with industry emphasis on precision work and the manipulating of small components creates, in the Institute's opinion, an excellent area of opportunity for the disabled worker.

At International Business Machines Corporation, for example, a wide variety of tasks are being performed by workers with physical disabilities. Of the company's manufacturing and engineering force of 37,200 employees, approximately 6.9 percent are classified as handicapped.

A trip through the IBM plant in Endicott, N. Y., shows about 114 different jobs being performed by people with some form of physical disability. At IBM's Poughkeepsie plant (see photo), 85 tasks are handled by handicapped personnel.

A company spokesman points out that no special distinction is made between the handicapped and the normal applicant for employment. This has been policy since 1914.

Ability Counts

"Both are evaluated strictly on personal qualifications and their ability to do the job," says the spokesman. Company experience indicates that in most instances the handicapped worker performs as well as his unhandicapped associate.

At IBM plants less attention is given to the construction of specialized equipment for use by handicapped workers than to job or procedural changes in work patterns.

The company feels routine methods can usually be altered without too much difficulty to accomodate persons who cannot move about freely or work in a normal manner. Also, the size and shape of objects to be manipulated can easily be limited to those most easily handled by a handicapped person.

line of Cable

Antenna Rotor Cables

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

Mil-Spec Hook-Up and Lead Wire

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

High-Voltage Cathode Ray Tube Lead

High dielectric strength. Small diameter with maximum flexibility.

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

Portable Cordage and Rubber Multiple Conductor Cables

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

RG/U Transmission Line Cables

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

These and many more

AVAILABLE from Stock

Community and Multiple Set TV Antenna Cables

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

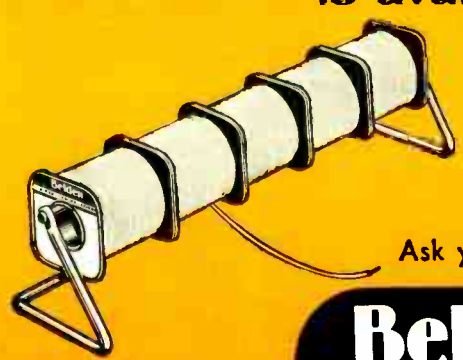
Test Prod Wire

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

Unshielded All-purpose Sound and Intercom Cables

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

Belden Electronic Wire and Cable is available in many different packages



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

Ask your Belden jobber

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

One wire source for everything electronic and electrical.

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

6-2-9

MEETINGS AHEAD

Oct. 19-21: National Academy of Sciences, Research Council, URSI, IRE, Fall Meeting, El Cortez Hotel, San Diego, Calif.

Oct. 19-22: Semiconductor Symposium, Fall Meeting, Electrochemical Society, Deshler-Hilton Hotel, Columbus, O.

Oct. 26-28: Aeronautical & Navigation Electronics, East Coast Conf., PGANE of IRE, Lord Baltimore Hotel, Baltimore.

Oct. 29-30: Electron Devices Meeting, PGED of IRE, Shoreham Hotel, Washington, D. C.

Nov. 3-5: Mid-American Electronics Conf., MAECON, Municipal Auditorium and Hotel Muehlenbach, Kansas City, Mo.

Nov. 4-6: Automatic Control, National Conf., PGAC & PGIE of IRE, Sheraton-Dallas Hotel, Dallas.

Nov. 5-6: Instrumentation Conf., School of Engineering, Louisiana Polytechnic Institute, Ruston, La.

Nov. 9-11: Radio Fall Meeting, IRE, EIA, Hotel Syracuse, Syracuse, N. Y.

Nov. 9-11: Instrumentation Conf., PGI of IRE, Biltmore Hotel, Atlanta.

Nov. 10-12: Electrical Techniques in Medicine & Biology, AIEE, ISA, PGME of IRE, Sheraton Hotel, Philadelphia.

Nov. 16-20: American Rocket Society, Annual, Washington, D. C.

Nov. 16-20: Magnetism & Magnetic Materials, AIEE, AIM, APS, IRE, ONR, Detroit.

Nov. 17-19: Northeast Electronics Research and Engineering Meeting, Annual, NEREM, Commonwealth Armory, Boston.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

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

PULSE

GENERATION

Five plug-in pulse generators provide any code—1 to 5 pulses—with completely independent adjustment of width and delay for each pulse.

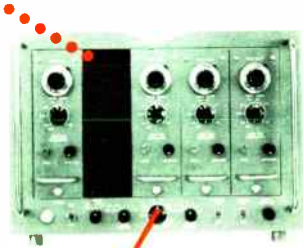
PULSE DELAY: variable 0 to 300 microseconds

PULSE WIDTH: variable 0.2 to 2 microseconds

PULSE TIME MODULATION: Sensitivity, 2 volts RMS per microsecond

CODED MULTIPULSE GENERATOR

Model MP-1A



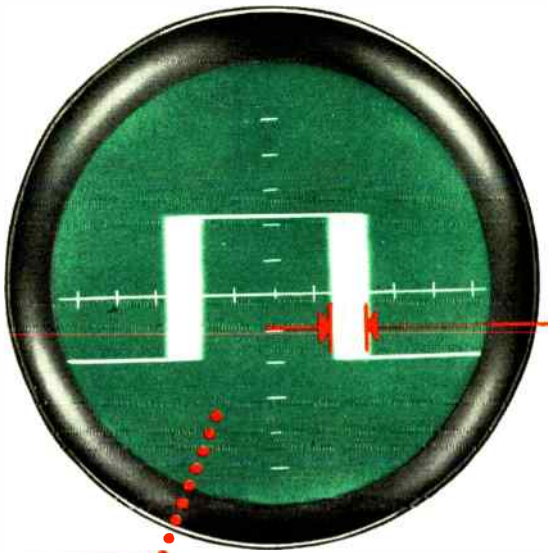
RISE AND DECAY TIME: 0.1 microsecond

GROUP REPETITION RATE: 10 to 10,000 pps

Used to modulate r-f signal generators with coded pulse groups. Internal or external sync; square wave output, 10 to 10,000 pps. Pulses can be independently pulse-time modulated by external signal.

APPLICATIONS: Design and testing of missiles, radar, beacons, IFF, telemetry, etc.

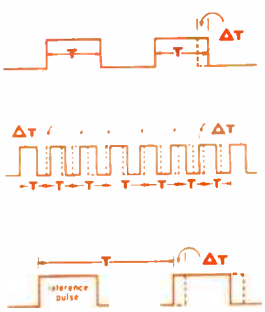
TESTING



PULSE JITTER TESTER

Model PJ-1

Displays the magnitude and waveform of pulse jitter (time deviation) in rate generators, pulse width modulators, encoding devices and precision time generators.



MEASURES:

PULSE WIDTH JITTER: Peak-to-peak time deviation (△T) at the half-amplitude points, between the leading and trailing edges of a recurrent pulse having a nominal width represented as "T" in the diagram at left.

ABSOLUTE JITTER: Time deviation (△T) at the half-amplitude points, from leading edge to leading edge of successive pulses (of duration "T" in the diagram) in a pulse train.

RELATIVE JITTER: Peak-to-peak time deviation (△T) at half-amplitude points of the leading edge of one pulse to the leading edge of a reference pulse. The time difference between the two is "T" in the diagram.

Repetition Rate Jitter: 5 millimicroseconds to 100 microseconds full [illegible] **Relative or Width Jitter:** 5, 10, 100 millimicroseconds.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

MAIL THIS CARD for complete specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

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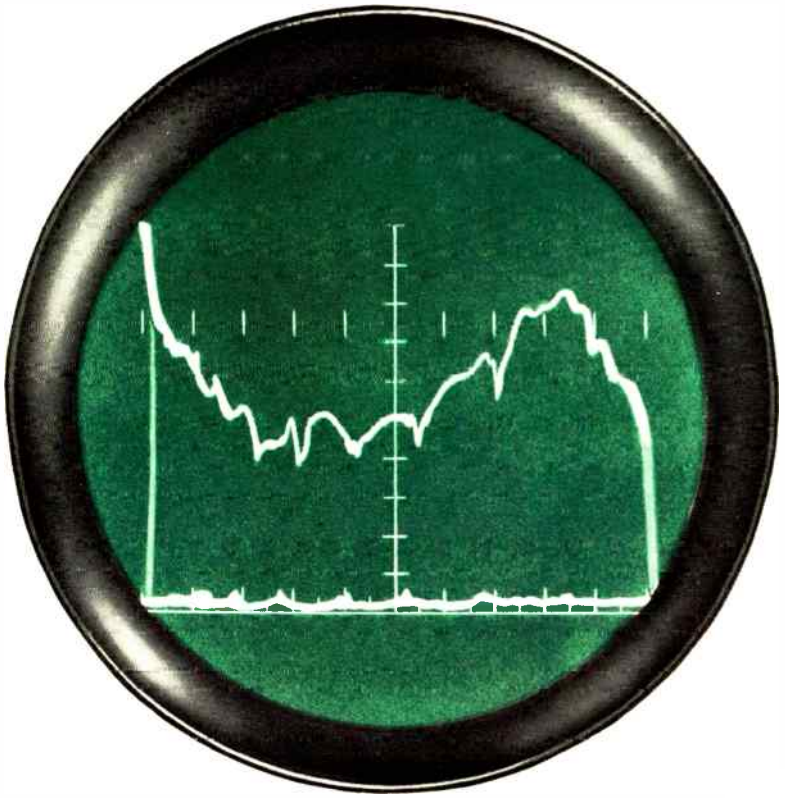
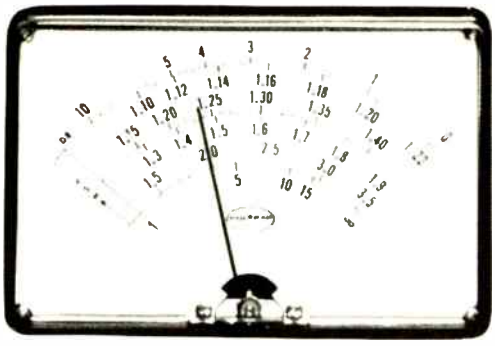
INSTANTANEOUS MICROWAVE ANALYSIS

SINGLE FREQUENCY OR OVER A FULL OCTAVE



Complete VSWR pattern of a microwave component over an entire frequency octave is displayed on a calibrated 7" CRT.

Instantaneous measurements at a single frequency or over an entire swept frequency range can be obtained with an Electronic Sweep Generator and a Rapid-Scan Ratio Scope



VSWR at any single frequency is indicated on the Ratio-Scope front panel meter.

Saves Engineering Manhours

1,000 to 15,000 mc

ELECTRONIC SWEEP GENERATOR

Model ESG 1,000-15,000 mc

Sweep width continuously adjustable, single frequency to an entire octave.

RAPID SCAN RATIO-SCOPE

Model VS-2

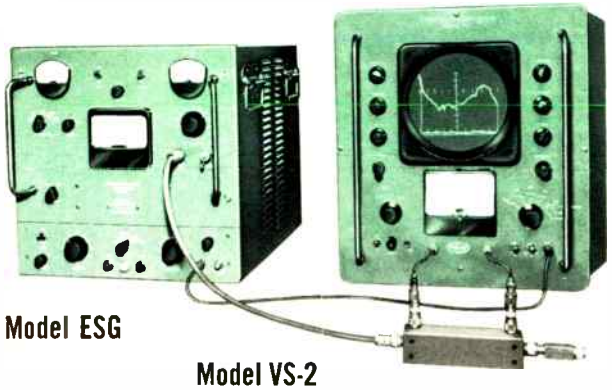
Displays the ratio of two input signals; gives visual plot of VSWR as a function of frequency.

Measure and Analyze:

VSWR, transmission and reflection coefficients, gain and attenuation, image rejection, sensitivity, selectivity, bandwidth and filter characteristics, antenna patterns, etc.

Microwave Components:

Radars, receivers, beacons, waveguides, antennas, pads, terminations, couplings and hybrid junctions, attenuators, crystal mounts, preselectors, amplifiers.



Model ESG

Model VS-2

Typical set-up for measuring VSWR of a microwave component. Directional coupler outputs feed incident and reflected signals separately into the Ratio-Scope. Scope displays the pattern of the ratio between the two inputs over the entire frequency range swept.

MAIL THIS CARD

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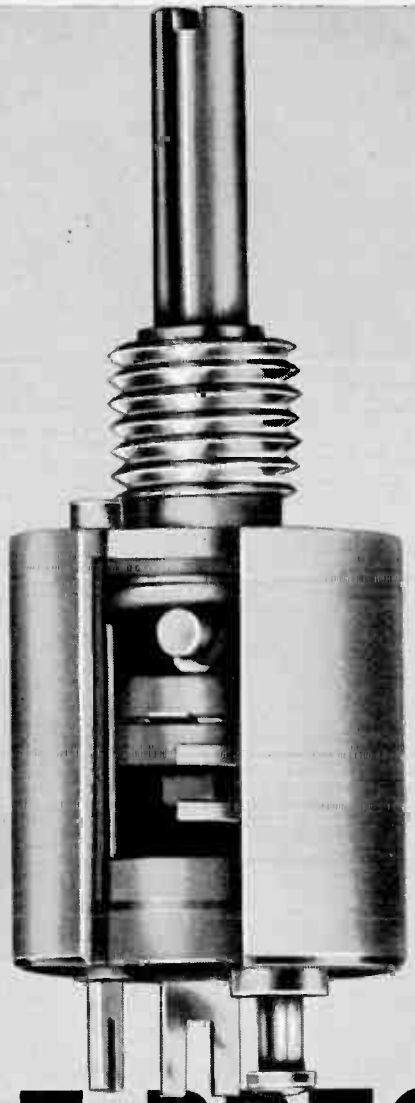
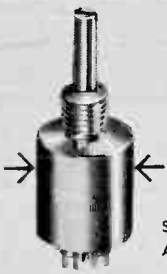


Series C-050 Potentiometers meet all requirements of MIL-R-12934B with the addition of 1000 hours load life (certified test data available).



SERIES C-050
ACTUAL SIZE

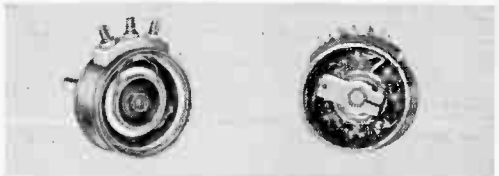
BIG-POT PRECISION
IN MICRO-MINIATURE SIZE

Here is the tiniest member of DeJUR's extensive line of precision potentiometers. The new Series C-050... combines micro-miniaturization with high precision and accuracy.

Just check these features:—Exclusive one-piece metal case and bearing design eliminates need for special field installation precautions. • Exclusive watertight molded covers with integrally cored, solid terminals which cannot loosen or transmit solder or resin. • Multiple finger brush. • Molded nylon side insulation. • Direct connection from winding ends to terminals. • Rotation: electrical, 320°; mechanical, 325° or continuous 360°. • Threaded bushing, servo or ball-bearing mounting. • O-ring sealed shaft and epoxy sealed cover (optional).

And while you're checking, look into some of the other single-turn precision potentiometers which include many different sizes and types. Chances are you'll find exactly the unit you need to solve that sticky design problem. If we don't show it in our catalog, we'll make it for you. Write today for DeJUR's new complete technical catalog on your company letterhead.

manufacturers of precision potentiometers for over 30 years



SERIES C-078. 7/8" miniature, height only 3/8", weight 1/2 oz. Multiple finger brush. Single or multiple gangs... completely enclosed. Cored terminals (can't loosen). Board integrally molded in housing.

SERIES C-200. 2"... independently phasable... multiple sections suitable for ganging... up to 40 adjustable taps in 320°. Ball-bearing or sleeve bearing.

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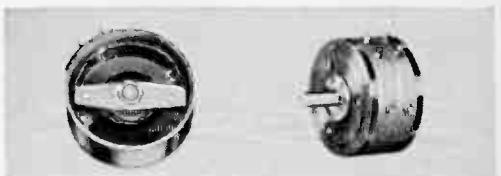


SERIES C-300 SINE. COSINE. 3". Independent brush contacts produce accurate sine-cosine outputs. Also available in multiple ganged units and 1 7/8" and 2" diameters.

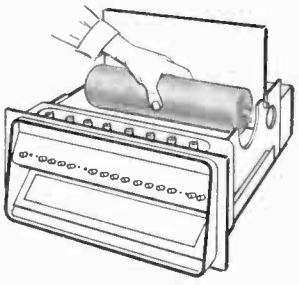
SERIES HP. 2", 3", 5" diameters. High resolution... long function angles... ganging multiples... welded taps. Completely enclosed. Piloted servo or tapped 3-hole mounting.

These features of

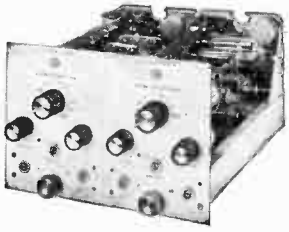
new Brush ultralinear recording systems...

. . . give you more application versatility!

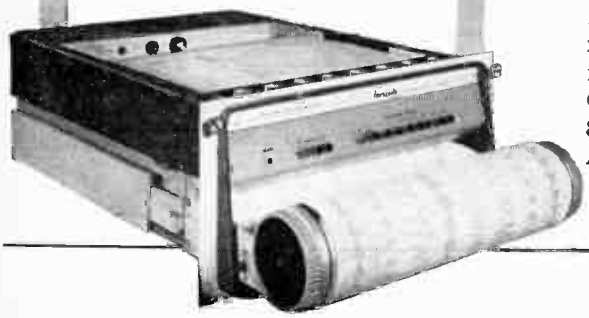
Simplified Chart Re-loading.



Interchangeable, plug-in signal conditioners.



Positive Chart Take-up Drive.



In the fields of telemetry, ground support systems, analog computing and laboratory testing, Brush recording systems have incorporated features which have consistently kept ahead of engineering requirements. Here are a few that show why—

INTERCHANGEABLE PLUG-IN SIGNAL CONDITIONERS. You get your *choice of sensitivities*—you get high input impedance—zero suppression.

SIMPLIFIED FAST CHART RE-LOADING. Loaded from the top—features automatic alignment and tracking.

ACCURATE, EASILY REPRODUCIBLE RECORDINGS. Your choice of rectilinear or curvilinear charts—rugged "throw-proof" pens.

Illustrated above is a Brush RD-1684 rectilinear, 8 channel recording system. Sensitivity of 10 millivolts per chart line—input impedance, 10 megs balanced or 5 megs grounded. Complete system includes mobile cabinet, oscillograph and 8 signal conditioners. No additional preamplifiers required. Available from stock.

brush INSTRUMENTS

DIVISION OF

37th & PERKINS — CLEVITE CORPORATION — CLEVELAND 14, OHIO

Laboratory testing of sensing devices. Blood pressure sensor is affixed to right index finger of test subject

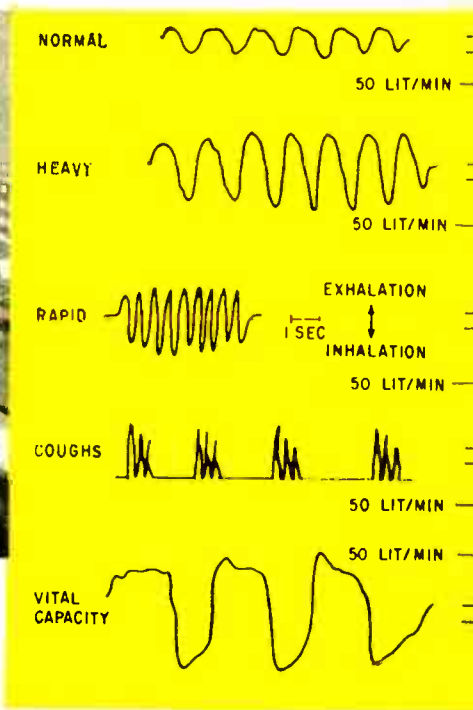


FIG. 1—Various human respiration curves

Environmental Testing Of Future Spacemen

New technique permits continuous, complete physical examination when subject and physician are separated by many miles. This article summarizes the electronic measurements of physiological factors and introduces engineers to a new area in medical electronics

By M. TRAITE, W. WELKOWITZ, J. KILDUFF, and C. PURPURO,
Medical Instruments Dept., Gulton Industries, Metuchen, N. J.

MOST satellite payloads today are instrumented with devices for measuring a number of physical parameters such as temperature, radiation, magnetic fields and ionization. Many of these devices were developed especially for satellite use.

A human being will be a payload in the near future and there is a variety of physiological and psychological data needed about him. This article will discuss some of the approaches to instrumenting a human being under conditions of space flight.

There are two general parts to a physiological instrumentation system. These are the transducers on the man and the transducer-associated circuits. The transducers must be external to the man, even though internal instruments would often provide more accurate and reliable measurements; to permit free movement of the man within the confines of his capsule; and be comfortable, to the point where he should be able to neglect their presence.

The transducer-associated circuits are required to

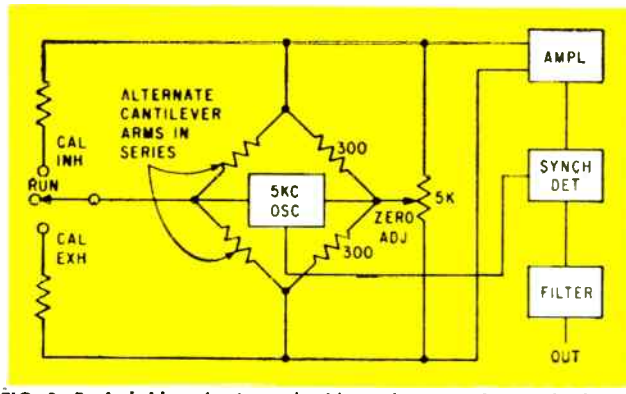


FIG. 2—Basic bridge circuit used with strain gages for respiration measurements

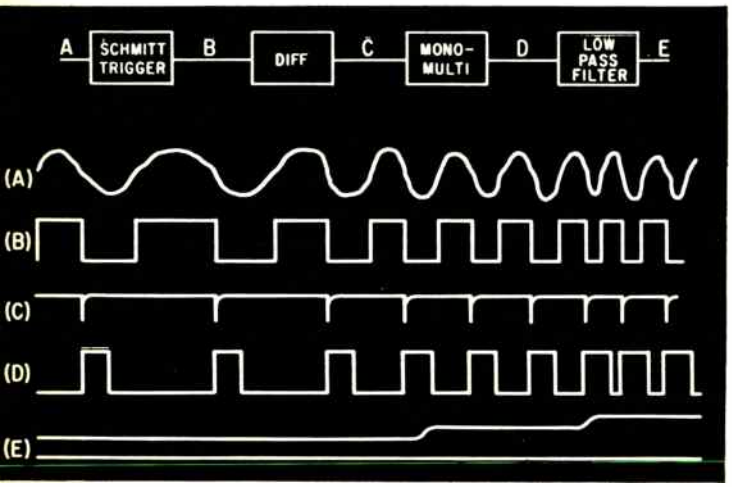


FIG. 3—Inhalation and exhalation waves (A) are shaped to produce final waveform for telemetering (E)

convert the transducer outputs to an analog voltage form for presentation to a telemetry system. The circuits must be reliable, small, lightweight and low on power consumption.

The circuit requirements generally dictate the use of transistors. Some of the physiological variables wanted are: respiration, electrocardiogram, temperature, blood pressure, heart sounds, skin temperature and electroencephalogram.

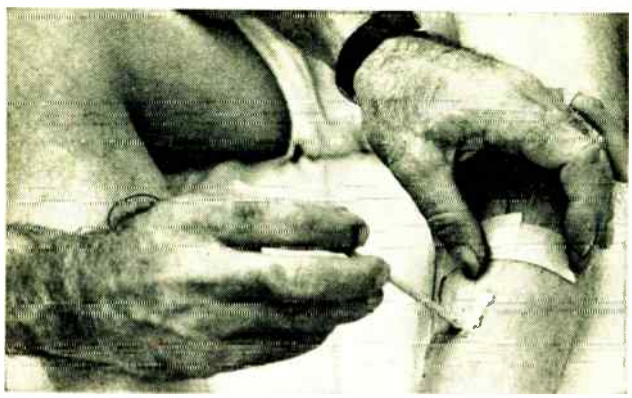
RESPIRATION—If the man is breathing he is still alive. But respiration measurements tell more than this. Some typical respiration flow waveforms are shown in Fig. 1. Marked differences from normal breathing can often tell fairly well what's going on. The pattern labeled *heavy* is similar to deep breathing at a normal rate, such as would be typical during or after heavy exertion. The pattern labeled *rapid* might be expected if he is having trouble getting enough oxygen and is compensating by taking in air more quickly. The pattern labeled *coughs* is self-explanatory.

One transducer that can be used for respiratory flow is a strain gage mounted in a face mask[1]. Strain gage wires are attached to opposite sides of alternate cantilever arms, and used in the basic bridge circuit shown in Fig. 2. The output is amplified and converted to a d-c analog of respiration flow by a synchronous detector and low pass filter.

Respiration rate, or the number of breaths per minute, can be determined by counting the rate at which the major waveforms of Fig. 1 come along. This is done continuously and automatically by the simple tachometer circuit shown in block diagram form in Fig. 3. The Schmitt trigger yields square waves (*B*) in a one-to-one correspondence with the inhalation and exhalation flow waves (*A*). These are then differentiated and one polarity clipped, to yield triggering pulses (*C*) for the monostable multivibrator. The monostable multivibrator resets itself at a fixed time after being triggered, yielding square waves (*D*) whose time duration and amplitude are constant. The only variable is then the time between square waves. The low pass filter removes the rises and falls of the square waves and yields a d-c output proportional to the breathing rate.

ELECTROCARDIOGRAM (ECG)—The electrocardiogram is a standard clinical diagnostic tool[2]. It measures the potentials appearing at various points of the body due to the electrical activity of the heart. A normal pattern for a standard electrode placement is shown in Fig. 4. A pattern indicating heart failure (ventricular fibrillation) is shown below.

The standard electrode types and placement for



Suspension of silver in collodion forms a light, sturdy, high conductance electrode that can be worn for days without irritation

One of the seven temperature sensors is applied under the armpit while others are placed about the body

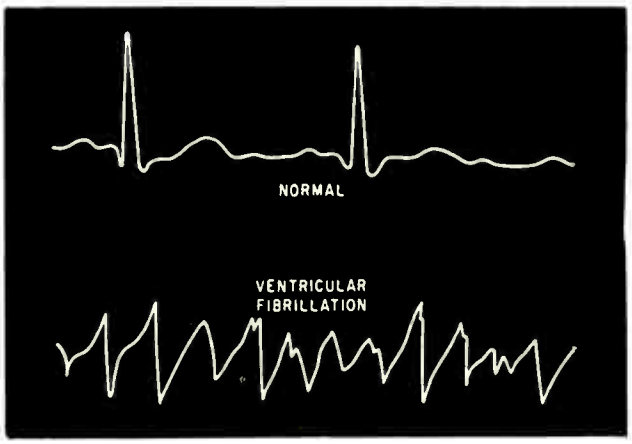


FIG. 4—Normal electrocardiogram compared with ventricular fibrillation (heart failure)

ecg present problems for use in space. Most standard electrodes are bulky, require the use of an electrode paste, cause severe irritation of the skin, and cannot be worn for more than about a half hour because the paste dries out. In addition, the standard positions for electrodes, on the arms and legs, are not suitable for gathering data from a man whose limbs must move. Spurious potentials due to action of the muscles causes interference sufficient to swamp the ecg.

The electrode position problem is alleviated by placing electrodes on the chest and back instead of on the arms and legs. This yields a less widely used type of ecg, but one less subject to interference from muscle noise.

An electrode type that has been found suitable for extended wearing uses a conductive paint, made of a suspension of silver in collodion. This is applied to the cleaned skin. A fine metallic mesh disk with a lead attached is laid over the painted area, and a second layer of paint is applied over and through the mesh. The preparation dries to form a light, sturdy, high conductance electrode that can be worn for days without irritating the skin or coming off.

Ecg potentials are in the order of millivolts, and the ecg waveform has major components in the frequency range from about 1 to 60 cps. A suitable amplifier for ecg should then be either a d-c or an a-c amplifier with the above band pass.

Heart rate can be determined by counting the rate at which the ecg spikes come along. This may be done by tachometer circuits similar to those described for breathing rate. For this case, the Schmitt trigger is set to operate in the upper half of the largest ecg spike.

TEMPERATURE—Temperature measurements can serve to indicate an abnormal feverish condition, or a subnormal cool condition for the entire body. In addition, the use of several temperature measurements at the fingers and/or toes can show poor circulation of the blood, such as is common in conditions of shock. This is indicated by abnormally cold temperatures at the extremities.

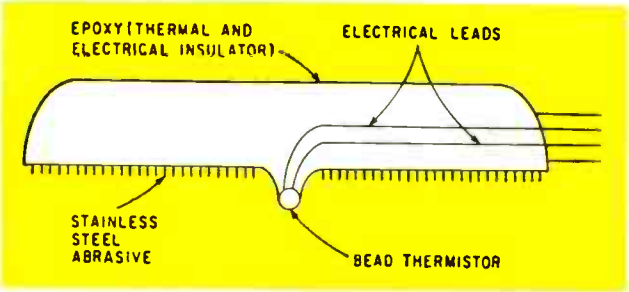


FIG. 5—Temperature sensors are mounted over the body to indicate poor blood circulation which may occur in conditions of shock

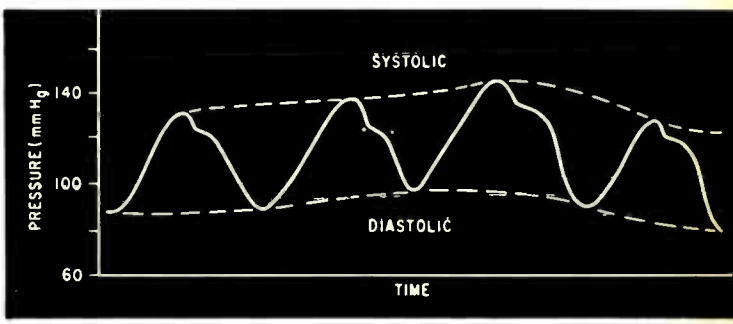


FIG. 6—Typical blood pressure curves showing normal variations

Thermistors are excellent for skin or body temperature measurements under space flight conditions. Their small size, low power consumption and high sensitivity offset the disadvantage of their logarithmic resistance variation with temperature.

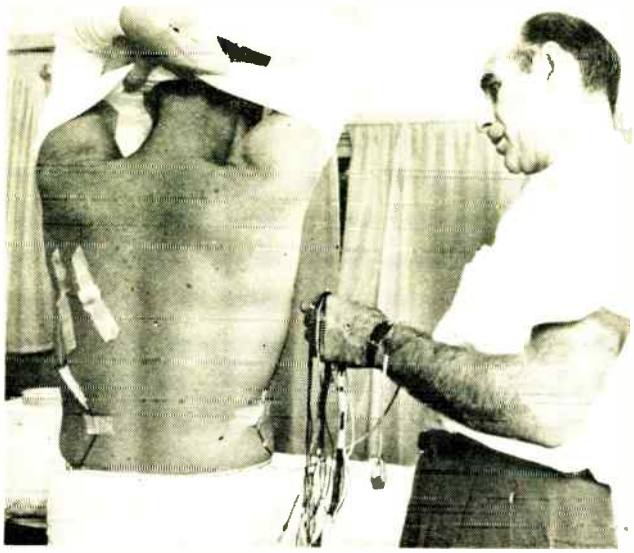
A sensor for skin temperature measurements is shown in Fig. 5. The sensing element is a bead thermistor suspended below a mounting plate. The plate provides a roughened surface to prevent movement when the probe is mounted on the skin. The upper section consists of a plastic coating that serves as a thermal insulator. This insures that the thermistor senses skin temperature and not ambient temperature.

The thermistor is used in a bridge circuit of the same type as that used for respiratory flow.

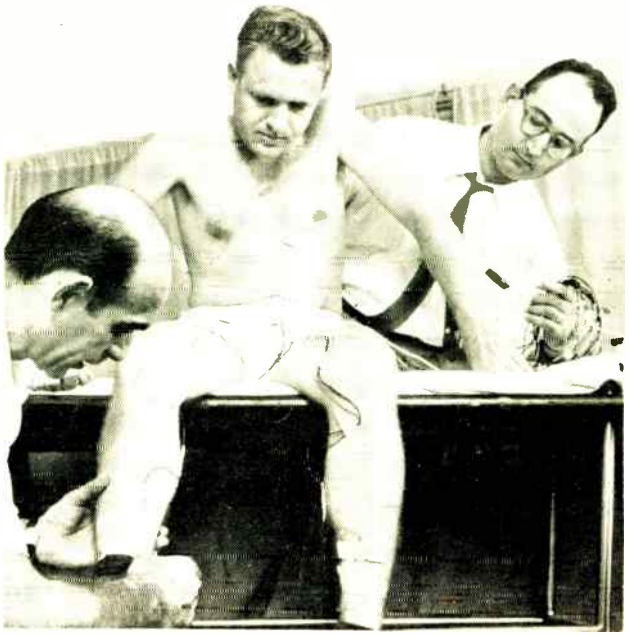
In the case of the respiratory strain gage, the sensitivity is low, and the maximum excursion of the bridge output from its null position is small and linear. For the thermistor, however, the sensitivity is high, and the excursion of the bridge output is large. It is large enough, in fact, so that it becomes markedly nonlinear when plotting output voltage against thermistor resistance.

With a proper choice of the fixed arms of the bridge, the nonlinearity of the bridge characteristic can be made to compensate closely the logarithmic thermistor characteristic over a temperature range from about 60 F to 115 F, the general range of skin and body temperatures. This results in a linear (to about 2 percent) output of voltage/temperature. A linear analog voltage output from the transducer electronics is not strictly necessary, but considerably simplifies the later display and processing of the data.

BLOOD PRESSURE—The blood pressure wave-



Electrocardiogram sensors applied to chest and back are less subject to muscle noise



Heart sounds microphone is applied to the chest and galvanic skin resistance electrodes are applied to both ankles

form is typically as shown in Fig. 6. Unfortunately, there is no simple way to obtain the entire waveform and to determine its position above the zero or reference level, without introducing some probe, such as a hypodermic needle, into a vein or artery.

There is an external measurement technique, however, that serves to determine the peaks of the waves; that is, that can give a reading of the maximum (systolic) pressure as often as once each heartbeat.

In essence the system consists of a feedback loop in which the forward path is electronic, and the feedback path is pneumatic (Fig. 7). An occluding cuff which may be pressurized is worn around the finger, and is connected to the pneumatic system. Beyond the cuff, at the tip of the finger, is a pickup that detects pulsations due to volume changes of the blood at the tip of the finger. These pulsations occur regularly, once each heartbeat.

While the pressure in the cuff is below the systolic pressure, the pulsations are picked up and amplified by the electronic circuitry. This signal causes the pneumatic system to increase the cuff pressure. As the cuff pressure reaches or passes the internal systolic pressure, the blood vessels in the finger constrict completely. This cuts off the pulsations. The pneumatic system slowly leaks off the pressure in the cuff until it falls just below systolic, at which point pulsations reappear and the cycle repeats. The net result is that the cuff pressure is maintained essentially at systolic pressure. A pressure transducer connected to the cuff line provides a readout of this systolic level.

HEART SOUNDS—External heart sounds are useful as a diagnostic tool in determining the operating condition of the heart valves. Under abnormal acceleration or reduced gravity conditions, the normal functions of the heart will be subject to change, and temporary valve malfunctions are possible. These may be detected by an electronic analog to the stethescope which is a small microphone mounted in an elastic chest band and positioned over the heart.

The microphone is shown in Fig. 8. It consists essentially of a diaphragm and ceramic element. The stainless steel diaphragm vibrates with the incident sound transmitted through the chest wall. A thin piezoelectric ceramic is bonded to the diaphragm. The ceramic operates in a radial-flexure mode, and generates a voltage across its faces proportional to the incident sound. This voltage feeds a high-input impedance amplifier, whose output may then drive a telemetry system.

Since most of the important heart sound components lie in the range from about 20 cps to about 2 kc, the flat response and small size of the microphone in this region makes it an excellent instrument for this application.

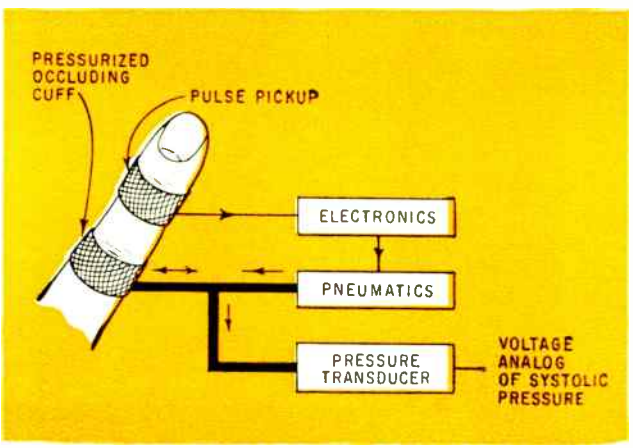


FIG. 7—Method for making electrical analog of systolic blood pressure

SKIN RESISTANCE (GSR)—The galvanic skin response is a measure of the d-c resistance of the skin between two electrodes on the body. This resistance decreases markedly with emotional changes, and with reactions to unexpected external stimuli.

The gsr can hence provide an indication of the general emotional state of the pilot and of his response to an emergency situation.

The electrodes are of the same type as described for ecg. They may be applied just above the ankles, to provide the least encumbrance for the pilot. The circuit is shown in Fig. 9. The B+ supply and the current-limiting resistor are chosen to supply essentially constant current of about 100 μa to the skin. The output voltage is then directly proportional to skin resistance. Normal basal level skin resistance depends on the electrode size and position and will usually be in the order of 5,000 to 20,000 ohms. Changes due to emotional reactions are in the order of 5 to 10 percent of the basal level.

Physiologically the resistance change seems to depend on the relatively slow action of the sweat glands in the skin. Response time is usually several seconds, with periods up to a few minutes for return to the basal level.

One of the distinct features of the gsr measurement is its simplicity, and that the output changes may be in the order of fractions of a volt, and hence will require little or no amplification before presentation to the telemetry.

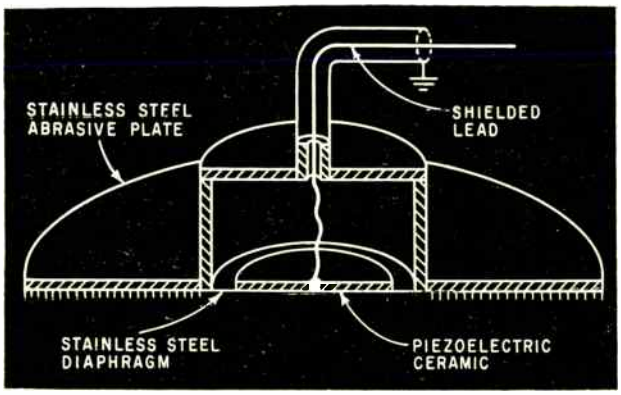


FIG. 8—Configuration of microphone used for detection of heart sounds

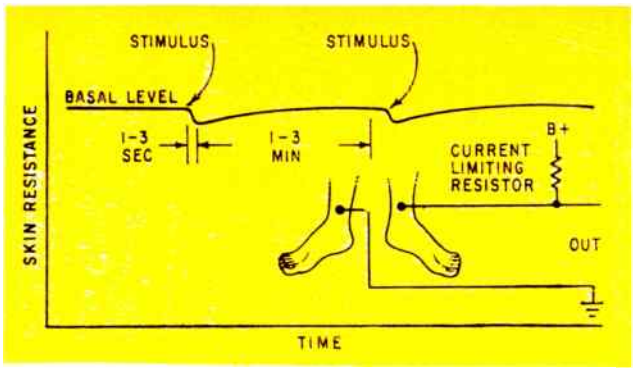


FIG. 9—Galvanic skin response circuit is similar to that used in lie detectors

ELECTROENCEPHALOGRAM (EEG)—The eeg, or brain wave pattern provides a general indication of the state of alertness of the pilot. In addition, there is evidence to indicate that the eeg is a sensitive indicator of anoxia. This seems reasonable, since the brain is the organ most sensitive to a deficiency of oxygen.

Because of the low signal amplitudes and low frequencies, eeg measurements require the use of very low noise differential d-c amplifiers, careful shielding and excellent electrode contacts to the scalp and forehead.

Ideally, an eeg preamplifier might be built into a skull cap to minimize the pickup problems. This is difficult, however, with present day amplifiers. The best commercially available low-level d-c amplifiers with the requisite bandwidth (d-c to 50 cps) and high input impedance (100,000 ohms or more) use mechanical choppers, which are relatively bulky and power consuming.

Transistorized choppers consume little power and are small enough, but have much too high a noise level, tenths of millivolts as compared to microvolts or less for mechanical choppers. A solution to the problem of eeg measurements hence seems to be waiting on the state of the art, and requires a low noise solid-state chopper, a tiny, rugged, low power mechanical chopper, or a completely novel approach.

CIRCUIT PACKAGING—There are many possible approaches to circuit packaging for physiological electronic circuitry.

One approach that has been found useful for a multichannel system, with essentially different functions on each channel, is to break the circuitry down into functional blocks, and mount each functional block on a replaceable plug-in module card. These cards slide into slots and plug into connectors in a card tray.

Since some of the transducers operate at low signal levels, pickup and cross-channel coupling into the initial low-level stages must be avoided. Shielding of critical circuit cards is achieved by using dummy metal circuit cards in the slots to either side of the low-level cards.

Inputs, outputs and interconnections between cards are made at the backs of the connectors. If a circuit malfunctions, all that is required is to pull the card and plug in another of the same type.

Balance controls, trimmer potentiometers and other circuit elements requiring adjustment are accessible from the same direction as the direction of insertion or removal of the card. All adjustments are screwdriver type, during normal operation of the circuit.

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(3) W. Halpern, An Electrical Method for Objective Determination of the Blood Pressure, Paper 56-36-2, 11th Annual Instrument Automation Conf, New York City, September 1956.
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Logic Networks Aid

Simple electronic circuits make up logical networks used by psychologists to determine how a subject solves problems. This computer-type device tests human ability to carry out logical analysis and synthesis

By **CAXTON C. FOSTER,** Research Associate, Mental Health Research Institute, University of Michigan, Ann Arbor, Mich.

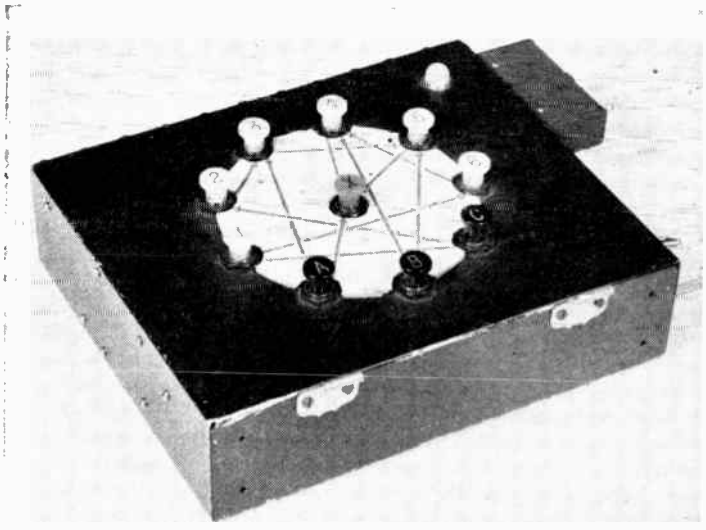

FIG. 1—Top-panel view of the transistorized problem-solving device shows the arrangement of pushbuttons with a problem disk in place

ONE ASPECT of intelligence is the ability to carry out logical analysis and synthesis. The device described here is intended to measure this ability in direct fashion by presenting a subject with a logical network that he must understand to solve a problem. The present device is an outgrowth of the problem-solving apparatus described by Miller and John.[1]

Blinking Lights

As can be seen from Fig. 1, there are six numbered lighted pushbuttons and three lighted pushbuttons, *A*, *B* and *C*, placed in a circle around a center light button, *X*. In the upper right hand corner of the panel is a small time light that alternates on and off, every four seconds. These on-off periods of the time light in the corner are called NIGHT and DAY.

Each problem is presented as a cause and effect relationship that can be understood by analyzing the sequence and timing of the blinking lights, and their dependence upon the on-off condition of the timing light.

Each pushbutton is connected through the problem plug to either a DAY bus or a NIGHT bus, only one of which is active at a time. Thus some lights may be turned on manually during the DAY only, and the remainder during the NIGHT only.

The subject's task is to discover the on-off relationships of these lights, so that he can control the lighting of the center light by pressing only the pushbuttons *A*, *B* and *C* in a correct sequence.

The subject is aided in his task by a white information disk that is placed over the lights. Each disk represents a problem to be solved. The information disk shows arrow connections representing a logical relation between any two lights. These relations may be full cause (direct connection), partial cause (AND), sufficient cause (OR); or inhibitor (NOT). The subject can understand the problem only when he understands what each arrow connection means with respect to the on-off condition of the lights. This logic cues the subject as to the correct order and time to press buttons *A*, *B* and *C*. While exploring these relationships, the subject can, of course, use any of the buttons he desires.

The circuits for these relations, shown in the logic networks of Fig. 2, are contained in the plug assembly visible in the right hand side of the device. Thus the networks are quickly interchangeable for stand-

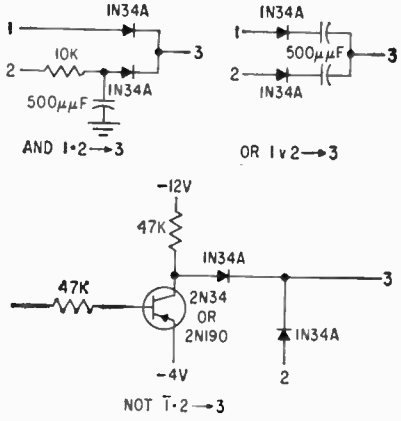

FIG. 2—Logical networks show relationships represented by arrows on the problem disk

Psychological Testing

ard tests, but new networks can be developed and produced in one or two hours when required.

Logic Diagram

Figure 3 is a logic diagram that helps give an understanding of the device. Light 1 is connected directly to light 2. Assume that light 1 is on. After four seconds have elapsed, light 1 will go out and light 2 will go on. If light 2 were directly connected to the *X* light, at the expiration of another 4 seconds 2 would go out and *X* would be lit. As previously mentioned, the timing light alternates four seconds on and four seconds off. The consequences of the DAY or ON periods will be discovered in the OFF or NIGHT and conversely.

To light center light *X*, lights 2 and *C* but not 4 are required. Light 2 may be lit from 1, which in turn may be lit by *B*. But *B* also lights 3 which in turn lights 4, inhibiting the center light. If *A* is activated while 1 and 3 are on, it inhibits 4 so that 2 and *C* together cause the center light *X* to go on. Therefore, the correct solution is *B*, then *A*, then *C*.

Logical Circuits

The circuits used are straightforward, similar to a trigger chain in its operation with the addition of logical circuits between the elements. Standard plug-in, transistorized, flip-flops are used as the storage elements for convenience in design and maintenance with minimum down time. The logic used is the positive-pulse type. Inverters for the NOT circuits are placed in the problem plugs because the added cost of one or two transistors was felt to be offset by the availability and low cost of the 33-pin plugs which contain too few connections to permit bringing out the complementary side of the flip-flops.

A four-second multivibrator drives a binary flip-flop which controls the timing light or DAY and NIGHT cycle. It also drives a reset generator to trigger the advance bus. A small loudspeaker is included, pulsed by the change in state of the DAY-NIGHT buses to give the subject an auditory clue to emphasize the time of transfer. The multivibrator flip-flop circuit was used so that DAY and NIGHT would be of equal duration without need for any balancing or possibility of drift. The actual duration of the periods is not critical, but they must be equal.

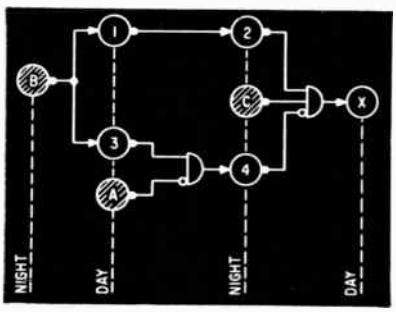

FIG. 3—Diagrammatic representation of a typical problem. This unfolding of the problem disk has been labeled to show the actual relationships existing. Sequence *B, A, C* causes *X* to light in the next time period

Why Use a Machine?

There are several reasons for using a machine rather than a pencil and paper test. Firstly, the task appears to the subject more as a contest or game than as a test. This keeps interest high and therefore performance near maximum. Secondly, the problem is contentless. It is not of the form "if John is . . . . then Bill . . . ., but . . ." which may carry emotional connotations in addition to the logical structure. Thirdly, if mistakes are made by the subject, they soon become obvious when the machine fails to perform in a logical manner. And lastly, in a paper and pencil test, it is often difficult to reconstruct the subject's methods and hypotheses from a final answer and a few scribbles. We can have with this machine, by the connection of an event recorder to the keys, a minute to minute record of each fact that the subject elicits from the machine and a record of the partial solutions that the subject tries.

Electronics and Behavior

The logical analysis device described here is an example of a useful application of digital techniques applied to measurements in the behavioral sciences. Increased uses of electronic devices are producing changes in research methodology of the science of behavior. Behavioral scientists have been quick to see the usefulness of such machines.

A logical analysis device, developed from the same source as the one described in this article, is being used at the Psychological Corporation, New York City, under the direction of Charles R. Langmuir, Head of Research and Special Services. Langmuir and G. K. Bennett recently developed an event recorder that provides an automatic timed record of every action performed on their logical analysis device. Data collected by them indicates that this device is useful in selecting computer programmers. Results of experiments at the University of Chicago differentiate between students of natural sciences and the social sciences

The unit was designed with a conventional mains operated power supply, but this may be replaced with eight type D dry cells for use in the field if that is required. Considerable data have been collected using this device, about individuals and groups of three. The unit has operated satisfactorily for almost a year with little downtime.

At present there are several basic problems and several "geographic varients" made by relabeling the lights on an unfolded logic diagram.

While formally identical, these look very different from each other and no subject has yet discovered the similarity. It is possible to arrange the problems to have long chains of casual sequences, or short multiple convergent chains. Research is now being conducted to discover if different people perform differently on these two kinds of problems.

A commercial version of the design is now available from Logic Research Corporation of Chicago.

REFERENCE

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High-Density Recording On Magnetic Tape

Self-clocking technique is used to bypass problems of digital recording at a density of 1,500 bits per inch. High reliability is obtained with no information drop out

By **ANDREW GABOR,** Senior Engineer, Potter Instrument Company, Plainview, N. Y.

EARLY MAGNETIC RECORDING, developed for audio signals, used a wire as the storage medium. Physical considerations imposed a limit of single channel operation, a limitation which has subsequently been removed with the advent of paper and then plastic base tapes. The parallel track tape offers the important advantage that a complete multibit character can be recorded directly in binary, binary coded decimal, or any other suitable coding, as a parallel-in, parallel-out operation. Most present computer systems with tape storage use the parallel method. Longitudinal bit packing density of 200 bits per inch is common and 300 per inch is becoming usual.

One important characteristic of the earlier wire recorder that is not possessed by the conventional parallel systems of today is the property of self-clocking within a single channel. This obvious requirement of any single channel system was obtained from a more complex waveform than the simple return-to-zero (RZ) or non-return-to-zero (NRZ) logic of parallel systems. The self-clocking feature depends, in one way or another, on having at least one flux reversal for each bit, whether it is a one or a zero.

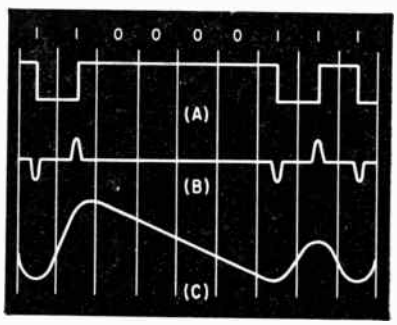

FIG. 1—Current through the recording head (A); playback signal for low density recording (B); playback signal at high density (C)

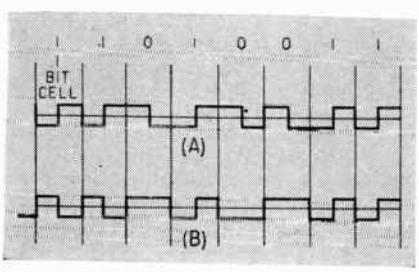

FIG. 2—Record current for at least one flux reversal per bit. Phase shaft method (A); frequency doubling (B)

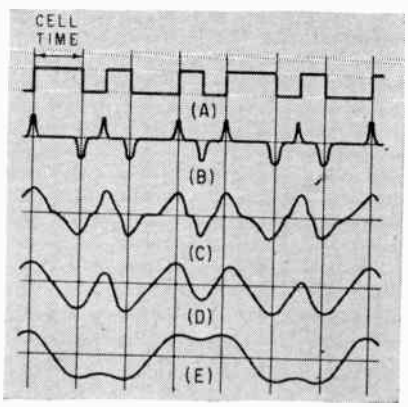

FIG. 3—Record current (A); playback signal for low-density signal of 100 bits per inch (B); playback for 500 bits per inch (C); 1,200 bits (D); 2,000 bits (E)

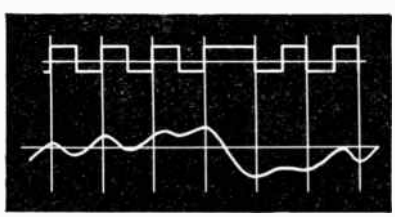

FIG. 4—Record current and playback signal at high density. Short wave signals are suppressed

High-Density Recording

This high density, multitrack recording system uses the self-clocking feature of the earlier system to bypass the enormous difficulties associated with pushing the density limits of conventional parallel recording beyond the 300 bits per inch level. Reliability greatly in advance of that reported for parallel high density systems has been achieved with this approach, and data transfer rates close to 500,000 eight-bit characters per second are feasible.

The three major problems of high density recording are pulse crowding, interchannel time displacement and information drop out. These points will be considered separately.

Pulse Crowding

When the longitudinal density of conventional NRZ recording is increased, two effects are noted, both stemming from the limited resolution of the system. One effect is that playback signal amplitude is large when the pulse spacing is wide, and small when the spacing is close. The ratio of amplitudes may be as high as 30 db, depending on pulse packing density and the resolution of the system.

The second effect is illustrated in Fig. 1. As the distance between flux transitions varies, which is characteristic of NRZ recording, the playback pulses either merge into each other or stretch over the

area that is supposed to contain no signal. Discrimination must be made between amplitude levels at different points in the waveform. Thus the pure absence-presence method of detection, a fundamental feature of digital circuits, must be abandoned and analog techniques adopted instead.[1]

The combination of the two phenomena is known as the pulse crowding effect. It should be noted that the pulse crowding effect in its severe form occurs only when high pulse packing density is combined with large spacing variation between successive pulses.

The difficulties can be overcome by providing at least one flux transition in each bit cell, thereby holding the distance variation to two to one.[1, 2, 3] Waveforms for two variations of the method are shown in Fig. 2.

The two methods of overcoming pulse crowding—phase shift and frequency doubling—are equivalent except that some circuit simplifications are possible with the frequency-doubling technique. The effect of bit density with this type of recording is shown in Fig. 3 for various arbitrarily labelled densities.

Waveforms

In Fig. 3E, the playback waveform of the 2,000 bit per inch signal is seen to have a small voltage swing for closely spaced flux transitions compared to the large voltage swing for the longer wave signals. The voltage difference is caused by the reduced high frequency response in the overall record-playback systems. The waveform shown is for a high frequency cutoff slope of 20 db per octave.

It would appear that an appropriate filter in the linear portion of the playback amplifier could restore the waveform to that of Fig. 3D or even 3C. This is true for the pattern of Fig. 3 but there are other considerations for the pattern of Fig. 4, where a different sequence of digits is used. A suppression of the short wave signals in the vicinity of a longer wave can be observed. Not only are there two different amplitudes for the two frequencies involved but there is a considerable amplitude variation in the short wave component. The amplitude variation depends on the distance from the longer wave signal. Since this is caused by nonlinear effects during recording, it is impossible to correct it by linear filters in the playback amplifier.

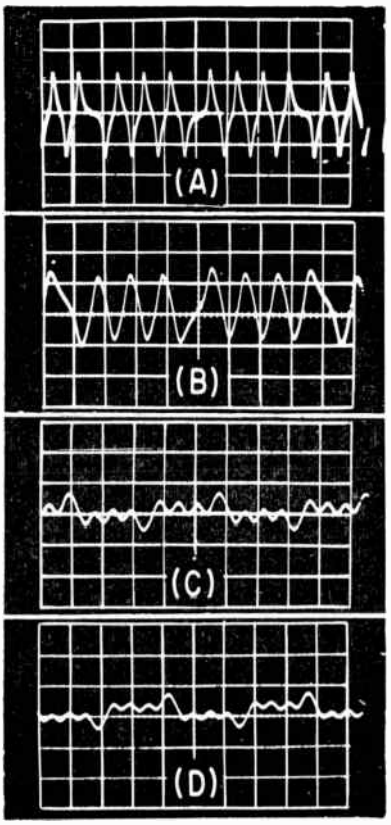

FIG. 5—Oscillograms (left) of 200 bits per inch playback (A); 1,000 bits (B); 1,500 (C); 2,000 (D)

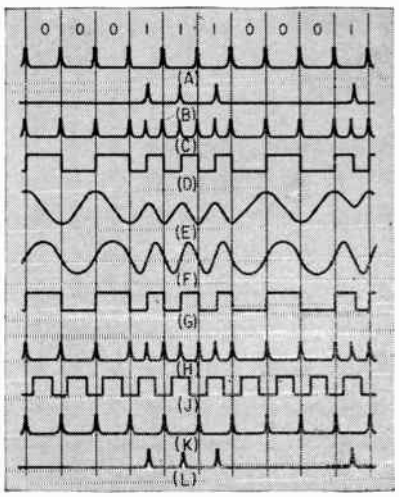

FIG. 6—Clock input to record circuit (A) data input to record circuit (B); clock and data added (C); record current (D); playback signal (E); playback after linear shaping (F); after clipping (G); after R-C coupling (H); gate derived from *H* signal (J); clock—*H* gated by *J* (K); data output —*H* gated by *J* inverted (L)

This short wave suppression is the factor that sets the practical limit of density to a value where the high-frequency cutoff slope of the overall record-playback system is not more than approximately 10 db per octave. Oscillograms of playback waveforms for a 10 to one packing density are shown in Fig. 5. The pattern recorded is 11101110-1110.

Inter-Channel Time Displacement

When a high bit packing density is used in conventional parallel recording, inter-channel time displacement becomes the limiting factor in system capability. Since the tape, the head and the drive system are responsible for a major part of the displacement, any improvement implies more critical mechanical design. While conservative machines operate at 200 to 250 bits per inch, some designs have pushed the limit to 555 bits per inch for computer applications and even higher where exceptionally high error rates can be tolerated.

Mechanical limitations, which are inseparable from parallel coincidence type recording, can be eliminated by electronic means. Clock information is derived from the recorded information itself. Since information and clock are recorded in the same track, inter-channel time displacement does not affect data recovery.

Figure 6 shows the waveforms of this self-clocking system.

Clock pulses that mark the bit cell boundaries are fed to the record amplifier continuously regardless of data bit combination. Data pulses —a pulse for a 1 and absent pulse for 0—are delayed to appear in the center of the cell boundaries. Data and clock pulses are mixed or added and then used to trigger a flip-flop. The flip-flop generates a current reversal for each pulse and the result is the record waveform of Fig. 6. The method is shown in Fig. 7.

The extra transitions at the cell boundaries serve a double purpose. First, by their regular appearance they prevent pulse crowding when recording a 1 after several 0's; second, they can be interpreted as clock pulses by using appropriate cir-

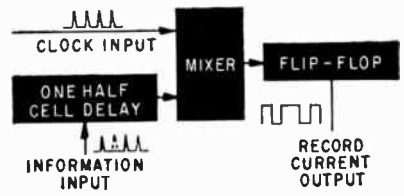

FIG. 7—Data is delayed one-half cell to obtain record current

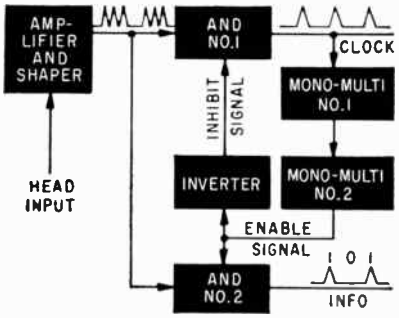

FIG. 8—Data and clock signals are separated. Monostable multivibrator No. 1 has a time delay of 0.25 of the repetition time, multi No. 2 has a time delay of 0.5 of repetition time

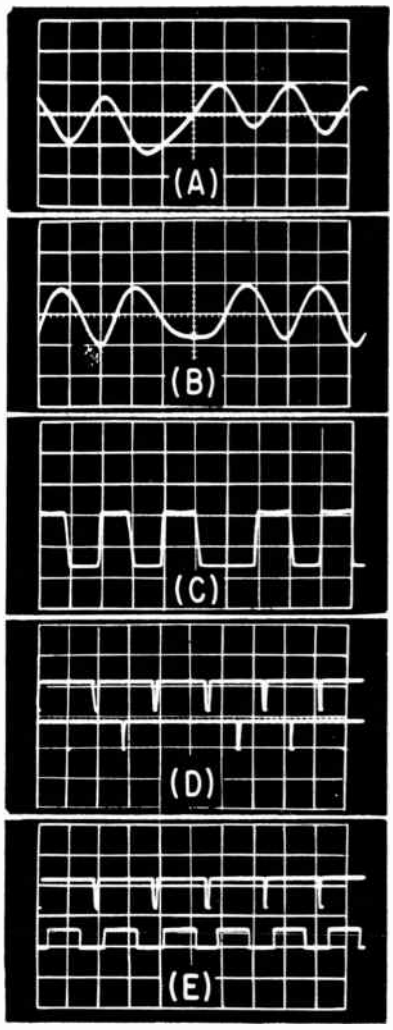

FIG. 9—Oscillograms of 1,500 bit system. Playback signal (A); signal after filter (B); after clipping (C); clock and data outputs (D); gate and recovered clock (E)

cuitry in the playback system.

The playback waveform, as obtained directly from the pickup head, is not suitable for information recovery but must pass through a linear shaping mesh. While there are a number of systems using delay and subsequent subtraction, a signal with many favorable features can be obtained by using a properly designed linear filter. A network composed of two R-C sections converts the playback signal of Fig. 6E into the waveform of 6F. Clipping the signal at both top and bottom close to the base line gives a signal which is the exact reproduction of the record current. Compare Fig. 6D with 6G.

After R-C coupling and full wave rectification, the signal of Fig. 6H, a reproduction of 6C, is obtained. These pulses are used to trigger an appropriate gating circuit which separates the clock and data as indicated in Fig. 6J, 6K and 6L. The gating logic is shown in Fig. 8.

The signal of Fig. 6H passes through an AND gate and triggers a monostable multivibrator which provides a 0.25 cell-time delay. The delayed pulse then triggers a gate multivibrator with a pulse width of 0.5 cell time. After inversion, this gate pulse is used to inhibit the information pulses so AND gate No. 1 passes the clock pulses only. At the same time, the gate pulse enables AND gate No. 2 to reject clock pulses and pass the information pulses only. Recovery of both the recorded information and clock is thereby completed.

Figure 9 shows typical oscillograms of the playback signals for a packing density of 1,500 bits per inch.

System Capacity

Single channel systems using serial recording are effective for those applications in which it is desired to maximize the information content of a tape storage system, but where the net data rate may be at conventional levels. For example, a system operating at 1,500 bits per inch, 8 channels, 3,600 feet of tape, has a capacity of 520×10^6 bits. A standard 200 bits per inch, 7 information channel reel of the same tape will have a total capacity of 60×10^6 bits.

Operating the high-density single-track tape at a speed of 70 inches per second gives the same result as the conventional system operated at 75 inches per second. Both yield 15,000 seven bit characters per second.

The principal disadvantage of the high-density single-track system is that one must switch to each channel in sequence, eight in the example cited above, with a time loss of at least a few milliseconds during the switching period. However, only a single channel record amplifier and a single channel playback amplifier are required. System cost, even including a serial-to-parallel buffer is therefore economical.

Multichannel operation may be used with high-density recording. Because the information in each channel is self-clocking, the multichannel, high-density system is free from critical reliance upon interchannel time displacement effects which destroy the reliability of conventional parallel coincidence type recording systems at densities in excess of several hundred bits per inch. The self-clocking feature of the recording controls the loading of a deskewing buffer for parallel recovery of multichannel data.

Circulating Buffer

To eliminate inter-channel time displacement effects, characters are read off the tape and stored temporarily in a circulating buffer (not a shift register). The number of columns in the buffer must equal the number of channels on the tape. The number of lines in the buffer must provide sufficient time for the maximum expected interchannel time displacement to be neutralized. Loading into the buffer is timed by playback clock pulses of each channel separately.

The buffer is unloaded a line at a time, each line constituting one character. The sequence operation is illustrated in Fig. 10, which

shows an interchannel displacement of one bit from channel to channel.

Circuit techniques of the circulating buffer depend on its size. Transistor flip-flops may be used for the smaller buffers while larger buffers are most economically constructed with coincident current magnetic cores. Fig. 11 is the block diagram of a 3-column, 4-line circulating buffer.

Information Drop Out

Reliability is a key consideration in digital storage devices. Tests have shown that the equipment will function with excellent reliability with a longitudinal density of 1,500 bits per inch and a lateral density of 16 channels per inch.

Longitudinal density up to 2,500 bits per inch has been checked; marginal operation occurs between 2,000 and 2,300 bits per inch. Short wave suppression is the most serious effect. Other limitations are susceptibility to drop-out, increased amplifier and stray noise effects resulting from a wider frequency band, and a drop in signal amplitude.[4, 5]

Lateral density up to 25 channels per inch has been checked with the following results:

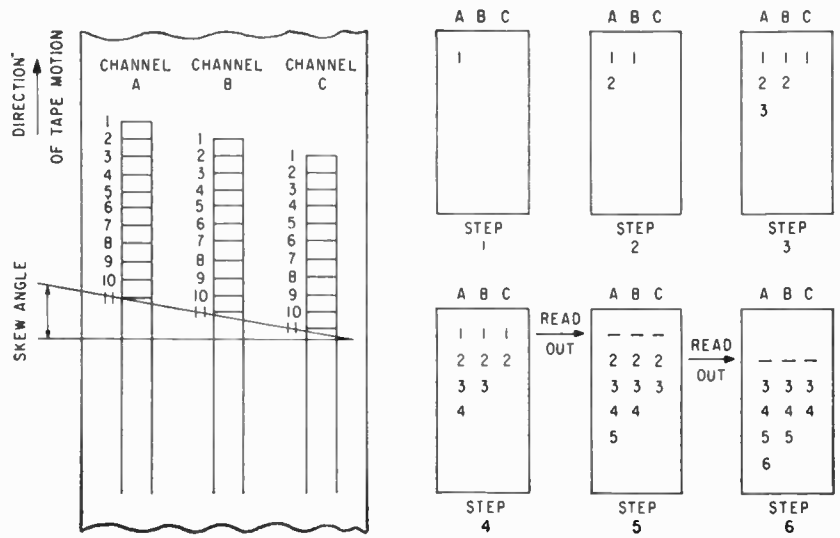

FIG. 10—Data from a three-channel tape with an inter-channel time displacement of one bit is stored temporarily in a circulating buffer. The buffer is shown at various stages in the storage-readout cycle

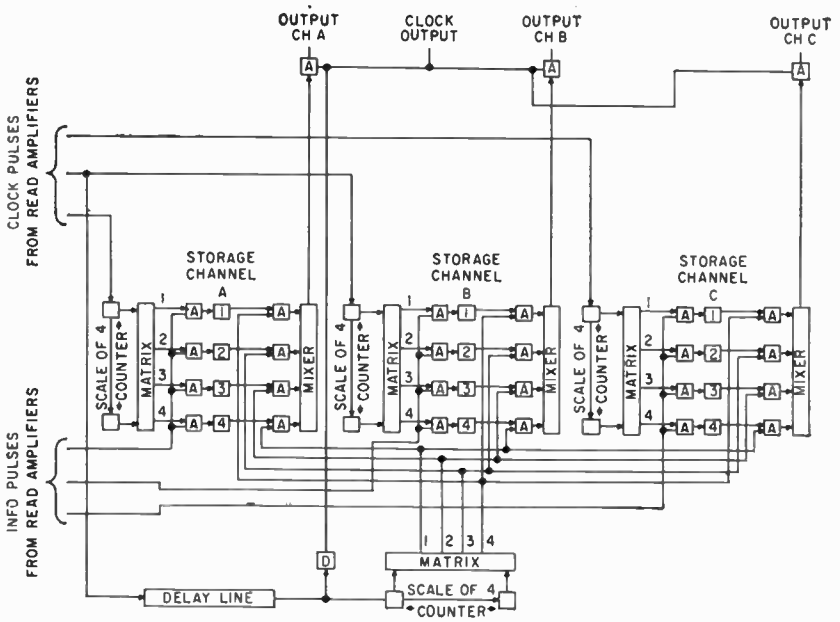

FIG. 11—Circulating buffer shown is a three-column, four-line circuit. The blocks marked A are AND circuits

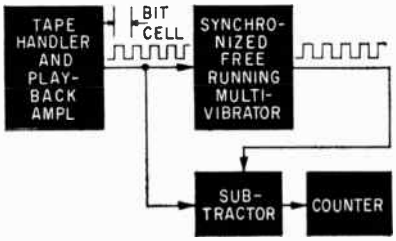

FIG. 12—Drop-out count circuit counts all lost bits. Tapes have been recorded with all ones since zeros would come through as lost bits

LATERAL CHANNELS PER INCH	LOST BITS OUT OF $65x10^6$
25	2319
22	482
20	57
18	0
16	0

Another set of tests was made to determine sensitivity to circuit parameter variations. The power supply voltage of the complete playback system was varied and drop-out observed. The following results were observed:

POWER SUPPLY VOLTAGE %	LOST BITS OUT OF $45x10^6$
133	0
100 (Nominal)	0
60	0
50	72
41	11,585

Tests were made to determine the effect of tape wear. Of a dozen new tapes from several well known manufacturers, one third showed no drop-out on the first run. Ten to 20 passes of the other two-thirds eliminated drop-out except for two areas where gross defects in the oxide surface of the tape were visible. After the wear-in process, no signal deterioration was observed in several thousand passes of short duration forward-reverse cycles.

A block diagram of the drop-out test is shown in Fig. 12.

The author acknowledges the contribution of A. W. Barber, G. E. Comstock III, J. T. Potter and R. L. Snyder.

References

(1) R. K. Richards, Digital Computer Components and Circuits," p 328, and p 333, D. Van Nostrand Company, Inc., 1957.
(2) J. T. Potter and P. C. Michel, High Density Digital Recording System, *Trans IRE on Digital Computers*, EC-1, p 60 Dec. 1952.
(3) U. S. Patent No. 2,853,357.
(4) R. A. Von Behren, Reduction of Drop-Out Errors in Magnetic Recording System, Bulletin No. 37, Minnesota Mining & Manufacturing Co., St. Paul, Minn.
(5) M. V. Wilkes, "Automatic Digital Computers," Methuen & Co., Ltd., London, England.

Electronic and Mechanical

Here are 11 gages suited to electronic production and test applications. Improved electronic gage designs extend measuring range to 10^{-14} mm Hg

LIFE AND RELIABILITY of electronic components can depend in many cases upon the competence with which a vacuum gage is chosen and installed in the production or test setup. Measuring high vacuum, like producing it,[1] poses distinct problems. Engineering advice should be considered an important part of an instrument purchase.

A gage installed in a radio tube exhaust manifold, for example, will measure vacuum in the tube only if the installation is properly designed. Release of adsorbed gases from materials near the gage, outgassing in the gage itself or obstacles to the line-of-sight paths of gas molecules will result in erroneous readings.

Characteristics and operating principles of various commercially available gages are described below in Table I. Exclusion of a gage or manufacturer does not imply an unfavorable judgement.

GAGING TECHNIQUES—The familiar mechanical or manometer gages may be used at moderate pressures. The McLeod design extends manometer range by compressing a sample of gas by a known volume ratio before pressure is read. Electronic gages, commonly of the conductivity or ionization types, are suitable for low pressures or continuous readings.

In conductivity gages, a heated wire is cooled in proportion to the number of gas molecules bombarding it. Sensitivity is limited to the pressure at which cooling by molecular transport is large relative to cooling by radiation.

Ionization gages measure ions produced by the collision of accelerated electrons with gas molecules. In a typical design (Fig. 1A), electrons emitted by a hot filament collide with a molecule at x. The resulting ions are measured at the plate as current flow. X-ray emission from the grid, causing a secondary emission current in the plate, becomes the limiting factor, at about 5×10^{-10} mm Hg.

IMPROVED DESIGNS—Nottingham and Bayard-Alpert designs (Fig. 1B) are similar, but use a single wire plate. The wire provides a small X-ray target and extends hot filament ionization gage sensitivity to 10^{-11} mm Hg. The upper limit is the pressure at which the filament oxidizes. Filament burnout is eliminated in the Alphatron by its use of a small radium ionizing source. It can be used at pressures above atmospheric; source constancy makes it highly accurate. In the Philips cold cathode ionization gage, electrons from a metal cathode are deflected by a magnetic field. The long electron path gives a high number of ionizing collisions per electron and produces a self-sustaining gas discharge.

The newest cold cathode design (Fig. 1C and 1D) is the Redhead[2] design. A large permanent magnet (not shown) provides a field perpendicular to the plane of electron travel. Electrons from the main cathode travel in hypocycloidal paths to the anode. Ionizing collisions occur and the ions return to the cathode. A self-sustaining gas discharge develops in which ion current is proportional to pressure. Since electron emission is proportional to ion bombardment, x-radiation is proportional to ion current. X-ray sensitivity limits are removed (field emission is probably the sensitivity limitation).

HIGH VACUA ACCURACY—These gages are precise enough for general vacuum work. However, the sensitivity of electronic gages varies with gas molecular weight, ionization potential and the like, and residual gas may not have the composition of the original gas. A mass spectrograph will give an exact picture of the gas supplied to the gage. Knudsen gage accuracy makes it of unique importance in laboratory work, but it is too fragile for industrial use.

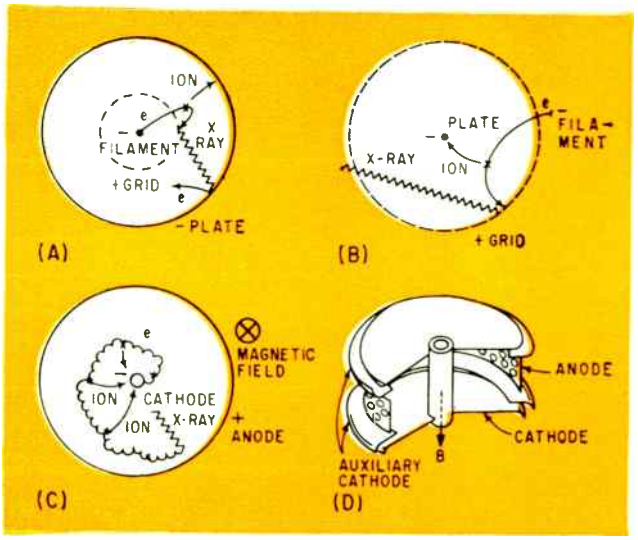

FIG. 1—Sketches show how ions are produced and collected for measurement in an ordinary hot filament ion gage (A), Nottingham or Bayard-Alpert ion gage (B) and Redhead ion gage (C). Anode-cathode arrangement in Redhead is also shown (D)

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(1) N. Beecher, High Vacuum Pumping for Modern Electronic Needs, ELECTRONICS, 32, p xx, Oct. 9, 1959.
(2) P. A. Redhead, The Magnetron Gauge—A Cold Cathode Vacuum Gauge, 1958 Vacuum Symposium, Am. Vacuum Soc., San Francisco, 1958.

Gages Check High Vacuum

By NORMAN BEECHER, Project Manager, National Research Corp., Cambridge, Mass.

Table I—Operating Principles and Characteristics of Representative Vacuum Gages

Gage Type and Mfgrs	Operating Principle	Range (mm Hg)	Accuracy[a] Gas Effect[b]	Advantages	Disadvantages
MECHANICAL					
Bourdon numerous	deflection of curved tube closed at one end	0.1–760	1% of fs note c	simple, inexpensive; aneroid somewhat more sensitive than Bourdon	mechanical linkages may stick or wear; range of an individual instrument rather limited; excessive pressure can cause damage
Aneroid WT	deflection of thin-walled evacuated box	0.01–760	0.5% of fs note c		
LIQUID MANOMETER					
Ordinary numerous	height of liquid column supported by pressure[h]	0.01–760	0.1% of fs note c	all are simple, provide absolute standard; ordinary type's measuring devices may be complex; Dubrovin is inexpensive; McLeod is very accurate	all have fluid in contact with system; ordinary must be vertical, vapor pressure may affect low pressure readings; Dubrovin is glass, must be vertical; McLeod is glass, non-continuous reading, does not measure condensable gases, Hg may stick
Dubrovin WL	same with differential float added to expand reading	0.1–20	0.1 mm note c		
McLeod LE, CE[i]	gas compression plus liquid manometer reading	10^{-3}–20	2% of pd note d		
HEAT CONDUCTIVITY					
Thermocouple NR, CE, VE[j]	temperature of wire heated electrically, cooled by gas	10^{-3}–1	20% of pd note e	simplest electrical gages, no burnout if exposed to air, rugged; Pirani is slightly more accurate	require electrical control; accuracy at low pressures reduced by radiation effects
Pirani NR, CE, VE[j]	similar, but wire temp measured by resistance change	10^{-4}–1	15% of pd note e		
IONIZATION					
Alphatron NR	measures ions produced by alpha particles from Ra emitter in shielded chamber	10^{-3}–100	2% of fs note f	accuracy unique for operating range; will not burn out	requires sensitive amplifier; disassembly only by trained personnel
Philips (Penning) NR, CE, LE	ions produced by electrons emitted from cold cathode	10^{-7}–0.5	10% of fs note f	cannot burn out; simple microammeter for reading	non-linear; Hg poisons; more easily contaminated, harder to outgas than hot cathode; high voltages
Redhead NR	magnetron type Philips gauge	10^{-12}–10^{-4}	10% of fs note f	very wide range, very high sensitivity	requires delicate circuitry, high voltage
Hot Cathode NR, CE, VE[j]	ions produced by electrons emitted from hot cathode	10^{-10}–10^{-3}	10% of fs note f	wide range, easily outgassed by hot filament	air exposure burns out filament; hot filament decomposes hydrocarbons; complex control and sensitive amplifier
MISCELLANEOUS					
Knudsen	measures difference in collision force of molecules from cold and hot source	10^{-5}–10^{-3}	note g note c	absolute standard, no electronic controls	delicate mechanical parts, hard to outgas

(a) Full scale is fs, pressure decade is pd (b) Effect of gas molecular weight on reading (c) No gas effect (d) No gas effect unless condensation occurs (e) More sensitive to lighter gases (f) More sensitive to heavier gases (a function of ease of ionizing gas) (g) Inherently very accurate, but has mechanical problems (h) Sensitivity may be increased by mechanical measuring devices (i) Also made by many scientific glassware manufacturers (j) Also made by others

Key to Manufacturers

CE	Consolidated Electrodynamics Corp.
LE	Lebold (German, available from NR)
NR	NRC Equipment Corp.
VE	Veeco Vacuum Corp.
WL	Welch Scientific Co.
WT	Wallace & Tiernan, Inc.

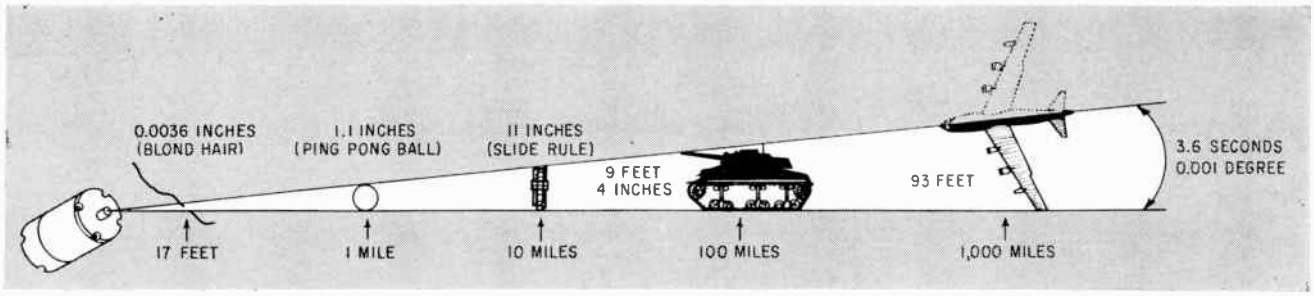
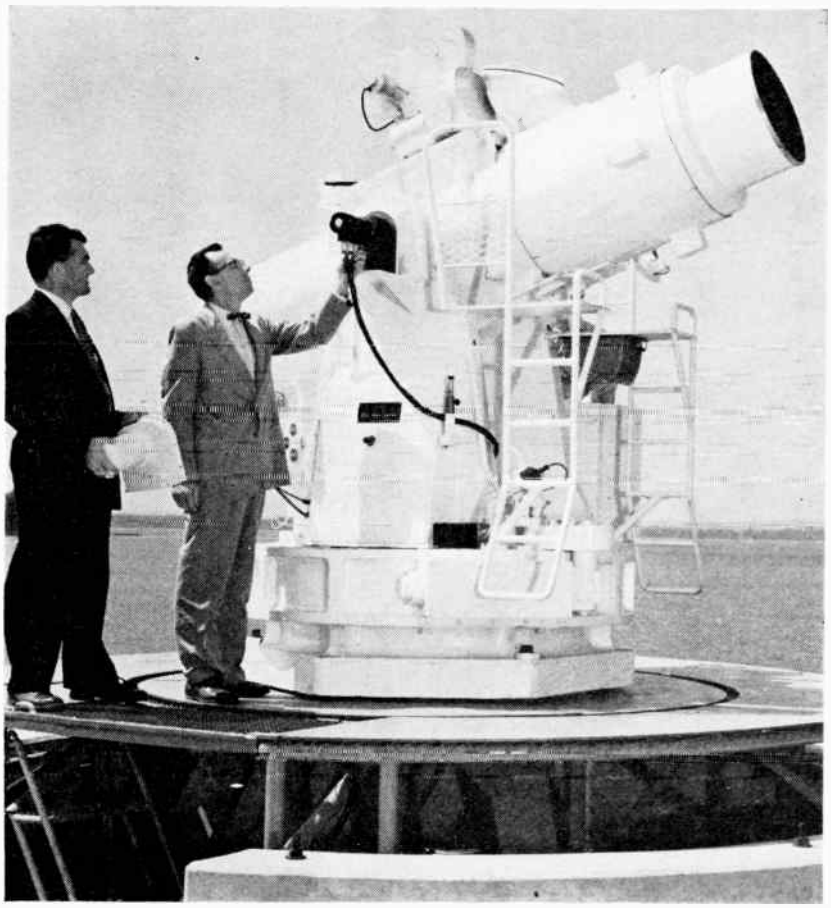


FIG. 1—Angle of 0.001 degree spans 93 feet at 1,000 miles. At the 5/8 inch shaft of the angle transducer, the span is 5.4 microinches

High Resolution Angle



Angle transducer is mounted to Space Probe Optical Recording Telescope. Telescope is representative of optical tracking instruments used at White Sands Missile Range

PRECISE, AUTOMATIC measurement of angular position is needed for optically guided, missile tracking instruments. A special angle transducer of unusual design and construction has recently been developed for the Ballistic Research Laboratories of Aberdeen Proving Ground, Maryland. The transducer allows real time digital recording of shaft position of special radars and optical tracking instruments.

The transducer feeds an electronic circuit which derives the angular information and operates a six figure digital readout. Angular resolution and accuracy is 0.001 degree, or 3.6 seconds of arc. The precision of an angle this size is illustrated in Fig. 1.

The transducer uses two means to sense angles over the full 360 degree circle. The coarse degree information is obtained from the well established brush and disk principle. The information is obtained in digital form and indicates the nearest degree of the angle. The vernier element further divides up the one degree into 1,000 parts and furnishes a signal which can be resolved to the nearest 0.001 degree. The vernier element introduces a new principle into analog to digital conversion: quantization by radio interferrometry.[1,2,3]

Operating Principle

High resolution vernier readings are obtained from a rotating electrostatic tone generator which is located inside the transducer. The principle of tone generation is illustrated in Fig. 2. The insulated stator and the grounded rotor are separated by an air gap of a few thousandths of an inch and together they form a variable capacitor.

As the rotor turns, the capacitance varies a few tenths of a micromicrofarad as the rotor serrations pass those on the fixed stator. The variation of capacitance produces an alternating current in the resistance-capacitance circuit. The alternating signal thus developed is essentially sinusoidal and is used to obtain the precise angular position of a shaft.

The number of serrations on rotor and stator is determined by the angular measuring system being used. For a readout in terms of degrees, 360 serrations are cut

Angle measuring and encoding system uses unusual transducer to obtain high resolution and accuracy. System can be adapted to binary numbers

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Transducer and Encoder

on both rotor and stator. The rotor is driven by a 900 rpm synchronous motor. The output frequency, then, is determined by the number of times the serrations line up with each other each second. For the transducer being considered, this is $f = (900/60)360 = 5.4$kc.

Two electrostatic tone generators are used in the angle sensing transducer. The rotors are mounted on the same shaft and are driven by the same motor as shown in Fig. 3. One of the stators is rigidly mounted to the frame of the transducer and produces a 5.4 kc signal which is used as a reference signal. The second stator is mounted on a separate movable shaft which is positioned as a function of the angle being measured.

When the serrations on the rotors are passing the serrations of the stators at precisely the same times, the two 5.4 kc signals will be precisely in phase with each other. But one degree of mechanical rotation of the movable stator will produce 360 electrical degrees of shift of the information signal. The amount of phase shift between the information and reference signal is thus a measure of rotation of the sensor shaft.

Transducer

Phase difference between the signals is a very accurate measure of shaft angle. The accuracy results from the fact that each of the two signals is generated by the simultaneous effect of 360 samples of the unit angle which is engraved on rotors and stators. Thus random layout errors are averaged out. Furthermore, errors caused by shaft runout, eccentricity, etc., are second order effects and thus minimized.

Figure 3 shows the assembly of the transducer. At the left is the synchronous motor which drives the two rotors. The fixed reference stator is shown as is the variable stator and input shaft. The degree code disc and brush assembly at right are used to determine shaft angle to the nearest degree.

Mechanically, the transducer is rugged and does not need delicate handling. Constant rotor motion circulates the enclosed air and equalizes temperature variations. Dimensional symmetry is thus maintained over a wide range of ambient temperatures.

To minimize the weight of the transducer, an aluminum alloy was used extensively throughout, with rotor and stator elements made of a free-machining brass. In every case, maximum dimensional stability was achieved by artificial aging, which included cycling from elevated oven temperatures down to −150 F. The driving motor is the smallest size that can start and run synchronously with the friction of grease loaded bearings at −55 C.

To maintain extremely high precision in all component parts and subassemblies, it was necessary to develop special machining and measuring techniques. For example, concentricities and face wobble of 0.0001 inch or less are held at all critical points.

One of the most important operations in the manufacture of the transducer is machining the teeth on stators and rotors. A special dividing engine was designed expressly for this purpose. To eliminate dimensional aberrations, flexure plates were used to support the cutting edge. Using a precision rotary table, angular positioning of the serrations was accomplished to about three seconds of arc. Each serration was made individually in eight passes of the cutting tool by semi-automatic programming.

All mechanical parts of the in-

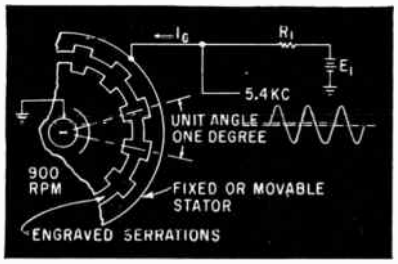


FIG. 2—Frequency of 5.4 kc is generated by the varying capacitance between rotor and stator

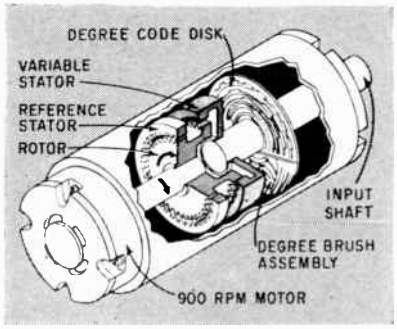


FIG. 3—Degree code disk establishes the angle to the nearest degree. Tone generators provide information to establish nearest one thousandths degree

strument had to be extremely stiff and rugged to prevent small bending and torquing which would affect the ultimate accuracy. Furthermore, the input shaft was kept as short as possible and its diameter is 0.6249 inches. To keep the weight of the rotor from bending the motor shaft and thus causing undesirable gyrations, the synchronous motor has a $\frac{3}{4}$ inch shaft.

A mechanical design objective was to minimize electrical cross-coupling between variable and reference circuits. Leads were carefully shielded and isolated. Furthermore, placement of metal around both stators was maintained dimensionally alike, so that output signals would be as nearly identical as possible.

Phase Measurement

The data from the transducer must be converted into digital signals. Fig. 4 is a block diagram of the electronic encoder. Signals from the degree code disc are used for the nearest degree information. Signals from the two stators are processed in identical channels. Each channel consists primarily of a 5.4 mc controlled harmonic oscillator, a divide by 1,000 chain and a phase comparator.

Each of the phase comparators receives two 5.4 kc signals, one from the transducer and the other from one of the 1,000 to one frequency dividers. For a phase difference between these signals, a control voltage is produced which is fed back to the 5.4 mc oscillator. The oscillator is thus controlled to produce exactly 1,000 cycles for each cycle from the transducer. The 5.4 mc oscillator is the equivalent of the 1,000th harmonic of the 5.4 kc transducer signal. The afc loop allows the shaft of the transducer to be slewed at rates up to 100 degrees per second without lag of the harmonic signal.

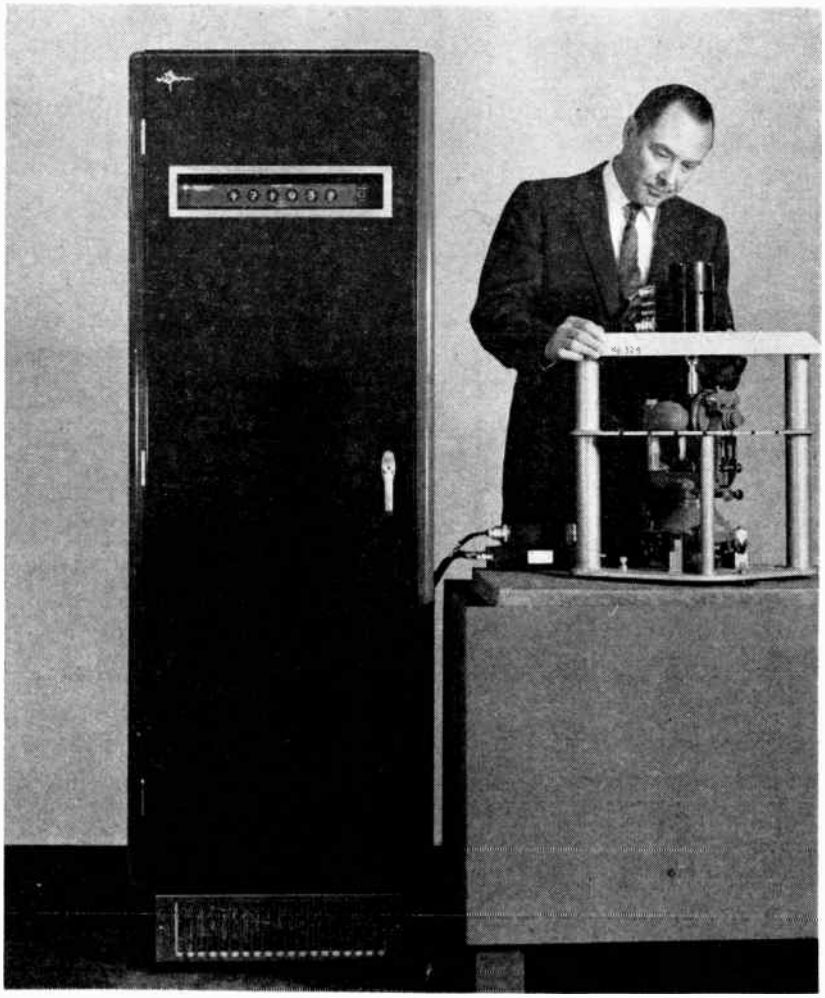
The reference phase harmonic oscillator operates continuously at a nominal 5.4 mc. But the variable phase oscillator will shift frequency as the transducer input shaft turns. If the input shaft is turned one degree per second in the same direction as the rotor is turning, the output of the variable phase stator will be 5,399 cycles instead of 5,400 from the reference phase. If the input shaft is turned against the direction of the rotor, the output will increase above 5.4 kc at a rate proportional to shaft rotation speed. Since the basic signals are multiplied by 1,000, a shaft slew rate of one degree per second produces a beat difference of 1,000 cps. At a shaft slew rate of 100 degrees per second, the beat difference or interference rate is 100 kc.

The signals from both oscillators are fed to a phase comparator or interference detector and to a directional or up-down count separator. As the variable phase harmonic oscillator moves in phase one cycle with respect to the reference oscillator, the phase comparator goes through one cycle of null and reinforcement. By means of derived quadrature components, the up-down separator circuit determines whether the variable phase oscillator is operating faster or slower than the reference oscillator and directs the interference count pulse to appear on either an up bus or a down bus for delivery to the counter.

A three decade reversible counter keeps a constant record of the counts and thus provides continuous storage of angular position in thousandths of a mechanical degree. When the input shaft of the transducer is stationary, both reference and variable oscillator operate at the same frequency. But the counter contains the latest angular information and can be interrogated at any time and at any rate.

Zero Crossing

The vernier counter is resettable to zero at any desired point, and will keep track of up and down



Electronic circuits and the digital readout are housed in the cabinet at left. A Wild T-3 theodolite, accurate to ±1 second of arc, is used to check transducer accuracy

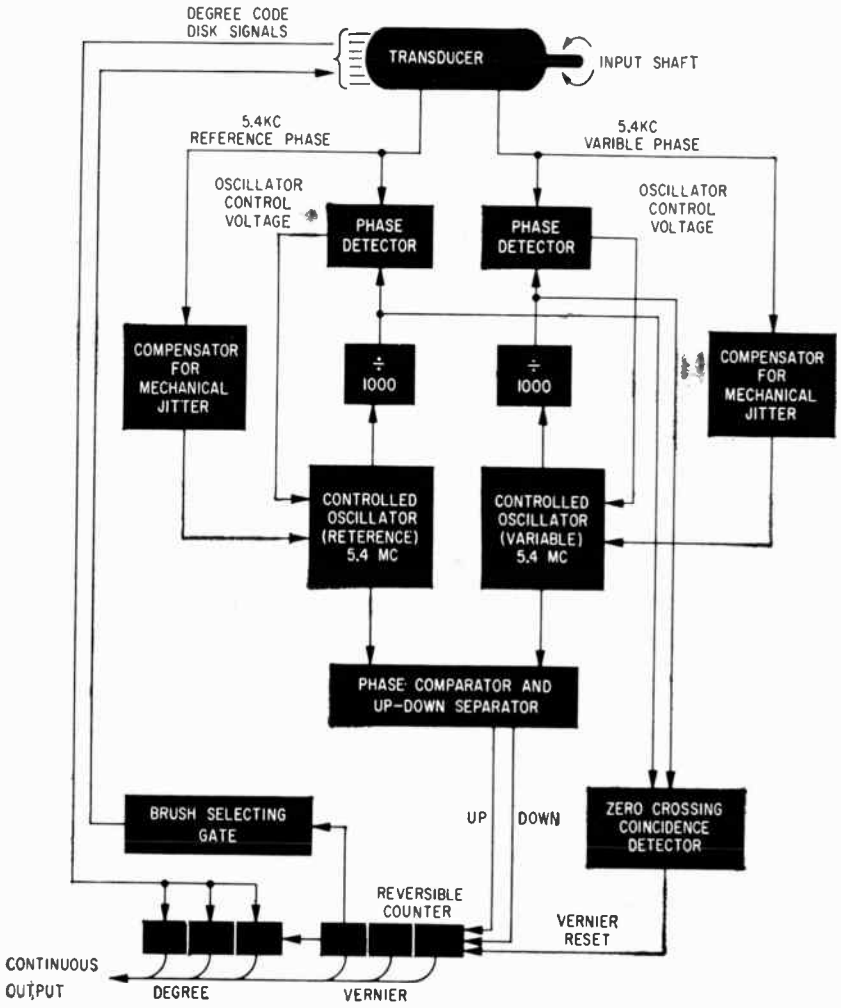


FIG. 4—Electronic circuits give angular readout accurate to nearest 0.001 degree. Brush selecting gate prevents error at degree crossover points

counts from that setting. To avoid cumulative error, the counter is reset to zero each time there is an absolute coincidence of the signals from the 1,000 to one divider chains. Except for negligible deviation in the phase control loop, the phase coincidence of these signals is the same as the primary signals from the transducer.

The zero crossing coincidence detector must operate with the same definition as the least count of the instrument. The vernier reset signal at each degree crossover serves as a safety feature to prevent loss of data in case of power failure or other event which might destroy the stored value.

Degree data is continuously available in binary coded decimal form for convenient recording and in pure decimal form for certain types of printers and for visual readout as shown in the photograph. Sampling of the digital data is at the discretion of the user.

An interesting refinement is a compensating circuit which removes the effects of the final unavoidable mechanical imperfection in the transducer. There remains a minute eccentricity in the mounting of the rotor shaft and stator rings which results in a small 15 cps modulation of the 5.4 kc signal from the transducer. The phase modulation which accompanies the amplitude modulation can swing the harmonic oscillators a few cycles. A jitter compensation circuit demodulates the amplitude modulation and injects this 15 cps voltage into the associated harmonic oscillator phase control loop, effectively canceling the mechanically introduced phase disturbances.

Bearing noise shows up as a fine high frequency modulation which is largely filtered out or treated identically by the two afc loops. Motor speed variations appear as frequency modulation common to both variable and reference phase signals but the effect is canceled in the final phase comparator and up-down separator. The transducer motor can operate at line frequencies of 58 to 62 cps with no change in the encoded output.

Remnant system noise appears as a jitter in the least significant digit. With Nixie lamp readout, readings to ½ count of the last significant digit can be made by noting when two adjacent numbers are glowing with equal brilliance.

Performance

The transducer and electronic apparatus are extremely rugged and reliable. The transducer can take wide temperature variations, and vibration and shock of several g's up to 500 cps with negligible effect on accuracy. While the transducer itself can be operated up to 100 rpm, the encoded readings freeze at a little over 100 degrees per second. The readings pick up the new correct readings when the slew rate returns to approximately 100 degrees per second.

The accuracy of the system is obtained with stators and rotors two inches in diameter. The mechanical precision could be maintained with rotors up to eight inches and, with more serrations available, the resolution might be improved by an order of magnitude. While the system described gives readings in degrees and thousandths of a degree, it is possible to use a pure binary number system. An encoder of the size presently being used would easily yield binary coded data to an accuracy of 2^{18} or 2^{19} bits.

The writers gratefully acknowledge the great assistance furnished by Colorado Research Corporation engineers Richard E. Howard, Wilbur W. Cloud and R. H. Bancroft.

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Results of life tests measuring forward voltage drop and reverse leakage current of four rectifier types at 25 C and 150 C

By C. L. HANKS,
Battelle Memorial Institute, Columbus, Ohio

Operational and Storage

SILICON RECTIFIERS are playing an increasingly important role in military electronic equipment. Their inherent characteristics of high efficiency, high current capability coupled with small physical size and stability at relatively high ambient temperatures have made them desirable for certain military applications. The introduction of silicon rectifiers into military equipment required the formulation of a specification to identify and control the parts used. The research program described reviews the initially proposed military specification on silicon rectifiers and studies rectifier life characteristics to get data for establishing realistic life-test procedures and requirements for a military specification.

PROCEDURE—Large sample sizes of four rectifier types representing two manufacturers were evaluated under three environmental conditions for 2,000 hours. Direct-current measurements of the rectifier characteristics were made periodically during the study.

Rectifier types investigated were limited to single-junction units of the lead mounted variety. An 800 peak-inverse voltage (piv) commercial type was used rather than a military type because of this single-junction limitation. No military types with an 800 piv rating were available when the program was initiated.

The evaluation was made at three environmental conditions: an operational-life study with the rectifiers operating at rated load in an ambient temperature of 150 C, and two storage-life studies with the rectifiers stored at ambient temperatures of 25 C and 150 C, respectively. Each study lasted 2,000 hours and included a total sample of 500 rectifiers. Since the type 1N540 rectifier was supplied by both manufacturers, there were 200 of this type in each study. Enough rectifiers were investigated to permit a fair amount of confidence and accuracy in establishing

Table I—Failure Data Obtained From Initial Meas-

Type	Current Rating (ma)	PIV Rating (v)	Spec Limits at 25 C	
			Forward Voltage Drop @ 2 × Rated Current (v)	Reverse Current @ Rated Voltage (μa)
1N538	250	200	1.1	10
1N540	250	400	1.1	10
1N540	250	400	1.1	10
1N547	250	600	1.2	2.0
1N560[d]	200	800	1.2	20.0

(a) Defective unit is one falling outside present MIL spec limits (b) Proposed MIL specs reject production lots receiving 100% inspection where % defective exceeds 1.0 (c) Meas-

Table II—Results of Shelf-Life and Operational-Life Tests

Type	25 C Shelf-Life Test				150 C Shelf-Life Test					Operational-Life Test				
	Samples[a]	Defectives			Spec Limits[b]		Samples[a]	Defectives			Spec Limits[b]		Samples[a]	Defectives		
		250 hrs	500 hrs	1,000 hrs	Voltage Drop[c]	Rev Cur[d]		250 hrs	500 hrs	1,000 hrs	Voltage Drop[c]	Rev Cur[d]		250 hrs	500 hrs	1,000 hrs
1N538	99	0	0	0	1.2	15	96	0	0	2	1.2	0.6	100	4	8	9
1N540	99	0	0	0	1.2	15	97	0	0	1	1.2	0.6	98	5	9	9
1N540	91	11	10	9	1.2	15	81	36	9	8	1.2	0.6	97	1	2	2
1N547	96	4	3	2	1.2	2.0	99	87	41	32	1.2	1.0	99	3	7	9
1N560[e]	99	0	0	0	1.2	20	93	63	43	43	1.2	1.0	100	15	20	27

(a) Rectifiers of acceptable quality based on initial measurements (b) From Measurement-Acceptance Tests, Part I, Production Tests of applicable spec (c) Forward voltage drop in volts at twice rated current (d) Reverse current in μa at rated voltage (e) Commercial type but tested to 1N548 proposed MIL spec

urements on the Four Rectifier Types Tested in the Shelf-Life and Operational-Life Tests

Samples	Defectives[a] in group for 25 C Shelf-Life Test			Defectives[a] in group for 150 C Shelf-Life Test			Defectives[a] in group for Operational-Life Test		
	Forward Voltage Drop	Reverse Leakage Current	Total %[b]	Forward Voltage Drop	Reverse Leakage Current	Total %[b]	Forward Voltage Drop[c]	Reverse Leakage Current	Total %[b]
100	1	0	1.0	4	0	4.0	0	0	0.0
100	0	1	1.0	3	0	3.0	1	1	2.0
100	9	0	9.0	19	0	19.0	3	0	3.0
100	3	1	4.0	1	0	1.0	0	1	1.0
100	1	0	1.0	1	7	7.0[c]	0	0	0.0

urements made at rated rather than 2 × rated current; therefore, there may be more rectifiers that exceed limits than quantity listed (d) Commercial-type but tested to 1N548 proposed MIL spec (e) One rectifier was out of limits for forward and reverse characteristics—counted as one defective

Life of Silicon Rectifiers

their mean life and failure rate.

Static d-c measurements of forward voltage drop at rated current, and reverse leakage current at rated voltage were made approximately every 50 hours for the first 500 hours, every 100 hours for the next 500 hours, and every 200 hours for the last 1,000 hours of the study. The measurements on the units in the storage-life studies were performed at an ambient temperature of 25 C. The rectifiers in the 150 C storage-life study were gradually returned to a 25 C ambient for measurement. The rectifiers in the 150 C operational-life study remained at the test temperature during the measurements. The load was continuous except for interruptions for the measurement of rectifier characteristics.

RESULTS—Rectifiers were grouped by type and manufacturer for each evaluation condition before initial measurements were made. This made a total of 15 groups of 100 rectifiers each. Eight of these groups, when measured initially, had more than the acceptable quantity of rectifiers outside the limits specified in the proposed military specifications for acceptance measurements as shown by Table I. However, no rectifier exceeded the limits by an amount that would be detrimental to its operation. This was substantiated by data obtained during the evaluations which indicated that the units that were out of limits appear capable of reliable operation.

Several types of failure resulted from the operational-life evaluations. However, the out-of-limits type of failure was the only one that occurred in the storage-life studies. An instability of the reverse characteristic was a leading cause of these failures and was particularly noticeable in the storage-life study conducted at an ambient temperature of 150 C. The presence of a contaminant within the rectifier's enclosure that is vaporized by the 150 C temperature

Table III—Anticipated Failures for Shelf-Life and Operational-Life Tests

Type	% Expected Defective[a] for 25 C Shelf-Life Test			% Expected Defective[a] for 150 C Shelf-Life Test			% Expected Defective[a] for Operational-Life Test		
	250 hrs	500 hrs	1,000 hrs	250 hrs	500 hrs	1,000 hrs	250 hrs	500 hrs	1,000 hrs
1N538	0.0–2.8	0.0–2.8	0.0–2.8	0.0–3.1	0.0–3.1	0.3–7.2	1.1–10.0	3.5–15.2	4.2–16.5
1N540	0.0–2.8	0.0–2.8	0.0–2.8	0.0–3.2	0.0–3.2	0.1–5.8	1.5–11.6	4.2–16.7	4.2–16.7
1N540	6.2–20.2	5.2–19.2	4.7–18.6	33.8–55.3	5.2–20.3	4.3–18.8	0.1–5.8	0.1–7.2	0.1–7.2
1N547	1.1–10.5	0.8–8.9	0.3–7.5	80.0–93.7	31.2–52.3	23.0–42.0	0.5–8.8	2.9–14.2	4.2–16.7
1N560[b]	0.0–2.8	0.0–2.8	0.0–2.8	56.7–75.8	41.5–61.7	41.5–61.7	8.6–23.6	12.6–29.3	18.5–36.8

(a) Computed with 95% confidence limit by following formula: (1 − confidence limit)^n = risk level, where n = size of sample
(b) Commercial type but tested to 1N548 proposed JAN spec

Table—IV—Life Estimates for Rectifiers operating at Rated Conditions in 150 C Ambient for 2,000 Hours

Type	Rating at 150 C	Reliability Data			Mean Life		Observed Failure Rate %/1,000 hrs
		Samples	Successes	Failures	Average Estimate (hrs)	95% Lower Confidence Limit (hrs)	
1N538	250ma, 200piv	100	100	0	>200,000	>66,767	<0.5
1N540	250ma, 400piv	200[b]	200	0	>400,000	>133,534	<0.25
1N547	250ma, 600piv	100	91	9	20,907	13,036	4.5
1N560[a]	200ma, 800piv	100	60	40	3,865	3,034	20.0

(a) Commercial type, output current derated to zero at 150 C by manufacturer, tested to military spec for 1N548-type rectifiers
(b) Sample size composed of 100 units each from two manufacturers

and deposited on and near the junction area when the temperature is reduced to 25 C is believed to be the cause of this instability. This theory is further substantiated by the results of the operational-life study conducted at 150 C where no instabilities were observed until the rectifiers were measured at room temperature after the evaluation was terminated.

Catastrophic as well as out-of-limits failures occurred in the operational-life study conducted at 150 C. The catastrophic failures were limited to and responsible for the greater portion of the defective rectifiers rated at 600 and 800 piv as shown in Table II. Both types of failure were limited to the reverse characteristic of the rectifiers; with the reverse leakage current exceeding specified values being responsible for the out-of-limits failures. The inverse resistance approaching a shorted condition or a decrease in the rectifier breakdown voltage to a value considerably less than its rated value were responsible for the catastrophic failures.

The 1N560 rectifier rated at 800 piv is a commercial unit and is derated to zero output current at 150 C by the manufacturer. Therefore, the rectifier was operated considerably above the manufacturer's recommended rating when evaluated at 150 C with an output current of 200 milliamperes in accordance with the JAN specification for the 1N548. Thus, the large number of failures observed is not surprising.

ANALYSIS—Statistical evaluations of the results include the percent defectives that may be expected in similar groups of rectifiers, as presented in Table III. These values were computed for a 95 percent confidence level, indicating that the application engineer may expect the percentage of defectives in any similar group of rectifiers to be between the limits specified for 95 percent of the lots or groups obtained. These defectives include units that are out of MIL spec limits but still operate satisfactorily.

A further analysis was made of the results obtained in the operational-life study conducted at 150 C. The results are given in Table IV. Mean-life estimates and failure rates were computed on the basis of catastrophic failures, assuming an exponential failure rate. The quotient of the total hours of operation divided by the number of failures is presented as the average estimate of mean life. The quotient of twice the total operating hours divided by chi^2 at a probability level of 0.05 and the degrees of freedom equal to twice the number of failures is the method used in computing the 95-percent lower confidence limit. This calculation provides the circuit designer with a minimum mean life expectancy for similar groups of rectifiers when operated at rated current and voltage at an ambient of 150 C. The values specified in this tabulation should apply to 95 percent of the groups or lots.

CONCLUSIONS—The rectifiers rated at 200 and 400 piv performed satisfactorily in that no catastrophic failures occurred with rectifiers for these ratings. Several units did, however, exceed the specified limits for forward voltage drop and reverse leakage current during the evaluation, but not to a degree that would be detrimental to their operation. Therefore, if the user is not concerned with extremely tight tolerances, an average failure rate of less than 0.5 percent per 1000 hours may be expected.

The 600 and 800 piv rectifiers have a failure rate that is at least 9 and 40 times greater, respectively, than that of the 200 and 400 piv units. The catastrophic failures and instability of the reverse characteristic are generally responsible for this failure rate. There apparently is still a contaminant problem in the manufacturing of silicon rectifiers and a need for further development and study.

The author is grateful for the assistance provided by A. E. Mace of Battelle Memorial Institute with the statistical analysis, the assistance provided by members of the Reliability Engineering Division, and to the Signal Corps Equipment Support Agency, Fort Monmouth, New Jersey, under whose sponsorship this evaluation was conducted as a part of Contract DA-36-039-SC-73212.

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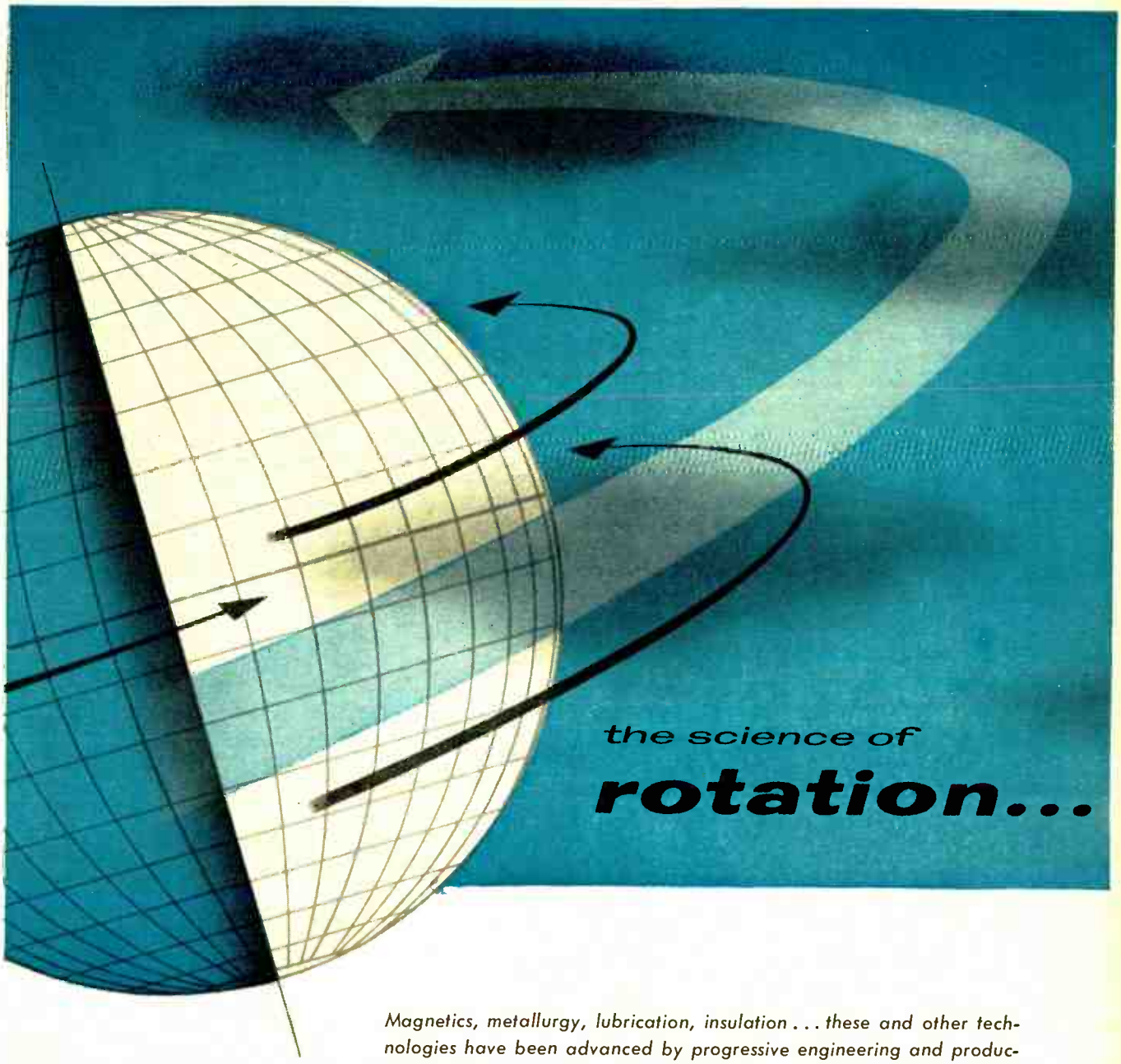

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Infrared Detector Controls Automobile Brakes

Transistorized circuit uses infrared detector to sense closure between automobiles. Small unit provides 10-w output to brakes

By W. E. **OSBORNE**, President and General Manager, 21st Century Electronics, Inc., Riverside, Calif.

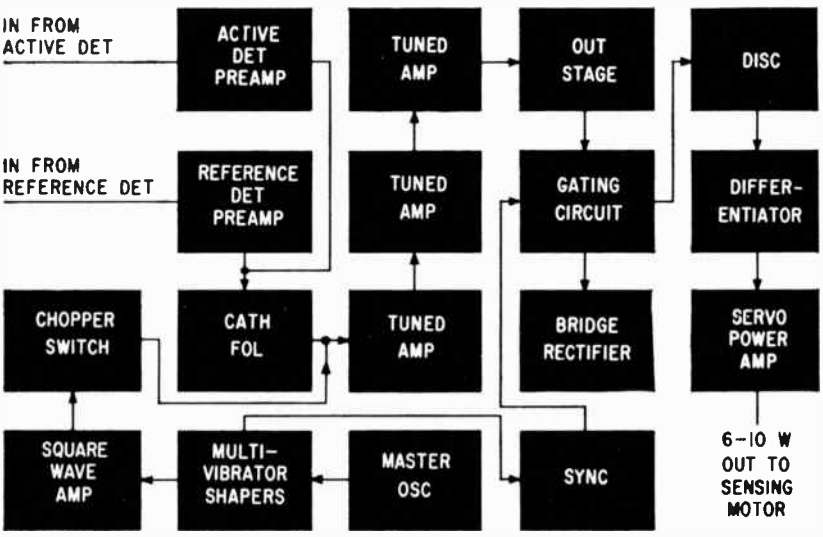

FIG. 1—Block diagram of infrared detection system shows the reference and active detector channels

A NEW SYSTEM to detect closure between automobiles and automatically apply appropriate braking is now in the development stage. The system overcomes many of the serious disadvantages of radar systems by utilizing infrared detection methods.

Although infrared has many limitations necessitating a provision for a manual/automatic changeover switch, it has two major advantages. The system, consisting basically of a moderately sensitive infrared receiver with rate circuits, requires no transmitter. A second advantage is the small size, weight, and cost. The 0.09-cu ft device weighs 8 pounds.

Circuit Description

The whole system is transistorized utilizing 21 transistors and nine diodes. Power transistors in the output servo amplifier provide approximately 10 w to operate a hydraulic braking system.

In operation, a signal from one or more cars in front is observed at a preset range of from 0 to 1,000 ft by a pair of uncooled indium antimonide detectors. One of them is blacked out and acts as a reference for measuring ambient temperature while the active one looks at the target and detects any difference in temperature from that of the reference cell.

A collimator is mounted directly under the front bumper and, in addition to being adjustable, has spirally cut groves on the inside in order to minimize reflections. It houses the optical system and infrared filters as well as the active phototube. Directly behind this, in a $1\frac{1}{2} \times 1\frac{1}{2} \times 1$ in. box, is a transistorized preamplifier and the reference detector.

The difference signal goes from the preamplifier (Fig. 1) to the main amplifier behind the dashboard and is electronically chopped at a frequency close to 1,000 cps. It then passes through a tuned amplifier (passband about 50 cps) to a gated output circuit which is synchronized with the input at the chopping frequency. This greatly improves the signal-to-noise ratio of the system. A differentiator provides for the closing-rate measurements preceded by a demodulator and followed by a servo-power amplifier.

The chopping transistors act as a synchronous-switch type of modulator and the gated output circuit in combination with the synchronous detector is equivalent to a ring-type demodulator. The discriminator circuit is a conventional phase-shift type. The rate signal, which is the most important value measured in this particular system, is obtained from a simple RC differentiator in series with the discriminator.

The servo amplifier output may be used to drive a d-c motor, an a-c motor, an aural or visual alarm or a combination of all of these.

Limitations

In practice it has been found that this system is only practical for cars almost directly ahead. On these it is extremely good and provides an excellent rate-of-closure signal, which is proportionately applied to the brakes by hydraulic action. In freeway traffic, however, with cars continually cutting in and out at an angle, the automatic system leaves much to be desired; therefore, manual operation under close proximity is recommended.

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Practical Retrieval System Developed

INFORMATION retrieval is receiving sustained interest in the electronics industry. Some engineers expect an upsurge in this interest because practical systems could greatly assist engineers in some phases of their work. In addition, the reliance of these systems on digital equipment has commercial implications for our industry. It is also probable that new electronic equipment will be developed for this application.

Among groups working in this area is the National Bureau of Standards, which has developed an improved model of an automatic document retrieval device for the Patent Office and the Navy Bureau of Ships. This program is one of several being conducted at the National Bureau of Standards.

Retrieval System

The machine rapidly retrieves information from massive files of correspondence, drawings, patents or similar printed matter that has been recorded on 35-mm film. Associated with each document image is a binary dot code that identifies its content. The machine examines the code at about 2,400 pages/min. When a document is found, it is photographed on recopy film.

The selector is an outgrowth of an idea originally proposed by Vannevar Bush more than 20 years ago. More recently, Yale University undertook redesign of the machine to meet its own requirements. The Bureau obtained a portion of the Yale equipment, modified the optical and mechanical systems, and redesigned the electronic circuits using modern computer techniques.

The machine identifies the document by examining a binary dot code associated with each document. One code frame is about ¼ in. long and as wide as the film, and contains 6 rows of 46 bits each. Forty bits are for document information and 6 bits for machine control.

As the film passes through the machine, its image is projected on a bank of photocells that scan the code. When a desired item is found, a high-speed clutch is activated. The clutch presses the recopy film to a drive drum, accelerating it to the same speed as the information film. By photography the desired item is registered on the recopy film. After the desired item passes the camera slit, the clutch is disengaged and the recopy film stops. As many consecutive items as desired can be copied without slowing or stopping the master film.

Test Program

To test the selector, a test film was prepared. It contains the contents of the NBS Technical News Bulletin for about a 10-year period to show the wide variety of subject material that can be located with the selector. In all, more than 250 individual categories, singly or in combination, were used in the index to describe the 900 articles. Successful searches have shown the practicality of the system.

The present selector is limited to one word per document. This word can represent many combinations of concepts. An improved electromechanical film transport combined with a multiword selector, now under construction, will perform much more rapid and sophisticated searches than the present machine. In the improved selector, signals caused by the recognition of the machine words can be combined using computer logic to give the printout command. A six machine-word code has been devised with which the Bureau of Ships is encoding a series of letters to be used in an encoding study. With this code system they will be able to find any letter or letters, written between certain dates, from a particular supplier about a specific type of equipment.

BOY'S MISSILE DETECTOR WINS SCIENCE FAIR

Fourteen-year-old boy's application of well known principles could greatly simplify guided-missile and atomic-blast detection. Pat Flanagan of Bellaire, Texas, won grand prize at the Houston Science Fair with the detector competing against 375 other projects.

Using spare parts Pat had around the house and about $5 of new parts, he made the detector in 4 months. He estimates that all new parts would cost about $30.

Operating Principle

As guided missiles blast off or an atomic explosion occurs, a trail of intensely ionized and superheated gases is formed as a vertical column. The atmosphere immediately surrounding the column is also ionized. A potential difference is created between the earth and the column. This potential and the disturbed electrons produce a low frequency electromagnetic field. The vertical column acts as an antenna and the wave is propagated over the earth's surface. Frequency is about 4,000 to 16,000 cps—a wavelength of 75,000 meters or more than 225,000 feet.

Pat built a receiver that would receive this low frequency and that had sufficiently broad response to pass this range of frequencies. A vacuum-tube receiver would be susceptible to higher harmonics of the 60-cps power line. For this and other reasons, transistors were used.

A circuit that would act as both antenna and resonant circuit was decided on. It compromises a loop antenna 4 ft in diameter wound to an inductance of 70 mh. A parallel resonant circuit is formed with a 0.22-μf capacitor.

Resistance of the antenna is high in proportion to input resistance of the receiver to provide broad band response. The coil contains 3,000 feet of No. 30 enameled wire. Hand wound, it took 12 hours to complete.

The detector consists of a 2N107 transistor in a common-emitter circuit. The signal is then amplified by a CK722 transistor, which is coupled into a 2N256 power amplifier. The receiver will operate for many months from a 9-volt battery.

The signal is a very strong intermittent noise that rises above the normal background noise and is easily discernible. Duration of the signal is dependent on distance from the launching. Estimated distance of reception is 4,000 miles.

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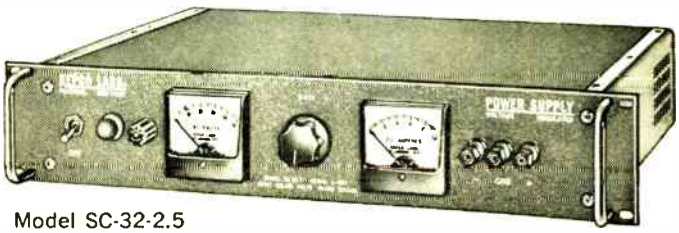
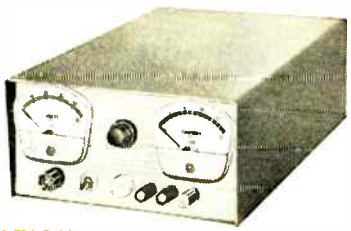


Model SC-32-2.5

0.01% REGULATION STABILITY

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-32-0.5	0-32	0-0.5
SC-32-1	0-32	0-1
SC-32-1.5	0-32	0-1.5
2SC-32-1.5	0-32	0-1.5
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
SC-150-1	0-150	0-1
SC-300-1	0-300	0-1



Model SC-18-2M

0.1% REGULATION STABILITY

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-18-0.5	0-18	0-0.5
SC-18-1	0-18	0-1
SC-18-2	0-18	0-2
SC-18-4	0-18	0-4
SC-36-0.5	0-36	0-0.5
SC-36-1	0-36	0-1
SC-36-2	0-36	0-2
SC-3672-0.5	36-72	0-0.5
SC-3672-1	36-72	0-1

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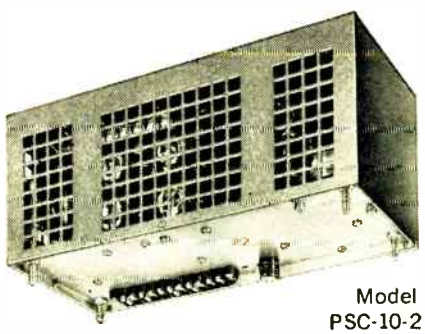
COMPACT PACKAGE TYPE

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
PSC- 5-2	0- 7.5	2
PSC-10-2	7.5-12.5	2
PSC-15-2	12.5-17.5	2
PSC-20-2	17.5-22.5	2
PSC-28-1	22.5-32.5	1
PSC-38-1	32.5-42.5	1



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cator. On command, it tells an operator present cloud height, and highest, lowest or predominant cloud height at any time in the last 10 min. It can also determine how often clouds occurred below some critical level during the same period.

The instrument was developed at the National Bureau of Standards as part of a program to assist and advise the Weather Bureau in applying computer techniques to automatic weather data analysis.

A ceilometer measures cloud height up to about 10,000 ft. A searchlight beam reflected by the clouds is received by a photocell placed at a known horizontal distance from the searchlight. Either the light or the photocell is rotated through 90 deg. Cloud height is calculated by simple triangulation, using the angle at which the reflection from the cloud is received and the known baseline. The light source is modulated by a rotating shutter, and the photocell operates in conjunction with a filter and tuned amplifier to discriminate against ambient light. The ceilometer scans the cloud 10 times/minute.

An operator interprets ceilometer indications using a cathode-ray display. By manual computation, he answers such questions as: At what height did most clouds occur over the past ten minutes (or one minute)? What was the lowest level at which a significant number of clouds occurred? The cloud-

Pulse Transformer Tank For Long-Range Radar

Tank to hold pulse transformer used in high-power search radar is welded at GE high voltage specialty transformer plant. Radar system was developed by GE for the Air Defense Command

height analyzer automatically answers these questions.

Data Analysis

To do this, the analyzer samples ceilometer output and records the height at which the greatest signal is received during each scan. These data are stored in a small 100-word magnetic drum memory. After each scan there is a short period during which no information is received and the stored data are analyzed. Equipment output is a set of answers pertaining to the last ten minutes, updated for each scan.

One of two inputs to the equipment is a shaft-position signal consisting of a series of pulses from the rotating searchlight. The pulses advance an altitude counter whose count is related to searchlight angle and in turn to cloud height.

The other input is an a-c signal from the photocell at the modulation frequency of the light source. It is passed through an analog-to-digital converter that samples it in synchronism with the modulated light source. At the end of each scan, the equipment has determined altitude number corresponding to maximum cloud signal.

The number is recorded on the memory in one of 100 spaces. Numbers from successive scans occupy consecutive spaces. The 101st number replaces the original number in space one, which was recorded ten minutes earlier. Thus, the data are continuously updated.

Between scans, data are summarized to determine which number occurs most often. At the end of this summation, an information storage unit contains the altitude that occurred most frequently over the past ten minutes. Other questions can be answered using counters and additional storage units to find the highest or lowest altitude at which the maximum cloud signal was observed 3 or more times.

The various outputs from the cloud-height equipment are decoded to decimal numbers, which are set up as switch contacts to control remote displays and teletype equipment. Except for output switches and magnetic drum, the equipment is transistorized and was made almost exclusively digital in operation to assure high reliability.

Heat Transfer in Component Design

IN THE DESIGN of electronic components, there is a general trend toward higher dissipation and smaller space. This is particularly true of power tubes where more energy output is wanted at higher operating frequencies which require smaller dimensions.

Heat transfer considerations are neither trivial or simple, according to M. Mark and D. R. Fairbanks of Raytheon's Wayland Laboratory. In a recent article on heat transfer these authors go into present packaging and performance requirements for electronic components[1].

Components

Basic heat transfer is discussed, so is general cooling design and heat densities; conduction, radiation and convection.

The authors point out that in most high density electronic components, the dissipated energy is either in the form of resistive loss in the metal, or electron beam energy dissipated on the surface of the metal. Examples of the first: resistors and solenoids; and of the second: many different types of electron tubes. In the latter category, the energy is dissipated, principally, on the interior surface of the anode, which is usually made of OFHC copper and must be conducted through a certain thickness of wall which separates the coolant from the evacuated space.

In most types of electron tubes, such as traveling-wave tubes, klystrons, and ordinary amplifiers, the anode is in the shape of a hollow cylinder or cup, with the coolant on the outside. However, in types such as magnetrons and amplitrons, the heat must be removed from internal anode vanes or paddles which are within the cavity.

When heat dissipation is high, the coolant must be brought into and circulated through the individual vanes. Such tubes are difficult to cool since the vanes are quite small and dissipate large amounts of heat.

The heat transfer article points out that allowable operating temperatures for the various tube types are generally governed by three considerations: the maximum allowable interior anode metal temperature, the maximum allowable glass-to-metal seal temperature, and the maximum allowable wetted surface temperature in touch with the coolant.

The first limit is necessary to prevent gassing of the tube by the release of dissolved gases from the interior surface of the anode metal. The second limit prevents mechanical failure, leakage, or glass degradation. The third limit is necessary to prevent decomposition of the coolant (scale formation, which is very detremental to high density heat transfer, unwanted boiling, or an impractical coolant pressurization requirement.

Allowable limits for the maximum interior anode metal temperature range from 100 C for some tubes very sensitive to gassing, to over 500 C for tubes that are relatively insensitive to gassing. A typical limit for the glass-to-metal seal is 200 C. The formation of scale or deposits at the wetted hot spot area is difficult to control at high temperatures. The most generally acceptable coolant is water, with the systems design and materials carefully selected, and with the water exceedingly pure. Allowable wetted hot spots rarely exceed 200 C.

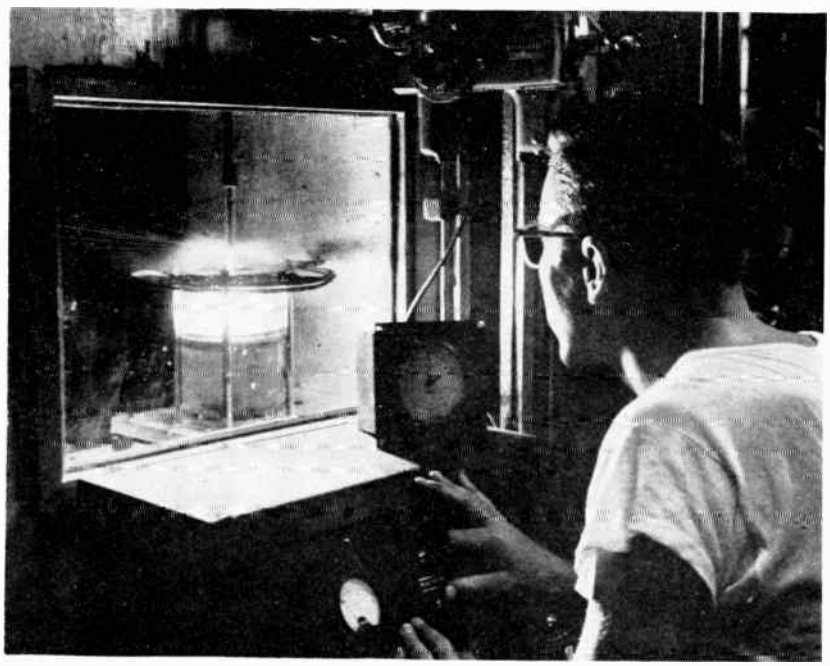
Careful Evaluation

The heat density in some components currently being designed is such that cooling is a prime obstacle. In the future, the authors state, the cooling problem may actually force a limitation on design unless concepts and techniques unknown at the present time can be developed.

With the present trend towards very high power components, cooling methods require careful evaluation leading to efficient designs.

As Marks and Fairbanks explain, free convection and radiation can prevent unacceptable temperature

New Nose Cone Protective Material



Developed by General Electric in its Missile and Space Vehicle Department Laboratory at Philadelphia, an organic plastic substance is shown here being exposed to a supersonic flame more than twice the temperature of the sun. The terrific heat is generated by a carbon arc encased in a water swirl. The scientist operating the mechanism is protected by darkened glass. The new material can be made elastic, flexible, or hard. In all variations it possesses excellent heat protective qualities

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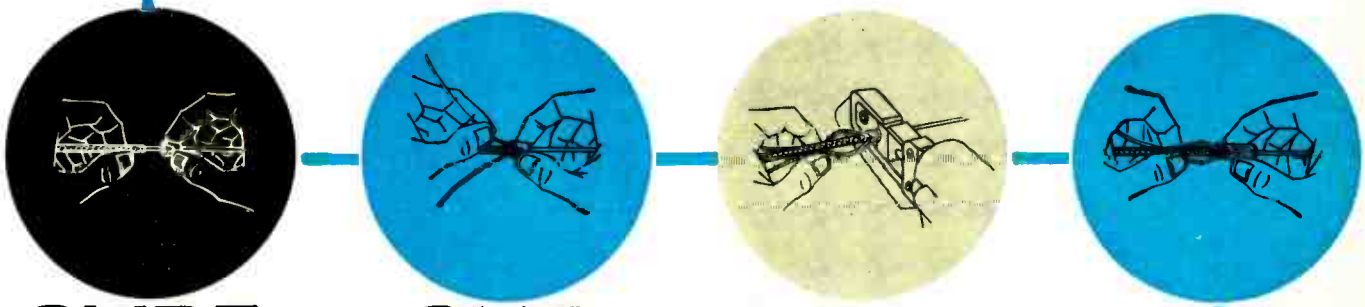

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rise for relatively large heat dissipations, providing the equipment is designed properly. There must be enough room surrounding the compounds to allow for the development of fluid velocities associated with free convection. Parallel vertical plane surfaces in air normally should be at least one-half inch apart for effective free convection.

Forced convection can be used either by channeling the cooling fluid directly over the components, or indirectly through a more complex cooling system involving a heat exchanger to which the component is attached by good conductive paths. When considering conduction, oxygen-free high conductivity OFHC copper is for practical reasons the material used with silver only slightly better. Finning is most advantageous when thermally poor coolants are used, but care must be taken in fin design.

REFERENCE

(1). M. Marks and D. R. Fairbanks, Heat Transfer for High Density Components, Raytheon's *Electronic Progress*, p 10, July-August 1959.

International Standards For Electronic Devices

THREE NEW publications of the International Electrotechnical Commission, IEC, are now available through the American Standards Association. These recommendations concern capacitors, resistors and measurement of r-f radiation.

Recommended methods of measuring radiation from receivers for amplitude-modulation, frequency-modulation, and tv broadcast transmission are described in IEC Publication 106. These methods were established to make possible comparison of the results of radiation measurements obtained by different observers. The first section of the publication covers measurement of radiation at frequencies below 30 mc from receivers for a-m broadcast transmissions, and radiation caused by tv receiver time-base circuits. A second section covers measurements between 30 and 300 mc.

Capacitors

Recommendations for ceramic dielectric capacitors, Type I, lay

down uniform requirements for judging properties of fixed ceramic dielectric capacitors specifically suited for resonant circuit application or any other applications where low losses and high stability of capacitance are essential. Excluded are capacitors for r-f currents exceeding one amp or for a reactive power exceeding 200 var, for telecommunication equipment and electronic devices employing similar techniques.

Publication IEC 108 describes test methods and gives a color code for the marking of values of capacitance and tolerance. Recommendations are given for classification into groups according to their ability to withstand conditions as specified in IEC Publication 68, Basic Climatic and Mechanical Robustness Testing Procedure for Components for Radio Communication.

Resistors

Recommendations for fixed nonwirewound resistors, Type II, applies to resistors with a rated dissipation not exceeding 3 watts and a rated resistance value between 10 ohms and 22 megohms, suitable for use in circuits where high stability of the resistance is not of major importance, for telecommunication equipment and electronic devices using similar techniques. This publication, IEC 109 lays down uniform requirements for judging the properties and classification into groups according to IEC Publication 68.

These standards can be obtained from the American Standards Association, in New York City.

Printed Circuit Jack

This novel jack is shown connected to base plates of circuit board. Contact-making surfaces are made of silver, and the tension springs are punched out of spring steel. Twin-contact jack was developed by J. Bernutz of Mix & Genest Werke, Stuttgart, Germany

Improve Ultrasonic Wash Methods

By D. E. KOONTZ and I. AMRON, Bell Telephone Laboratories, Inc., Murray Hill, N. J. and Laureldale, Pa.

ULTRASONIC CLEANING efficiency can be improved by attention to factors revealed in a series of tests comparing various cleaning methods and conditions. The tests also demonstrated that ultrasonic cleaning is superior to some other commonly used methods of cleaning electron device parts.

On the basis of test results, ultrasonic washing tanks of the type shown in Fig. 1 were built and are giving satisfactory service. Contaminants which could cause device failure are successfully removed. Among these are loose carbon on carbonized vacuum tube anodes and gas diode electrodes, lint and other solid particles on fine wire grids, chips in glassware and glass seals, and contaminants which would cause the plating of semiconductor device parts to blister and scale.

Ultrasonic cleaning before brazing and soldering results in better wetting of the parts by the braze or solder.

Test Procedures

In the first test, 30 flat cathodes were lapped with diamond dust suspended in a grease base, washed with petroleum spirits, air-dried and weighed. They were trichlorethylene vapor degreased 3 times and reweighed. Next, the cathodes were boiled twice in distilled water, rinsed with acetone and reweighed. Finally, they were ultrasonically washed in a detergent solution (Igepal, Antara Chemicals), dried and reweighed. Results are shown in Fig. 2.

Secondly, small platinum gauze cylinders were coated with a cement-like shell of grease and alumina powder. Results of tests designed to show the efficiencies of aqueous cleaning methods are given in Fig. 3.

Another series of tests established the efficiencies of ultrasonic cleaning equipment at high and low frequencies (Fig. 4). The tests were made on axially corrugated cylinders of thin stainless steel sheet, periodically rotated in the bath. Low frequency ultrasonic fields are more efficient, are less directional and irradiate a larger area. Larger components and more components can be irradiated simultaneously and uniformly.

Stable standing sonic waves must be maintained in the solution for the most efficient cleaning. This happens when the surface of the liquid opposite the transducer is at a node. Cleaning time is shortest when work is placed at an antinode (Fig. 5). This effect can be compensated for inactual practice by moving the parts in the bath.

Flowing Bath

Redepositing of removed contaminants can be prevented by a flowing wash bath, but dissolved gas in such baths impair ultrasonic cleaning efficiency (Fig. 6). However, ultrasonic energy can be used to outgas clear water in 15 to 20 minutes and detergent solution in 75 to 100 minutes. Outgassing is

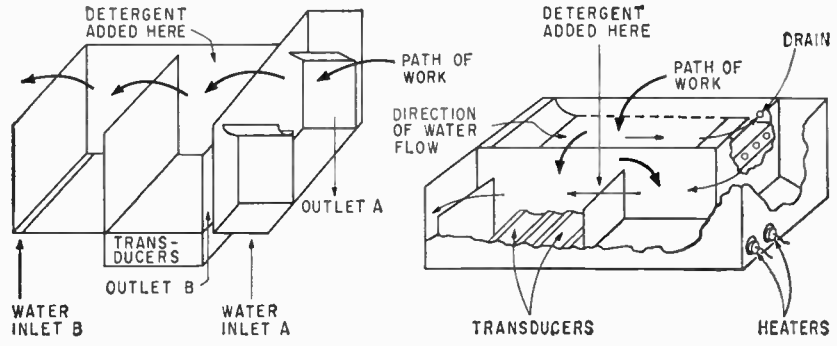


FIG. 1—These ultrasonic washing tanks were designed around advantages and limitations disclosed by tests of ultrasonic efficiency under various conditions

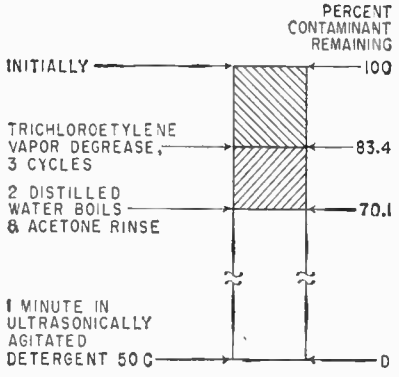


FIG. 2—Improvement of cathode cleaning by ultrasonically-agitated detergent bath

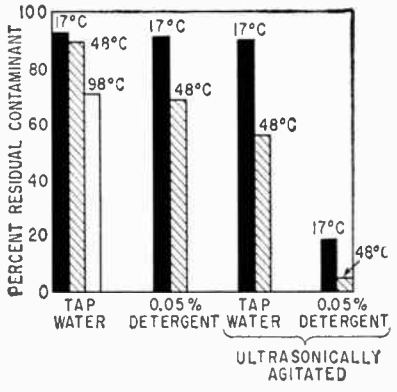


FIG. 3—Comparative efficiencies of aqueous cleaning methods

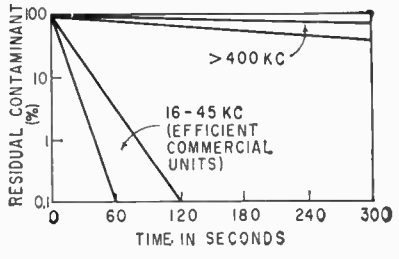


FIG. 4—Cleaning rates of high and low ultrasonic frequencies

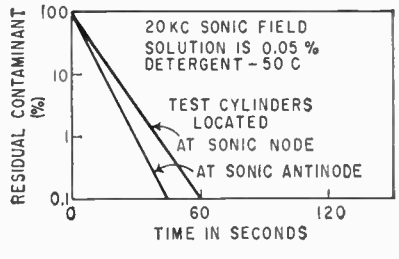
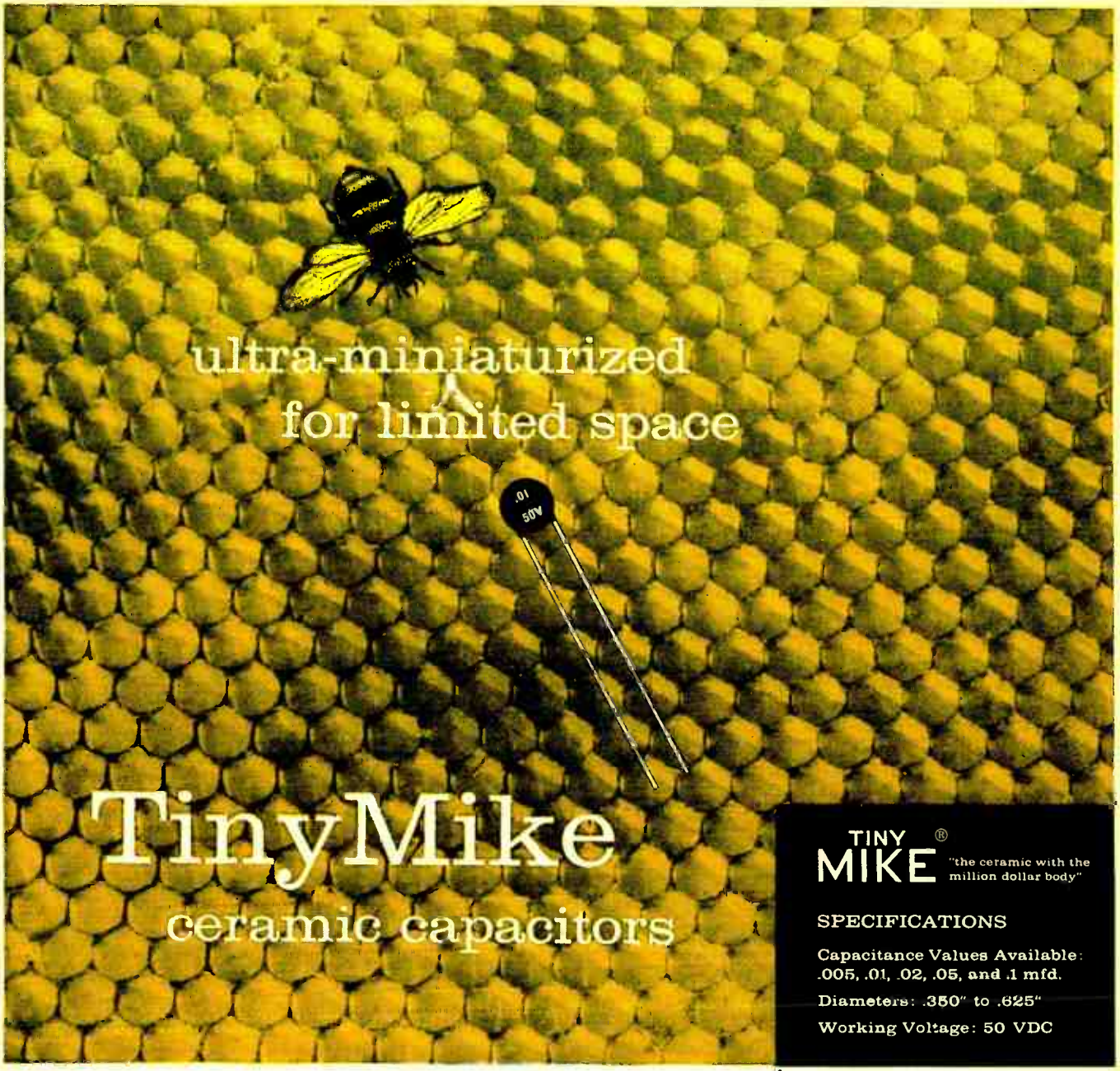


FIG. 5—Comparison of ultrasonic cleaning at sonic nodes and antinodes



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CAPACITORS

complete when streams of gas bubbles no longer rise to the surface. Gas in tap water will prevent cavitation almost entirely if flow is greater than 1 percent of volume per minute, but this flow is usually adequate for cleaning electronic components.

If parts are to be held in baskets during washing, baskets should be made of screens finer than 200 mesh, screens coarser than ¼ inch or thin sheet material with drainage perforations. Intermediate screens scatter large portions of the radiation. Large numbers of parts should not be packed in the basket, since this also scatters the radiation. Parts should be separated by jigs or spread in thin layers at right angles to the radiation.

In the tanks of Fig. 1, flowing water removes gross contaminants before ultrasonic washing in a detergent solution. Weirs control the flow and discharge of surface water containing gross contaminants.

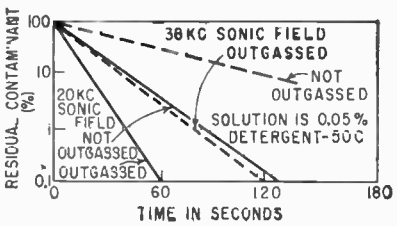


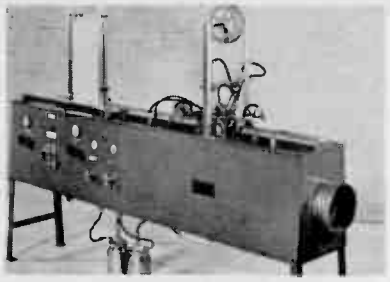
FIG. 6—Comparison of ultrasonic cleaning efficiency of baths with and without dissolved gas

These units are operated at a bath temperature of 50-60 C, a maximum flow rate of 1 percent of ultrasonic tank volume per minute and with ultrasonic frequencies below 45 kilocycles. Maximum distances of workpieces from transducer is usually 12 inches.

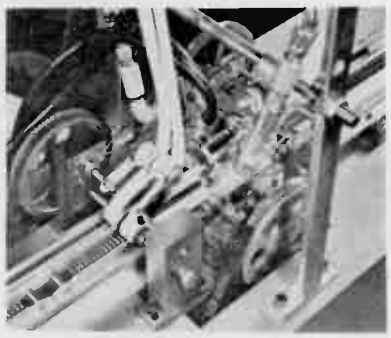
(From a paper by the authors in "Symposium on Cleaning Electronic Device Components and Materials", ASTM STP 246, American Society for Testing Materials, Philadelphia, 1959.)

Traveling Masks Limit Spray Coating Area

TRAVELING MASKING strips are used in a spray-coating machine which will automatically encapsulate 4,000 diodes an hour. The masking



Traveling masks are fed from rolls, racks from magazine and spray coating from pressure tanks



Closeup of spraying station

method permits automation since mechanical spray masks, registering devices and mask cleaning operations are not necessary, according to Conforming Matrix Corp., Toledo, Ohio.

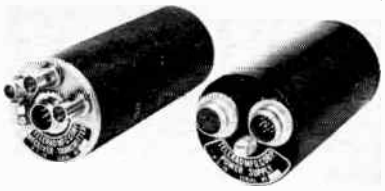
The strips limit the spray to the diode body and selected portions of the leads. Components are loaded onto racks which move continuously through the spray station. The diodes are spun in the racks for even coating. Coatings can also be applied to capacitors, fuses, resistors and transistors, the firm reports.

Soldering Iron Holds Constant Temperature

THERMOSTATIC soldering iron has recently been introduced in England. The iron, made by Cardross Engineering Co. Ltd., Cardross, Scotland, is reported to provide a temperature control of ±15 C at a normal setting of 230 C to 250 C.

Differential expansion of an inner rod and outer case operate a snap action switch by an intermediary magnifying lever movement. Heat transference to the handle is reduced by cutting short the copper alloy expansion rod and joining it to a low-conductivity metal. The iron is made in 70 w and 500 w sizes.

On The Market



S-Band Beacon
small and light

TELERAD MFG. CORP., Flemington, N. J. Model 19SC is an S-band beacon for space communications. The receiver-transmitter is 6¼ in. long by 2½ in. diameter; the power supply, with an input voltage of 6.5 ±0.5 v d-c at 2.5 amperes and voltage output of 150 v d-c, measures 5 in. long by 2½ in. diameter. Each unit weighs 2 lb.

CIRCLE 200 ON READER SERVICE CARD

Power Supply
dual-range

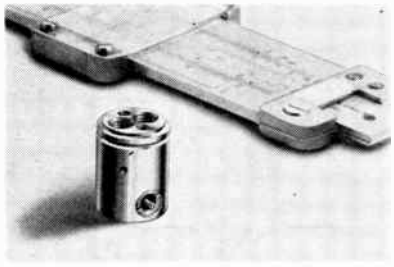
MODEL RECTIFIER CORP., 1675 Utica Ave., Brooklyn 34, N. Y. The DV-III transistor power supply provides these continuously variable outputs: 0-60 v d-c at 1 ampere, or 0-30 v d-c at 2 amperes, or 0-115 v a-c at 1.2 amperes. It features continuously variable autotransformer; 2-section choke input filter; 2-range voltmeter and 2-range ammeter, accurate to 2 percent; 5-way output binding posts; magnetic circuit breaker and range-indicating pilot lights.

CIRCLE 201 ON READER SERVICE CARD

Counter-Timer
versatile unit

ERIE-PACIFIC DIVISION of Erie Resistor Corp., 12932 S. Weber Way, Hawthorne, Calif. Model 400 100-kc universal electronic counter-timer is suited to measurement, calibration, timing and control. It can count regular or random events to 100,000 cps-manual gate, and has a time interval measurement range of 0.5 millisec to 278 hr.

CIRCLE 202 ON READER SERVICE CARD



Acceleration Switch
5 g to 50 g

INERTIA SWITCH, INC., 311 W. 43rd St., New York 36, N. Y. Used in missiles and aircraft, series 5 I-S switch is responsive to axial acceleration, uni- and bi-directionally, from 5 g to 50 g. Actuating time is 20 millisec, accuracy within 5 percent. It has only one moving part: a precision ground ball held by a uniform magnetic field. The ball is released to close or open an electric circut when force of acceleration exceeds the magnetic force. Service life of the switch is 100,000 cycles.

CIRCLE 203 ON READER SERVICE CARD

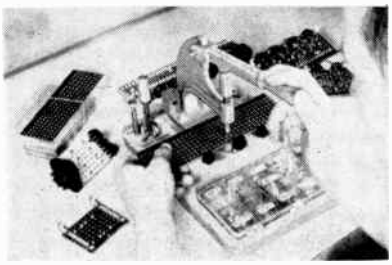
H-V Power Supply
meets Mil Specs

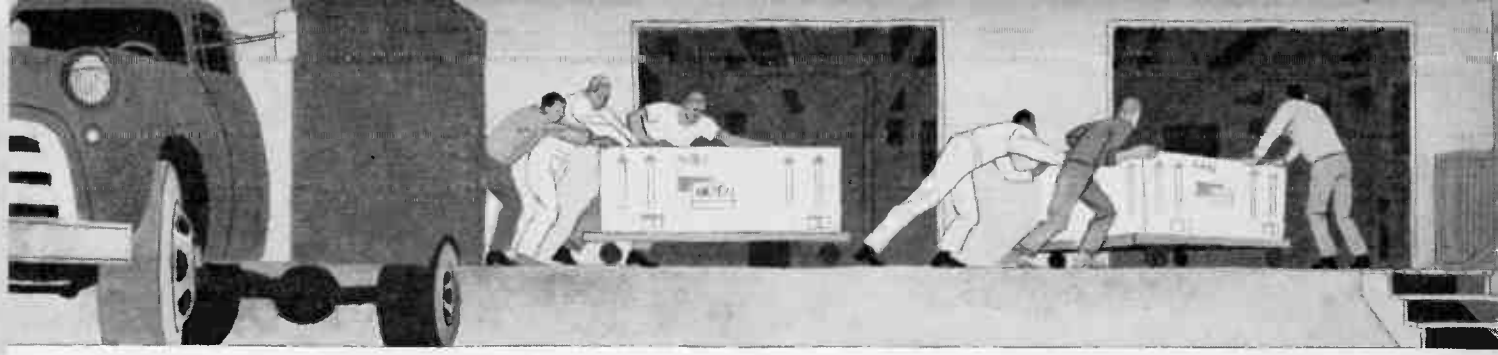
SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer Road, Houston, Texas. Model PS-28 h-v power supply produces 16 kv d-c at 200 μa from 26.5 v d-c 650 ma nominal input. Conversion is through a mechanical vibrator, transformer and voltage doubler. Unit is housed in a die-cast aluminum case measuring 4¾ in. high, 6⅜ in. wide and 6¾ in. long, and weighs 8 lb. It can operate at ambient temperatures from −65 to +125 F.

CIRCLE 204 ON READER SERVICE CARD

Mounting Kit
all-in-one tool

ALDEN PRODUCTS CO., 117 N. Main St., Brockton 64, Mass. Terminal card mounting kit No. 42 is a low-cost, all-in-one tool for rapid construction of resistor boards, turrets, vertical plane circuits, plug-in units, etc., for prototypes and small production runs. In addition to providing a faster, easier method of mounting standard components the kit is also a logical means to get started with plug-in unit construction. This universal tool punches terminal holes, swages terminals, eyelets sockets, and





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John A. Hickey, Industrial Products Manager, discusses new Raytheon PF Transformer line with William P. Sharpe, Product Planning Manager.

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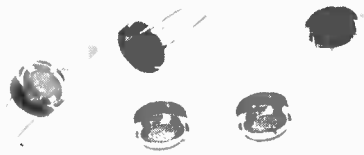
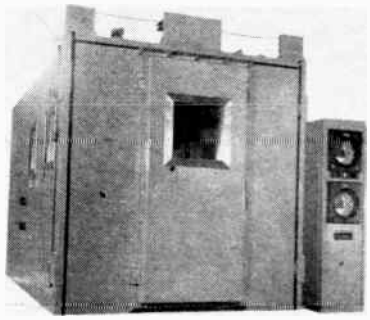


Resistors light dependent

FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y. Small, light dependent resistor, with resistance ratio in excess of 25,000 to 1 for a light intensity change from total darkness to 1,400 ft candles, consists of cadmium sulfide cell with silver electrodes. Can eliminate high gain amplification stages, has an interminable service life and is low cost. Used for automatic control of tv picture brightness and other applications calling for a change of circuit resistance as light intensity varies.

CIRCLE 206 ON READER SERVICE CARD

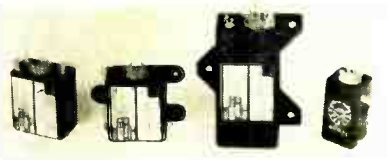


Test Chamber walk-in type

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model WD-420 walk-in environmental test chamber has a temperature capability from +500 F to −100 F. Available humidity control range is 20 percent to 98 percent from 35 F dew point to +185 F. Several instrumentation options can be furnished. Unit pictured shows electronic potentiometer type programming recording controllers. These instruments operate from a copper

constantan thermocouple and have a calibrated accuracy of ¼ of 1 percent of scale.

CIRCLE 207 ON READER SERVICE CARD



Time Delay Relays highly accurate

TEMPO INSTRUMENT INC., P. O. Box 338, Hicksville, N. Y. A group of time delay relays with transistor timing module are accurate to ±3 percent under any combination of the following: input voltage variations from 18 to 31 v d-c; temperatures, −55 to 125 C; vibration to 20 g's, 2,000 cps; shock to 50 g's, 11 millisec; acceleration to 20 g's. Time delay, which is fixed and occurs on pull-in, may be specified anywhere between 0.70 and 300 sec.

CIRCLE 208 ON READER SERVICE CARD

Power-Film Resistors noninductive

FILMOHM CORP., 48 W. 25th St., New York 10, N. Y. Type RD resistors exceed requirements of MIL-R-11804C. They are noninductive and ideal for power and h-f applications. Standard temperature coefficient is less than 0.035 percent per deg C. Units can be supplied in values from 10 ohms to 3 K ohms in standard sizes of 7 to 150 w. Standard tolerances are ±2 percent and ±5 percent. All resistors are derated to zero at 235 C.

CIRCLE 209 ON READER SERVICE CARD

Microwave Relay heterodyne repeater

SARKES TARZIAN, East Hillside Drive, Bloomington, Ind. RMW-1A crystal-controlled heterodyne re-

FILLS THE 20-30w HI-FI POWER GAP!

10-15 W	15-20 W	30-50 W
G-E 6BQ5 6DZ7	G-E 7189-A	G-E 6L6-GC

NEW

7355
BEAM POWER PENTODE

General Electric's new 7355 answers a hi-fi, stereo need that is felt sharply—for low-distortion power in the 20 to 30 watts range. Fast-selling "middle of the line" instruments require this output. Two 7355's provide it, with these advantages to the designer: (1) tube and circuit costs are economical. (2) Tube size is right—only 3" high seated. (3) The tube quality is there—same 5-ply plate construction as the premium-performance G-E 6L6-GC. See ratings, at right, for power that is hand-tailored for medium-size hi-fi with superior tone! Further information about new Type 7355 available from any General Electric tube office below.

Max plate dissipation	18 w
Max screen dissipation, continuous	2.5 w
Max screen dissipation, peaks of speech and music	5 w
Power output for two tubes p-p Class AB_1 under following conditions: $E_b = 300$ v, $E_{c2} = 250$ v, $E_{c1} = -21$ v, $R_L = 4000$ ohms	20 w to voice coil, with only 1.8% distortion without feedback

* * *

In addition to 5 power tubes that cover a wide output range, G.E. makes available these 4 high-quality types for other hi-fi, stereo applications:

5AR4	Rectifier tube
6CA4	Rectifier tube
7025	Low-noise twin triode for pre-amplifier use
7247	Utility low-noise double triode with dissimilar sections

200 Main Ave., Clifton, N. J.
(In Clifton) GRegory 3-6387
(In New York City)
WIsconsin 7-4065, 6, 7, 8

3800 N. Milwaukee Ave.
Chicago 41, Illinois
SPring 7-1600

11840 W. Olympic Blvd.
Los Angeles 64, Calif.
Phones: GRanite 9-7765
BRadshaw 2-8566

Progress Is Our Most Important Product

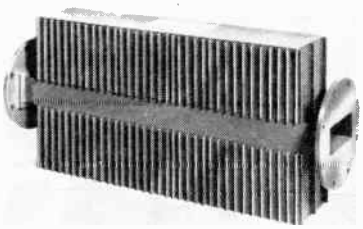
GENERAL ELECTRIC

2-211-103

CIRCLE 105 ON READER SERVICE CARD

peater microwave relay for multihop installation allows unattended operation for intercity interconnections in the 2,000 mc band. Video and audio dropouts can be made at any intermediate point.

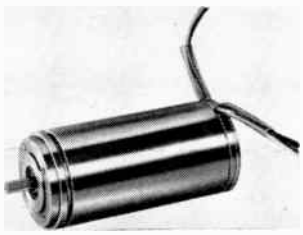
CIRCLE 210 ON READER SERVICE CARD



Harmonic Filter high-powered

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Filter designed to suppress typical harmonic and spurious signals generated by high-power magnetrons, klystrons and twt's. Intended for use in waveguide line between tube and antenna, it has an insertion loss in excess of 25 db for all signals from 5,400 mc to 10,000 mc, can handle power levels up to 5 megawatts, has an insertion loss below 0.2 db throughout pass band from 2,700 mc to 3,100 mc; vswr across both pass and stop bands is less than 1.8.

CIRCLE 211 ON READER SERVICE CARD



Motor Tach Generator meets MIL-E-5272

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc. Size 15 temperature compensated motor tach generator incorporating a 4-pole 115 v fixed phase motor with a 36 v control phase center tapped winding suitable for transistorized operation is available. Motor's stall torque is 1.5 oz in. and no load speed 9,500 rpm. Generator has 115 v excitation winding, output voltage gradient of 2.2 v per 1,000 rpm, linearity 0.05 percent up to 4,200 rpm, and ± 0.2

THREE TOOLS FOR QUALITY CIRCULATION

Members of a select group, the readers of **electronics**

As fast as subscription orders are received they are examined individually—by Hugh J. Quinn, Circulation Manager, who stamps each card:

ACCEPTED—to indicate a subscriber is actually engaged in research-design/production/management as a maker or user of electronics equipment.

QUESTIONNAIRE—to delay acceptance until information concerning the subscriber—his function, his company, his title are definitely known.

REJECTED—whenever the order indicates that the individual is NOT within the editorial field of the publication.

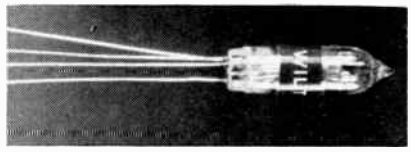
electronics is a member of a select group too—The Audit Bureau of Circulation publications—comprised of those magazines and newspapers whose publishers believe that a reader's interest in a publication is best demonstrated when he pays to receive it—those publishers willing to submit to exhaustive periodic audits in order to prove that their circulation is among those individuals they are pledged to serve, and among screened *selected* individuals ONLY.

The Electronics Man "buys" what he reads in . . .

ABP/ABC A McGRAW-HILL PUBLICATION / 330 WEST 42nd STREET, NEW YORK 36, N. Y.

percent maximum variation in output voltage over ambient temperature range of — 10 C to + 95 C.

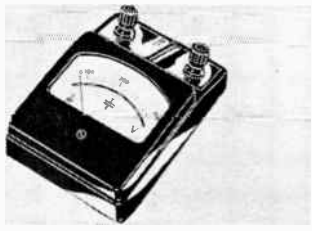
CIRCLE 212 ON READER SERVICE CARD



Indicator Thyratron dual-control

WILTEC ELECTRONICS, INC., 53 Water St., South Norwalk, Conn. WC-20 subminiature indicator thyratron requires two coincident signals of 4.5 v and negligible control current to produce bright neon indicating glow in dome, visible from any angle. A single signal applied to either of two control grids will not produce an indication. Use in computers, data processors, signal systems, and keyboard equipment.

CIRCLE 213 ON READER SERVICE CARD



Voltmeters electrostatic

GRH HALLTEST CO., Valparaiso, Ind. Electrostatic voltmeters, available as table models and panel instruments, have ranges from 0-250 v up to 0-2,000 v d-c and a-c. Instruments have magnetic eddy current damping. Capacity of meter movement is 12 to 65 millimicrofarads, internal resistance in dry air 10^{15} ohms.

CIRCLE 214 ON READER SERVICE CARD

Miniature Choppers general-purpose

COLLINS ELECTRONICS MFG. CORP., Stevensville, Md. Series of choppers for aircraft and line frequencies in spdt or dpdt types, 60 or 400 cps, in both make-before-break and break-before-make designs. They are hermetically sealed and dry-gas filled for operation in

any known climate. Insertion and removal is simplified by connections brought out through the base. Maximum noise is 450 μv across 1 megohm at 400 cps.

CIRCLE 215 ON READER SERVICE CARD

Silicon Rectifiers
compact design

SYNTRON Co., Homer City, Pa. Style 30 silicon a-c to d-c power rectifiers weigh $\frac{1}{4}$ oz, and, with an $\frac{1}{4}$-in. hex stud base, maximum height is $1\frac{1}{16}$ in. They are rated at 10 amperes average at 150 C ambient; are available with piv ranging from 50 to 400 v in 50-v steps. Outer case is nickel plated to withstand severe service without failure.

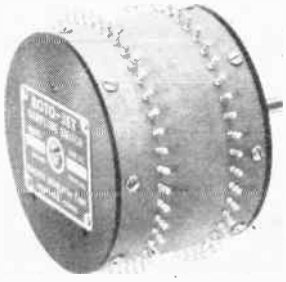
CIRCLE 216 ON READER SERVICE CARD

Airborne Converter
rugged unit

ALTO SCIENTIFIC Co., INC., 855 Commercial St., Palo Alto, Calif. Model M1116 d-c to d-c converter is hermetically sealed to meet missile flight environments. It has input voltage of 28 v $\pm$10 percent; output, 350 v at 110 ma; regulation, $\pm$5 percent from 75 to 100 percent

of full load; base plate temperature range, 30 F to 135 F; storage temperature, −65 F to +160 F; output ripple, less than 1.2 v rms; efficiency, more than 60 percent.

CIRCLE 217 ON READER SERVICE CARD



Sampling Switch
wiperless contacts

ELECTRIC REGULATOR CORP., Norwalk, Conn. Roto-Jet sequential sampling switch, actuated by a rotating jet of air, can make more than 3,600 closures per sec. Signals of 1, 2 and 3 mv can be transmitted free from noise without amplification or filtering. Applications include use with thermocouples, strain gages, light-sensitive devices and similar elements of computer, telemetering, and complex process control systems. Sampling speeds available up to 40 rps.

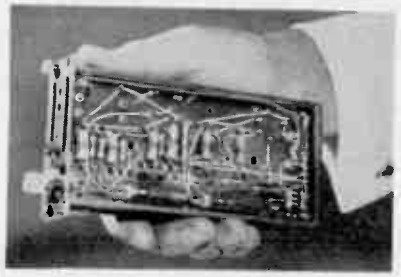
CIRCLE 218 ON READER SERVICE CARD

Pulse Transformer
low duty cycle

EDGERTON, GERMESHAUSEN & GRIER, INC., 160 Brookline Ave., Boston, Mass. Pulse transformer to supply pulse energy to sonar transducers withstands 15,000 psi water pressure at 36,000 ft below

sea level. Peak pulse is 8,000 v. It is mounted in an oil-filled Plexiglass container with neoprene rubber end plugs. Oil filling under vacuum exhausts contained gases, making the unit a solid mass able to resist extreme pressures. Diameter is 2½ in.; length, 11 in.

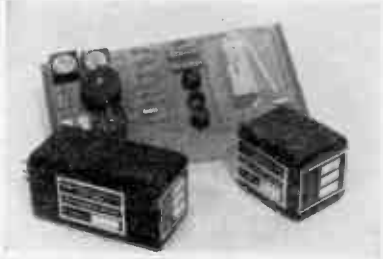
CIRCLE 219 ON READER SERVICE CARD



F-M Record Amplifier
airborne type

CONSOLIDATED ELECTRODYNAMICS CORP., 300 N. Sierra Madre Villa, Pasadena, Calif. Type 1-151 amplifier, for use with airborne magnetic tape recorders, will operate from −54 C to +71 C. Center frequency range is from 1.685 to 54 kc in six steps for recording at tape speeds from 1⅞ to 60 ips. Peak-to-peak sensitivity range is 1 to 10 v; deviation on all frequencies, ±40 percent.

CIRCLE 220 ON READER SERVICE CARD

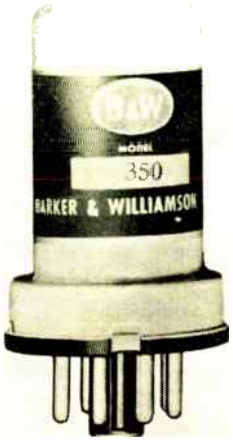


Oscillators
subcarrier type

DORSETT LABORATORIES, INC., 401 E. Boyd St., Norman, Okla. Three new silicon transistor voltage controlled subcarrier oscillators for telemetering applications. Model O-7A is available in all 7½ percent IRIG channels with a 5 v input range sensitivity for full channel deviation, affords output of 1 v rms into 1,000 ohms, has self-contained potentiometer controls for centering and output level adjustments, weighs less than 5 oz, occupies ap-

proximately 3 cu. in. O-7B is a p-c version for plug-in card rack applications. O-8 is a subminiature unit, about a 1 in. cube, and provides for remote location of alignment controls.

CIRCLE 221 ON READER SERVICE CARD



Phase-Shift Network
± 1.5 deg accurate

BARKER & WILLIAMSON, INC., Bristol, Pa. Model 350, type 2Q4 compact phase shift network splits any 300 to 3,000 cps audio signal into two equal amplitude components that are 90 deg out of phase with each other. Typical applications include receiving and transmitting circuits in ssb suppressed carrier radio-telephony. Unit is designed to plug into a standard octal socket, and requires no adjustments.

CIRCLE 222 ON READER SERVICE CARD

Digital Encoder
solid state

MISSILE ELECTRONICS ENGINEERING CO., 14644 Keswick St., Van Nuys, Calif. Digital encoder provides parallel to series digital information for input to strip chart recorders or other airborne recording devices. System consists of six front panel switches calibrated 0 through 9 each. Any series of numbers may be selected by front panel switching and the output displayed in digital form to any recording device. Basic

timing markers are variable from millisec to 30 sec in duration. Size is 2½ in. by 5 in. by 3½ in. Price is $495.

CIRCLE 223 ON READER SERVICE CARD

Spectrum Analyzers
two new models

RAYTHEON Co., 520 Winter St., Waltham 54, Mass. New Rayspan spectrum analyzers use 100 filters to analyze signals. Models MRFR-30-5 and -6 can detect transient responses frequently missed by conventional sweeping-gate-type analyzers. Applications include vibration analysis, acoustic studies, industrial noise reduction, complex waveform analysis, tube microphonics and telemetered data analysis. Price: $4,500 and $4,950 respectively.

CIRCLE 224 ON READER SERVICE CARD

Wire Wrapper
subminiature

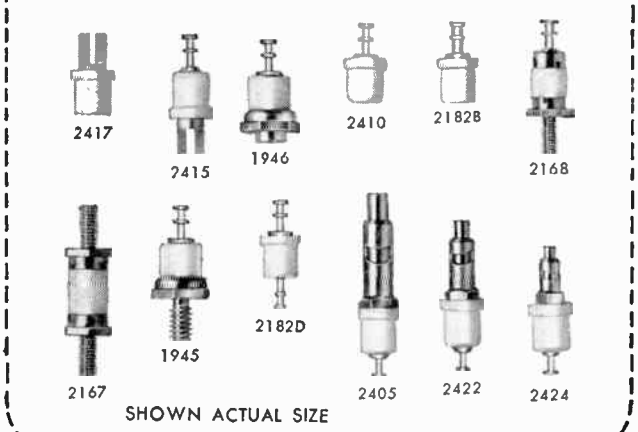
WINKLER LABORATORIES, 5225 N. 20th St., Phoenix, Ariz. Tool makes secure connections to subminiature and transistor sockets. It will accommodate all wire sizes compatible with subminiature terminal size and spacings including No. 26 Awg and smaller.

CIRCLE 225 ON READER SERVICE CARD

Delay Network
good attenuation

RATIGAN ELECTRONICS INC., 425 W. Cypress St., Glendale 4, Calif. The

Build STAMINA Into Your Circuits

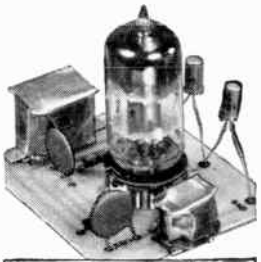


CAMBION® Teflon-insulated terminals and diode clips offer a wide choice of quality-guaranteed components designed to withstand the shock and vibration of today's toughest operating and service requirements. Uniquely fastened Teflon sections provide positive, press-type mountings as well as superior insulation. Spring-loaded diode clips for wire diameters up to .085" and ferrule contact types for pins up to .085" diameter assure tight, troublefree connections. Terminals and clips brass per QQ-B-626a ½ hard. Terminals silver plated, clips bright alloy plated unless otherwise specified. Get complete information. Write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts.

CIRCLE 148 ON READER SERVICE CARD

LOWER COST MAGNETIC SHIELDING

Co-Netic & Netic Foils Permit Max. Miniaturization, Improved Performance . . . Extremely Versatile— Readily Cut to Any Shape, Wrap Like Tape



How Co-Netic & Netic foils lower your magnetic shielding costs: 1) You use less shielding material because (a) foils are only .004" thick and (b) foils cut easily to exact shape required, minimizing waste. 2) Permit simple shielding of odd shapes and hard-to-get-at components, saving valuable time and eliminating tooling costs and inflexibility of rigid metals. These advantages make possible much smaller and less costly systems, as components may be positioned in close proximity without interference from damaging magnetic fields.

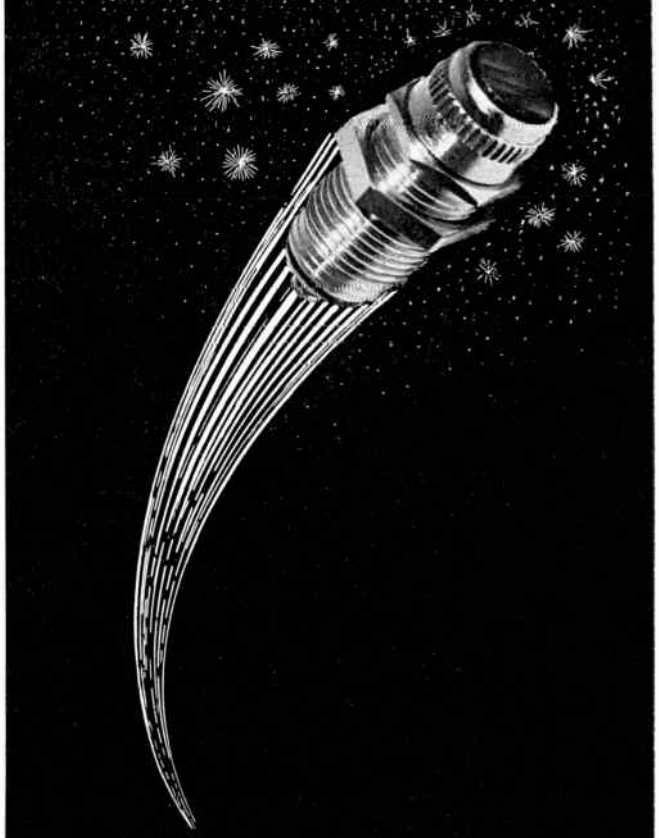
These foils are non-shock sensitive, non-retentive, require no periodic annealing. They effectively shield electrostatic and magnetic fields over a wide range of intensities. Both foils available from stock in any desired length in various widths.

Co-Netic & Netic foils are successfully solving many types of magnetic shielding problems in numerous critical satellite, missile, magnetic tape and other military, airborne, electronic and laboratory applications. These foils can help you solve your magnetic shielding problems.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue • Chicago 22, Illinois
Originators of Permanently Effective Netic Co-Netic Magnetic Shielding

CIRCLE 149 ON READER SERVICE CARD

Color-Lite the touch of BRILLIANCE



...in panel design

Only COLOR-LITES permit the design of compact, low cost panels. Their small size and clean, neat appearance assist in the design of more functional indicator panels for test equipment, production machinery, missile test stands and aircraft.

Design your next panel with COLOR-LITE subminiature indicator lights in mind. For unusually high quality, easy to install panel indicator lights, always specify COLOR-LITE

Write for COLOR-LITE Catalog A-58.

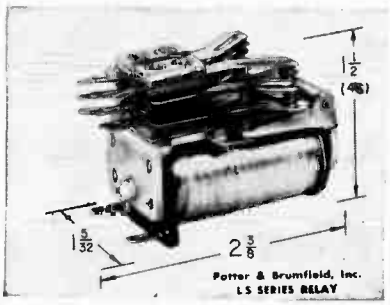
THE SLOAN CO.
4029 Burbank Blvd.
Burbank, California
Victoria 9-4667

Color-Lite

CIRCLE 115 ON READER SERVICE CARD

LD228 delay network operates at extreme altitudes of MIL-E-5272 and MIL-STD-202A. Time delay, 75 μsec ±5 μsec; taps at 38 μsec ±3 μsec, and 47 μsec ±3 μsec; network impedance, 330 ohms; input rise time, 1 μsec, output rise time, 4 μsec maximum; attenuation, 3.5 db maximum; distortion, 15 percent maximum distortion; size 7 by 4 by 1.3 in.; mounting, 4-8x32 screws.

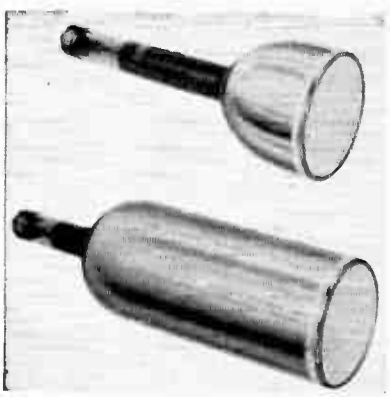
CIRCLE 226 ON READER SERVICE CARD



Relay
telephone type

POTTER & BRUMFIELD, INC., Princeton, Ind. LS relay with stainless steel hinge pin and riveted contact pusher pins can carry 10 milliamperes over 160 million operations. Can be equipped with up to 20 contact springs. Standard sensitvity is 65 mw per movable arm and 35 mw per movable arm can be supplied. Bifurcated contacts are rated at 4 amperes, 115 v, 60 cycles for resistive loads.

CIRCLE 227 ON READER SERVICE CARD



C-R Tubes
expanded line

CBS ELECTRONICS, INC., 100 Endicott St., Danvers, Mass. Line of 12 new ultra-resolution crt's in four resolution levels, up to 2,000 lines per in.; three screen sizes and three

screen phosphor characteristics; advanced applications in strip radar, photo reconnaissance, visual indication, closed circuit tv, and remote data pickup. The tubes are rugged, dependable and can be supplied with interchangeable yoke, focus coil, and video driver stage to provide maximum resolution.

CIRCLE 228 ON READER SERVICE CARD

Enclosed Motor explosion proof

WESTERN GEAR CORP., 132 W. Colorado St., Pasadena, Calif., announces a totally enclosed explosion proof motor designed for 200/115 a-c, 400 cps, 3 phase operation. It is rated at ½ h-p at 4,500 rpm ±5 percent. Motor operates at 75 percent efficiency, requires 4.5 amperes. It has a minimum of 1,000 hr life and incorporates permanently lubricated shielded ball bearings with corrosion resistant shaft. It measures 6.5 in. long by 4⅛ in. diameter.

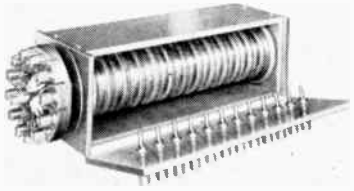
CIRCLE 229 ON READER SERVICE CARD

Bistable Amplifier highly sensitive

WESTINGHOUSE ELECTRIC CORP., 256 Collins Ave., Pittsburgh 6, Pa. Bistable amplifier for general use

as a sensitive static relay is particularly applicable to indicating and regulating systems. Operating from a low-level sensing element, it will drive a power amplifier stage to serve as a low-cost regulating system. It can be used in both proportional and on-off systems. Static elements are used exclusively.

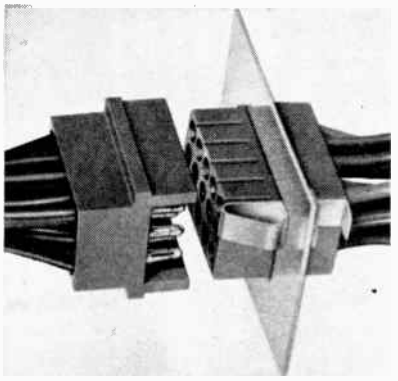
CIRCLE 230 ON READER SERVICE CARD



Slip Ring Assembly
high voltage

GENISCO, INC., 2233 Federal Ave., Los Angeles 64, Calif. The 21 kv slip ring assembly has 12 slip rings and brushes which carry 50 ma current at voltages up to 21,000 v, ring to ring and ring to ground. Rings and terminals are proportioned to prevent corona. Terminals also serve as controlled air gaps which breakdown around 28 kv, protecting insulation surfaces from flashover due to excess voltage.

CIRCLE 231 ON READER SERVICE CARD

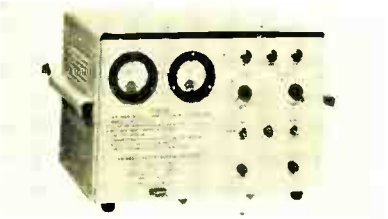


Plug & Receptacle
multiple circuit

MOLEX PRODUCTS CO., 9515 Southview Ave., Brookfield, Ill. Low cost plug and receptacle features up to 60 circuit combinations. Terminals are automatically crimped to wires and securely snap-lock into male and female units. They are easily removed with a simple ejector tool. A skirt on the plug serves as both terminal protector and positive po-

larity. Snap clips permit quick, easy mounting and removal for panel installations. A unit for 15 circuits measures only 1⅛ in. long and ⅞ in. wide.

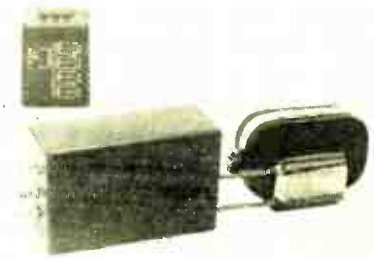
CIRCLE 232 ON READER SERVICE CARD



Battery Tester and charger

CHRISTIE ELECTRIC CORP., 3410 W. 67th St., Los Angeles 43, Calif. Type BC24-25T automatic tester and charger for 24 v aircraft batteries of the lead-acid or nickel cadmium types. Charging is precise despite variations in a-c line within range, battery initial state of charge or temperature. Voltage regulation is accomplished through magnetic amplifier control. Meets military standards.

CIRCLE 233 ON READER SERVICE CARD



Encapsulation Cups meet MIL specs

ELECTRONIC PRODUCTION & DEVELOPMENT, INC., 138 Nevada St., El Segundo, Calif. Line of encapsulation cups meet environmental requirements of airborne electronic systems. Fit standard cores and laminations, are light weight. Headers, glass-seal feed-throughs and potting molds are not required.

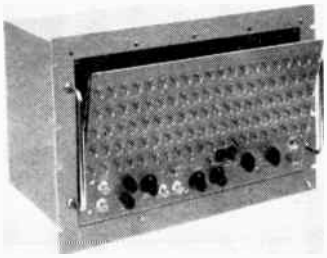
CIRCLE 234 ON READER SERVICE CARD

Insulating Material glass-Teflon

ROGERS CORP., Rogers, Conn. Duroid 5870 glass-Teflon insulating material in copper clad sheet, and

as rod, tubes and flat sheets. Microglass fibers coated with Teflon, developed primarily as high temperature circuit base stock, missile antenna dielectric and microwave strip insulation.

CIRCLE 235 ON READER SERVICE CARD



Generator
pulse pattern type

LA ROE INSTRUMENTS, INC., 1709B E. Montgomery Ave., Rockville, Md. Model 110 test set provides simulated and flexible time division pulse pattern. It features 1-100 pulses in any desired pattern, 2^{100} possible combinations; pulse sequence controlled from front panel; up to ±30 percent pulse width bias; pulse rate continuously variable from 100 pps to 10,000 pps from internal oscillator.

CIRCLE 236 ON READER SERVICE CARD

Amplifiers
negative resistance

MOTOROLA INC., Military Electronics Division, 8201 E. McDowell Rd., Phoenix, Ariz. Parametric amplifiers for 220 mc and 450 mc feature low noise figure and pump power. The 220 mc unit gain is 13 db; bandwidth, 500 kc; noise figure, approximately 1.5 db; pump power, 100 μw at 800 mc. The 450 mc gain is 11 db; bandwidth, 900 kc; noise figure, less than 2 db; pump power, 4 mw at 1,300 mc.

CIRCLE 237 ON READER SERVICE CARD

Servo Motors
size 18

AMERICAN ELECTRONICS, INC., 1025 W. Seventh St., Los Angeles 17, Calif. Size 18 servo motors meeting new high temperature specification of Navy Bureau of Ordnance, for continuous operation up to 250 C in shipboard Terrier and Tarter

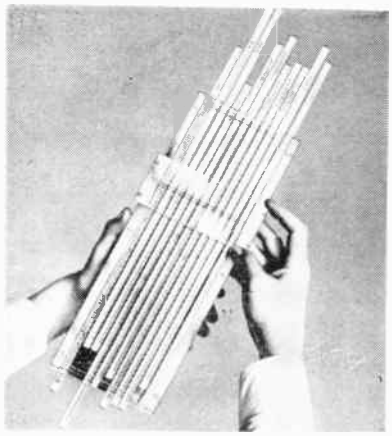
missile system computers. Ratings are: no-load speed, 3,000 rpm; stall torque, 2.5 in. oz per minute; weight, 14 oz; power input, 12.5 w. Acceleration at stall is twice normal rate of servo motors of the same frame size.

CIRCLE 238 ON READER SERVICE CARD

Resistors encapsulated

KELVIN ELECTRIC CO., 5907 Noble Ave., Van Nuys, Calif. Series EP encapsulated precision wirewound resistors have mounting designed for quick interchangeability on computer boards or where rapid change of resistance values is required. Maximum resistance, to 25 meg; 0.5 w to 2.5 w; 400 to 1,200 v max.; temperature coefficient, ± 0.002/deg C; tolerance, to 0.05 percent; size range ½ in. to 1 in. diameter; mounting centers, 1.460 in. to 3.085 in.

CIRCLE 239 ON READER SERVICE CARD

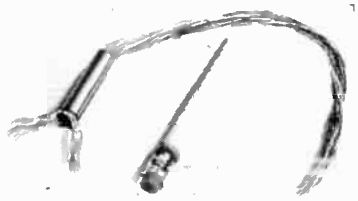


Slide Rule frequency response

BOONSHAFT AND FUCHS, INC., Huntingdon Valley, Pa. This slide rule provides a direct reading of amplitude ratio and phase vs. frequency of all the terms in a complex transfer function. With one setting the desired information is presented for 20 frequency intervals per decade through six decades. There are 11 channels on the rule. One channel

holds a frequency scale covering six decades from 0.001 to 1,000. Each of the 10 remaining channels holds a scale which represents one term of the transfer function. Twenty-four such function scales are furnished.

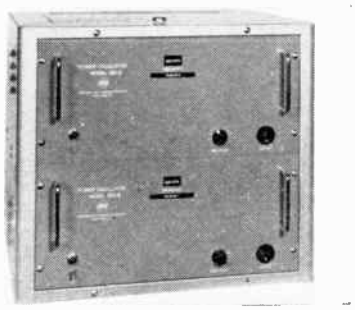
CIRCLE 240 ON READER SERVICE CARD



Slip Ring and brush assembly

SLIP RING CO. OF AMERICA, 5456 W. Washington Blvd., Los Angeles 16, Calif. Subminiature stable platform slip ring and brush assembly has 50 slip rings and 100 brushes ball bearing mounted and packaged in dust sealed housing 1.250 in. long. Noise levels are maintained below 50 μv; breakaway friction level, below 50 gram cm.; maximum temperature, 350 F; meets MIL-5400A. Brushes are tuned to different resonant frequencies to insure electrical continuity despite vibration.

CIRCLE 241 ON READER SERVICE CARD

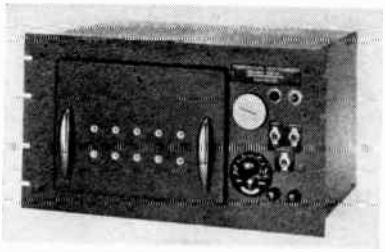


Power Oscillator 400 cps

THE INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York, N. Y. Model 150-2 power oscillator supplies 320 va of power at a fixed frequency 400 cps ±0.25 percent. Output voltage is continuously variable from 0-120 v for each phase. Displacement between phases is maintained at 90 deg ±1 deg. Features include: less than 1 percent

distortion and better than 1 percent regulation from no load to full load. Use of silicon diodes in the plate supply circuits reduces the heat dissipated, and enables the unit to be supplied in a relatively small enclosure.

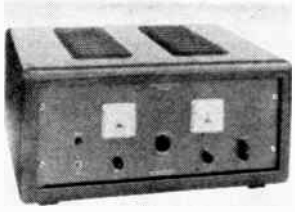
CIRCLE 242 ON READER SERVICE CARD



Test Chamber —100 F to +500 F

DELTA DESIGN ENGINEERS, INC., 7460 Girard Ave., La Jolla, Calif. Model 6545R rack mounted temperature test chamber. Test volume is 10 by 7 by 7 in.; height is 10½ in. in standard 19 in. rack. Direct reading thermostat automatically controls temperature within ±2 F at any point from −100 F to +500 F. Low temperatures are attained by injection of liquid CO_2 through a solenoid operated valve. A built-in heating element provides high temperatures.

CIRCLE 243 ON READER SERVICE CARD

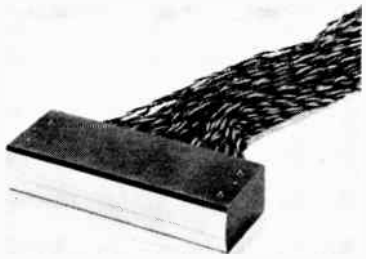


Power Supply current regulated

MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif. Magnetic control elements are used in the RSS-1 power supply to provide smooth control of high currents as normally encountered in twt focusing solenoids. A stabilized feedback loop using Zener reference diodes and a high gain d-c amplifier are used to control the saturation characteristics of a reactor transformer. Current range is 3.2 to 5.1 amperes d-c into a 20 ohm load. Regulation is better than 2 percent

for line variations of ±10 percent and load variation of ±20 percent. Ripple is less than 1 percent.

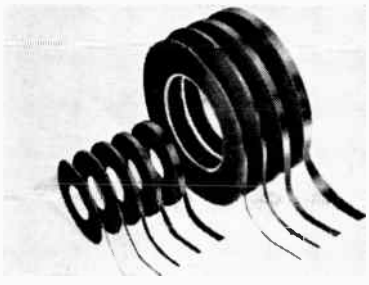
CIRCLE 244 ON READER SERVICE CARD



Drum Head
precision machined

J. B. REA CO., INC., 2202 Broadway, Santa Monica, Calif. The HD14-64X is an all metal precision machined 64-channel drum head originally designed for use on a 4-in. research laboratory drum. Track width is 0.024 in. ±0.0005 in.; track spacing center to center, 0.0625 in.; gap length, 0.0005 in.; maximum deviation from head base to back of any stack, ±0.001 in.; and gap scatter, ±50 μin.

CIRCLE 245 ON READER SERVICE CARD



P-C Drafting Aids
nonstaining

BY-BUK CO., 4314 W. Pico Blvd., Los Angeles 19, Calif. Black pressure sensitive photographic tape with clear non-staining adhesive in widths from ... in. (0.015) to any fraction of an inch in 15 and 60 yd rolls, for making printed circuit master layouts.

CIRCLE 246 ON READER SERVICE CARD

Coatings
humidity proofing

COLUMBIA TECHNICAL CORP., 61-02 31st Ave., Woodside 77, N. Y. A series of HumiSeal coatings on

polyurethane bases are especially formulated for humidity proofing, and also offer excellent weathering and corrosion resistance to many metal surfaces. Advantages include: single-component system, room temperature cure, solderability so that coated components may be replaced or repaired by simply soldering through the coating without necessity of its mechanical or chemical removal, excellent adhesion, flexibility, and outdoor durability.

CIRCLE 247 ON READER SERVICE CARD

Circuit Packs light weight

RAYTHEON MFG. CO., Semiconductor Division, 225 First Ave., Needham heights 94, Mass. Circuit-Paks contain semiconductor devices and other components connected to provide desired circuits. Types available include bridge rectifiers, phase comparators, diode switches, amplifiers, and flip-flops. Assemblies are reliable, easy to use, free from atmospheric effects, simplify equipment assembly and reduce production errors.

CIRCLE 248 ON READER SERVICE CARD

Precision Meters bifilar-suspension

GREIBACH INSTRUMENTS CORP., 315 North Ave., New Rochelle, N. Y. Extreme sensitivity and ruggedness characterize a line of precision meters based on the use of the bifilar-suspension movement. Meters are available in many models—microammeters, milliammeters, ammeters, millivoltmeters, voltmeters, megohmmeters, multirange meters to 23 ranges, and voltammeters for current and voltage in the same instrument.

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Literature of

MATERIALS

Aluminum Clad Copper Wire. Sylvania Electric Products Inc., Warren, Pa. A technical booklet, "Aluminum Clad Copper 40%" describes a high conductivity wire recently developed for high temperature magnet wire and a variety of applications in aircraft, missiles and high-speed industrial equipment.

CIRCLE 270 ON READER SERVICE CARD

COMPONENTS

R-F Interference Filters. Filtron, Inc., 10023 W. Jefferson Blvd., Culver City, Calif., has compiled a 350-page catalog which carries design and engineering data as well as product information on interference suppression devices for electronic equipment.

CIRCLE 271 ON READER SERVICE CARD

Frequency Detector. Airpax Electronics Inc., Seminole Division. Fort Lauderdale, Fla. Bulletin F-25 describes the Magmeter, a frequency detector delivering a d-c output voltage proportional to input frequency.

CIRCLE 272 ON READER SERVICE CARD

Synchros, Servos. Ketay Department, Norden Division, United Aircraft Corp., Commack, L. I., N. Y. An illustrated 170-page catalog of synchros, servo motors, servo amplifiers, resolvers, rate gyros and potentiometers contains specifications and outline drawings of 200 units. Included are details on synchros manufactured to the newest MIL specs (MIL-S-20708A).

CIRCLE 273 ON READER SERVICE CARD

EQUIPMENT

BWO/TWT Power Supply. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. A recent issue of "New From PRD" describes the type 813 universal bwo/twt power supply which powers and modulates back-

the Week

ward wave oscillators, backward wave amplifiers, voltage tuned magnetrons, and traveling wave amplifiers.

CIRCLE 274 ON READER SERVICE CARD

Tape Control Positioning. Jones & Lamson Machine Co., Springfield, Vt. Description, chief advantages and applications of tape control positioning are contained in an illustrated booklet.

CIRCLE 275 ON READER SERVICE CARD

Control Chassis. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Rapid acquisition of data and its retention and translation are key features of a control chassis described in bulletin No. 111.

CIRCLE 276 ON READER SERVICE CARD

Centrifugal Blowers. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y., has published a 12-page catalog on its centrifugal blowers illustrating typical single blower units.

CIRCLE 277 ON READER SERVICE CARD

Power Supply. Electronic Measurements Co., Inc., Eatontown, N. J. Data sheet 3070 describes the Regatron model 2-212A, a dual power supply for transistors.

CIRCLE 278 ON READER SERVICE CARD

Portable Analog Computer. Electronic Associates, Inc., Long Branch, N. J. Bulletin AC934 describes the PACE TR-10 transistorized, desk-top analog computer.

CIRCLE 279 ON READER SERVICE CARD

FACILITIES

Facilities Brochure. General Machine Products Co., Inc., Old Lincoln Highway at Pennsylvania Turnpike, Trevose, Pa. A brochure describes the company's facilities for the manufacture of: special machinery, tools, communications equipment, controls, aircraft components and subassemblies, electrical and electronic equipment and subassemblies, and precision parts of all types and sizes.

CIRCLE 280 ON READER SERVICE CARD

For Ashley, free enterprise

FREE ENTERPRISE AWARD for Horatio Alger-type success in electronics goes this year to Harry Ashley, energetic and ebullient president of Electronic Instrument Co. Kitmaker Eico is one of very few electronics firms whose main trading point is that customers do the work.

Harry Ashley, born in Brooklyn in 1912, has never really left home. He went to Brooklyn College at night, studying the physical sciences while he made his living as a radio serviceman. Even then, in the middle of the depression, he was an independent operator—a phrase that accurately describes him today.

He left college to sell aircraft insurance, and used to puddle jump all over the eastern seaboard to service his accounts. He got his own pilot's license in 1941, but the outbreak of the war put it and his insurance business on the shelf.

In the closing days of the war, during idle time at his Navy job, he planned on breaking into the instrument business, but he quickly found out that without experience he couldn't get a materials priority. He was able to make kits, however, and after the war he sank all of a $4,000 nest egg into that line.

At first he operated on a shoestring, buying up surplus parts, designing and assembling the kits himself, merchandising them among the jobbers on New York's Cortlandt Street, even delivering them in an old '32 Plymouth. Gradually the kits caught on—"principally," he figures, "because the radio serviceman likes to know his test equipment inside out. He doesn't mind building it himself; it gives him a surer feeling about it, because he gets intimate knowledge of its theory, parts and maintenance."

Since then Eico has expanded into hi-fi and ham gear, has lately been selling transistorized kits. Engineering plays a big part in the firm; as Ashley says, "you've got to design around the fact that fairly inexpert people will put these things together."

Pipesmoker Ashley was married in 1937, has three daughters. He loves the outdoor life, lives his summers in the pool, on the golf course or on his motorlaunch—in which, incidentally, he tests marine electronic gear out on Long Island Sound. He builds his own home equipment, of course, including his ham station K2UVY. He's a good fisherman, too—a 60-lb sailfish caught off Florida adorns the wall of his informally appointed office.

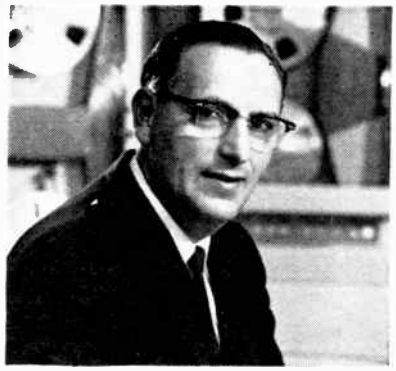
With a raft of outlets for his own bouncing energy, he is quick to point out that "kit-building is a relief from tension," thinks this factor is just as important to Eico's success as the low cost of the kit compared with preassembled gear.

IRE Conference Set for Atlanta

THE FOURTH IRE Instrumentation Conference and Exhibit sponsored jointly by the Atlanta Section IRE and the Professional Group on Instrumentation will be held at the Atlanta Biltmore Hotel on Nov. 9, 10, and 11. There will be six sessions featuring symposia on reliability, measurements, data gathering and display, nuclear instrumentation, semiconductor applications, and missile and satellite instrumentation.

New products of more than 100 manufacturers will be shown in the accompanying exhibits.

For information describing the 28 papers to be given, the exhibits, and program, contact B. J. Dasher in care of the School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

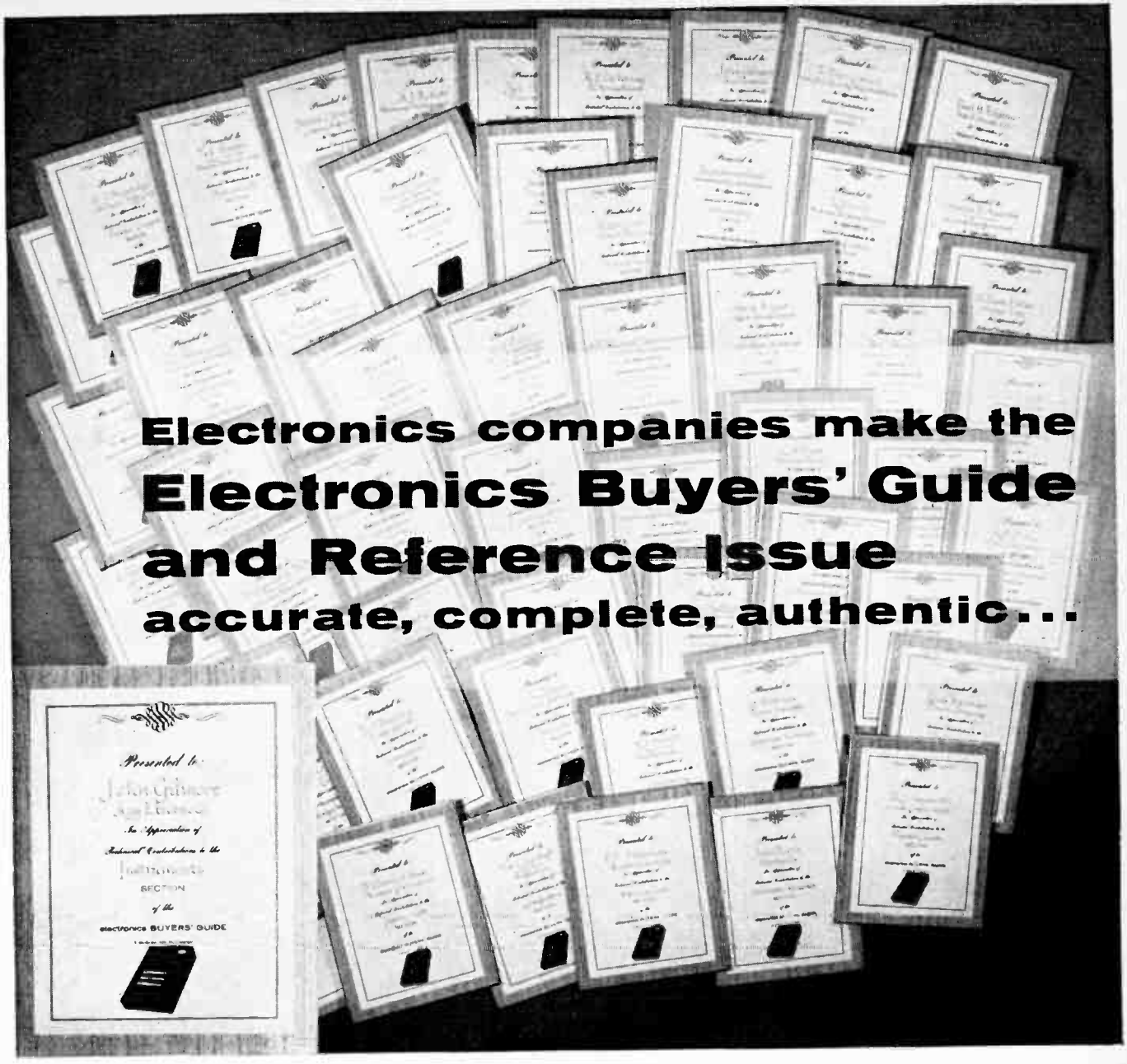


Jipp Becomes Ampex V-P

JOHN JIPP, Ampex Instrumentation Division's manager since 1957, has become a vice-president of the corporation. He is one of five men newly elevated to this rank by the board of directors of the magnetic tape recording firm at a recent quarterly meeting.

Jipp joined Ampex Corp. in 1953 as instrumentation sales manager, and upon the creation of a separate Instrumentation Division in 1954, he was designated marketing manager of the new group.

The other men affected are Neal K. McNaughten, manager of the Professional Products Division; Herbert L. Brown, manager of Ampex Audio, Inc.; Walter T. Selsted,

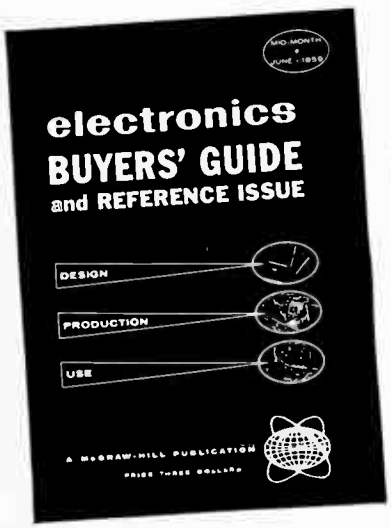


For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics . . . one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.



Published mid-year as the 53rd issue of **electronics**

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director of research; and John M. Leslie, manager of Orr Industries, Inc.

Harbison Joins Lear, Inc.

RICHARD W. HARBISON has joined Lear, Inc., Santa Monica, Calif., as assistant to the executive vice president. He was formerly vice president of eastern operations with Cook Electric Co., Chicago, Ill.

His initial assignment with Lear will be the expansion of the company's research and development and service activities.

Kidde Promotes R. A. Cline

ROBERT A. CLINE has been named staff assistant to Paul D. Eberhardt, vice president of Kidde Ultrasonic & Detection Alarms, Inc., Clifton, N. J. In his new position he will

be responsible for the coordination of research and development, new products, sales, sales promotion, sales research and engineering.

Cline joined Kidde in 1958, and has worked in product sales and new product development. Previously he was associated with Soundings, Inc., of Stamford, Conn., and held the post of experimental director.

Elect Runyan R&D V-P

RAYMOND A. RUNYAN is the newly elected vice-president of research and development of Data-Control Systems, Inc., Danbury, Conn. He is one of the original founders of the company.

In his new post, Runyan will be responsible for the company's enlarged research activities in telemetry and associated fields.

News of Reps

Appointment of **Engineering Service Co.**, Kansas City, Mo., as manufacturers' reps for the Amerelay Corp., New Hyde Park, N. Y., is announced. ENSCO, with branches in Wichita and St. Louis, will cover the territory that includes Missouri, Kansas, Nebraska and southern Illinois.

Chemtronics Inc., Brooklyn, N. Y., names two West Coast manufacturers' rep firms. **Mark R. Markman Co.** of Los Angeles will cover Arizona, southern California, and southern Nevada. **William Logan** of Daly City, Calif., will handle sales in northern California.

Freed Transformer Co., Inc., Brooklyn, N. Y., announces appointment of **Conway Electronic Enterprises** of Toronto, Ontario, as its sales agent in Canada.

E. S. "Mike" Needler has been appointed sales agent for the state of Indiana by the William Brand & Co., Inc., of Willimantic, Conn. Needler will handle the complete Brand line of Turbo wires, cables and insulating tubing for the electronics and electrical industries.

COMMENT

Magnetic Pickups

In the course of preparing my university examination paper, problems (in the area of magnetic-pickups) arose to which I did not succeed in finding any satisfactory explanation in the Hungarian technical literature known by me. I found a short description on the subject in your magazine which was of great help to me. It appeared on p 156 of your Sept. 1, 1957, issue, under the title "Magnetic Field Pickup Follows Buried Cables," by Roger R. Webster and James M. Carroll.

My request is that you kindly give me some information about the iron-core pickup coil of the equipment, as I did not find in this description the data I need. I would ask that you send me, if possible, some drawings showing me the diagram of the iron-core pickup coil, and let me know on what theoretical or mathematical principles the construction of the coil is based, considering that the variations in the magnetic field inducing response are not even sine-shaped . . .

LOSONCZY LAJOS
DUNAKESZI, HUNGARY

We get letters from all over of this nature, which we generally refer to the authors involved. Author Webster sent reader Lajos a careful explanation, including circuit diagrams and mathematical formulations, from which we quote only a part:

. . . The core was a ferrite material (General Ceramics type Feramic "Q" with toroidal permeability of about 100). The size of the core was about ¼-in. diameter by 6 in. long. The coil was about 400 turns, two layers, wound nearly the full length of the core.

Although the magnetic field was not sine-shaped, we were interested in only the fundamental component, since the harmonics were largely rejected by the tuned amplifier. Thus, for practical purposes, we did consider the field to be sinusoidal with an amplitude calculated from the known amplitude of the square wave.

The design of the coil was in-

tegrated into the overall design of the equipment. We were required to deliver a certain output from the amplifier when a coil was placed a certain distance from a wire carrying a certain current. In addition, the amplifier input impedance was to be 10 ohms. Other requirements were placed on size and weight.

Our problem was to maximize the coil output . . . The optimum winding was determined experimentally by winding several coils, loading the coils with 10 ohms, placing them on a core in the magnetic field, and plotting voltage output as a function of number of turns . . .

ROGER R. WEBSTER
TEXAS INSTRUMENTS
DALLAS

Parametric Amplifiers

I am a graduate in mechanical engineering now serving my obligated service in the Navy as electronics officer on a destroyer. Some time ago I took a subscription to ELECTRONICS in order to become better acquainted, broadly, with the field in which I am working. I have found that ELECTRONICS not only keeps me abreast of the general field of electronics, but it has also imparted to me much useful information of a technical nature which allows me better to do my job.

I have read several articles on parametric amplifiers and I think I have a sketchy idea of what they are and how they work. However, I would like to know what their capabilities and limitations are specifically. From what I have read it appears to me that the Navy could increase the life and quality of its radar equipment in the fleet by using better designed, lower noise receivers than they now have installed. This would not only increase the detection capabilities of the radar, but would probably cost the American taxpayer much less than complete redesign and replacement of material . . .

DAVID L. DAVIDSON
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