Are Fiber Transistors on the Way?

page 26

electronics

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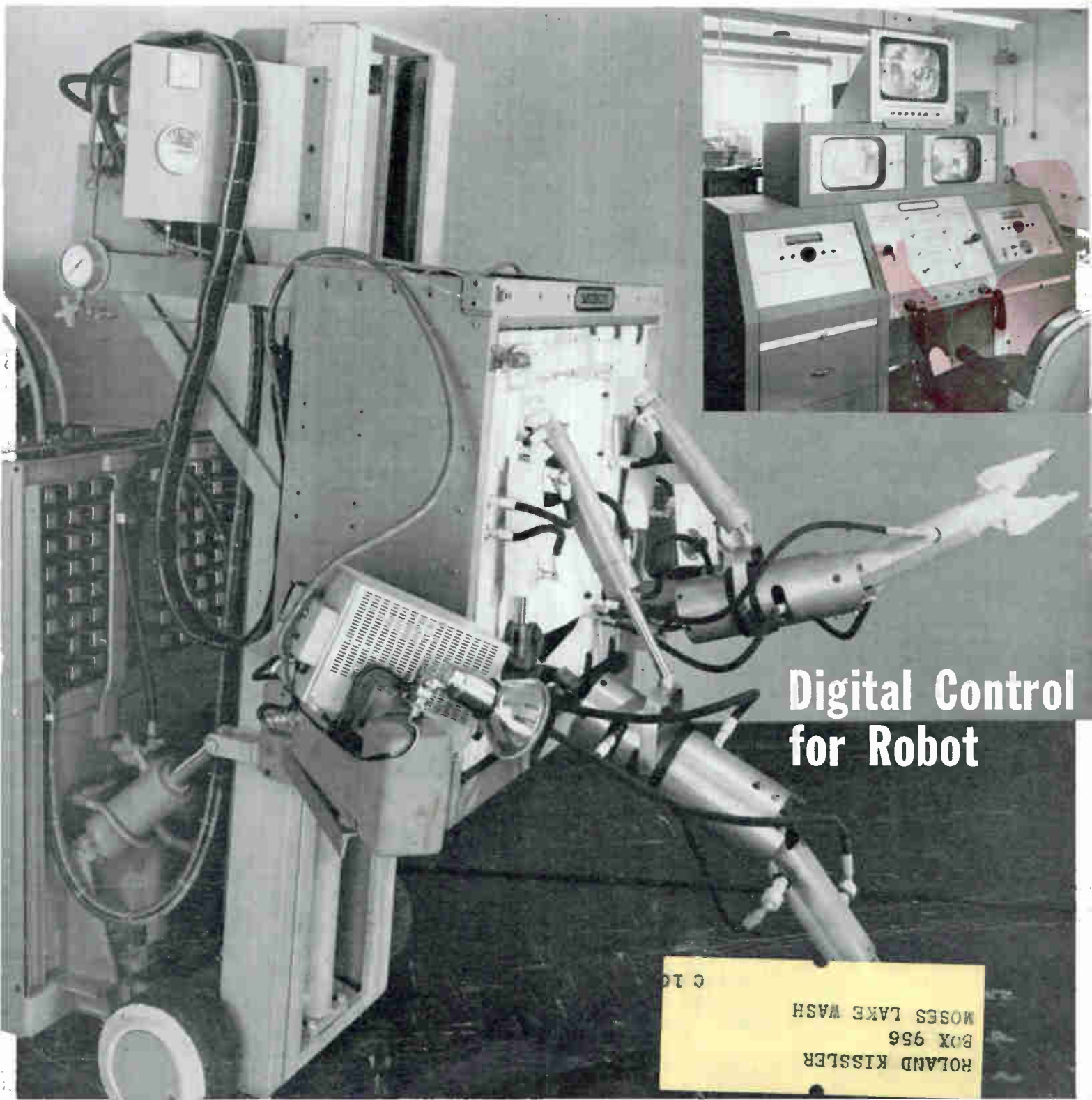

Digital Control for Robot

Keep them Accurate . . .

General Radio Type 1429-A Fuel-Gage Tester checks the fuel-gage system in a typical commercial aircraft, an American Airlines' Boeing 707 Jet Flagship.

In use, the Tester's precision capacitors simulate the capacitive sensing elements in the aircraft's fuel tanks. The Tester dials are set to the known capacitance of the tank elements for a given quantity of fuel. The gage is then adjusted to indicate the simulated fuel quantity correctly.

. . . with the New Type 1429-A Tester for capacitance-type aircraft fuel gages.

Military designation is TTU-68/E (fulfills same function as military Type MD-1 or former General Radio Type P-579 Tester).

- ★ Can be used for calibrating fuel gages in either jet or propeller-driven aircraft.
- ★ Incorporates compensating capacitors to correct for dielectric variations in different types of jet fuels.
- ★ Smaller, lighter, and easier to read than previous models.
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JANUARY 22, 1960

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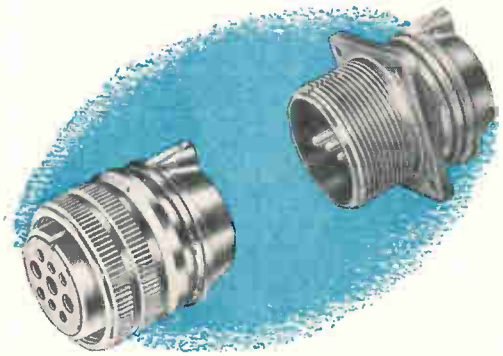

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MIL-C-5015, the governing Specification on AN/MS connectors, has established certain standards which must be met on these types. AMPHENOL Stub E and Stub R exceed these standards:

STUB E is the shortest, lightest "E" environmentally-resistant connector available. Although "E's" cannot be used in new designs to MIL-C-5015D, Stub E is the ideal commercial connector or replacement on existing MIL. designs. Consider some of the plus features: Shortest, lightest "E"; unitized, easy-to-assemble rear grommet; metal-to-metal bottoming; easy contact soldering; uniform contact tinning.

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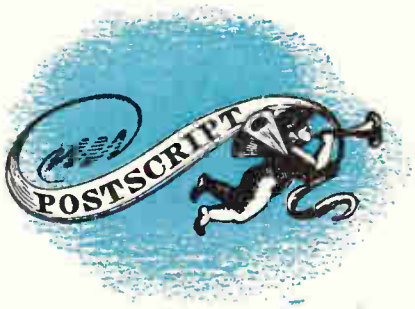

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SHOPTALK . . . editorial

ALLIED SCIENCES. Many years ago electronics had to do principally with radio communications. In more recent times, electronics has become a broad science in its own right, developing unique technology and assimilating large portions of other disciplines.

In the early forties the physicist came into electronics, initially interested in microwaves. He stayed to solve important problems in optics, wavepropagation and solid-state. Later came the metallurgist, as transistor technology advanced. The mechanical engineer made important contributions in design of control systems.

Today interest focuses on a region of mutual interest to electronics engineers and organic chemists. At the top of the news is a report from USSR claiming a method for making transistor-like devices out of a synthetic fiber. A new GE technique for information storage that can handle color-television signals uses thermoplastic film as the storage medium. Weekly we receive announcements of new insulations, lubricants and substrates with improved properties at higher and higher temperatures.

Contributions from organic chemists advance the state of the electronics art as much as new circuit designs. Even more valuable contributions can be expected from chemists and from other allied scientists such as physicists, applied mathematicians, linear programmers, operations researchers.

W W MacDonald

EDITOR

Coming In Our January 29 Issue . . .

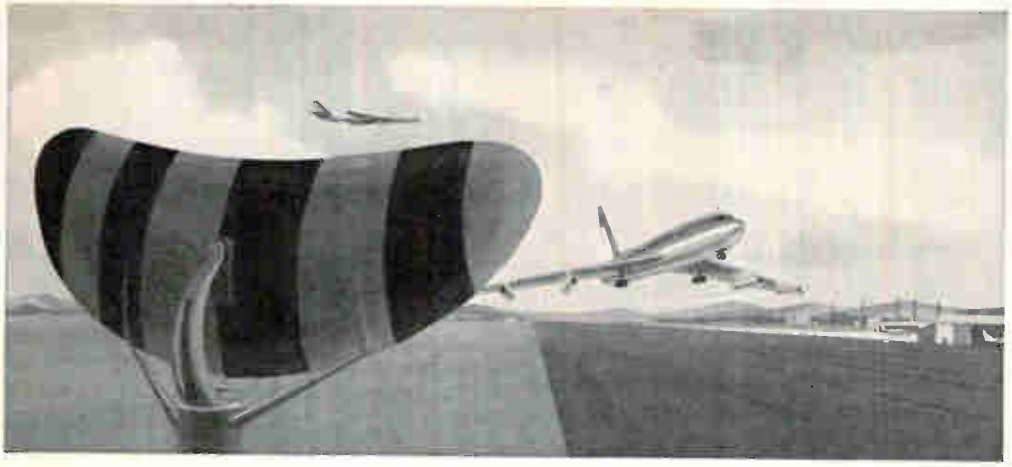
EJCC HIGHLIGHTS. As researchers strive for smaller and faster computers, two approaches stand out as especially promising, cryogenics and microwave components (ELECTRONICS, p 77, Nov. 20, 1959). Progress in both these areas was noted by New England Editor Maguire when he attended the Eastern Joint Computer Conference in Boston recently.

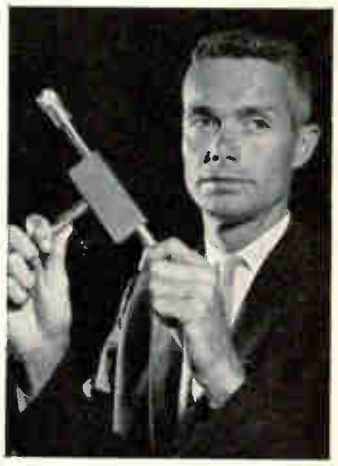
Next week, Maguire's conference roundup spotlights several interesting and significant results of the push toward 1,000-mc computers. You'll learn how high-speed computing rates are being obtained by using variable-capacitance diodes and tunnel diodes in combination with microwave coupling techniques. You'll also read about crossed-film cryotron switching and storage circuits, a tunnel-diode arithmetic cell, a magnetic-disk memory unit and a miniature high-density memory for missiles.

AIRCRAFT DETECTION. Relative performance of three methods of aircraft detection—visual, infrared and radar—varies with the prevailing weather. Visual detection is difficult in haze and fog, infrared detection is difficult in heavy fog and K-band radar detection is difficult in heavy rain.

In our next issue, M. E. Seymour of GE in Ithaca, N. Y., compares the effective range of two types of radar and two types of infrared with visual sighting, for weather ranging from light fog to cloudburst. Sample calculations indicate the different degree to which ground-level infrared and radar systems are affected.

Data tabulated in Seymour's article result from a study performed on the applications of infrared to airport surveillance under closed field conditions. Seymour has been associated with infrared projects at GE since 1949.





Firm price and delivery on low noise parametric amplifiers

Firm price and delivery schedules are available for negative resistance, cavity type amplifiers in the L, S, C, and Lower X-Bands. You can choose from either development models for evaluation in your system, or custom designed, fully qualified units in production quantities. The table at right shows typical amplifier characteristics now being obtained in development models.

With noise figures as low as 2 db, these amplifiers are ideally suited to radar acquisition and tracking systems, tropo-scatter communications, telemetering, satellite tracking, and microwave relay links.

They recover from overload in milliseconds—are resistant to deterioration and failure from high power. Phase jitter and gain stability characteristics are excellent, and with the associated ferrite circulator, the amplifier is fail-safe in case of pump or diode failure.

Small in size and weight, the amplifier can easily be retrofitted to many existing systems.

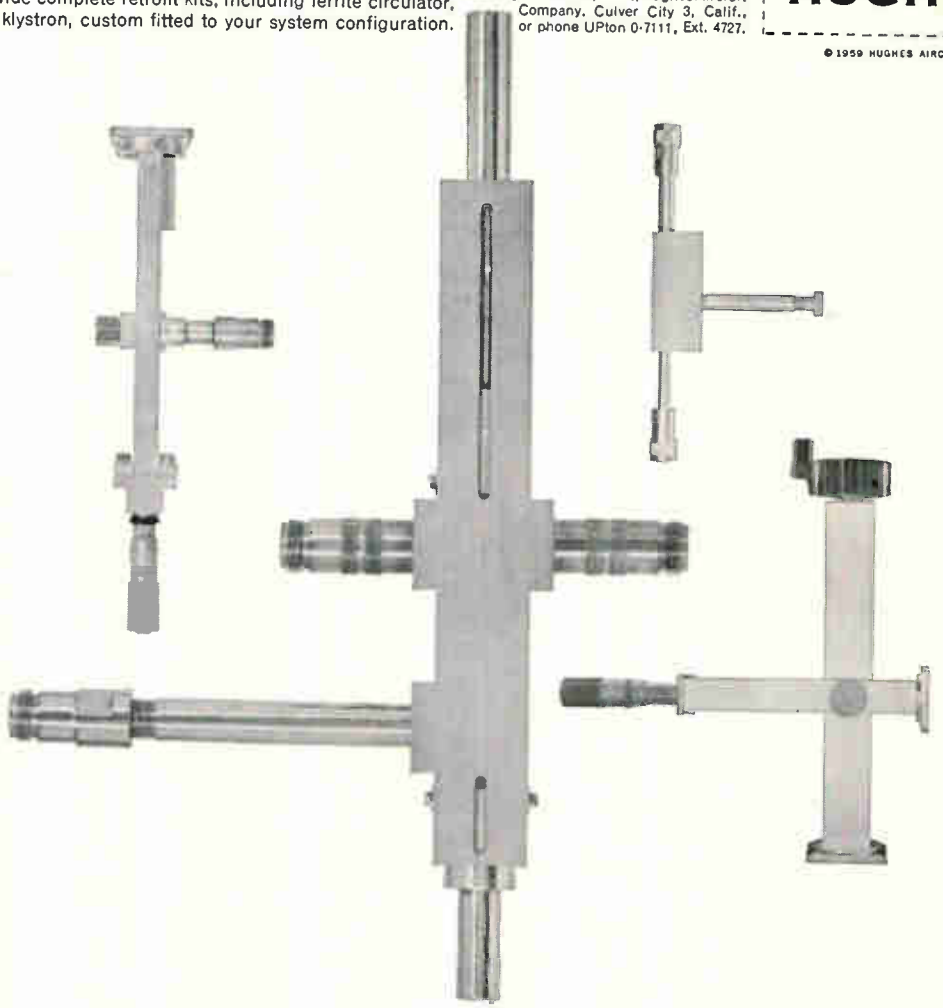
Hughes Microwave Products can provide complete retrofit kits, including ferrite circulator, amplifier, pump circuitry, and pump klystron, custom fitted to your system configuration.

HUGHES PARAMETRIC AMPLIFIERS—Typical Characteristics

	L Band	S Band	C Band	X Band
Pump	50 mw at S or C Band	100 mw at X Band	100 mw at X or K_U Band	150 mw at K_U Band
Gain	15 to 20 db	15 to 25 db	15 to 25 db	15 to 20 db
Bandwidth	2 to 10 mc	Up to 25 mc	Up to 25 mc	2 to 8 mc
Noise Figure	2 to 4 db	2 to 4 db	2 to 4 db	6 db
Remarks	Non-degenerate	Non-degenerate	Non-degenerate	Quasi-degenerate

For information on price and delivery dates, or for further technical data, write Microwave Products, Advanced Program Development, Hughes Aircraft Company, Culver City 3, Calif., or phone UPton 0-7111, Ext. 4727.

HUGHES



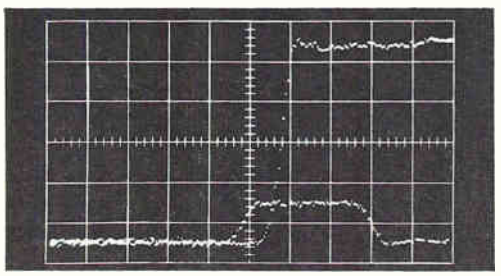
NEW INTERNALLY TRIGGERED

TEKTRONIX®

0.6-Nanosecond Risetime

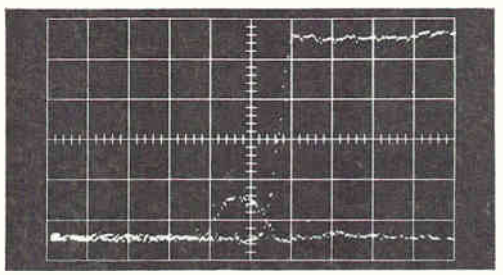
(approximately 600-MC Bandwidth)

The waveform photographs below show the ability of the Tektronix Sampling System to display a wide range of pulses. These photographs were purposely chosen to illustrate the system's abilities under marginal conditions.



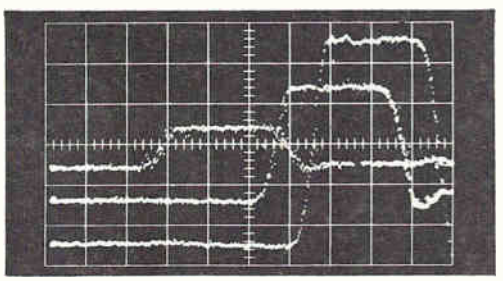
1

The alternate pulse feature of the Type 110 pulse generator is being used to generate a large, long pulse, and a short, small pulse. The trigger take-off system's sensitivity is set for maximum. The signal level is 100 mv/cm, and the sweep speed is 1 nsec/cm. There is clearly less than 1 nsec time difference in triggering on the 100 mv, 3 nsec and the 500 mv long step signals.



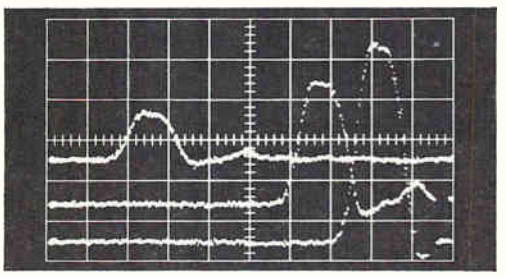
2

This picture shows the same conditions as in Fig. 1, except the small pulse is now only 1 nsec wide. The time shift relative to the large step is just over 1 nsec.



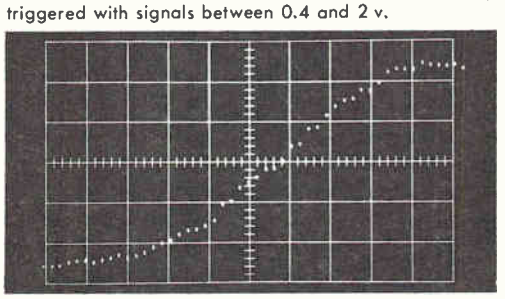
3

The system is operating at maximum sensitivity, 20 mv/cm. A triple exposure, positioned vertically to align the 50% points, allows easy measurement of the time slip. Under these extreme conditions, the smallest pulse has an energy of about 24 millipicojoules. The trigger take-off system then removes approximately 1 millipicojoule for application to the switched system of amplifiers and the trigger regenerator.



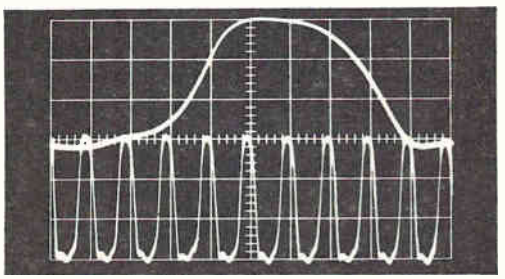
4

The amplifiers in the trigger channel (used in the previous 3 pictures) are switched out. The sensitivity is 2 v/cm. The smallest of the 1 nsec wide pulses furnishes approximately 0.4 v to the trigger regenerator, through the trigger take-off system. This picture is of interest since this is the narrow-pulse response which is obtainable with both the 110 and N Units, when externally triggered with signals between 0.4 and 2 v.



5

The leading edge of the large pulse of Figure3 is displayed with the 1 nsec/cm sweep speed magnified ten times. This gives an equivalent sweep speed of 100 picoseconds/cm. The risetime of the complete system—110 pulse generator, 110 trigger take-off, 113 delay cable and the N unit—is well under 0.6 nsec.



6

Double exposure shows a 60-mv, 100-mc continuous pulse train at equivalent sweep times of 1 nsec/cm and 10 nsec/cm. The Type 110 derives a trigger from the signal, permitting the Tektronix Sampling System to operate without external triggers, counting down from 100-mc to the 100-kc sampling rate of the N Unit.

PULSE-SAMPLING SYSTEM

for use with all Tektronix Plug-In Oscilloscopes

Characteristics

TYPE 110—

TRIGGER TAKE-OFF SYSTEM

10 v, 200 nsec regenerated trigger derived from signals of 20 mv to 50 v, with repetitian rates from 50 c to 100 mc, at a signal loss of less than 2.5%. (The recovery time is 10 μsec; thus above 100 kc signals must have increasingly greater regularity of spacing. Differences in signal level and polarity are taken care of with a flexible switching system by means of switched coaxial cables.)

1-nsec switched trigger shift for time calibration.

Less than 2.5% transmissian and reflectian loss of signal being viewed.

PULSE GENERATOR

Less than 0.25-nsec pulse risetime.

0.4-nsec minimum pulse length (longer pulses with external charge lines).

700/sec nominal repetitian rate.

50-ohm output impedance.

50 v maximum calibrated output on internal power supply, higher externally.

Alternate pulses of different lengths, polarity, or heights possible.

TYPE N—

0.6 nsec risetime (approximately 600 mc).

20 mv/cm sensitivity. (2 mv or less amplitude noise.)

1, 2, 5, and 10 nsec/cm equivalent sweep times (20 to 50 psec time noise).

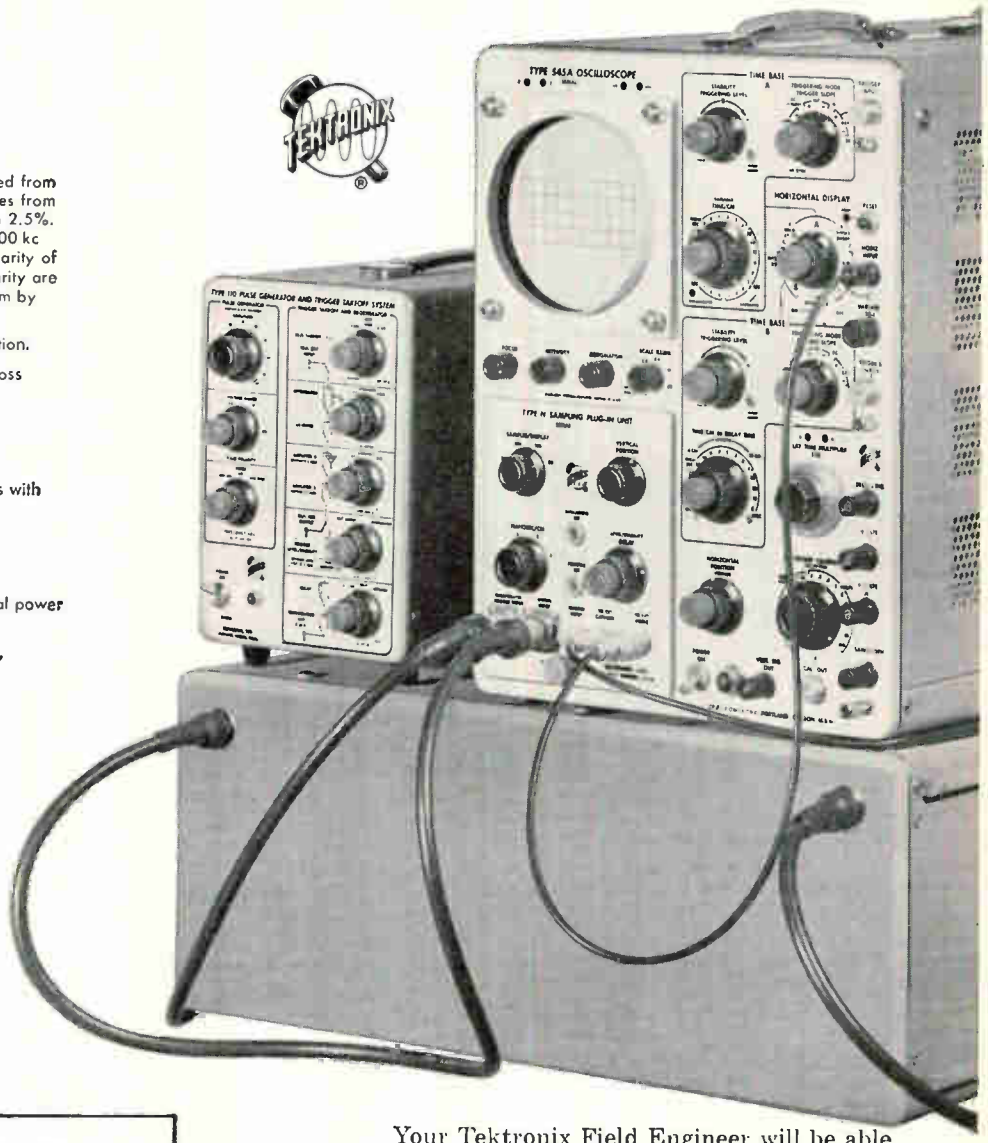
50-ohm input impedance.

50, 100, 200, and 500 samples per display.

Sampling rate—50 c to 100 kc.

120 mv minimum linear range (safe overload 4 v).

External trigger ability: 0.5 v, 1 nsec duration, 40 nsec in advance of signal. The recovery time is 10 μsec. Counts down above 100 kc to about 50 mc.



The Tektronix Pulse-Sampling System has a high degree of inherent flexibility . . . you purchase only the parts needed in your application. For instance, if the signal source can furnish a trigger of 0.5 v to 2 v, the Type 110 will not be required; if the trigger is furnished as a "pre-pulse," the Type 113 Delay Cable may not be required.

PRICES

Type N Sampling Plug-In Unit **$600**
Type 110 Pulse Generator and Trigger Take-Off **$650**
Type 113 Delay line, 60 nsec, 0.1 nsec risetime **$200**
(prices f.o.b. factory)

Your Tektronix Field Engineer will be able to arrange a demonstration in the very near future. Call him for complete specifications.

Tektronix, Inc.

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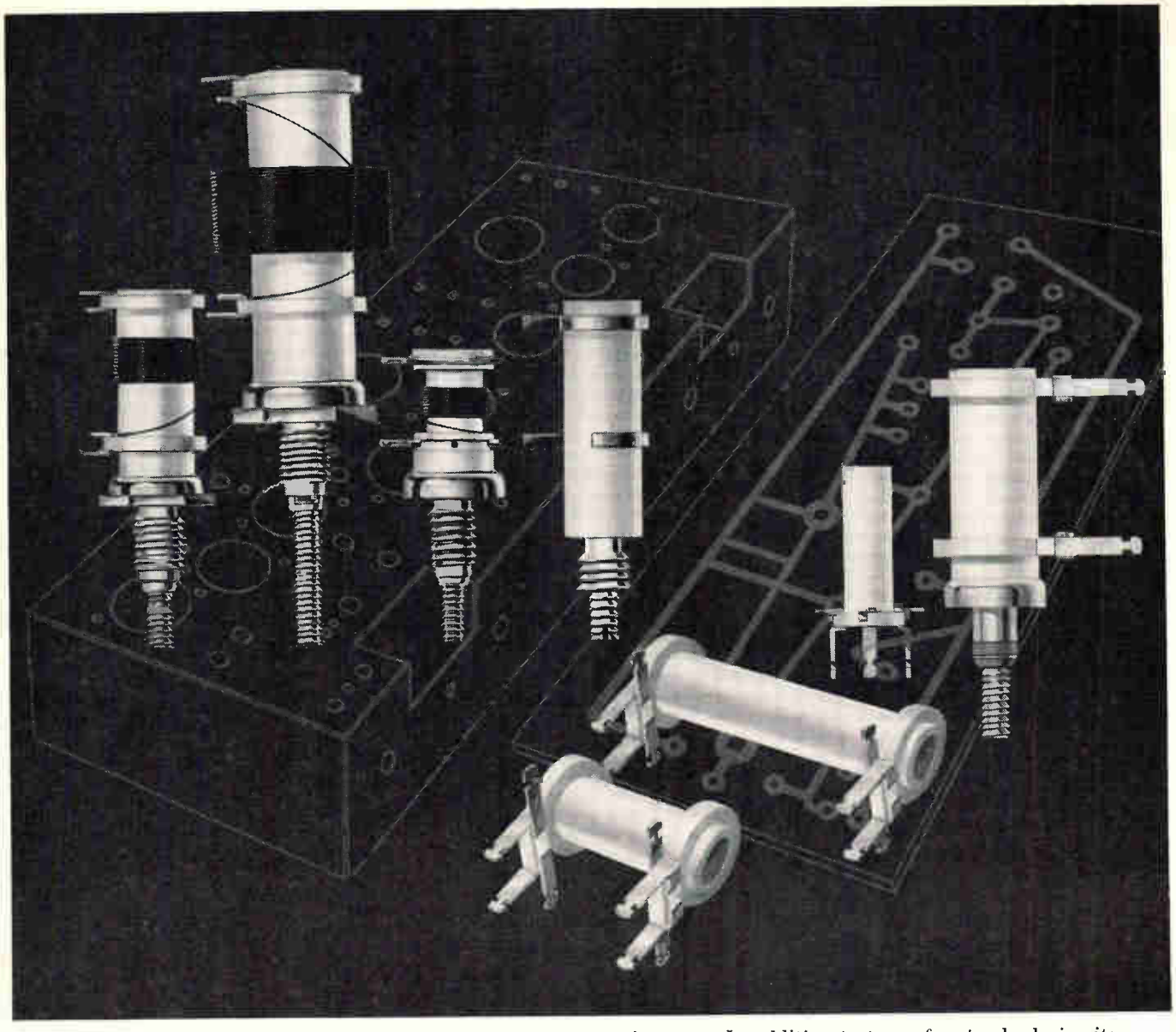


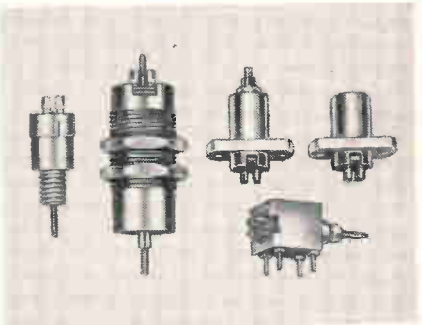
CAMBION standard coil forms cover the widest range of requirements. In addition to types for standard circuits, printed circuit types, designed to eliminate a separate soldering operation, are available in horizontal or vertical mounting styles, the latter including ceramic units with fiberglas collars.

Big variety... big advantages

To the already huge family of CAMBION® coil forms, ceramic and phenolic, new members are constantly added to meet increasing needs. Like the complete CAMBION line, they meet or better government specifications in every detail. CAMBION standard coil forms, designed for use in any type of circuit, can be custom-wound whenever required. Windings can be single layer, close wound or spaced, single or multiple pie. New coil forms are custom-designed to solve new problems.

Standard or custom, most CAMBION coil forms are available with Perma-Torq® tensioning device, which allows locking of tuning cores while still tunable. All are delivered promptly, in any quantity. And all CAMBION components — coils, coil forms, capacitors, solder terminals, insulated terminals, terminal boards, swagers, hardware — are products of top-ranking engineering, workmanship and quality control that make every one of them *guaranteed.*

Available locally through authorized CAMBION Distributors. Or write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts. On the West Coast: E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles, California. In Canada: Cambridge Thermionic of Canada, Limited, Montreal, P. Q.



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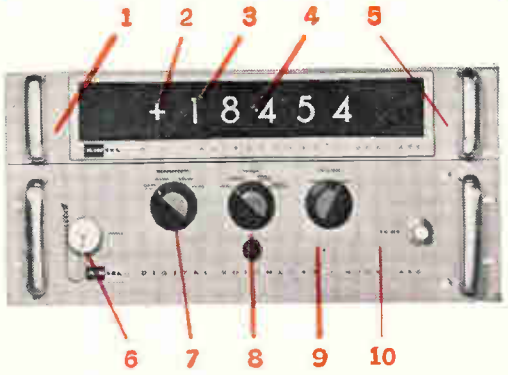
HERE'S WHY CALCULATING ENGINEERS USE KIN TEL DIGITAL VOLTMETERS

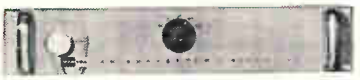


MODEL 501
DC DIGITAL VOLTMETER

1. **Single-Plane Readout**...no superimposed outlines of "off" digits...readout lamps have ten times longer life.
2. **Automatic Polarity Indication**...no lead switching.
3. **Ten Times Greater Resolution** at decade voltage points than other 4-digit voltmeters. A unique extra fifth digit in the left decade indicates "0" or "1" to provide 100% over-ranging.
4. **Automatic Ranging**...decimal point is automatically positioned for maximum resolution and accuracy.
5. **Remote Readout Mounting**...no electronic circuitry in readout allows easy remote mounting.
6. **Floating Input**...input may be floated above or below chassis ground...10 megohms input impedance...input connectors on front and rear.
7. **Adjustable Sensitivity**...control permits decreasing sensitivity to allow reading of noisy signals...greatly increases instrument usefulness.
8. **Built-in Printer Drive** for parallel input printers...control permits either automatic operation when voltmeter reaches null, or remote operation by external contact closure.
9. **Reliability**...transistor drive circuits provide "cushioned" DC drive for stepping switches for long, trouble-free operation.
10. **Accuracy**...measures DC from ±0.0001 to ±1000.0 volts...continuous, automatic calibration against internal standard cell provides 0.01% ±1 digit (of reading) DC accuracy.

Price: $2995

These let you measure AC, increase sensitivity, measure ratios, scan multiple inputs

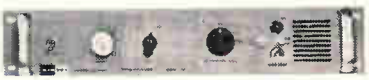


AC CONVERTER Price: $850

The Model 452 AC converter can be added to the basic 501 DC digital voltmeter to permit 4-digit measurement of 0.001 to 999.9 volts AC, RMS, 30 to 10,000 cps. Accuracy is 0.2% of full scale and ranging is manual (auto-ranging models are available).

DC PREAMPLIFIER Price: $1475

The Model 459 differential DC preamplifier has a gain of —100 which extends the DC sensitivity of KIN TEL digital voltmeters to 1 microvolt. Overall system accuracy when the 459 is used with a digital voltmeter is 0.15% ±5 microvolts. Input resistance is greater than 5 megohms, and input and output circuits are completely floating and isolated from each other and chassis ground. Common mode rejection is 180 db for DC and 130 db for 60 cps with up to 1000 ohms input unbalance. Input can be floated up to ±250 volts.



AC-DC PREAMPLIFIER Price: $1225

The Model 458A is a single-ended preamplifier with a gain of —100 which extends the sensitivity of KIN TEL digital voltmeters to 1 microvolt DC, and 10 microvolts AC from 30 to 2000 cps. An additional +1 DC gain position provides >10,000 megohms input impedance and 0.001% gain accuracy.

DVM & RATIOMETER Price: $3835

The Model 507B measures both DC voltages from ±0.0001 to ±1000.0 volts and DC/DC ratios from .0001:1 to 999.9:1. Ranging is automatic and accuracy is 0.01% ±1 digit both for ratios and voltage. Any external reference between 1 and 100 volts may be used for ratio measurements.

INPUT SCANNER Price: $2500

The Model 453M master scanner automatically or manually scans up to 400 1-wire, 200 2-wire, or 100 4-wire inputs. Addition of a slave scanner (453S) permits scanning up to 1000 data points.

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BUSINESS THIS WEEK

New Solid-State Components Coming: Cadmium Sulphide Diode and Triode

Large and controllable amounts of current are obtainable in solid insulating materials, it has been found in experiments at England's Birmingham University. Relatively high current densities have been obtained in thin insulating crystals of cadmium sulphide with a few volts applied, according to G. T. Wright of the university's department of electrical engineering.

He informs ELECTRONICS that **a new class of solid-state "dielectric devices" is now being developed** "which is expected to complement semiconductor devices in high speed switching or high frequency applications, where insensitivity to temperature changes is required, or in operation at moderately high voltage or impedance levels."

Anticipated response times of these dielectric diodes are of the order of the electron transit time and should be in the range 10^{-11} to 10^{-8} second depending on crystal thickness and applied voltage.

Wright says that one of the most interesting of the devices envisaged is a dielectric triode formed by inserting a control grid into the dielectric diode.

"Gain-bandwidth products approaching 1,000 mc should be realizable and, by using a crystal containing large numbers of shallow electron traps," he adds, "it should be possible to obtain extremely high mutual conductance at very high frequencies."

Wright says "much more" research must be done before successful and reliable devices can be produced, suggests that if electronics companies make the effort "it should not be long before space-charge-limited dielectric devices become available." An article by Wright will appear soon in ELECTRONICS.

Aviation Agency Rules Out British Hyperbolic System for Navigation

The Federal Aviation Agency has just revealed its technical conclusions with regard to the performance of the British Decca Mark X navigational equipment, a subject of controversy since February 1959 when a special meeting of the International Civil Aviation Organization (ICAO) voted to adopt the American VOR-DMET system as the international standard.

British representatives complained bitterly then that the ICAO had not taken certain technical facts fully into consideration. FAA carried out helicopter tests of the Decca hyperbolic system from February 1959 to September 1959 (ELECTRONICS, p 29, May 22, '59).

With the announcement of its conclusion, FAA appears to close the door finally to any further U.S. consideration of the British system. **The agency has concluded that "the Decca Mark X was not able to meet the requirements for a primary Instrument Flight Rules (IFR) navigation aid or for use as a steering device."** FAA found that on 61 percent of the test routes flown the pilots reported failure of the gear to give navigation intelligence necessary for use of the system as a primary IFR nav-aid.

Also, says FAA, pilots were unable to maintain a constant heading of the aircraft or to change to a new course without the aid of other instruments.

Commerce Department Forecasts $2.2-Billion Consumer Market in '60

Record year is forecast for the electronics industry in 1960 by the Commerce Department's Business and Defense Services Administration.

Factory sales of consumer electronic products, now estimated at a $1.95 billion annual rate, are expected to level off at $2.2 billion in 1960. BDSA sees continued growth in color tv, slower sales rises for black-and-white tv and radio receivers, a lesser increase in automobile radio sales, and an upward trend for f-m receivers.

An increase of "better than 15 percent" over last year is expected by BDSA in electronic equipment for the military and for the space agency.

Gain of at least 10 percent is looked for in commercial and industrial electronic equipment.

BDSA estimates total industry sales in 1960 at $10 billion, includes equipment and components at the factory, but not research and development contracts, nor distribution, service and installation revenues.

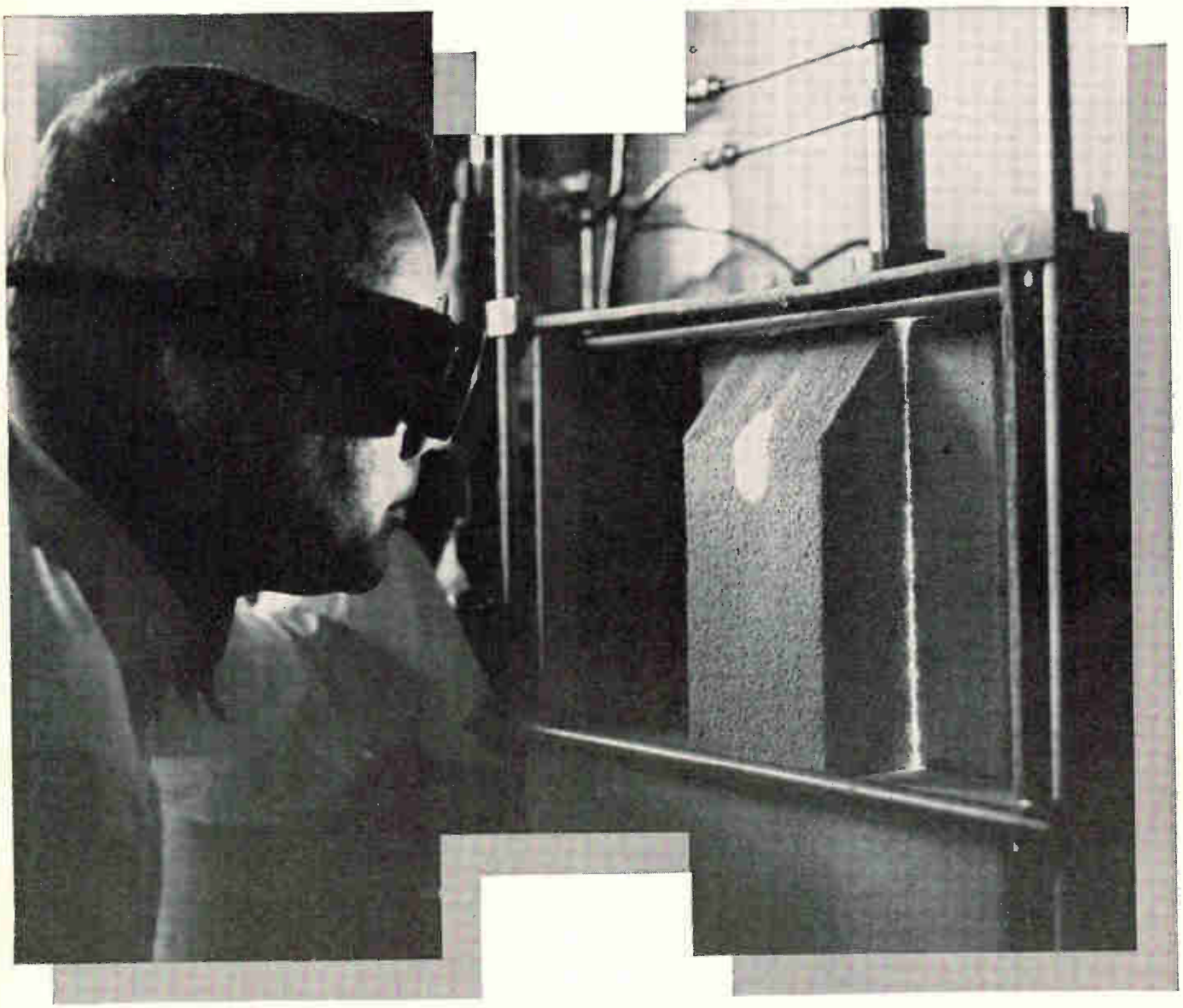
ELECTRONICS NEWSLETTER

Laboratory model of a thermoplastic recording system (ELECTRONICS, p 11 & 46, Jan. 15) demonstrated by GE last week produced a black-and-white video picture comparable to ordinary kinescope. In color presentations greens and reds predominated. The company predicted use of the system in radar, ir detection and ecm. Data recording and retrieval were among other applications envisaged but not demonstrated.

Solid state high-sped printer-plotter that prints and plots from computer-prepared magnetic tape has been developed by Briggs Associates, Inc., Norristown, Pa. BAI will market variations of the machine at prices ranging from $150,000 to $300,000. Up to 10 graphs can be plotted at one time and fully annotated. Machine could be adapted to print up to 120 characters per line at a rate of 8,000 per second.

Stereo 4-channel tape recorder manufactured in Tokyo by Akai Electronics under a technical agreement with Roberts Electronics, Hollywood, Calif., is expected to be marketed in the U.S. for about $700 in April pending patent approval by the U.S.

alchemy in the 20th



century

In medieval times, alchemists spent lifetimes trying to transform the commonplace into the precious without success. Today, in the Hughes Research Laboratories, scientists and engineers using advanced methods and equipment, are synthesizing many new and precious materials to be used in solid state research.

The photograph, for example, shows a Hughes Research Laboratories scientist observing the growth of an yttrium aluminum garnet crystal using the flame fusion method. This work, as well as other crystal growth techniques, is part of a major Hughes materials research and supply program for the synthesis of ruby, sapphire, spinel, ferrite, garnet and related oxide single crystals. These materials provide atomic circuit elements which are the key to quantum electronics.

As solid state research at the Hughes Research Laboratories continues to expand and intensify, a supply of new and tailor-made materials in the form of high-quality single crystals is essential. Effective utilization and improvement of existing and new crystal growth methods requires extensive knowledge of their range of applicability, crystal growth mechanisms and the relationships between growth parameters and perfection of the resulting materials.

Feedback *in the form of performance data and suggestions for modifications to advanced Hughes Systems is provided by Hughes Field Engineers.*

Development *of new and highly reliable direct display storage and microwave tubes is being carried on at the Electron Tube Division, Hughes Products.*

Materials research is contributing significantly to existing ferrimagnetic, paramagnetic and absorption spectroscopic studies...and is opening new areas of investigation by providing materials not previously available as large single crystals.

Other Hughes activities cover practically every part of the electronics spectrum...providing stimulating outlets for creatively-oriented engineers. These include: Space Vehicles, Nuclear Electronics, Ballistic Missiles, Advanced Data Handling and Display Systems, Infrared Devices, Three-Dimensional Radar...and many others.

The variety and advanced nature of Hughes projects provides an ideal environment for the scientist or engineer who wishes to increase his professional stature.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	Field Engineering
Infra-red	Equipment Engineering
Plasma Physics	Commercial Sales
Digital Computers	Microwave & Storage Tubes
Systems Design & Analysis	Communications Systems
Circuit Design & Evaluation	Micro Electronics

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Hughes General Offices, Bldg. 6-D1, Culver City, Calif.

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WASHINGTON OUTLOOK

SOME of Washington's missile-space proponents were disappointed by President Eisenhower's State of the Union message.

The President's reference to a doubling of space expenditures is not considered astounding. It represents only the natural growth of a program underway for just two years, not the crash program many missile-space proponents have been plumping for.

Many critics here feel that space exploration and the military missile program should not be looked upon as separate operations.

Several members of Congress are excited about the so-called space issue. But Rep. Overton Brooks, chairman of the House Space Committee, concedes that there is not really much that the lawmakers can do to push the space program any faster.

Nevertheless, both Brooks and presidential aspirant Lyndon B. Johnson, chairman of the Senate Space Committee, are planning full-scale investigations into our space program. Some observers question the value of such inquiries, complain about the vast amount of time top-level officials will be spending before congressional committees—frequently covering ground already covered by other committees—instead of managing the operations for which they're responsible.

The Pentagon's top brass for instance is lined up for appearances before at least six different committees within the next month—each wanting a briefing on U.S. "defense posture."

- **The Titan ICBM project** is reportedly in trouble. There's been no successful test launching since May 4. The Air Force indicates that the project's timetable has slipped several months. Reports are that seven of 31 test missiles produced have been damaged in handling or on static test stand operations—two beyond repair.

  Meanwhile, the Martin Company, major prime contractor for Titan, has made a major overhaul in management of the project. Board Chairman George M. Bunker has taken over personal supervision.

  Pentagon officials say there's no plan to kill or cut back the Titan project as of now. Some $1 billion has been spent on the project so far; several hundred million dollars more are earmarked for it this year.

  Titan's electronics contractors apparently do not figure directly in the project's troubles.

  Bell Telephone Laboratories is the associate prime for a radio-command-guidance system to be used in the first few Titan squadrons—with Remington Rand producing the computer for the radio-command-guidance system. General Motors' AC Spark Plug div. is associate prime for an all-inertial guidance system for later Titan units scheduled to be set up in underground launching facilities; IBM makes the computer for the all-inertial guidance system.

- **A new Washington rumpus** is shaping up over the administration's recent cut in the Air Force B-70 bomber development program. The program was trimmed in December to save some $85-million this year, and to reduce expenditures in the near future. Contracts for the bomber's subsystems—bombing-navigation, electronic countermeasures, and mission and traffic control—were cancelled and the production schedule slashed from 13 test aircraft to two.

  Air Force Chief of Staff Gen. Thomas D. White now makes it clear that he opposed the B-70 cutback. He declares the manned bomber will still be needed, despite development of ICBM's. He says that he will appeal the B-70 decision to Congress. White also reveals that the air-launched ballistic missile, formerly called Bold Orion, now in the early stages of development for use on the B-70, has been renamed the "Sky Bolt."

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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6036

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hp 200CD Wide Range Oscillator

hp 200J Interpolation Oscillator

hp 200T Telemetry Oscillator

hp 201C Audio Oscillator

hp 202C Low Frequency Oscillator

hp pioneered the world-famous resistance-capacity oscillator circuit

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Larger work sizes for more efficiency...for short run punching — 30" x any length ... for production run hole duplication — 25" x 30".

Adjustable table for greater accuracy and flexibility...for punching to closer tolerances in angles, shapes and formed parts as well as flat sheets.

New, no-jam electric head eliminates down time...and the need for pressurized air. Fewer parts minimize maintenance — ensure quieter, more positive operation.

Wide range of hole punching capacities...from a 3½" hole (round or shaped) in 16 gauge to a ½" hole in ¼" mild steel.

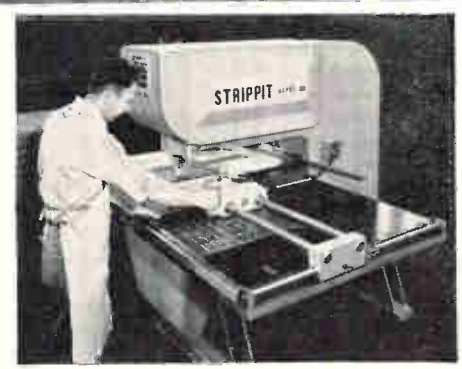
Corner and edge notching...up to 5" x 5" in 16 gauge mild steel — 90° corners. rectangular, vee, radii and special shape edge notches.

Straight line nibbling and contour shearing...at 165-strokes per minute in ⅛" mild steel. Instant changeover from single stroke punching.

New swing-shift punch holders...quick-opening. positive-closing — for right or left-hand operation. Electrical interlock for safety.

Exclusive quick-change tooling system...using standard stock punch and stripping guide assemblies and die buttons. Size changes take less than 20 seconds.

New quick-set gauging system...with micrometer settings for fast, accurate layout and rapid work positioning.



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AP 143

Four Bond Sales Announced

LING-ALTEC ELECTRONICS announces private sale of $5 million of 6-percent notes with common stock purchase warrants to a group of institutional investors including two insurance companies and a bank. Funds will be used to finance plant expansion for operations in connection with the Anaheim, Calif., company's backlog of about $55 million, and for general corporate purposes. The firm is working on sonar, radar and super-power communications systems.

• **Litton Industries,** Van Nuys, Calif., reports private placement of $6 million worth of 15-year 5¼-percent convertible subordinated debentures due Dec. 1, 1974.

• **Dynatronics,** Orlando, Fla., lacks only five percent to complete subscription of a bond issue placed on public sale Dec. 3, 1959. Each bond, par value $500, entitles the owner to purchase 143 shares of common stock at $3.50 per share after Nov. 14, 1960. The firm is engaged in research, development and production of data collecting systems and digital data handling equipment.

• **Tenney Engineering,** Union, N. J., awaits approval on filing for $500,000 of 6½-percent convertible subordinated debentures to be due in Jan. 1970. The bonds are to be offered at public sale at 100 percent of principal amount with a nine-percent commission to the underwriters. Also pending is application for sale of 25,000 shares of common stock. The firm now has 500,079 common shares outstanding.

• **Sanders Associates, Inc.,** Nashua, N. H., announces that two major investment firms have purchased blocks of its common stock. The One William Street Fund and the Lehman Corp., each purchasing 15,000 shares, will add more than $1¼ million to Sanders' equity. The New Hampshire company is engaged in R&D on missile and weapons systems and expects to reach or better a sales goal of $15 million in the coming fiscal year.

• **Craig Systems,** Lawrence, Mass. reports an increase in dividends to 15 cents a share last year, compared with 10 cents in 1958. Present backlog is up 50 percent from last year, with over 15 percent of the volume in items where Craig or its subsidiary, LeFebure, has proprietary rights.

• **Specialty Electronics Development Corp.,** Syosset, N. Y., announces profits of $145,041 on net sales of $1,204,644 for the first quarter of its fiscal year which began Aug. 1, 1959. After allowance for federal income taxes, net profit totalled $75,041, equal to six cents a share on 1,172,050 shares outstanding. The Long Island company produces specialized communications equipment and associated hardware. Projected sales for fiscal 1960 are about $4 million.

25 MOST ACTIVE STOCKS

WEEK ENDING JANUARY 8

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	1,094	26¼	24⅜	24¾
Gen Electric	1,040	99⅞	94¾	96½
Ampex	941	110	96⅛	102⅞
Gen Dynamics	909	52½	47⅝	52½
Avco Corp	840	15⅜	14⅝	14¾
Elec & Mus Ind	725	12	10⅞	10⅞
Int'l Tel & Tel	724	39⅝	36⅞	37⅛
Collins Radio	623	69½	61¾	62½
Litton Ind	610	67¼	58⅞	61¼
Varian Assoc	599	45⅜	40	41⅝
Raytheon	581	53⅜	50⅛	50¾
Reeves Sndcrft	578	11⅛	10	10⅛
Spartan Corp	572	9¼	8	9⅛
Univ Control	566	18⅝	17⅜	17¾
Gen Tel & Elec	561	84¾	82⅛	82¾
RCA	560	70	66⅛	66⅜
Dynamics Corp Amer	518	12⅜	11¼	11⅞
El-Tronics	479	1⅞	1½	1½
Philco Corp	470	33½	30¼	30⅜
Westinghouse	413	114	109	109
Int'l Resistance	388	23⅞	21¼	21⅜
Texas Inst	365	171¼	154	158½
Muntz TV	335	6¼	5½	5⅞
Lear	273	20¼	19	19
Clarostat	267	15⅞	14⅛	14⅞

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.

Sola reduces prices on ±1% static-

Sola Sinusoidal type Constant Voltage Transformers for universal application, now moderately priced

Housed unit with mounting plate typical of structures employed in 60va to 1kva ratings.

An important advance in the field of voltage regulation is the development of a new line of Sola Standard Constant Voltage Transformers with sinusoidal output. New design enables us to price them about the same as previous models not having sine-wave output. Now you can have the advantages of ±1% static-magnetic voltage regulation in new applications requiring harmonic-free input where previously the cost was a deterrent.

These new units provide output voltage regulation of ±1% for line voltage variations as great as ±15%. They regulate automatically and continuously. Fast response time averages 1.5 cycles or less. Output has less than 3% total rms harmonic content, and formulae based on sinusoidal wave shape may be used in designing related load circuitry.

Design and production innovations make these new units substantially smaller and lighter than previous models. They are relatively compact compared to other equipment for comparable ac voltage regulation. They are easy to select and order —the buyer merely selects the stock unit whose output capacity equals or exceeds the desired equipment input. Sola Standard Sinusoidal CV Transformers are available in nine stock output ratings from 60va to 7500va. Custom designs to meet specialized requirements are available in production quantities.

Write for full information . . .

With electrical control systems and components continuing to increase in number and complexity, and imposing more rigid reliability requirements, these new Sola Constant Voltage Transformers provide many advantages and virtually unlimited application. They are the result of over four years of development, design, and production engineering in the Sola laboratories and plant.

These developments mean superior voltage regulation, giving you a bonus in equipment reliability and performance at no increase in cost.

For full information, please write for technical literature on Sola Constant Voltage Transformers. We will mail it promptly, or if you wish, we will have a representative call on you.

magnetic voltage regulators

Sola Normal-Harmonic type Constant Voltage Transformers now specifically designed and priced for component use

End-bell unit with separate capacitor typical of structures engineered for component use.

Re-design of Sola "Normal-Harmonic" type static-magnetic voltage regulators has resulted in a significant reduction in their size and weight. Prices on many of these units have been reduced. Now it's possible for you to improve equipment performance by using them in many new fields at less cost than ever before. Redesign has in no way sacrificed the performance of these units—they provide all the outstanding benefits which have made them the standard of the industry for more than fifteen years.

Sola Normal-Harmonic type voltage regulators provide ±1% output voltage with line voltage variations as great as ±15%. This group has an average of 14% total rms harmonic content in its output voltages and is suited to equipment not extremely sensitive to voltage wave shape.

Sola Normal-Harmonic type voltage regulators are available in nineteen stock ratings from 15va to 10kva, including those mechanical designs specially engineered for use as built-in components. With many of the most popular ratings now reduced in price, these Sola Constant Voltage Transformers provide one of the most economical means of close voltage regulation in a broad range of applications.

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Sola Manufactures: Constant Voltage Transformers, Regulated DC Power Supplies, Constant Wattage Mercury Lamp Transformers and Fluorescent Lamp Ballasts

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MARKET RESEARCH

Sell Systems, Not Hardware

ELECTRONICS INDUSTRY manufacturers should aim to sell systems instead of hardware to industrial customers.

That's the gist of the message presented at the recent Industrial Electronics Conference, held by Electronic Industries Association in New York City.

There is little doubt that interest in industrial system-selling is mounting among electronics industry manufacturers. The 210 management and marketing executives, representing well over 100 electronics manufacturers, who attended the all-day conference attest to this conclusion. Moreover, investigations into the industrial systems market was one of the more popular subjects of market studies made by electronics firms last year.

What is systems selling?

A concrete answer is impossible. But speakers at the conference provide a rough picture.

It consists essentially of selling products on a packaged basis, said one. More than pieces of hardware, a system includes a considerable planning and advisory work; such service costs may equal 70-80 percent of total costs. Systems selling emphasizes the needs and possible economic benefits to the customer rather than the characteristics of the hardware used, said another.

Why the growing interest in industrial systems?

One reason is the increasing domination of the electronics industry by military business which currently accounts for well over half of total industry sales. Because military business is taking so much of our industry's energy we may be neglecting the tremendous opportunities available in the industrial market which is currently the fastest growing segment of the electronics industry, says James D. Secrest, EIA's executive v. p.

But more specifically, systems selling is the only way to tap the great potential the industrial market holds for the electronics industry, other speakers said.

Electronics manufacturers have equipment capability to enable industry to score an advance in the art of production greater than that achieved by the Industrial Revolution, claims Pat Robinson of John Diebold & Associates, management and computer consultants.

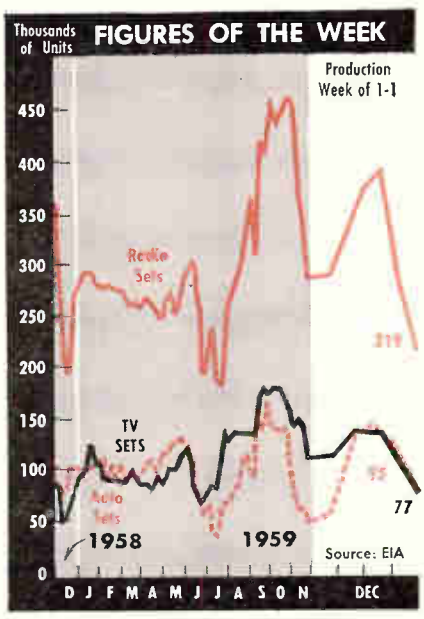
Electronics' technical progress is beyond the comprehension of the average industrial customer, says Irv Koss, manager of Motorola's microwave department. However, the industrial customer can understand the economic benefits to his firm such as improved quality, reduced costs and faster flowing operations which can be provided through an integrated system, he adds.

Sales Experience Lacking

Industrial systems-selling is such a novel development that little in the way of specific information is available on the subject. Only a handful of electronics firms are actually selling industrial systems today and their experience is limited.

Consequently, conference speakers stressed general and basic selling principles which have found application in all industrial selling.

Electronics manufacturers will find they have to know more about the customer's business, his needs and thought process when selling systems than when merely selling hardware, they said.



Crosley Radar

And . . . . . .

America's defense

Soon the latest in ground radar from Crosley will stand watch along the distant approaches to the North American continent. Since 1955 Crosley's radar engineers have been at work—designing, perfecting, improving this important new radar unit.

Now the FPS-26 ground radar is ready for production, and Avco's Crosley Division has been named prime contractor by the U. S. Air Force.

The huge radar—so new that it is still classified—will be housed in a radome more than 50 feet in diameter. It will be mounted atop a reinforced concrete tower more than 70 feet high and will consist of more than 300,000 parts, including some 3500 tubes and diodes.

Handling the design and production of complex, challenging radars is "old hat" to Crosley, prime contractor of the famous MPS-16 height finder radar now widely used by the armed forces. Similarly, Crosley now is prime contractor to the Air Force for the radar-directed fire control system that puts a 50-caliber "stinger" in the tail of the B-52 bomber.

Radar is just one example of Crosley know-how in both engineering and production—*designing* the best possible performance into the product . . . *producing* it on schedule, and at a reasonable cost.

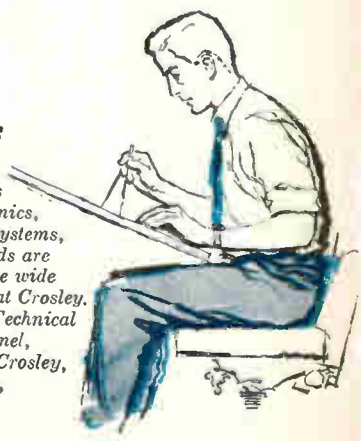
Today Crosley is recognized as a leader, not only in radar, but in communications, marine electronics, electronic ground support, infrared, fire control systems, air traffic control, ordnance and missile arming and fuzing.

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

Avco / Crosley

ENGINEERS:

Creative research and development engineers experienced in electronics, mechanics, weapons systems, and ordnance warheads are urged to investigate the wide range of opportunity at Crosley. Write to: Director—Technical and Scientific Personnel, Dept. E-10E. Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.



Only three seconds each . . . permanent, solderless connections

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Gardner-Denver believes there's no substitute for men—it has been our philosophy of growth for 100 years. Your Gardner-Denver air tool specialist has helped many uncover ways to speed the production pace . . . lower costs. He's a good man to know.

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In only three seconds you make a solderless, metal-to-metal electrical connection that's lastingly secure . . . one that conquers vibration failure and fights corrosion.

And it's all so easy and inexpensive with a lightweight, fast-acting Gardner-Denver "Wire-Wrap"® tool. Even an inexperienced operator becomes an expert in no time. But see for yourself . . . look at these profit-building benefits:

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Lower production costs. You eliminate the expense of precise process control required by other methods.

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Higher quality. Mechanically strong connections electrically stable—proved most reliable in the industry.

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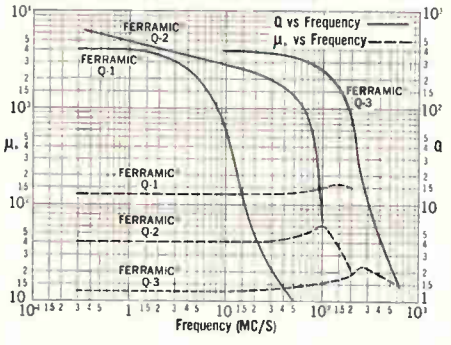
Only GENERAL CERAMICS offers a complete line of

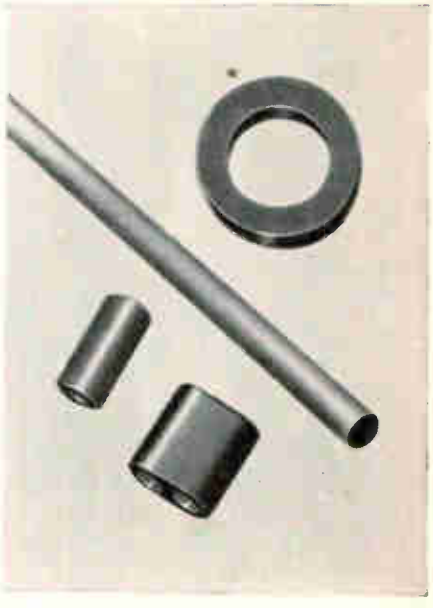
HIGH FREQUENCY FERRITE CORES

Make G-C your single source for a complete line of H-F ferrites ranging in frequency from 300 kc to 220 mc.

Ferramic® Q-1, Q-2 and Q-3 materials, developed and introduced by G-C, feature exceptionally low losses, temperature stability and high permeability. Whether your ferrite requirement is for the commercial entertainment industry, military, ground or air borne communication equipment or industrial electronic applications, G-C will meet your needs with the broadest line of high frequency ferrite materials and in the shapes you require.



This curve demonstrates the exceptional qualities of G.C's "Q" family of materials — high permeability and low loss.



Q-1 Material

Ideally suited for IF transformers at 455 kc and antenna cores from 500 kc to 1700 kc.

Magnetic properties include: Initial permeability at 1 mc/sec. — 125; Maximum permeability — 400; Saturation flux density — 3300 gauss; residual mag. — 1800 gauss; coercive force — 2.1 oersted; temperature coefficient of initial permeability — .10%/°C max; Curie point — 350°C; vol. resistivity — high; loss factor at 1 mcs/sec. — .000020; loss factor at 5 mcs/sec. — .000050.

Standard Ferramic parts in various sizes and shapes offer a dependable, quick solution to design problems. Custom parts can be produced to your specifications. Contact General Ceramics' engineering advisory service. Our staff is ready to discuss your problems and make recommendations.

Q-2 Material

This material produces excellent results in TV receiver IF applications at 45 mc; and FM radio applications at 10.7 mc.

Magnetic properties include: Initial permeability at 1 mc/sec. — 40; Maximum permeability — 115; Saturation flux density — 2400 gauss; residual mag. — 750 gauss; coercive force — 4.7 oersted; temperature coefficient of initial permeability — 0.10%/°C max; Curie point — 450°C; vol. resistivity — high loss factor at 10.0 mc/sec. — 0.000085; loss factor at 50.0 mc/sec. — 0.000017.

Q-3 Material

The exceptionally high Q, excellent temperature stability and high permeability of Q-3 ideally suits it for applications in the 88 mc–108mc FM band and television RF frequencies from 50 mc–216 mc.

Preliminary specifications include: Initial permeability μ_o — 14; Maximum permeability μ_{max} — 42; Saturation flux density B_s — 2600 gauss; Residual magnetism B_r — 1470 gauss; Coercive Force — 21 oersted; Q at 100 mc — 250; Q at 150 mc — 150; Q at 200 mc — 70; Resistivity high; Curie point 330°C; Temperature coefficient of μ_o — .09%/°C max.

A New 16-page
FERRITE PARTS CATALOG

is available to engineers by request on company letterhead. It contains complete engineering data on stock parts and materials. When requesting your copy, please address Dept. E.

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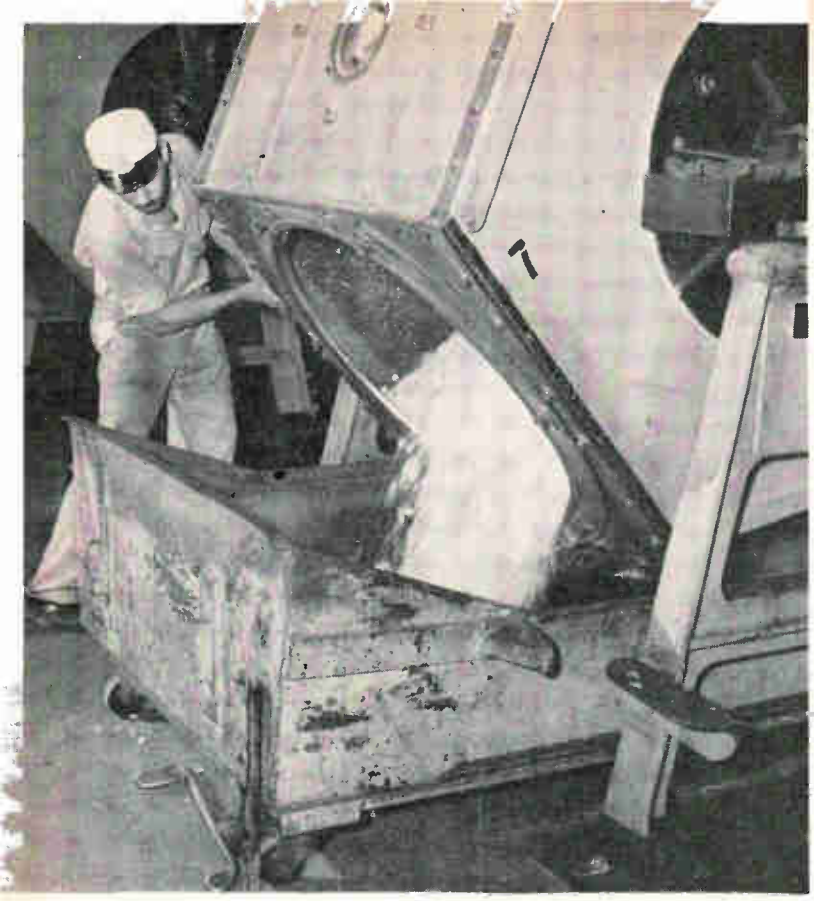


Raw plastic like this form of acrilonitrile is being used to make semiconductors, according to Soviet news agency

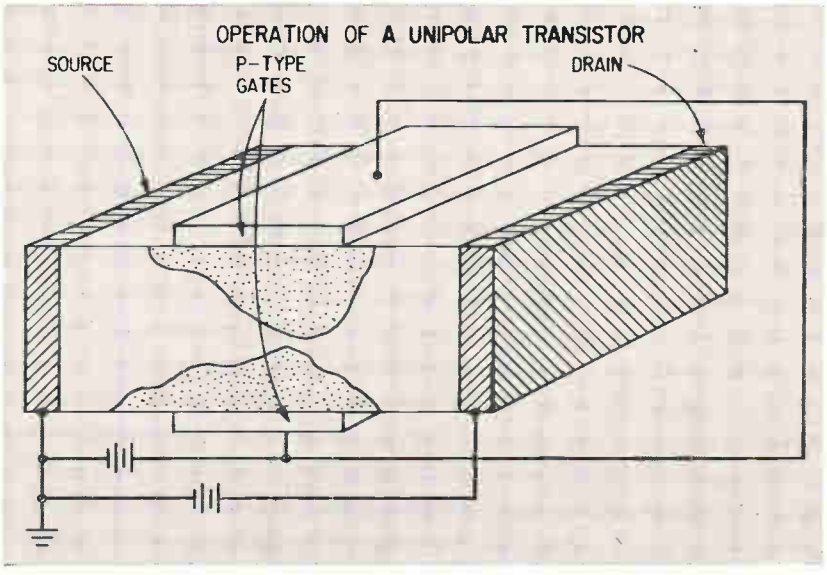
USSR Claims Plastic Fiber Transistor

USSR report of transistors made from plastic fiber is stirring wide interest among U.S. electronics and chemical companies

RUSSIAN-MADE plastic transistors—fact or fancy? U. S. industry reactions this week to such a claim reported by Tass (ELECTRONICS, p 11, Jan. 1) elicit several facts.

• Many U. S. electronics firms have been quietly at work on plastic bombardment to produce semiconductor effects.

• Publication of results, say some researchers, has been held up because a really workable commercial transistor is not yet a reality in their opinion.



N-type semiconductor block is provided with a contact on each end. Between source and drain is a finite resistance. Current flow through this resistance in response to applied d-c produces a linear voltage drop along the block. Two p-type plates (gates) make p-n junctions with the main block which are reverse-biased. Voltage drop along the block effectively increases net negative bias on the junctions in the direction of the collector. This results in depletion of charge carriers in the region of the junction to an extent which increases in the direction of the collector. If source-drain potential is large, neutral channel may be pinched off entirely

• Other plastics besides polyacrilonitrile (mentioned in the Soviet claim) are being investigated. For more on semiconductive plastics, see p 68.

One transistor manufacturer, commenting on the scant information available, suggests that the Russian device is most likely unipolar depending on a field effect to control current rather than upon the injection of majority carriers into the base region.

Research engineers and commercial producers both express doubts that a polyacrilonitrile transistor will pose a serious threat to conventional units in the foreseeable future. One scientist at a major research laboratory told ELECTRONICS that organic compounds made to act as a semiconductor have been familiar to his colleagues for some time. He added that it would be "surprising" if the device described by the Russians performed in any way comparable to conventional transistors.

Close Watch

Although most comments obtained this week indicate skepticism that plastic transistors will become technically acceptable, chemists and

electronics engineers are keeping a close watch on work being done in plastic bombardment.

Technical interest in transistors by chemical companies has, for the most part, centered around research on encapsulation compounds. However, reactions to the Soviet announcement, indicate that chemical industry interest may be enlarged.

Polyacrilonitrile producers, for example, are showing keen interest. They admit that the bulk volume of the plastic as it might be used in transistors would not be great. But an opportunity to diversify into the field of chemical electronics is commanding their attention.

In addition to the possible establishment of research programs in new areas, say the chemists, there is a chance that recruiters from chemical companies may show increased interest in hiring electronics engineers.

More Claims

Additional Soviet claims, reported by *McGraw-Hill World News*, include mention of another organic semiconductor made of a combination of polyacrilonitrile and silicon. The Russians say additional studies will be made at Leningrad's Institute of Semiconductors.

Details on the method of irradiating the combination substance, as well as information on the dosage used, have not been made public. Radiation for the all-plastic transistor is reported to be 4.5 million roentgens.

What Tass Said

London (AP) — The government news agency Tass said that a Soviet scientist has invented a plastic transistor as good as those made of germanium.

The agency said the new plastic type was developed by Nikolai Semyenov from a synthetic wool substitute known as polyacrilonitrile. The plastic was bombarded by radioactive matter and "became as electrically conductive as germanium and silicon," Tass said.

"The plastic semiconductors are more stable than those made of germanium and can be procesed more easily. They can be synthesized out of natural gases and oils.

"When they go into commercial production industry will have a practically unlimited supply," Tass added.

Japan Launches Color TV

TOKYO — JAPANESE tv setmakers have roared into 1960 with record sales and with ambitious plans for mass production of both color sets and transistorized black-and-white sets.

Although marketing of color sets may be some time off, Japan paved the way for full-scale color tv set manufacture and possible export of color sets to the U. S. by adopting, as 1959 ended, the American NTSC (National Television System Committee) standard for color broadcasts.

At the same time, a number of manufacturers plan commercial production of transistorized black-and-white sets and there is already talk of exporting them to the U. S. in about a year.

As the Japanese setmakers rush preparations on these two fronts, their sales of ordinary black-and-white sets are skyrocketing. Some 3 million Japanese homes had tv sets at the beginning of October. By late December some industry sources expected that total to climb another million by January 1.

New Stations

Reason for the sales upsurge, which showed no sign of abating as 1960 began, was the start of operations of seven new stations in November. Four are part of the government NHK network, three are new commercial stations.

Demand for sets was so strong that a bottleneck developed in the supply of glass envelopes for picture tubes (ELECTRONICS, p 11, Jan. 15). Supplier Asahi Glass Co. can produce 300,000 glass envelopes a month, expects to boost output by 50,000 in March. The six leading manufacturers have a combined capacity of 500,000 sets a month.

On the color front, licenses were expected to be formally granted this month to NTV (Nippon Television Co.) and NHK (Nippon Hoso Kyokai) to go ahead with color telecasts using the U. S. system. The broadcasters have been experimenting with the NTSC system for two years. Manufacturers of tv sets were thus far from being caught unaware.

Industry consensus is that the color sets could bear a $400 price tag in Japan when mass production is reached. Manufacturers did not say when they expect to mass-produce color sets.

However, it is significant that NTV plans to expand its color programming immediately from its present one-hour color program each evening in Tokyo.

Postal Service Minister Haruhiki Uetake said the action was taken only after two international conferences—in May 1958 and in August 1959—failed to adopt a single world standard.

Meanwhile, two Japanese manufacturers—Toshiba and Matsushita—were reported this week to be close behind Sony in developing a transistorized black-and-white set for production (ELECTRONICS, p 11, Jan. 8). Sony is scheduled to produce 1,000 to 1,500 units a month starting in mid-March, but doesn't expect to export any to the U. S. this year.

Industry sources say other manufacturers — Hitachi, Mitsubishi, Hayakawa, Sanyo, Japan Victor, Japan Columbia and Yao—are also racing to put transistorized tv sets into production.

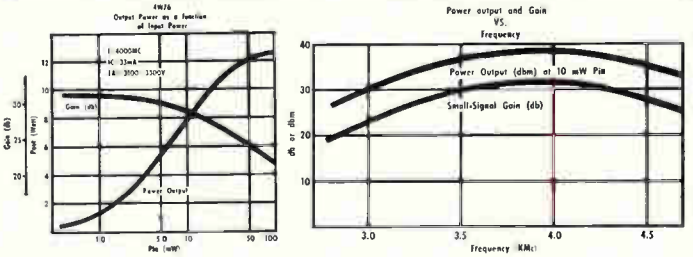
Transistorized portable which Sony expects to produce by March

package-type TWT power amplifiers with NEC's new long life cathode

Production of traveling wave tubes at NEC began seven years ago and introduction of the package-type three years later. As chief supplier to Japan's complex network of microwave communications, NEC has become the world's largest maker of TW tubes. With the high development costs amortized and large manufacturing capacity, NEC is now able to supply these tubes at well below usual prices.

NEC's new doped nickel cathode core material, a 10-year development, increases both emission and tube life. It has been thoroughly field-proven in disc-sealed planar triodes for 2000 mc equipment of a large U.S. systems manufacturer (name on request). With its cooler operating temperature, evaporation rate of oxide is less than any other known core materials. This extends tube life up to 50%.

Designers will appreciate the compactness these tubes will give to their systems and operators the reliability and economy. Tubes connect to standard IEC waveguide flanges and can be shipped from stock. For specifications sheets, please write to Tokyo.



4W76

The 4W76 operates in the 4000-mc band and has nominal saturated power output of 10 watts. High amplification over a wide range of power levels results in small-signal gain of approx. 30 db. The band width at half-power points is 1400 mc, but the tube can be used in the frequency range of 2800 to 5000 mc.

Typical Operating Characteristics at 4000 mc

First Anode Voltage	2,640 V	Saturated Power Output	12.5 watts
Helix Voltage	3,220 V	Small-Signal Gain	32 db
Helix Current	0.7 mA	Noise Figure	approx. 25 db
Collector Current	33 mA	VSWR	less than 2 to 1 (from 3500 to 4300 mc)
Focusing Electrode Voltage	-40 V		

NEC TRAVELING-WAVE AMPLIFIERS

PERMANENT MAGNET FOCUSED AMPLIFIERS

4W75	4000-mc band	1.5 watts	8W75	7000-mc band	1.5 watts
4W76	" "	5-10 watts	8W76	" "	5-10 watts
6W50	6000-mc band	5-10 watts	11W17	11000-mc band	1.0 watt

ELECTROMAGNET FOCUSED AMPLIFIERS

4W85	4000-mc band	0.1 watt	4W72A	4000-mc band	1.5 watts
4W86	" "	1.0 watt	7W52	6000-mc band	5-10 watts

Advantages of package-type

- NO focusing or impedance matching at installation
- NO dummy space for removal
- NO power source or current stabilizer for electromagnet

NEC *Nippon Electric Company Ltd.* Tokyo, Japan

COMPONENTS / SYSTEMS

At the 1960 National Motor Boat Show, boatsmen show keen interest in electronic accessories for their craft

Transistors Star in Small-Boat Gear

Automatic gas-fume detectors and shoal alarms join radio, radar and navigation aids to make up new $10-million market

NEW YORK—ELECTRONIC LIFELINES — radar, loran, radiotelephones, direction finders, alarms—were prominently exhibited this week at the Golden Anniversary National Motor Boat Show, held here at the Coliseum.

Manufacturers showed gear to meet navigational requirements of every kind of craft from the small catboats to lavish yachts. Design emphasis was on compactness, waterproofing, transistorization, low power consumption and decor. The last attribute was a bid for the acceptance of the increasing number of women who are taking to the water as pleasure-boating becomes a family activity.

Growing Market

Pleasure boaters spent almost $2.5 billion in 1959 to keep a total of 7,800,000 craft of all type afloat, according to boating industry spokesmen. Of this sum, the electronics industry's share is estimated at $10 million. Federal Communications Commission reports 82,600 marine radiotelephones currently licensed, an increase of 13,000 over 1958. Two thirds of this figure is estimated to represent pleasure-boat installations.

As in other years, marine radiotelephone gear was much in evidence; radiotelephones normally account for about 30 percent of annual electronics sales volume. But at this year's show there was stiff competition from low-powered Class D citizens' radiophones, whose low cost appeals to small-boat skippers.

At least eight manufacturers were competing for shares of the pleasure-boat radar market. Various systems shown ranged in scope size from 5 to 10 in., in operating range from half a mile to 48 miles, in input power from 250 w to 1 kw. Highest peak output power shown was 60 kw.

Manufacturers also differed in choice of transmitter location, some preferring a location aloft with the antenna, others in the wheelhouse. Prices ranged from about $1,500 to about $4,500.

Two models of loran navigation receivers with 3-in. scopes were exhibited, priced at $1,495 and up.

Transistorization Popular

Advantages of transistor compactness and low power consumption have been engineered into small-boat direction finders, entertainment receivers, and depth sounder-fish finders. New designs

of nav-aids using transistors were well received by the small-boat fraternity because of the instruments' independence of batteries or generators. One manufacturer offers eight models of do-if-yourself navigation aids as construction projects for the hobbyist when his favorite lake or bay is frozen over.

A newly developed electronic gasoline-fume detector employs a platinum filament which emits infrared energy when gasoline fumes are present. The air acts on a solar cell shielded to see only the platinum wire. Infrared energy is converted by the cell to a signal voltage which is fed to a transistorized amplifier. Amplifier output triggers a flashing warning light on the boat's instrument panel. The device can be quickly tested from a panel switch.

A depth alarm based on depth-sounder principles aids skippers cruising inshore. The boatsman sets the device for any minimum depth which he considers safe. Operating unattended, the unit sounds a bell warning whenever the minimum depth is approached.

Israel Weighs National Tv Net

TEL AVIV — A decision for or against establishing nation-wide tv facilities in Israel will be made in 1960, a spokesman for the Prime Minister told ELECTRONICS. If the verdict is affirmative, the station will be ready for transmission a year later.

"We are approaching the point," he said, "where we can afford tv and make it available to the whole population—almost certainly within the life of the present Knesset (Parliament)."

The spokesman said the Israeli government has received many offers from firms in several countries to foot the bill for establishing tv in Israel in return for certain concessions. Though the final word rests with the government, he said, in view of these offers, the station will probably be run commercially.

For nation-wide reception, the project would cost about $1.6 million in foreign currency and about $1 million in local money.

Helping to keep computers compact...

The space and weight saving characteristics of Gamewell Sinusoidal Potentiometers make them a popular choice for equipment employing sine-cosine operations. Far lighter and more compact than gears, cams, and other complicated mechanisms, they're widely used in analog computers, data converters, Tacan systems, and radar components. Wire wound card and double brushes produce sine-cosine functions with a smoothness and precision unobtainable by other resistive methods . . . ideal for low frequency sine wave generation.

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Resistance	16,000 ohms ±5%
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Mechanical Rotation	Continuous
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PRECISION POTENTIOMETERS

INTEGRALS OF HIGH PERFORMANCE

GROWTH COMPARISON CHART OF RADIO BROADCAST USAGE				
	1958		1959	
SERVICE	STATIONS	TRANSMITTERS	STATIONS	TRANSMITTERS
MARINE	79,200	80,000	92,200	95,000
AVIATION	69,900	85,000	81,700	125,000
LAND TRANSP'N	52,600	345,000	81,000	445,000
INDUSTRIAL	44,600	420,000	55,000	538,000
PUBLIC SAFETY	28,000	307,000	30,500	332,000

1.7 Million Transmitters Says FCC

Yearend report from Federal Communications Commission shows more than 1½ million transmitters now on the air in more than 50 services

RADIO TRANSMITTERS in categories other than broadcasting now outnumber broadcast transmitters in use by 165 to 1 according to yearend report by Federal Communications Commission.

In marking its 25th year of operation, FCC points out the increasing complexity of nonbroadcast services dealing with protection of life and property as well as those used for business and personal communications.

Latest count of users shows a total of over 570,000 licensees using more than 1,700,000 transmitters, plus almost two million authorizations for operators. In addition to broadcast facilities there are now more than 50 other categories of radio services.

Uhf Tv Drops

Almost 50 percent of all uhf tv permits issued since 1952 have been voluntarily surrendered by holders. The report indicates that 92 of the 167 uhf stations constructed and operated in the past seven years are now off the air.

Pay television, although the subject of frequent discussion during the year, came no closer to reality during 1959. Commission comment is that no acceptable application for testing under the limited conditions prescribed has been submitted.

There are now over 500 tv stations in operation throughout the country plus an additional 172 authorizations for more. (Of the stations now on the air only 76 are uhf.) Translator stations increased only by 70, making a present total of some 270 installations authorized to bring tv to remote localities which are, for the most part, unable to receive direct tv broadcasts.

Other Services Increase

Educational television stations have risen to 45 from 35 in 1958. Authorizations have been granted for an additional 30. Of the 45 educational tv stations now in operation, 12 are uhf.

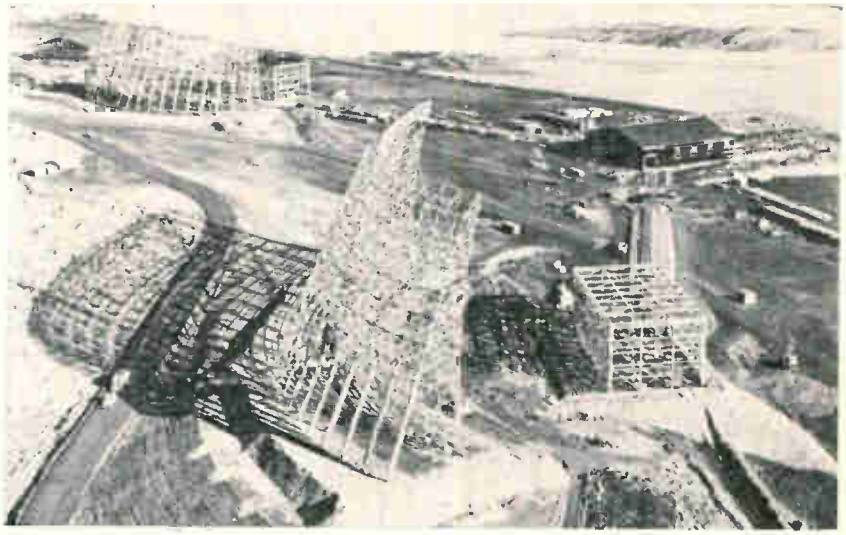
More than 550,000 authorizations in the safety and special radio services account for the use of more than 1,400,000 fixed, mobile and portable transmitters. Present totals show an increase of about 85,000 stations and 300,000 transmitters for the year.

Four new services provide radio for local governments, manufacturers, business establishments and industrial manitenance. Amateur radio authorizations rose by about 14,400, going from 188,600 in 1958 to nearly 203,000 in 1959.

Present count in the Citizens radio service now totals nearly 70,000, an increase of 27,800 over 1958.

Both a-m and f-m broadcast stations increased during the past year.

Antennas for Early Warnings



Installation of 400-by-160-ft antennas for Air Force Ballistic Missile Early Warning System in the Arctic nears completion. The scanner and transmitter-computer buildings serving the antennas are connected by covered passages

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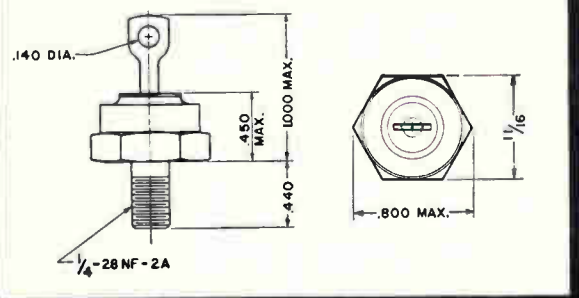
High Performance
Extreme Reliability

From the leading manufacturer of power transistors, new Silicon Power Rectifiers to meet your most exacting requirements. Even under conditions of extreme temperatures, humidity and mechanical shock, these diffused junction rectifiers continue to function at maximum capacity! Thoroughly dependable, completely reliable—new Delco Rectifiers are an important addition to Delco Radio's high quality semiconductor line.

Conservatively rated at 40 and 22 amperes for continuous duty up to case temperatures of 150°C.



TYPE	AVG. DC CURRENT	PIV	NORMAL MAX. TEMP.	MAX. FORWARD DROP	MAX. REVERSE CURRENT
1N1191A	22A	50V	150°C	1.2V at 60 amps.	5.0 MA
1N1192A	22A	100V	150°C	1.2V at 60 amps.	5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.	5.0 MA at 150°C case temperature and rated PIV

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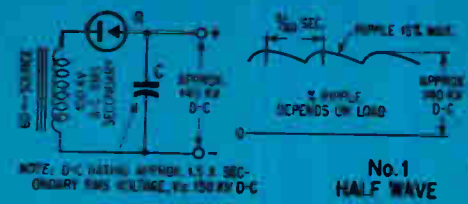
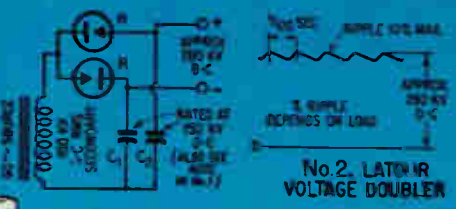
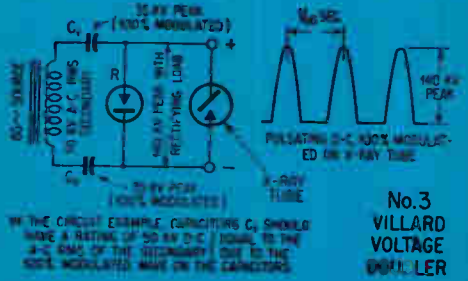
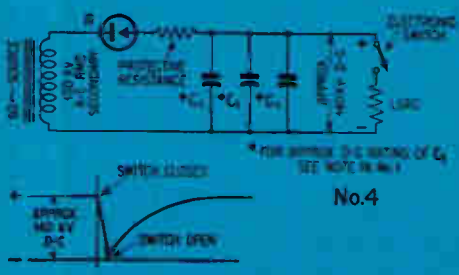
25,000 to 200,000 volts DC in a single unit

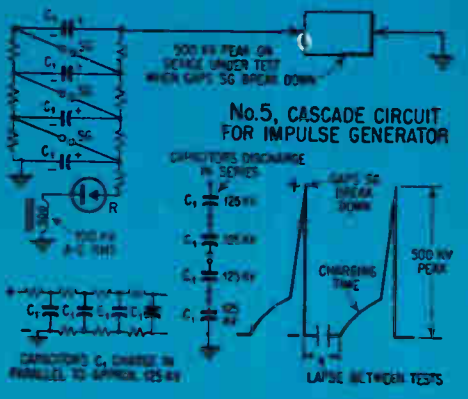








with Cornell-Dubilier ULTRA-HIGH-VOLTAGE CAPACITORS



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TUBULARS (25 KV to 200 KV) —for betatrons, nuclear accelerators, impulse-test and cascade circuits, X-ray and other voltage-doubler circuits.

TUBULARS

- 25,000 to 200,000vDC; .001 to .6 mfd., depending on voltage.
- Cast aluminum, dual-purpose end caps, seven different styles, serve as electrical terminals and banking-mounting means.
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- Welded, hermetically sealed steel case.
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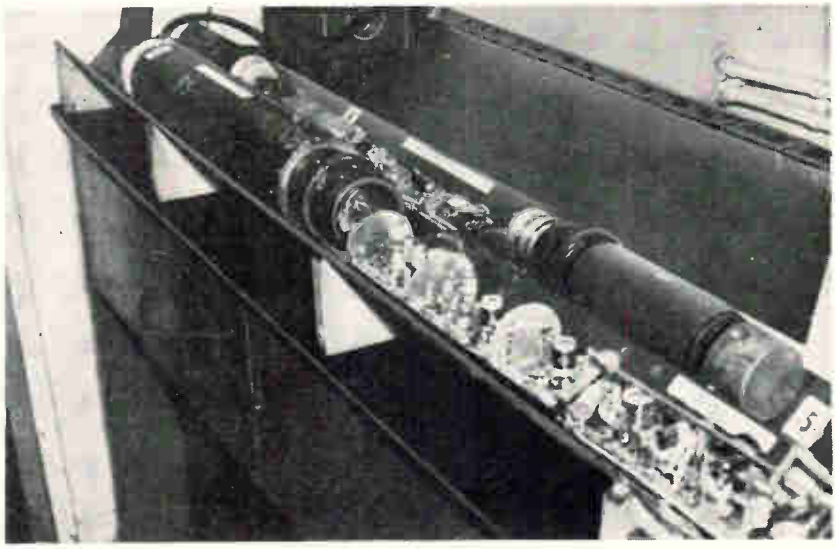
Sea Forecasts Could

Report on oceanographic research says undersea fleet effectiveness could be doubled



Telemetering hydrophone, such as this one aboard a U. S. oceanographic vessel, is typical of new electronic devices designed for oceanic research

OCEAN ENVIRONMENTAL FORECASTS could almost double the effectiveness of the Navy's undersea fleet.

This is the most telling point in a report on basic research in oceanography released last month by the Committee on Oceanography of the National Academy of Sciences—National Research Council.

The committee recommends that the Navy set up an ocean data-gathering network. Right now, few persons close to the oceanographic research picture will even guess as to the eventual extent of such a network.

Need for Data

"Practically every weapon system now used or being developed by the Navy could be markedly improved in effectiveness through more reliable environmental forecasts," the committee declares. "In undersea warfare this is so much the case that it can be argued that the effectiveness of our present forces could be nearly doubled by taking environmental factors fully into account. This is particularly true of submarine weapon systems."

The report suggests that naval and commercial ships, along with certain aircraft, could be tied into a marine environmental forecasting center and supplemented by deep moored or floating buoys. Observers think the latter might be automatic stations containing various types of measuring and recording instruments and telemetering gear.

The committee calls for forecasts of such basic properties of the ocean as temperature, salinity and currents. From these, forecasts of a more applied nature can be made, such as the locations of fish, underwater sound propagation ranges, paths of drifting icebergs and movement of radioactive materials in the deep.

With acceleration of oceanographic research and planning expected in 1960, some study and design contracts might be forthcoming. Some Navy sources feel that for certain purposes new instrumentation would be "highly desirable," but they do not go beyond this comment, except to say that oceanographers are generally familiar with the electronic state of the art.

It is likely that if and when a

Aid Subs

marine environmental data and forecasting center is set up it will be an adjunct to the Navy's Hydrographic Office, which is now engaged in a pilot test program of collecting readings of surface temperature for facsimile broadcasting. It's believed that the Hydrographic Office could develop the capability of doing this on a routine basis if given sufficient funds.

Implementing Suggestions

The Office of Naval Research is already trying to implement as many of the committee's recommendations as is feasible, considering both its present budget and various other "serious and vital problems."

"The need for environmental predictions of various kinds has begun to be apparent in the commercial fisheries as well as in merchant ship operations," the committee also points out. "Some small beginnings have been made which indicate that practical results are not too difficult to achieve."

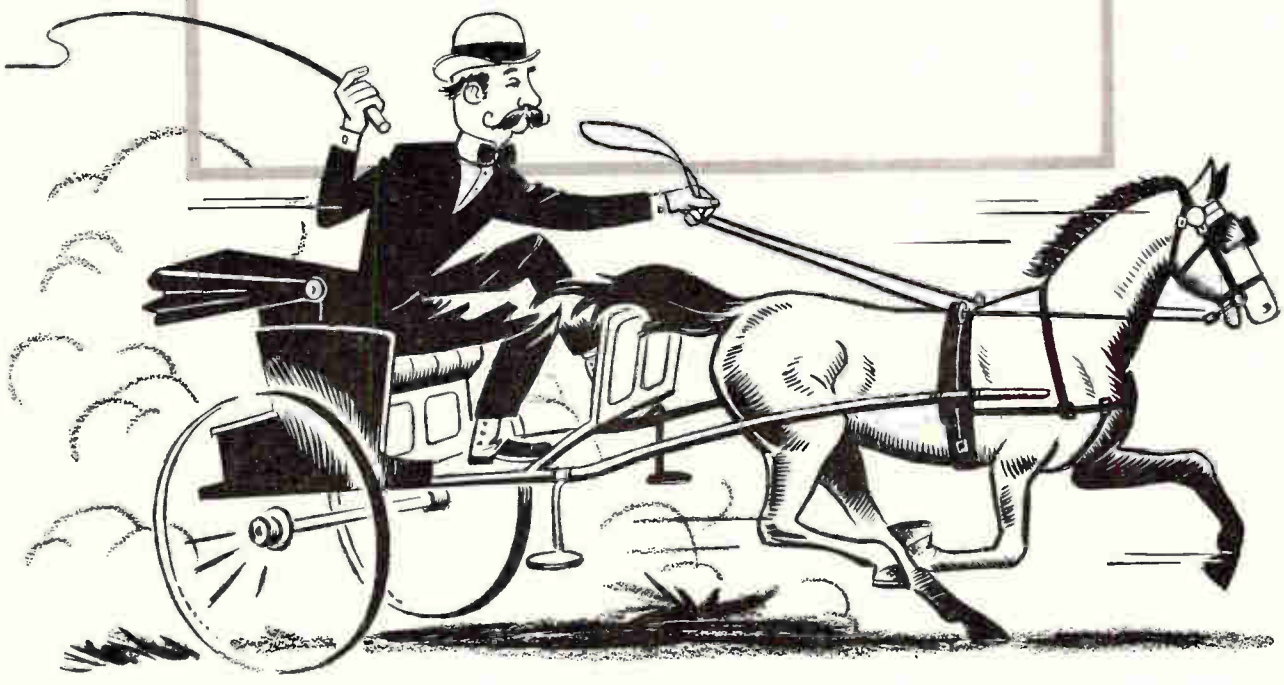
Ocean environmental forecasts are not new. The U. S. has engaged for some time in ice forecasting, particularly around the Grand Banks fishing area and in Baffin Bay in the far north. Sea, swell and surf forecasting systems were well developed during World War II and have since been improved.

However, the U. S. has nothing comparable to the 10-day surface temperature forecasts now made regularly by the Japanese Meteorological Office for a stretch of ocean 500 to 600 miles around the Tokyo area.

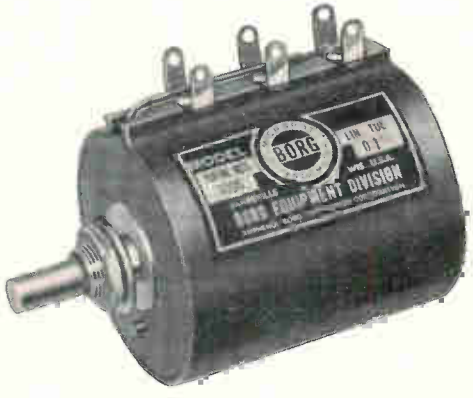
The time scale for certain oceanographic forecasts is much slower than that for the atmosphere. Hence, less up-to-date data is needed for the forecasts and the forecasts themselves are useful for a longer time.

The report, "Basic Research in Oceanography During the Next Ten Years," is one of 12 chapters prepared or in preparation for the Committee's over-all report titled "Oceanography 1960 to 1970."

How to get fast delivery of precision potentiometers



Wherever you are located, there's a Borg "Tech-Rep" or distributor near you with a stockpile of Borg 1100 Series Micropots ready for delivery. 1100 Series Micropots are precision potentiometers economically priced. Units with a total resistance of 50 to 500 ohms inclusive are supplied with a .25% independent linearity. Resistances from 1000 to 100K ohms are delivered with .25% or .1% independent linearity. Call your nearest Borg distributor today.



WRITE FOR DATA SHEET BED-A132

BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation
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Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards

Services Want Inventions

More than 200 devices involving electronics are needed by the Army, Navy and Air Force

LATEST LIST of "Inventions Wanted By The Armed Forces," offers 320 new problems, 28 from the May 1959 Supplement, and five revised problems. More than half the total involve electronics.

Compiled by the National Inventors Council, with the cooperation of the Army, Navy and Air Force, each problem is one to which the military is currently seeking a solution.

Ideas toward solution of any problem listed should be typewritten and mailed to the National Inventors Council, U. S. Department of Commerce, Washington 25, D. C. Each description should be as complete as possible, and might include: (1) reference to the principles underlying the invention; (2) a discussion of any experimental work or tests conducted; and (3) the points of novelty or superiority of the invention as compared to existing devices or techniques.

Components Needed

Here are some of the items listed under the various categories:

Electronic Components and Systems: microwave filters—extremely sharp cut-off selective microwave filters (L-band or X-band); low loss, high power ferrites for use as microwave phase shifter; a broadband maser amplifier for use in the microwave region; a new method of electronically (not with frequency change) scanning an antenna; reliable long-life cathode—an efficient indirectly heated unipotential thermionic cathode having 100,000 hours life in negative grid tube with current density of 50 ma d-c/cm^2.

Solid state oscillators capable of producing more than 50 megawatts of microwave power in the frequency range above 2,000 mc to serve as a solid-state pump for parametric amplifiers; microwave delay line of reasonable size, with stable electrical characteristics and capable of producing delays in the order of several hundred microseconds.

Transistors, Antennas

Transistors with power gain and linear characteristics at extremely small emitter currents and collector voltages permitting efficient operation at low signal levels; transistors capable of operation at ambient temperatures well in excess of 250 degrees C; transistors whose characteristics change considerably less with temperature than present units.

Antennas: techniques for suppressing sidelobes of high gain antennas below any specified minimum; miniature antennas in the 6-mc to 60-mc range; wide-band antenna with medium gain, unidirectional, 10 to one frequency range which must maintain a single lobe pattern and be circularly polarized and also capable of receiving linearly polarized signals.

Measuring Devices

Instrumentation, Testing, and Measurement: altimeters—pressure sensitive mechanisms for measuring pressure altitude to 500,000 ft or higher; device for determining zero airspeed of helicopters and convertiplanes; a simple and rapid means of in-flight alignment of a parent inertial guidance system to a slave system; reliable solid state gyros and accelerometers having low power requirements.

Also, accelerometer capablle of making precise measurements of missile-launching acceleration; a method of measuring pitch, yaw and roll of missiles in flight which employs a principle different from the telemetry of gyroscopic reference measurements.

For data presentation, the Council would like a large screen, high resolution, multicolor system for radar and alphanumeric data display.

MEETINGS AHEAD

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

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

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

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

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

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

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

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Apr. 11-13: Protective Relay Engineers, Annual Meeting, A&M College of Texas, College Station, Tex.

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

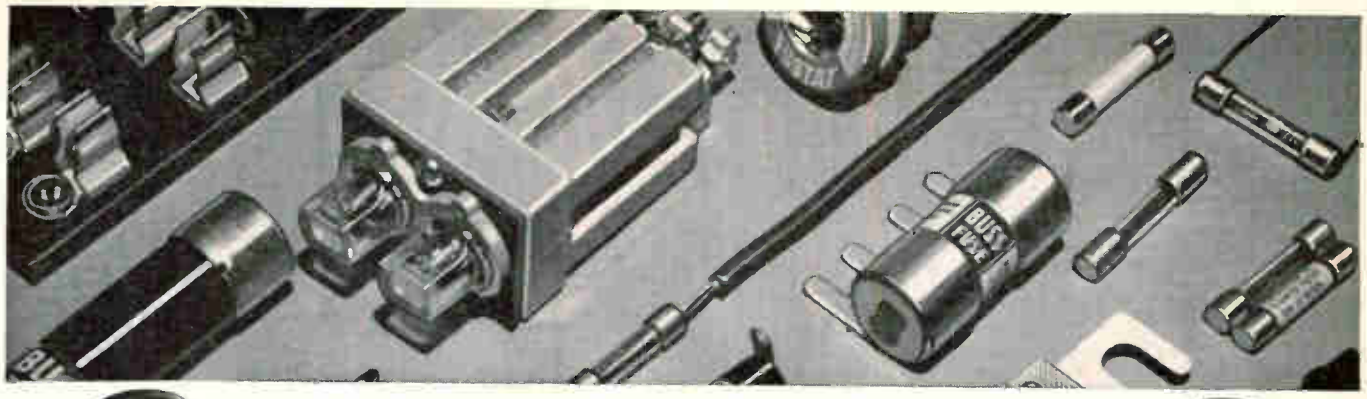
Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

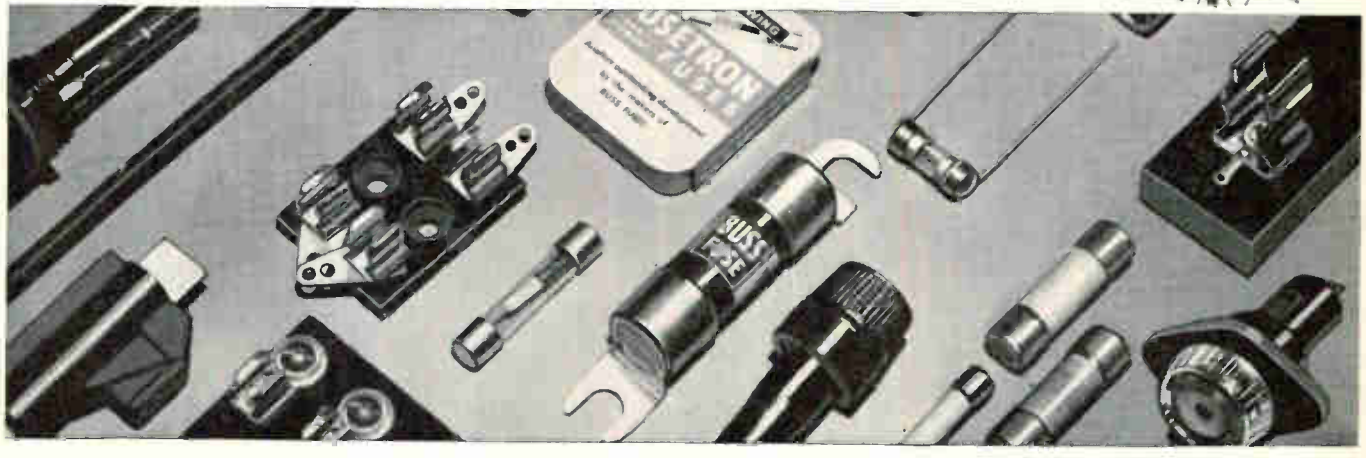
Apr. 20-22: Southwestern IRE Conf. & Electronics Show, PGME of IRE, Shamrock Hilton Hotel, Houston, Tex.

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 76.



Specify BUSS Fuses!



Because there's a BUSS or FUSETRON fuse to fit Your Every Electrical Protection Need.

With the world's largest fuse research laboratory plus 44 years of experience in solving electrical protection problems — it isn't surprising that BUSS has the most complete line of fuses in the industry.

The BUSS and FUSETRON fuse lines includes:

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

Single-element fuses for normal circuit protection.

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

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

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion line of fuse clips, blocks and holders. Whatever your fuse requirements, the chances are more than good there's a BUSS or FUSETRON fuse to satisfy them.

If you have a special protection problem . . . extensive BUSS laboratory facilities and a large engineering staff are at your disposal to help you save money and engineering time.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders, write today for BUSS bulletin SFB.

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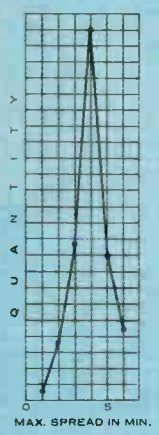
SYNCHROS *for* GYRO PLATFORMS

by cppc



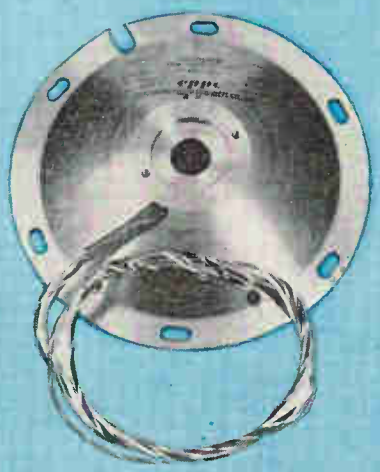
6′ max. error spread Synchro for Gyro Pick-Off

The SG-17- and ST-17- type pancake synchros (SG-18- and ST-18- with housings) are our most standard line for gyro pick-off applications.

These units have been manufactured in large quantity and are readily available for prototype breadboarding. The high accuracies shown on the left are obtainable in standard 26v or 115v units.

Pancake Resolver for Gimbal Mounting

Clifton Precision produces special pancake resolvers for direct gimbal mounting. They were developed for use in cascaded amplifierless resolver systems and have been trimmed for 10K input impedance, 0° phase shift and a constant transformation ratio, with temperature, at 900cy. Accuracies of 4′, perpendicularities of 3′ and nulls of 1mv/v of output or less can be held.



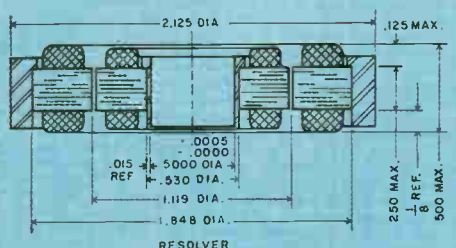
Special techniques maintain concentricity between rotor and stator — thus reducing difficulties commonly encountered in gimbal mountings.

Custom Designed Pancakes

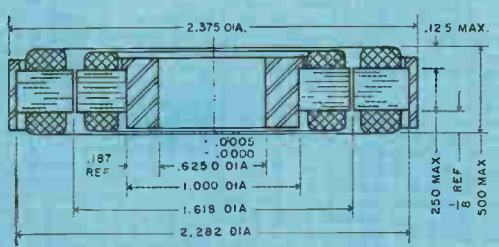
CPPC has developed a number of special pancakes (drawings below) with relatively large bores and narrow stack heights.

Means have been devised to minimize error due to clamping pressures on these thin units.

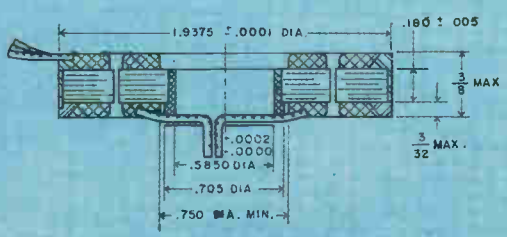
Special accuracies have been maintained where required. Let us know your needs.



RESOLVER



TRANSMITTER OR RESOLVER



TRANSMITTER

electronics
JANUARY 22, 1960

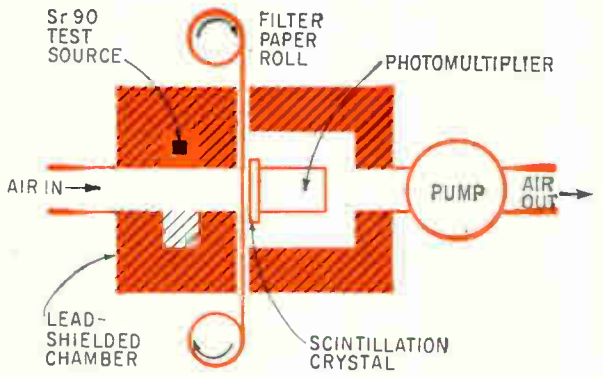


FIG. 1—Air flow system contains Sr 90 source for calibration of equipment

Air flow detector system is in left-hand section. Other portion holds the electronic circuits

How Radiation Monitor Guards Nuclear Navy

Nuclear-powered vessels require special monitoring equipment to protect personnel from harmful effects of excessive radioactive dust particles. This article describes a transistorized radiation monitor that sounds an alarm when alpha and beta radiation in the air reaches a preset level

By **H. E. DeBOLT,** Fairchild Camera and Instrument Corp., Defense Products Division, Syosset, N. Y.

NUCLEAR-PROPELLED VESSELS must be equipped with devices to detect the presence of hazardous radiation conditions which could endanger personnel. In the event of a radiation leak into a compartment, the atmosphere in that compartment may become lethal.

The air particle monitor discussed in this article is sensitive to concentrations in the range 8×10^{-10} to 8×10^{-7} microcuries per cc and produces a visual and audible alarm if the radiation level exceeds predetermined levels.

The system pumps air from the compartment being monitored and passes the air through a filter paper which collects minute dust particles. A scintillation counter examines the filter paper for radiation and passes any resultant signal to the computer system which indicates the radiation level of the dust particles and sounds local and remote alarms if the level becomes dangerous.

AIR FLOW SYSTEM—The air flow and detector system is shown in Fig. 1. Air is drawn from the compartment being monitored through the lead-shielded detector chamber and back into the compartment. The radiation detector is sensitive to alpha and beta radiation emanating from the dust particles clinging to the filter paper. The filter paper is moved across the air opening at one-half inch per hour. For calibration purposes, a source of Sr 90 (strontium

90) is placed in the detector chamber. The pump maintains a steady air flow.

COMPUTER—The anthracene scintillation crystal, 0.079-inch thick, is attached to the multiplier phototube window. When an alpha or beta particle strikes the crystal a pulse of light is generated and picked up and amplified by the multiplier phototube. The signals are passed through emitter follower Q_1 (see Figs. 2 and 3), amplifier Q_2 and emitter follower Q_3 to the counter flip flop consisting of Q_4 and Q_5. The counter flip flop operates from the positive-going pulse output of Q_3. Emitter follower Q_6 is operated cutoff and the adjustment of the degree of operation below cutoff constitutes a discriminator which provides a vernier adjustment of the operating point of the computer. Coarse discriminator adjustments can be made by varying the high voltage applied to the multiplier phototube.

The counter flip flop output is coupled to a logarithmic count circuit' whose output is displayed on the front-panel meter.

The half-wave push-pull logarithmic integrator used is shown in Fig. 4 with its synthesis formulas. The output of each half-wave portion is rectified by a separate pair of diodes. The circuits are made common at R_8 so that R_8 carries current from both logarithmic integrator circuits.

In Fig. 4, it is assumed that the time between pulses is always equal; the voltage source from the counter flip flop transfers from ground potential to voltage V when one pulse arrives and remains there until the next pulse arrives $1/N$ second later when the voltage transfers back to ground potential where it remains for $1/N$ seconds; the voltage drop in the diodes is neglected when they conduct; the time constant of the meter circuit $C_m R_8$ is long compared with the time between pulses; and the pulses have been applied long enough for steady-state conditions to exist.

ALARM CIRCUIT—When the counter flip flop output at point A of Fig. 3 goes negative, diode D_1 conducts causing a negative pulse to appear at the lower end of the secondary of transformer T_1. If the bias voltage applied to T_1 secondary by potentiometer R_1 is greater than the signal voltage coming from C_1 plus the applied pulse amplitude, diode D_2 will not conduct. If the positive-going signal voltage coming from capacitor C_1 becomes large enough, D_2 will conduct during the applied negative pulse and the resulting negative pulse will appear at the base of normally saturated transistor Q_6 through coupling capacitor C_2. The amplitude of the negative-going pulse applied to the base of Q_6 will increase as the signal from C_1 becomes more positive. When this pulse is of sufficient amplitude, Q_6 will come out of saturation and the Q_6—Q_7 bistable will reverse conditions with Q_7 saturated.

When Q_7 becomes saturated, relay K_1 is energized. When this happens, contacts on K_1 apply power to another relay (not shown in Fig. 3) which automatically latches itself up through a thermistor time delay (a time delay is required to prevent operation during switching transients), and supplies power to the remote alarms.

The remote relay remains latched up sounding the remote alarms until it is manually reset.

The counter flip flop Q_4 and Q_5 always counts at the minimum rate of 10 transitions per second due to slight leakage from the radioactive test source built into the detector. A front-panel indicator lamp lights when the counter flip flop stops operating for any reason. As shown in Fig. 5, rectified 115 v is applied between indicator lamp I_1, series resistor R_1 and ground. This rectified voltage is sufficient to strike the gas indicator lamp. A bias consisting of the rectified signals from the counter flip flop is applied to the lower end of the indicator lamp. When this bias is

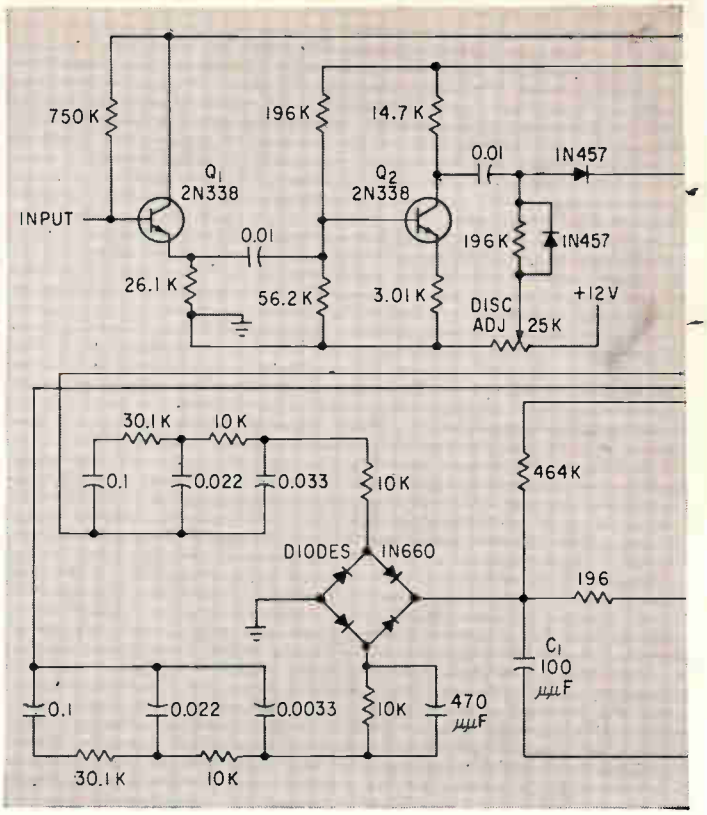


FIG. 3—Basic circuit of monitor. Output of counter flip flop is integrated and displayed on front panel radiation level

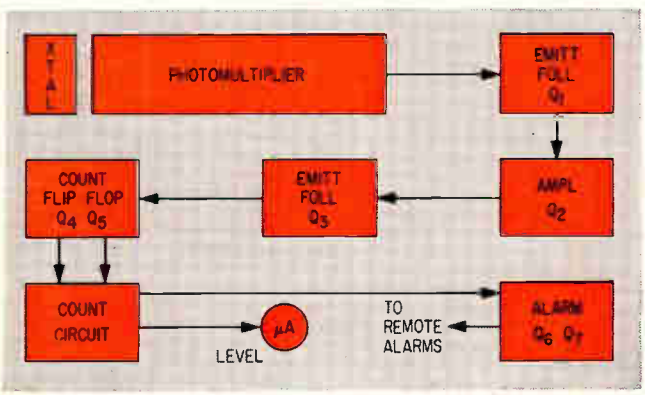
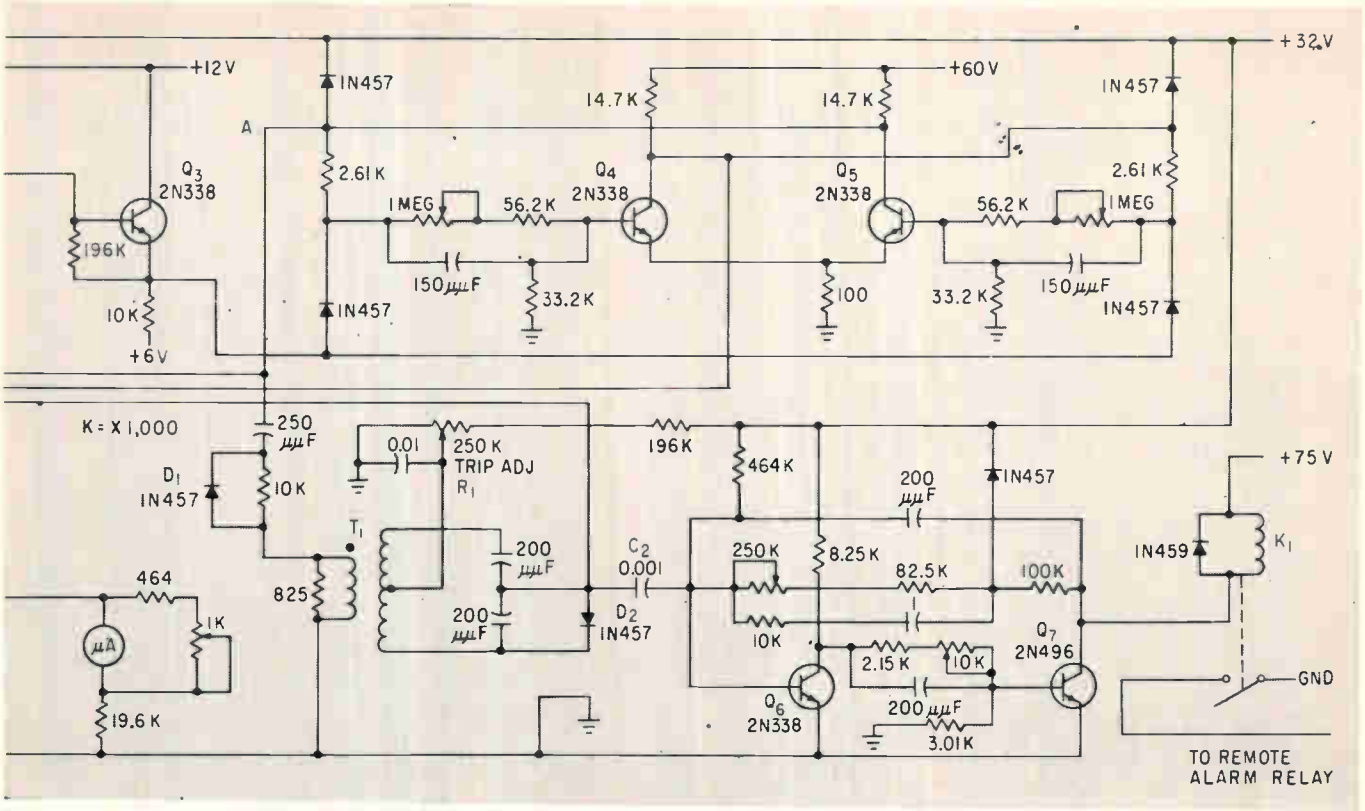


FIG. 2—Light flash in crystal generates approximately 1-volt pulse



meter. When output exceeds predetermined level, alarm circuit operates to close relay and actuate remote audible and visual alarms. Alarms must be reset manually

present it is sufficient to keep the indicator lamp from striking. If the counter flip flop stops operating for any reason, the bias voltage is removed and indicator lamp operates.

Other indicators show the condition of the d-c supply, multiplier phototube failure, transistor failure or if the air flow is too low (clogged paper) or too high (broken paper).

CALIBRATION—The equipment is calibrated by applying a known quantity of Sodium 24 to the filter paper. Beta rays emitted by the Sodium 24 produce photomultiplier tube signal pulses of all amplitudes up to a maximum determined by the beta energy of the Sodium 24. This known quantity of Sodium 24 must produce a counting rate in the equipment as required by the calibration curve of the meter. The multiplier phototube high voltage and the computer discriminator controls are adjusted for the correct meter indication. Once the setting has been made, the Sr 90 test source is introduced into the detector and the indication obtained on the meter is compared with known radition level of the Sr 90.

Variation with age of the equipment can be compensated by comparing the indication of the Sr 90 test source with the known decay rate of the Sr 90. A typical Sr 90 calibration curve is shown in Fig. 6.

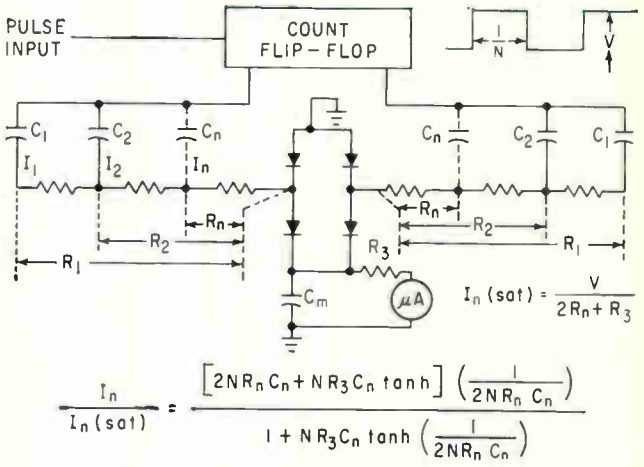


FIG. 4—Logarithmic integrator connects to opposite ends of flip flop

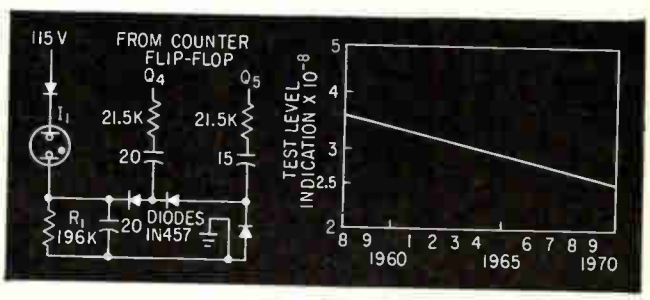


FIG. 5—Front panel indicator lamp operates when counter flip flop stops

FIG. 6—Example of typical SR-90 test-source decay rate

Reference

(1) H. E. DeBolt, A Simplified Logarithmic Integrator Circuit, *IRE Trans Nuclear Science*, NS-6, 2, June 1959.

Multiplex Circuits

This robot performs jobs in dangerously radioactive areas while its operator controls and watches it on the tv screen of a distant console. Here are the robot's control circuits

By D. A. CAMPBELL,
Research Engineer, Nuclear Electronics Laboratory, Hughes Aircraft Co., Los Angeles, California

BETWEEN 50 and 100 channels are required to control the robot shown in the photo. Another requirement is that the multiplexed commands travel by either cable or radio between control console and the robot. The data rate is low as it is limited by human reaction time to about 0.1 second per individual control channel. To keep the handling mechanisms simple, on-off controls are used for all control actions.

The control system meets the requirements and is applicable to numerous other remote control problems where many functions must be operator-controlled over a considerable distance. A digital control system is used since it minimizes linearity requirements in the communication link, and permits the use of synchronous commutating switches to accomplish multiplexing.

A single 3-conductor cable carries the pulse trains which carry the control information. This cable also conveys 60-cps power to the vehicle, and two tv channels and one audio channel from the vehicle to the control console. Television and audio information are separated from the control channels by r-f carrier frequency discrimination.

Control System

The basic components comprising the remote control system are shown in Fig. 1. When one of the control switches is closed, 45 volts appears at a contact on the local commutating switch. Local and remote commutating switches are synchronized so that corresponding contacts are sampled simultaneously. Therefore, when the energized contact is sampled, a voltage pulse appears at the corresponding contact of the remote commutating switch. The remote switching circuit accepts the pulse train from the control switch and produces a continuous relay closure as long as the train continues. A relay such as K_1 can be used to operate any function requiring on-off control.

Using a 45-v battery to supply the control pulses, a simple remote switching circuit was possible. The power that can be transmitted through the commutating switches to the remote switching circuits is principally limited by the capacitance of the 220-ft-long interconnecting cable. A 270-ohm resistor in series with the cable at each end limits the cable charging current. A 10,000-ohm resistor in parallel with the cable at each end discharges the cable capacitance between contact closures. If the 10,000-ohm resistors were omitted, a pulse from one control channel would cause spurious operation of several succeeding channels because of the charge stored in the cable capacitance. Thus, most of the supplied power is used in charging the cable capacitance.

The 60-cps power operates the motors driving the commutating switches as well as many other units on the Mobot. Since the outer grounded shield of the triaxial cable is common for the power and control signals, the drop in the 60-cps voltage along the shield appears as an a-c component on the control

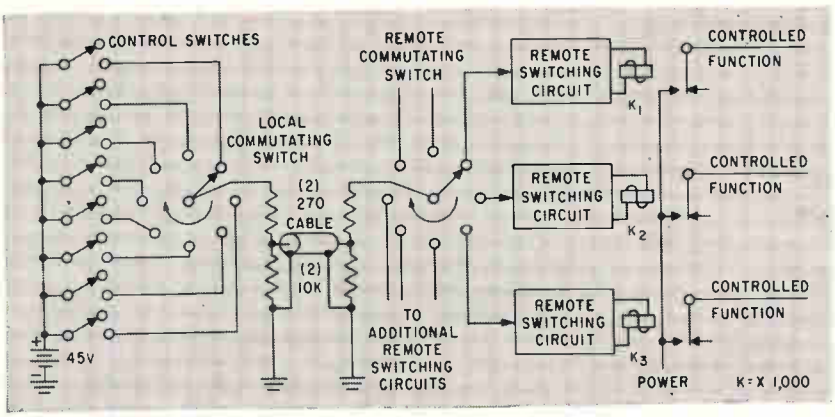
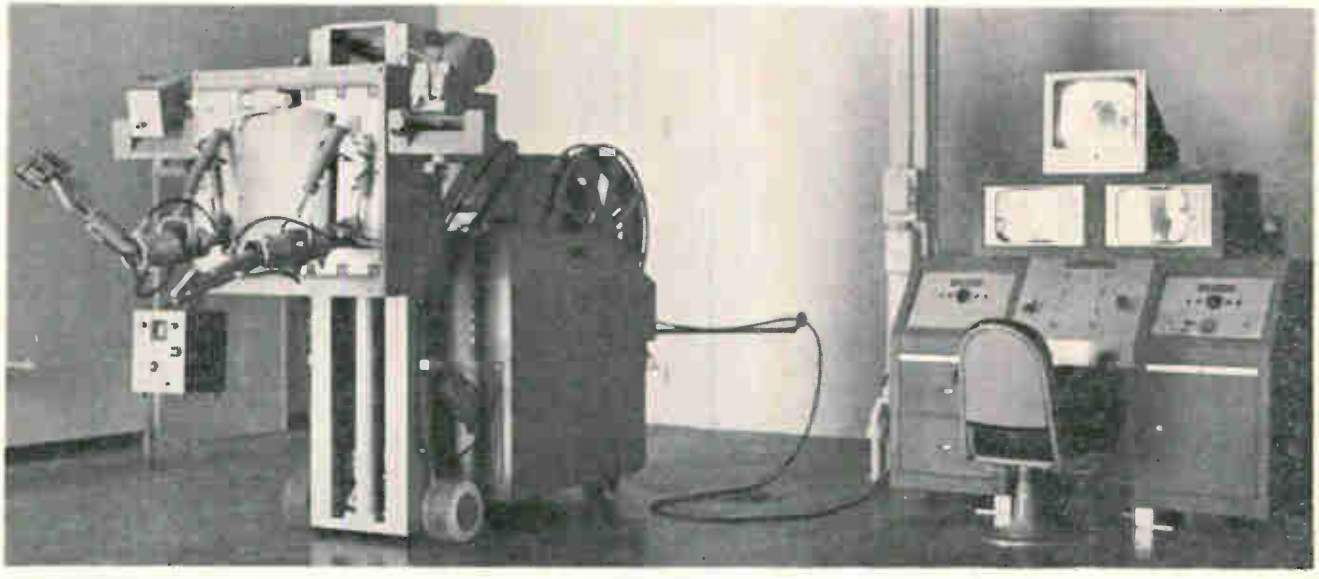


FIG. 1—Multiplexing circuits for controlling robot

for Control of a Robot



THE FRONT COVER. Hughes Mark I Mobot. Television screens display robot's gages and give views of the robot at work

pulses. The control pulse amplitude must be large compared to this a-c component; therefore a practical lower limit to the control-pulse amplitude is set by the required 60-cps transmission.

Each commutating switch has 54 contacts. Although break-before-make operation is used, the ratio of contact to intercontact time is more than 0.8. Minimum speed of rotation is determined by the required response time of the control channels. It is necessary that the sampling frequency for each channel be greater than the reciprocal of the response time. For this application the desired response time is about 0.1 second; thus a sampling frequency of 30 per second was chosen. This frequency corresponds to a rotational speed of 1,800 rpm for the commutating switches.

Remote Switching

Each remote switching circuit must accept a train of pulses which have a duration of about 500 μsec with a 30 cps repetition rate and produce a relay closure by the time the third pulse occurs. The relay must then remain actuated as long as the pulse train continues, and it must open within 0.1 second of the conclusion of the pulse train.

The number of control channels required exceeds the number of contacts (54) on the commutating switches. By connecting a switching circuit sensitive to positive pulses and a switching circuit sensitive to negative pulses to a contact, two control channels operate through one contact. Fortunately, a majority of the robot's operations involve opposing motions such as drive forward, drive reverse; steer right, steer left; tilt forward, tilt back. Since simultaneous operation of these opposing motions is never desired, control of two functions through a common contact is possible with no loss of flexibility or response time.

Figure 2 shows the remote switching circuits which are sensitive to positive and negative inputs.

OPERATING A ROBOT

The robot's drive and steering motors are powered by a 12-v battery which is continuously recharged; charging rate depends on the battery's condition. This battery also powers a hydraulic pump which operates elevator and mast tilt cylinders.

The robot's arms are operated by hydraulic cylinders which are supplied from a separate hydraulic pump powered by the 60-cps supply. Speeds of the various arm and hand motions are adjustable over a wide range by flow-control valves. These valves are preset for the desired response speed. Motor-driven pressure regulators adjust the gripping force of the robot's hands. The operator adjusts hand grip as he watches a tv screen at the control console.

All remote controls are at this console. The operator drives the robot by placing the left-hand drive lever in forward or reverse and pressing down on the foot-operated speed control. Four available speeds move the robot up to 2 mph. The right-hand lever steers the robot, automatically bringing it back to a straight-ahead direction when the operator releases it. Right and left-hand pistol-grip handles control the robot's arms. Most of the other control switches are telephone-type switches (center-off, spring-return, three-position); a few are two-position toggle switches.

An operator gets most of his information feedback by observing the tv monitors. Cameras can be panned through 300 deg and tilted plus or minus 45 deg to allow observation on all sides. Audible information is provided by an intercom having a low-frequency carrier.

All functions which may require independent operation are connected to positive input circuits only.

Tube V_{1A} of the positive-input circuit is a diode detector. Its time constant is 0.1 sec so that it holds an appreciable charge across C_1 between pulses. This positive voltage switches on the normally cut off V_{1B}, energizing K_1. The circuit values are chosen so that relay actuation and deactuation times are almost identical.

Tube V_{2A} of the negative input circuit is also connected as a diode detector. Tube V_{2B} has a much higher gain than V_{1B} because of the low value of R_2, thus only a portion of the input signal is required to cut off the normally conducting V_{2B}. With an input signal, the armature of K_2 switches from its energized to its deenergized position.

Switch Synchronizing

A fundamental requirement of this time-sharing multiplex control system is that the commutating switches be accurately synchronized. The angular error between the two switch rotors should be less than 1 deg. Using synchronous motors with the same rated speed to drive the switch rotors, it is easy to attain equal rotational velocities. The rotors can be adjusted to sample corresponding contacts on the two switches simultaneously by rotating the stator of one motor on its axis while both motors are driving the switches at synchronous speed. Synchronism can be checked by placing the rotors side by side

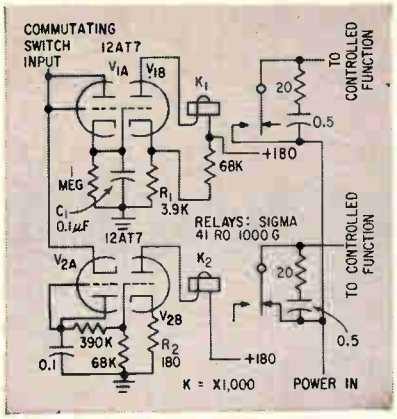


FIG. 2—Polarity-sensitive switching circuits

and using a stroboscope. For a more exact method of detecting synchronism, a voltage source is connected to a contact of one switch and a load resistor is connected to the corresponding contact of the other switch. A voltage pulse is observed across the load resistor at rotor synchronism using a triggered oscilloscope. A very accurate adjustment can be made by manually rotating the motor housing to achieve maximum pulse duration as observed on the synchroscope.

If reluctance synchronous motors are used to drive the switch rotors and the motor frames are clamped in the positions found above, no further adjustment is necessary since reluctance synchronous motors synchronize at fixed angular positions. A four-pole motor which runs at 1,800 rpm will phase in one of four positions which are 0, 90, 180, and 270 deg apart. If one motor runs continuously and the other is turned on and off periodically, because of the random choice of phasing positions, the second motor will eventually drop into its properly synchronized position. This method for achieving synchronism was not considered satisfactory, however, and an automatic method was developed for synchronizing the switch rotors.

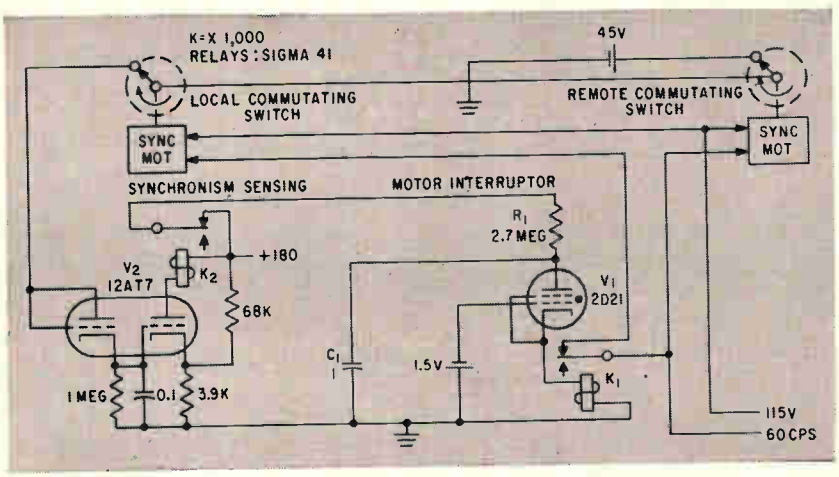


FIG. 3—Local motor operation is interrupted until it syncs with remote motor

Automatic Synchronizing Circuit

The automatic synchronizing circuit consists of a motor interrupter and a synchronism sensing circuit (Fig. 3). The motor interrupter circuit uses thyratron V_1 as a relaxation oscillator. Capacitor C_1 charges through R_1, a large resistance, until the breakdown voltage of V_1 is reached. At this point, C_1 discharges through the tube and relay K_1. Tube V_1 again becomes cut off and the cycle repeats. The surge of current through the relay coil opens the contacts momentarily, thus opening the circuit to the motor driving the local commutating switch. The time constants in the interrupter circuit are such that the motor drops back only 90 deg with respect to the motor driving the remote commutating switch each time relay K_1 is pulsed. Depending on the initial phase difference between the two rotors, up to 3 interruptions of power to the local motor may be required to drop the switches into synchronism. When this condition is reached, the synchronism sensing circuit stops interruptor-circuit operation.

The synchronism sensing circuit is identical with the remote switching circuits (Fig. 3) previously described which are sensitive to positive input pulses. One contact on each commutating switch is required for the synchronizing circuit. A 45-v battery is connected to this contact of the remote switch and the synchronism sensing circuit is connected to the corresponding contact on the local commutating switch. When synchronism is attained, the sensing circuit closes relay K_2, thus disconnecting the plate voltage from the interruptor circuit.

These circuits automatically bring the two commutating switches into accurate synchronism within a few seconds, once the initial orientation has been accomplished.

Electroluminescent Alphanumeric Display

Ferroresonant storage and switching circuits are combined with alphanumeric indicators to form an electroluminescent typewriter. Principle can be extended to display systems requiring hundreds of characters

By **THEODORE HAMBURGER**, Electronic Div., Westinghouse Electric Corp., Baltimore, Md.

FEASIBILITY OF DISPLAY systems using electroluminescence and ferroresonance has been demonstrated by building an electroluminescent typewriter.[1] Information is entered into the typewriter by a conventional keyboard and then displayed sequentially on five alphanumeric indicators. After the five characters have been written, they may be selectively or totally erased.

Electroluminescence (EL) produces light by exciting phosphors with an electric field produced in an EL cell by an alternating voltage. The phosphors are embedded in a dielectric medium sandwiched between two conducting electrodes as shown in Fig. 1. By segmenting an EL panel and exciting various segment combinations, numbers, letters or symbols may be formed.

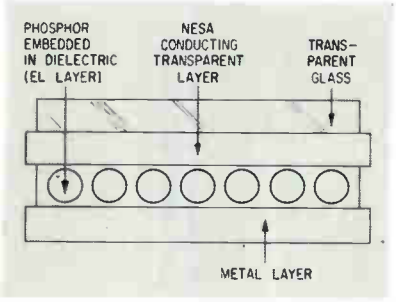


FIG. 1—EL cell has dielectric film 1 mil thick to minimize fringing aound electrode segments

This principle is used in alphanumeric indicators (ELECTRONICS, p. 44, July 10, 1959).[2]

Ferroresonance

Each alphanumeric indicator contains 14 segments. These segments appear electrically as lossy capacitors. Capacitance of a single segment is approximately 450 $\mu\mu$f and its resistance is 1.6 megohms. Two-hundred thirty volts at 400 cps is required to illuminate a given segment to rated brightness. A practical and efficient method of controlling these segments is by ferroresonance. By use of an iron-core nonlinear inductor and an ordinary capacitor, it is possible to obtain a bistable a-c switch having an unlimited memory. This method is compatible with electroluminescence since each of the alphanumeric segments is a lossy capacitor.

An initial understanding of ferroresonance may be had from Fig. 2. Assuming the inductor and capacitor have no power loss, then the volt-ampere characteristics of a single capacitor and a single inductor

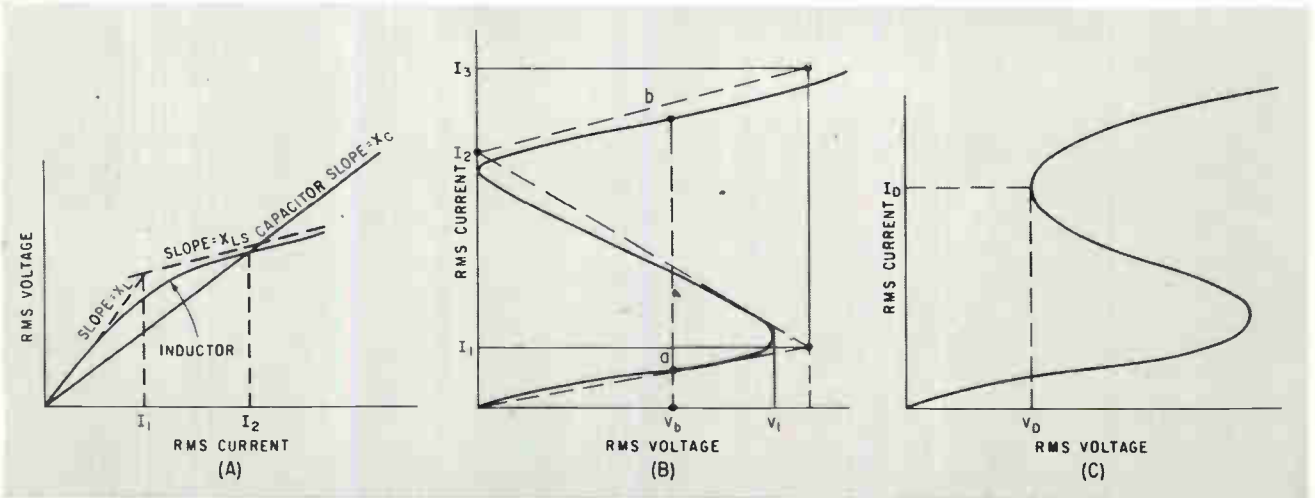


FIG. 2—Assuming no power loss, nonlinear inductor and linear capacitor have characteristics of (A) and, when in series, characteristic of (B); actual curve of lossy inductor and capacitor is shown in (C)

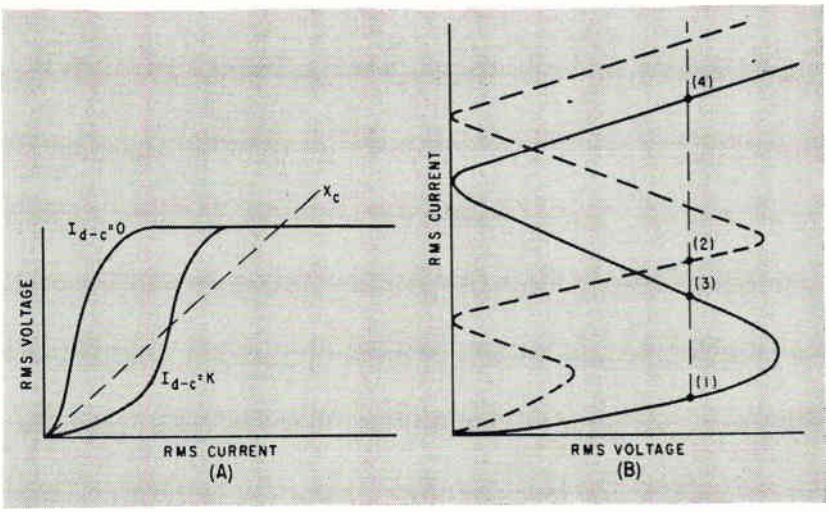


FIG. 3—Inductor characteristics (A) are varied by d-c saturating pulses that place system in sequence of four current states (B)

appear as in Fig. 2A. If these two elements are now connected in series, the combined characteristic is as shown in Fig. 2B.

The curve of Fig. 2B is derived as follows. Since the voltage across the capacitor is 180 degrees out of phase with the voltage across the inductor, a plot of the difference in ordinates of Fig. 2A yields the voltage across the series combination. The currents of Fig. 2A and 2B are identical. At some voltage V_1 two current states may exist. The first of these states is indicated by point *a* while the high current state is indicated by point *b*. This high current will develop a voltage across the linear capacitor of the EL segment which may be several times larger than the applied voltage.

Circuit Design

Neglecting higher order harmonics, if the volt-ampere characteristics of the inductor are assumed to be straight line as shown by the dotted lines in Fig. 2A, then the volt-ampere characteristics of the two in series will also be straight line as shown in Fig. 2B. These curves can be defined mathematically as $V_{XC} = IX_C$, for $0 < I$; $V_{XL} = IX_L$, for $0 < I \leq I_1$; and $V_{XLS} = IX_{LS} + I_1 (X_L - X_{LS})$, for $I_1 \leq I$

The minimum current which is required to sustain the ferroresonant state, I_2, can now be found by equating V_{XC} to V_{XLS}, for $I = I_2$. This yields $I_2 = (X_L - X_{LS})\ I_1/(X_C - X_{LS})$.

The stable states of the inductance capacitance combination are

$$I = V/(X_L - X_C), \quad 0 \leq I \leq I_1 \quad (1)$$

$$I = [V + I_1 (X_L - X_{LS})]/(X_C - X_{LS}), \quad I_2 \leq I \quad (2)$$

The ratio of the critical currents, shown by the points I_3 and I_1 of Fig. 2B, is found, by eliminating V between Eq. 1 and 2, to be

$$1 < I_3/I_1 = (2X_L - X_C - X_{LS})/(X_C - X_{LS}) \quad (3)$$

Equation (3) is most significant since it gives an approximate ratio of ON to OFF current. The ratio will be a minimum when X_{LS} is zero. For a given ON to OFF ratio, one may solve for the required ratio of linear inductance to linear capacitance, thereby obtaining $X_L/X_C = (A + 1)/2$, where $A = I_3/I_1$ and $X_{LS} \equiv 0$.

The actual circuit components, voltage and frequency requirements can now be readily defined. For example, the capacitive reactance must be less than the linear reactance of the inductor if bistability is to occur. The value of capacitance chosen for the typewriter is 0.01 μf. This value completely swamps any variation in capacitance of the alphanumeric segments.

Linear inductance requirements are dictated by the OFF or low current requirements of a given application and the ON to OFF ratio required. Since the brightness of an electroluminescent cell varies exponentially with voltage, for peak voltages less than 30 volts, the light output is negligible. A transformer having a linear inductance of over 100 henrys is adequate to maintain the EL segments in the OFF state.

Low Current State

The low current state is also dependent upon the external voltage applied to the LC series combination. If this voltage exceeds V_1 in Fig. 2B, the circuit will, of its own accord, switch to and remain in the high current state. This critical maximum line voltage is approximately, from Fig. 2A, that voltage at which the incremental inductive reactance equals the capacitive reactance. That is, the slope of the reactor volt-ampere curve equals the reactance of the linear capacitor. In the typewriter application, or any other bistable system, the applied voltage must be less than the critical maximum voltage V_1 of Fig. 2B.

Just how much lower than V_1 the applied voltage may be depends upon the losses in the system. Physical reasoning infers that the high current state can only be maintained as long as the energy storage transfer between capacitor and inductor exceeds the energy loss in the system. The losses in the sys-

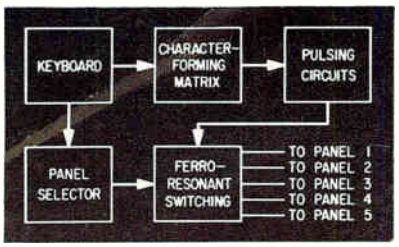


FIG. 4—Typewriter system generates five alphanumeric characters

Table I—Symbols

V_{XC}	Voltage across linear capacitor
V_{XL}	Voltage across inductor in unsaturated region of inductor volt-ampere curve
V_{XLS}	Voltage across inductor in saturated portion of inductor volt-ampere curve
X_C	Capacitive reactance
X_L	Unsaturated inductive reactance
X_{LS}	Slope of inductor volt-ampere curve in saturated region of inductor
I	Current
I_1	Current at which slope of inductor volt-ampere curve changes from X_L to X_{LS}

tem consist of I^2R losses due to the finite resistance of the reactor and capacitor and the core losses in the transformer. In a practical system these losses cannot be neglected. The actual current-voltage curve of the capacitor and inductor in series now appears as in Fig. 2C.

The point at which the system drops from the high current state to the low current state has the coordinates I_p, V_p. This point corresponds to the intersection of the volt-ampere curves of the nonlinear inductor and capacitor taken separately. Since at this point the reactive voltage across the capacitor equals the reactive voltage across the inductor, the line voltage must only be sufficient to supply the losses. The losses are thus V_p/I_p. If bistability is to be possible, the line voltage must, therefore, be greater than the dropout voltage V_p (Fig. 2C) and less than the critical maximum voltage V_1 (Fig. 2B).

There are several ways whereby reliable controlled switching of current states may be achieved. Increasing or decreasing the line voltage can cause switching between the high and the low current state. Also, varying capacitance or inductance or frequency can cause switching of current states. In the typewriter, the inductor characteristics (Fig. 3A) are varied by applying a d-c saturating current to an alternate winding.

Initially, the system is in the low current state as shown by point 1 in Fig. 3B. A d-c saturating pulse will result in an increase in current as shown by point 2. Upon removal of this d-c pulse, the current will tend to fall to point 3. This point, however, is unstable because it is located on the negative reactance portion of the current-voltage characteristic. In a series system of this type, the current will, therefore, tend to run away until the stable high current state, denoted by point 4, is reached.

Actual d-c pulse width and magnitude required to accomplish switching depends upon the core characteristics and number of secondary turns. In general, however, as the pulse width is reduced, the pulse height must be increased. If switching is to be reliable, the pulse width should at least equal the excitation period. If the switch pulses are synchronized with the excitation voltage it may be possible to reduce the pulse width and height.

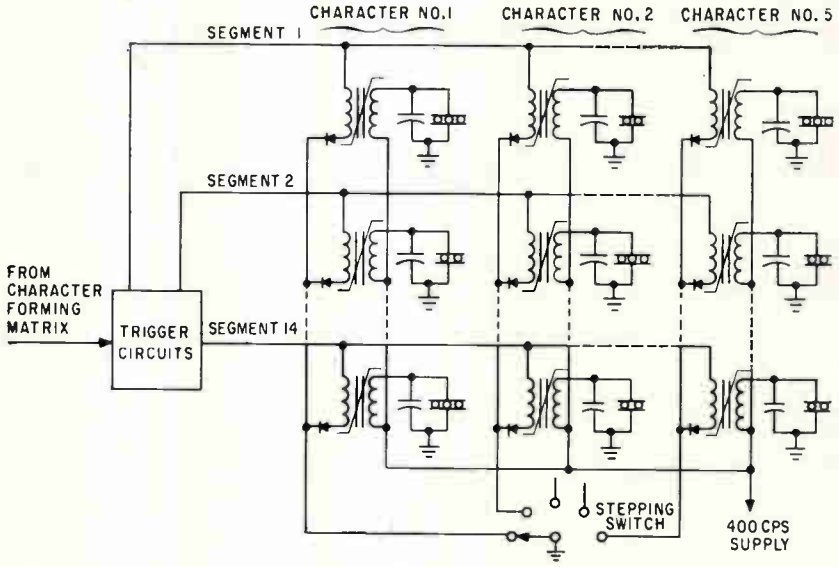


FIG. 5—Ferroresonant storage and switching circuit controls alphanumeric segments

A block diagram of the typewriter system is shown in Fig. 4. When the desired keyboard key or switch is depressed a pulse is applied to the character-forming resistor matrix. This matrix determines which combination of indicator segments is to be energized when a given key is depressed.

The output of the character-forming matrix provides the input signals for the pulse amplifiers which trigger the ferroresonant bistable switches. These switches then apply the required voltage to the electroluminescent segments. After information has been entered on one panel, a stepping relay advances the pulsing circuits to the ferroresonant switches associated with the following panel as shown in Fig. 5.

A ferroresonant trigger circuit is shown in Fig. 6. The transistor is normally cut off. A pulse from the matrix into the base saturates the transistor and the capacitor discharge is sufficient to trigger the system into the ferroresonant state. The inductor in series with the capacitor and alternate trigger winding serves a two-fold purpose. First, it limits the a-c voltage appearing on the collector due to transformer action. Secondly, the inductor appears as a high impedance load on the alternate trigger winding. The loading effect that the trigger circuit has on the primary winding can thus be neglected.

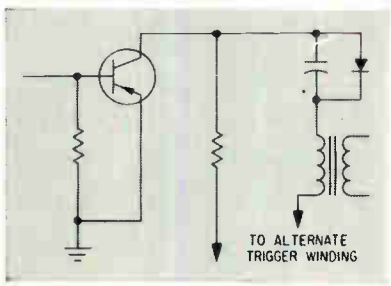


FIG. 6—Trigger circuit receives pulses from character-forming matrix

If it is desired to erase information from the alphanumeric indicators, the ferroresonant circuit must be switched to the low current state. To selectively erase a single panel on the typewriter, the current is forced into the low current state by switching a large resistor in series with the associated 400-cycle excitation source. To erase any and all information on the typewriter, the 400-cycle oscillator, which drives several buffers and push-pull power output stages, is momentarily shorted by an overall erase pushbutton.

The author thanks J. Earl Painter, Jacques Pessin and Ray Smith for help in design and construction and acknowledges the work of Dr. E. A. Sack who first suggested the electroluminescent typewriter and circuits.

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2. *Rayescent Lamp Brochures*, Westinghouse Lamp Division.

Measuring Critical Current In Cryogenic Circuits

Measurement of critical current in superconducting contacts requires test equipment with fast response because of the short periods such currents can be maintained. Here is a workable system using oscilloscope display

By J. I. PANKOVE and R. DRAKE, David Sarnoff Research Center, RCA Laboratories, Princeton, N. J.

A MAJOR DIFFICULTY in measuring the critical current in superconductors is that this current cannot be maintained for a prolonged time. The critical-current density is of the order of a million amp/cm². When the material becomes normal, that is resistive, Joulean heating occurs and the device can be damaged; therefore the current must be measured for a very short time. The critical current was maintained for less than 100 μsec during the tests to be outlined. A test set, described here, was built to display how critical current through the contact is modulated by a current external to the contact.

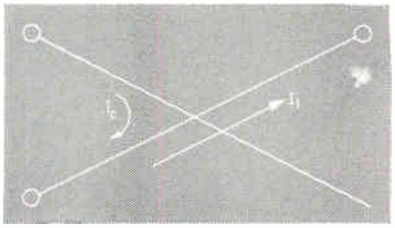


FIG. 1—Basic structure of the superconducting device tested

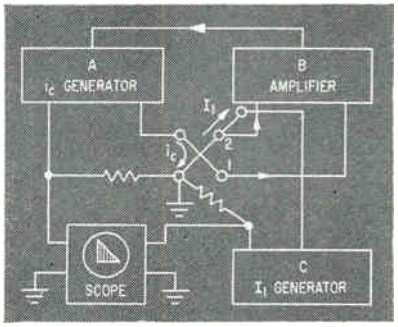
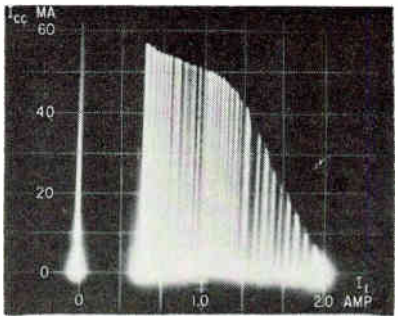


FIG. 2—Simplified diagram of the testing method used

The superconducting device for which this test system was designed is shown in Fig. 1. It consists of two crossed superconducting wires in contact. The contact forms a minute region where superconductivity can be quenched by a small current, I_{cc}, through the contact. The quenching current I_{cc} is controlled by a current I_1 flowing along one of the wires. Such a miniature device needs little power for operation and exhibits fast response. It can be used as switch, modulator or amplifier.

Principles of Operation

Figure 2 shows the general principle of the test set. Stage A generates a sawtooth pulse of current i_c which flows through the contact. When the critical current I_{cc} is reached, the contact becomes resistive and a voltage develops across the contact; this event is sensed by stage B which then turns off the sawtooth generated by A. For convenience, extra connections 1 and 2 are made to the device to measure voltage across the contact. While circuit A generates a number of pulses, circuit C gradually increases current I_1 along one of the wires. When I_1 reaches a preset maximum value, I_1 returns to zero and another slow sweep of I_1 starts. Currents I_1 and i_c are displayed as the



Photograph of automatic tracing of I_{cc} versus I_1. The characteristic curve is the envelope portion of the figure

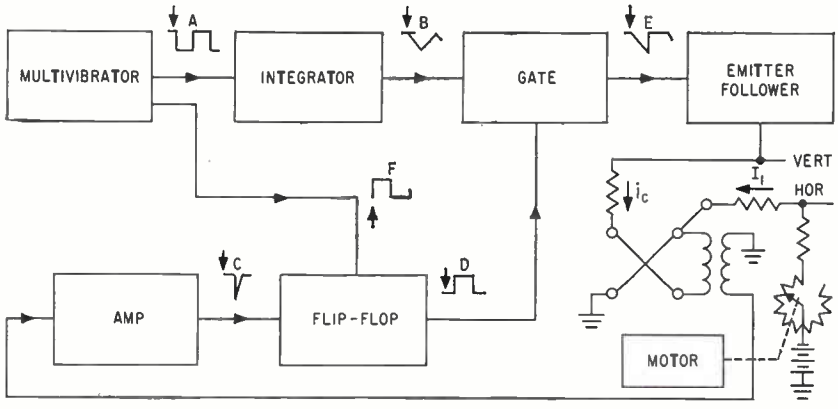


FIG. 3—Functional diagram of arrangement employed for measuring superconductor critical current

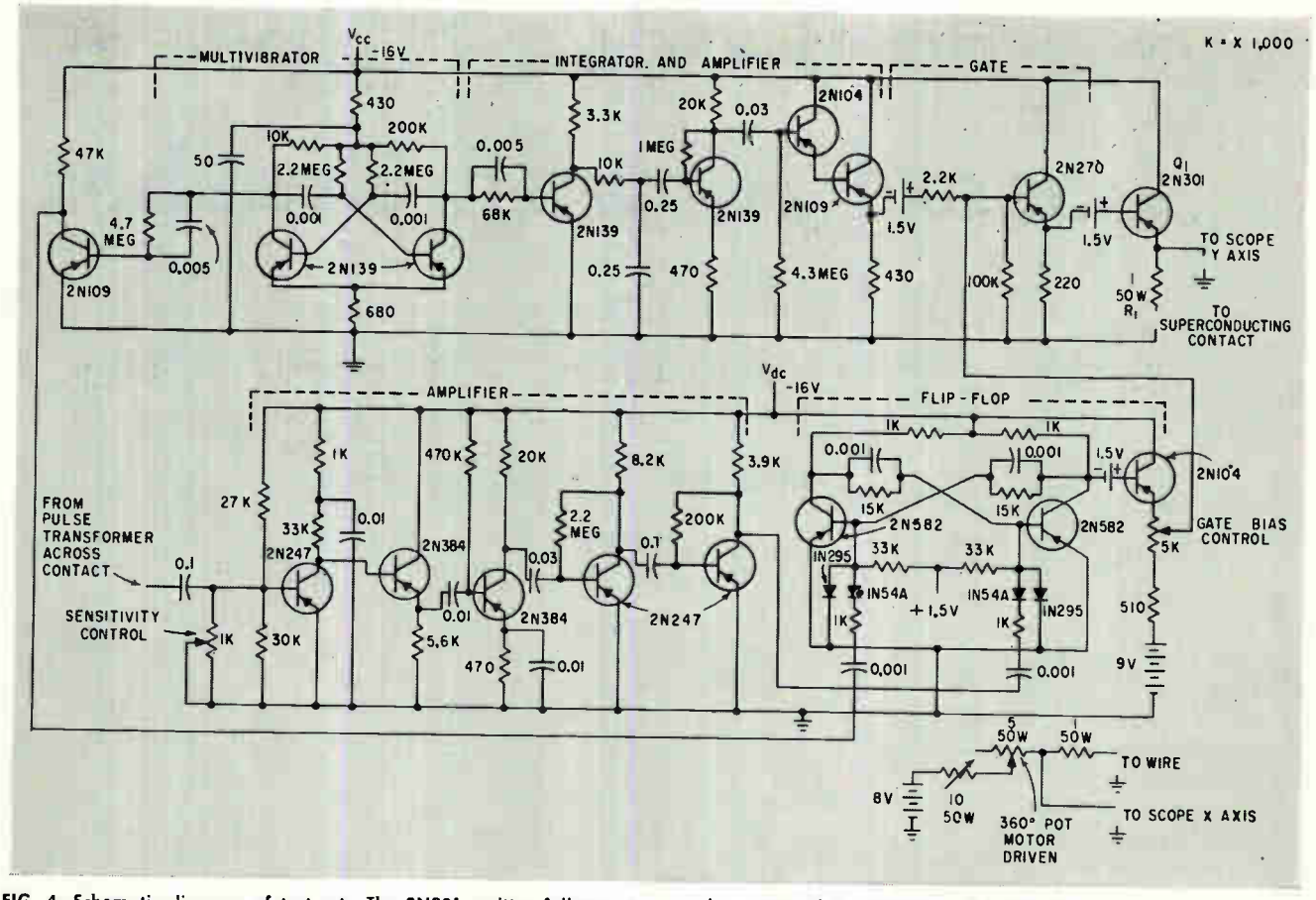


FIG. 4—Schematic diagram of test set. The 2N301 emitter follower can supply current of 2 amperes to the contact

abscissa and ordinate on an oscilloscope. Because the extremity $i_c = I_{cc}$ is the value of interest, the characteristic being sought is the envelope of the oscilloscope pattern.

Circuit

A block diagram of the testing system is shown in Fig. 3. Arrows at the beginning of every waveform mark a reference time. A free-running multivibrator produces a series of square waves (A) at a rate of about 1 kc. An integrating circuit converts the square wave into a triangular pulse (B) which is fed through a gating circuit to an emitter-follower stage. The voltage developed across the contact when the latter switches out of superconductivity forms an impulse, (C), which is strengthened by a high-gain amplifier and used to trigger a flip-flop stage into state (D), which turns off the gate. Thereby, current (E) through the contact is cut off when it attains critical value I_{cc}. The gate is reopened for the next sawtooth by a reset pulse (F) generated by the multivibrator and applied through the flip-flop.

The testing circuit is shown in Fig. 4. Transistors were used throughout the test set. The emitter follower is capable of supplying a maximum current of 2 amp. For smaller ranges of current i_c, 1-ohm resistor R_1 is connected between emitter of Q_1 and ground and is shunted by larger resistor R (not shown) in series with the device.

WEATHER ADVISORY

Cryogenically noting—be it January or July—readers are advised to don frost-proof garb to study this authoritative report of testing performance of superconducting contacts at 4.2 K, near absolute zero. At low-thermometry electronics, this is a degree point where, mathematically, resistance in superconducting contacts is zero; that is, theoretically an electric current in a closed superconducting circuit should continue, undiminished, forever.

Fast-performing superconductor contacts exhibit possibilities in work by engineers designing advanced cryogenic switching, modulating and amplifying circuits

In this way the current through the contact is $1/R$ times the current measured by the oscilloscope.

Auxiliary Stages

Amplifier and buffer stages were needed between functional blocks to match impedances, change signal polarity or raise signal level. The slow scan of I_1 was obtained by a motor-driven 360-degree potentiometer in series with a battery and the superconducting wire. A series resistor sets the maximum excursion of current I_1. This current should be maintained below critical current to avoid burning out wires when they become nonsuperconducting.

The photograph shows an oscillogram for a crossed-wire device. Characteristic I_{cc} versus I_1 is the envelope of the bright area. The $I_1 = 0$ value is obtained when the rotating potentiometer passes an open-circuit point. From there, I_1 jumps to a value determined by the maximum resistance of the potentiometer and other resistors in the circuit.

Radio Beacon Helps Locate Aircraft Crashes

This radio beacon, designed to withstand high g's and extreme environments, flies free of a crashing aircraft and then automatically transmits a distress signal

By **DAVID M. MAKOW,** Radio and Electrical Engineering Div., National Research Council of Canada, Ottawa

DESIGNING A RADIO BEACON which will survive an aircraft crash and then radiate a useful distress signal poses several problems not encountered in conventional equipment. Such a beacon must be safely separated from the crashing aircraft as early as possible—no present equipment can withstand the tremendous forces and temperatures encountered in a direct crash. The beacon must somehow be transferred to a safe and operational position not too far from the wreck; it then should transmit a useful signal for about 100 hours and over a wide range of temperatures, even if it lands in swamp, in water or in vegetated country.

The Crash Position Indicator,[1,2] is a promising solution. It consists of an enclosure shaped somewhat like a short section of an aircraft wing inside which, potted in plastic foam, is a specially designed battery-operated radio beacon. Two units have been developed: a large beacon and an enclosure, called the tumbling aerofoil, with the total weight of 11.4 lb, for large aircraft (to the left in Fig. 1); and a small unit with the total weight of 5.7 lb, for small aircraft, shown to the right.

Operation

The indicator is placed on the tail of the aircraft and is held by a slim metal ribbon passing through a spring-loaded knife (see Fig. 2). The knife is operated by a change in tension of the tightly stretched trigger wires connected to the extremities of the aircraft structure. Any abnormal structural change in the aircraft as a result of a crash or other emergency is transmitted through the wires and releases the aerofoil, switching on the beacon, which is then quickly rotated into the airstream and rapidly pulled away by the aerodynamic lift and drag forces. These cause it to curve away on an arc of about 100-foot radius and slow down by half every 35 feet until it reaches its terminal velocity of 20 to 25 mph at sea level. Its safe landing speed is about 40 mph. The unit will also float about 85 percent out of water and will act as a snowshoe because of its small wing loading.

To operate as outlined, the indicator must have all parts including the transmitting antenna placed inside the aerofoil, and the ratio of weight to aerofoil area must be small. A fractional wavelength capacitor antenna could be designed to fulfill the first requirement. A beacon system with great battery economy has also been obtained using a pulsed-carrier, pulse-filament transmitter in connection with the Sarah search receiver which is available commercially[3]. This has been chosen in preference to a c-w signal where crystal control and several frequency multiplier stages would have to be provided in the beacon so that the communication receivers available on aircraft could be employed during a search.

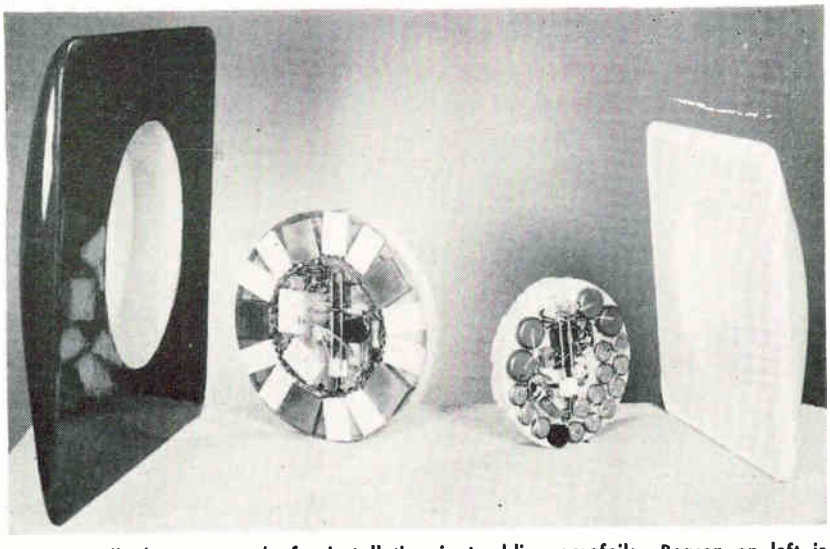


FIG. 1—Radio beacons ready for installation in tumbling aerofoils. Beacon on left is 14 inches in diameter; its aerofoil measures 2 ft × 2 ft × 5 inches. Right beacon is 10 inches in diameter; its aerofoil, 20 inches × 20 inches × 4.5 inches

Antenna Characteristics

Choice of carrier frequency was influenced by the antenna size,

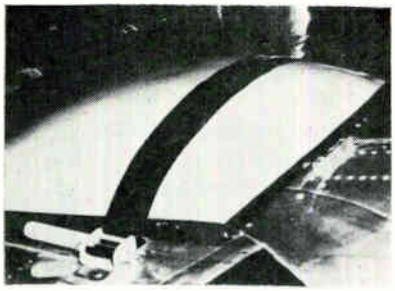


FIG. 2—Crash position indicator is held on aircraft tail by a slim metal ribbon passing through a spring-loaded knife. Extreme tension in trigger wire operates knife

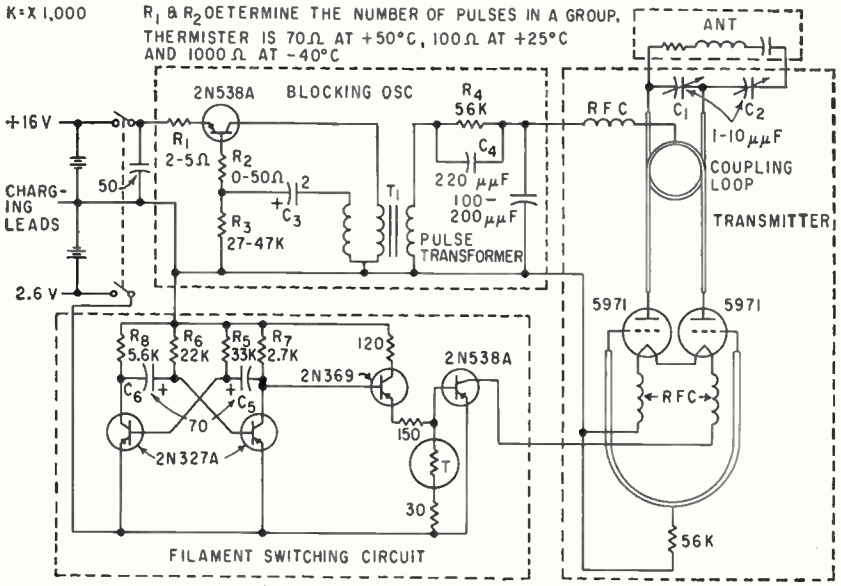


FIG. 3—Complete circuit of the radio beacon for the crash position indicator

which was restricted by the dimensions of the aerofoil. The frequency of 243 mc, used in distress signaling, was considered the best compromise, as at this frequency a relatively efficient low-Q capacitor antenna[4] could be realized and compatibility with the Sarah receiver was possible. The antenna consists of two aluminum or copper disks which form the capacitor plates. In the large unit the disk diameter is 14 inches and disk spacing 1½ inches. In the small unit the corresponding values are 10 and 1¼. The capacitor dielectric is plastic foam with a small dissipation factor. The equivalent circuit of the antenna is shown in Fig. 3. The elements in the dashed rectangle represent a series resonant circuit consisting of the capacitor antenna, an inductive lead and the radiation resistance. The adjustable capacitors C_1 and C_2 are used to obtain an optimum matching condition at the operating frequency. Measurements of the large antenna at 243 mc indictate a value of Q = 50 and an efficiency of 80 percent. The Q of the small antenna is estimated to be 120 and the efficiency is 60 percent. The measured radiation pattern, when the antenna is placed on the ground, is shown in Fig. 4; grazing angle depends on the conductivity of terrain.

Transmitter

Figure 3 shows the circuit of the beacon transmitter. Conversion of the available d-c power into r-f power could be efficiently carried out employing pulse plate modulation of the transmitter tube. An unusually high peak power output has been obtained with the filamentary oxide-coated cathode, CK 5971 vhf triode by using short pulse width and a relatively long pulse interval[5, 6] and by exceeding the maximum anode voltage considerably. This tube, in a push-pull oscillator, consumes 89 ma at 1.3 v for the filament, has a peak anode current of 16 ma, and delivers 2-3 watts peak r-f power for a 9-microsecond pulse of 300-400 v applied to the plate. This is about 10 times the power available at the rated value of 90 v d-c. The parallel line resonator, shown in Fig. 3, offers satisfactory mechanical and electrical stability. The antenna has been coupled with a small coupling loop placed over the shorted end of the parallel line.

Modulation Waveform

Plate pulse modulation, in addition to the above-mentioned property, requires no separate plate supply, as the high voltage pulses which are generated in a transistorized blocking oscillator (Fig. 3) are applied directly through a step-up transformer to the plates of the transmitter oscillator tubes. A low voltage supply can then be used to operate the blocking oscillator. The modulation waveform consists of groups of pulses with a repetition frequency of about 65 groups per second. Four pulses in a group, 9 microseconds wide and spaced by about 75 microseconds, were chosen. The first pulse of each group triggers the sweep of the Sarah receiver, thus permitting the remaining three pulses to be displayed on the screen of this receiver. As a result of synchronization of the time base, these pulses appear stationary, improving the rejection against the unstationary noise and interference signals. The pulse width was determined by the properties of the receiver, and the number of pulses in a group was chosen from considerations of reliability of reception and effectiveness of display. The group repetition frequency, preferably high, was limited to 65 groups a second, as the highest values permitted by the capacity of the batteries.

The process of pulse group formation in the blocking oscillator is, in its simplest representation, similar to the squegging (generation of several frequencies simultaneously) operation of an r-f oscillator. At the end of the fourth pulse the capacitor C_3 (see Fig. 3) has charged to a voltage value which exceeds the potential of the emitter, and the transistor cuts off. During the OFF period, the charge accumulated in C_3 leaks away through R_3 until the potential of the base decreases below that of the emitter and the operation is restored again. The number of pulses in a group is

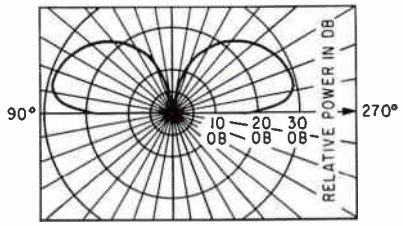


FIG. 4—Radiation pattern of the parallel plate capacitor antenna when the beacon is on the ground

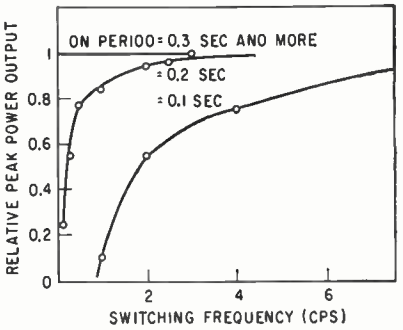


FIG. 5—Peak power output as a function of the filament switching frequency

determined by the charging time constant and the group repetition frequency by the discharging time constant of this capacitor. The pulse spacing is related to the primary inductance of the pulse transformer T_1 and the pulse width can be modified with the pulse slicing circuit R_1C_1.

Filament Switching

In addition to pulse plate modulation of the transmitter, further economy in battery supply can be achieved by periodically switching ON and OFF the filaments of the tubes[7]. The relationship between the r-f output power and the switching frequency for three values of ON periods is shown in Fig. 5. For filament ON periods equal to 0.3 sec or more, the maximum r-f output is obtained, as the filament has reached the operating temperature. If the ON period is reduced, the power output decreases at low switching frequencies but approaches the full value at high switching frequencies as a result of an increase in the average filament temperature. The filament is switched by a transistor operated through a grounded collector stage from a transistorized multivibrator as shown in Fig. 3. The ON and OFF periods have been adjusted to 0.8 sec and 1.2 sec respectively, since this ratio has been found to result in favorable performance. Total power consumption of the filament-switching circuit is about 5-10 mw, which is a small fraction of the total filament power. Although, in general, switching of the filament reduces the life of a tube, a large number of tests have indicated that the CK 5971 operates satisfactorily for at least 500 hours, which is 5 times the required period of operation.

Power Supply

For its power source, the beacon uses Saft Ni-Cd cells, trickle-charged from the 28-v aircraft battery. The respective voltages are obtained then with dropping resistors in series with diodes which prevent reverse discharge. In the large unit, where the filament is continuously operated and not switched ON and OFF periodically, a 1.3-v filament supply with a 160 ma drain is provided by five 4-amp hr VO4 Saft Ni-Cd cells, totaling 2 lb. In addition, a 16-v supply with a drain of 6.5 ma is made up by twelve 0.8 amp hr VO8 Saft Ni-Cd cells, totaling 1.3 lb. Total weight of the beacon supply is 3.3 lb. This supply will power the beacon for 125 hours at room temperature and 106 hours at −40 C.

In the small unit, filament switching has been used permitting a reduction of the battery weight. Here, four Saft Ni-Cd 2 amp hr button cells form a 2.6 v supply with a drain a 85 ma and weight of 0.94 lb. Fourteen 0.5 amp hr button cells form a 2.6-v supply with a drain of 7 ma and weight of 0.66 lb. The total weight is then 1.6 lb. Using a filament ON period of 0.8 sec and an OFF period of 1.2 sec this supply will last 80 hours at room temperature and slightly less at −40 C.

Experimental Results

The radio beacon potted in the tumbling aerofoil has undergone several tests simulating the conditions of an actual aircraft crash and subsequent search. Aircraft crashes were simulated by a rocket sled speeding into a cliff at a known velocity. The unit, suitably mounted on the sled, was designed to be released when the nose of the rocket hit the obstacle. In the tests, one at 120 mph and the other at 230 mph, the unit upon release was lifted high in an arc and landed safely away from the point of impact. Normal flight operation of a Beechcraft Expeditor with the unit on its tail has been proven in two flight tests.

Laboratory shock tests were made on a spring-mounted platform shocked by heavy hammer blows about three different axes. The unit tested survived, with no change in performance, a total of 18 tests up to 1,100 g; the batteries and electronic components received shock up to 700 g.

In numerous flight range tests at altitudes of 9,000 ft, using Sarah search equipment, ranges of 20-35 miles were obtained when the unit was located in an open exposed site, and ranges of 5-12 miles were obtained when it was buried in snow in a narrow valley.

Appreciation is expressed to colleagues in the Royal Canadian Air Force, the Defence Research Board, Canadian Army Signals and the divisions of Applied Chemistry, Mechanical Engineering, and Radio and Electrical Engineering of the National Research Council of Canada, for their cooperation and assistance. In particular, the author wishes to thank H. T. Stevinson of the Flight Research Section, who was in charge of the mechanical and aerodynamical development of this project, H. Ross Smyth, head of the Navigational Aids Section, and W. A. Cumming of the Microwave Section who designed the antenna.

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Efficient Photoflash Power Converter

Single-transistor circuit has high efficiency and uses Zener diode to stabilize output voltage. Auxiliary transformer promises waveform improvements

By **RICHARD J. SHERIN,** Swampscott, Mass.*

IMPORTANT PHOTOFLASH converter characteristics are: high efficiency of energy conversion, rapid recycle, low standby current and regulated output voltage. The energy conversion efficiency in the converter to be described could exceed the 50-percent value which is the approximate theoretical upper limit on most conventional[1, 2] circuits in this application. Converter action is halted when the desired output voltage is reached. The circuit then periodically replaces the charge lost by capacitor leakage.

Capacitor Charging

An elementary circuit is shown in Fig. 1. Basically the converter is a flyback (or ringing choke) oscillator which is freerunning when the voltage on the regulator capacitor C_2 is less than the Zener voltage for the reference diode D_2.

In operation the core is first charged through the conducting transistor Q and then, during a flyback interval in which Q is nonconductive, the core discharges its $LI^2/2$ energy through the diode D_3 into the storage capacitor C_3. The output winding N_3 is so poled that D_3 blocks during the core charging intervals and conducts during the flyback intervals. The storage capacitor is brought up to full voltage by many such consecutive on-off cycles of Q.

It will be seen later that the low voltage Zener diode D_1 is needed in the operation of the regulator.

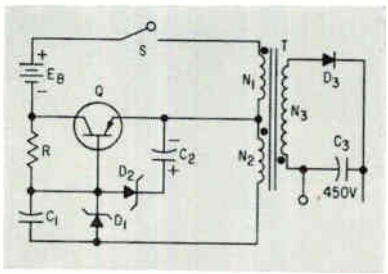

FIG. 1—Elementary conveter circuit shows operating principle

The starting capacitor C_1 provides a path for the transistor base current at the start of each core charging interval before the regenerative action has made the hold voltage induced in N_2 sufficiently large to make D_1 conductive in the reverse direction.

Voltage Regulation

During each flyback interval, regulator capacitor C_2 is charged through D_1 and D_2 to a voltage approximately proportional to the voltage reached by the storage capacitor C_3. When full output is reached, the voltage on C_2 exceeds the Zener voltage for D_2 and biases the transistor base sufficiently positive with respect to the emitter to abruptly halt the oscillation. The low voltage Zener diode D_1 prevents C_2 from discharging through N_2, while still permitting the flow of base current during those intervals when Q is conductive. C_2 slowly discharges through resistor R.

When the off-bias on Q is sufficiently reduced, the on-off cycling of Q resumes and continues for several cycles until the storage capacitor has been restored to full voltage. The transistor is then cut off as before.

Improvements on Basic Circuit

Experiments have shown that the Zener diode D_1 of Fig. 1 could be replaced to advantage with parallel diodes as shown in Fig. 2. In the

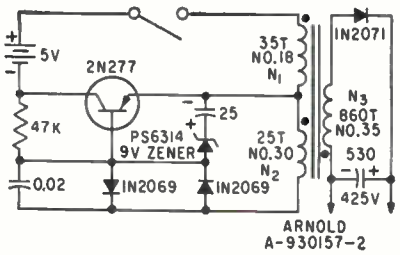

FIG. 2—Diodes replace Zener D_1 in improved version of photoflash circuit

elementary circuits the base current waveform is not optimum. Further experiments indicate that a current balancing transformer may be used to make the transistor base current increase with the collector current during the core charging cycle. This improvement will lead to a significant reduction in power wasted in overdriving Q at the beginning of core charging intervals.

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*This work was done while the author was with the Boeing Airplane Company

Choosing Transistors for Monostable Multivibrators

By JOSEPH R. KOTLARSKI, Hughes Aircraft Co., Culver City, California

A SIMPLE DEVICE frequently used as a variable delay generator is the transistorized version of the monostable multivibrator (Fig. 1). When triggered, its output consists of a gate of either polarity. The natural period of this gate, determined by an R-C timing circuit, can be considerably shortened by a logical trigger.

Often the ratio of the natural period to recovery time, T/τ, designated σ, can be rather large (> 10). In such cases, particular care should be exercised in choosing the semiconductor unit.

This paper, which presents limitations encountered in design of such circuits, shows that the major limiting factor is the d-c gain, β, of the transistor; it shows further that the minimum gain necessary for predictable operation is a function of σ.

General Circuit

Figure 1 shows the general circuit. Two basic assumptions are made: voltage drop across the saturated transistor is zero; equal currents are switched from Q_2 to Q_1 during its quasistable state. Resistors R_1 and R_2 are chosen so that two states of the circuit are satisfied: Q_1 cut off during stable state, Q_2 saturated; and Q_2 saturated during the quasi-stable state, Q_1 cut off.

In the stable state, the current through Q_2 is determined by the external resistors R_L and R_E.

$$I_C = (V_{CC} - V_E)/R_L \cong V_{CC}/(R_L + R_E) \quad (1)$$

$$R_L I_C = V_{CC} - V_E \quad (1A)$$

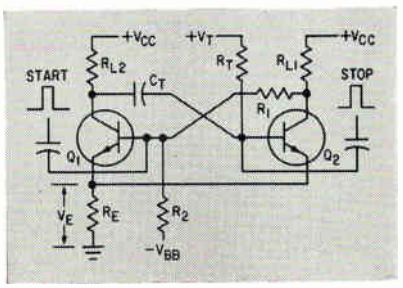

FIG. 1—A monostable multivibrator such as this is frequently used as a variable delay generator

Since there is a considerable variation in individual transistor β from a given family of units, the design must accommodate the lowest gain unit. Thus, for all units of a family to be in saturation in the Q_2 position, a base current of $I_{B\max}$ must flow:

$$I_{B\max} = I_C/\beta_{\min} = (V_T - V_E)/R_T \quad (2)$$

or substituting (1) into (2)

$$I_{B\max} = (V_{CC} - V_E)/\beta_{\min} R_L \quad (3)$$

Combining (3) and (2), and solving for R_T

$$R_T = [(V_T - V_E)/(V_{CC} - V_E)]\,\beta_{\min} R_L \quad (4)$$

Let $(V_T - V_E)/(V_{CC} - V_E) = \gamma$

Then Eq. (4) reduces to

$$R_T = \gamma\,\beta_{\min}\,R_L \quad (4A)$$

Since the delay of the circuit (used interchangeably with natural period of the blanking gate) is a function of R_TC_T, and since Eq. (4) shows that R_T is proportional to V_T, a smaller C_T can be used if R_T is returned to a high potential. This device may be employed when large delays are used and the physical size of the capacitor is limited.

As stated above, the delay is a function of R_TC_T. Explicitly, the wave form at the base of Q_2, upon the receipt of the initial trigger, can be expressed as

$$E_O(t) = [V_T + I_C R_L - V_E][1 - exp(-t/R_TC_T)] \quad (5)$$

Delay of the circuit is uniquely defined because the base of Q_2 has regained its pre-trigger potential by rising R_LI_C volts. At this point Q_2 fires and the circuit returns to its stable state. Therefore, when

$$I_C R_L = [V_T + I_C R_L - V_E][1 - exp(-T_O/R_TC_T)] \quad (5A)$$

Eq. (5A) must satisfy the relation

$$T_O = R_TC_T \ln [1 + I_C R_L/(V_T - V_E)] \quad (6)$$

But using (1A) and (4A), (6) becomes

$$T_O = \gamma\,\beta_{\min}\,R_LC_T \ln [1 + 1/\gamma] \quad (6A)$$

After returning from its quasi-stable state, the circuit requires a finite time before it returns to its initial stable state. To assure predictable operation, the voltage at the collector of Q_1 must return to at least 95 percent of its initial value before the next trigger. The 95 percent

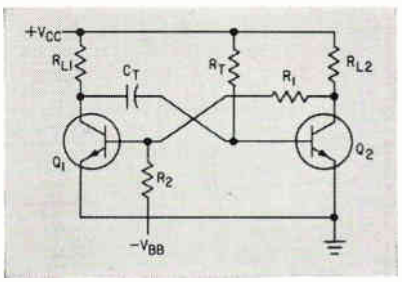

FIG. 2—In this circuit, charging network return is identical to the collector supply

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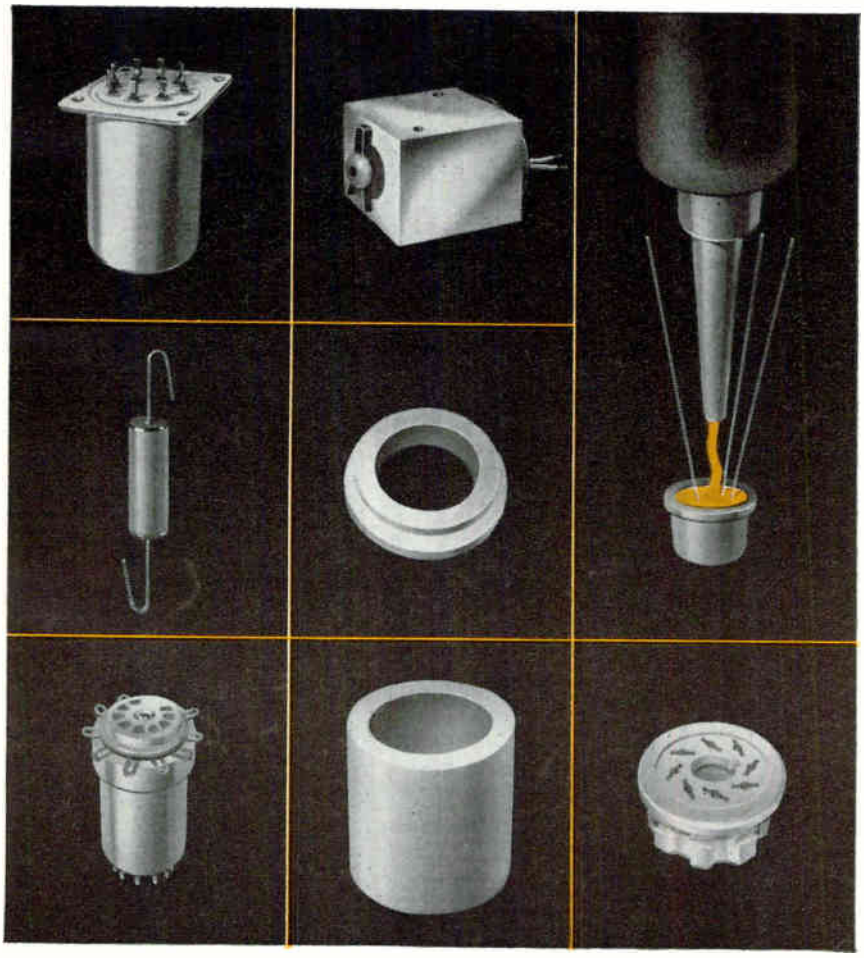

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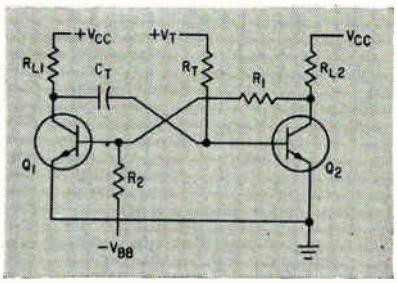


FIG. 3—Lower gain transistors may be used in this circuit if V_T is a higher source than V_{cc}

point, which corresponds to three recovery-path time constants, was arbitrarily chosen since an infinite time is required for the collector of Q_1 to completely recover. The recovery-path time constant is $(R_L + R_E)C_T$ and a duration equal to three time constants is considered sufficient for complete recovery of the collector of Q_1. This recovery time is designated as τ and during this time the collector of Q_1 will return to 95 percent of its initial value. Thus, the recovery time is

$$\tau = 3\,[R_L + R_E]\,C_T \qquad (7)$$

and σ, which is T_o/τ, is

$$\sigma = \frac{[\gamma\,\beta_{min}\,R_L/3\,(R_E + R_L)]}{\ln\,(1 + 1/\gamma)} \qquad (8)$$

From Eq. (8) the relationship for minimum d-c gain, β_{min}, is readily obtained:

$$\beta_{min} = \frac{[3\,(1 + R_E/R_L)/}{\gamma \ln\,(1 + 1/\gamma)]\,\sigma} \qquad (9)$$

For cases where the charging network is identical to the collector supply (i.e., $V_T = V_{cc}$ and $\gamma = 1$)

$$\beta_{min} = \frac{3\sigma\,(1 + R_E/R_L)/\ln 2 =}{4.3\,(1 + R_E/R_L)\sigma} \qquad (9A)$$

If the circuit in Fig. 2 is used, where $R_{L1} = R_{L2} = R_L$ and $Q_1 = Q_2 = Q$, and R_1 and R_2 are determined as for Fig. 1, and since $R_E = 0$, then Eq. (9A) simplifies to

$$\beta_{min} = 4.3\,\sigma \qquad (9B)$$

As a rule of thumb, Eq. (9B) can be used for choosing transistors, given σ and a single supply. When additional higher supplies are available, it is advantageous to employ them as returns for the timing resistor R_T. The advantages are twofold: smaller sized capacitors may be used and, more important from the designer's viewpoint, lower gain units may be used.

If $(V_T - V_E) \lessgtr 5(V_{cc} - V_E)$ or, equivalently, $1/\gamma \lessgtr 0.2$, the approximation $\ln(1 + 1/\gamma) \cong 1/\gamma$ may be used with less than a 10 percent error. Then Eq. (9) becomes

$$\beta_{min} = 3\,(1 + R_E/R_L)\,\sigma \qquad (10)$$

If a circuit similar to Fig. 3 is used, where $R_{L1} = R_{L2} = R_L$, and R_1 and R_2 are determined as for Fig. 1, then, because $R_E = 0$,

$$\beta_{min} = 3\,\sigma \qquad (11)$$

Thus, comparison of Eq. (9B) and (11) shows that lower gain units may be used by returning R_T to a higher source. The greater the ratio of V_T/V_{cc} the less error introduced by the logarithmic approximation.

Figure 4, a normalized plot of Eq. (9), shows the β_{min} necessary to obtain a given σ. Additional information needed for this graph is determined by other circuit considerations, such as load, stability, etc.

Examples

Example A—Given the circuit of Fig. 1, with the following values: $V_T = V_{cc} = 50$; $R_E/R_L = 0.1$; $R_{L2} = R_{L1} = 4{,}700$ ohms; $R_T = 36{,}000$ ohms; $R_E = 470$; $C_T = 0.015$; $Q_1 = Q_2 = 2N336$; and from Fig. 4, $\beta_{min}/\sigma = 4.8$. A σ of 13 is desired (where $T_o = 3{,}750$ μsec and $\tau = 280$ μsec.). Thus a β_{min} of 62 is required. The 2N336 can be used since its β_{min} is 76.

Example B—In systems with more than one supply, the same circuit requirements may be met by the same circuit (Fig. 1) using a lower gain transistor. Circuit values are: $V_{cc} = 50$; $V_T = 300$; $R_{L2} = R_{L1} = 4{,}700$ ohms; $R_T = 2.2$ megohms; $R_E = 470$; $C_T = 0.01$; $Q_1 = Q_2 = 2N338$. Ratio σ is 13; $V_T = 6V_{cc}$.

In this example, the numerical value of γ is required. To obtain γ, the voltage V_E, across the common emitter resistor, R_E, is required. Since $I_E = I_C + I_B$, and since usually $I_C >> I_B$, $I_E \approx I_C$. Thus, $V_E = I_C R_E$. Value of I_C, calculated from Eq. (1), is 9.7 ma; thus, $V_E = 4.55$ v. Now γ is readily calculated since both V_{cc} and V_T are known.

For this example, $\gamma = 6.5$; and $R_E/R_C = 0.1$. By interpolation on Fig. 4, $\beta_{min}/\sigma = 3.4$, making $\beta_{min} = 44$. Therefore, a 2N338 can be used since its β_{min} is 45.

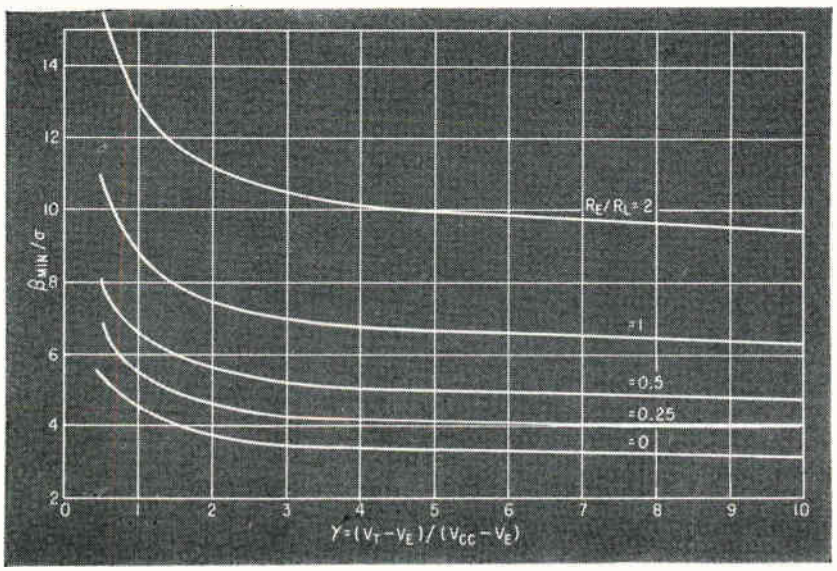
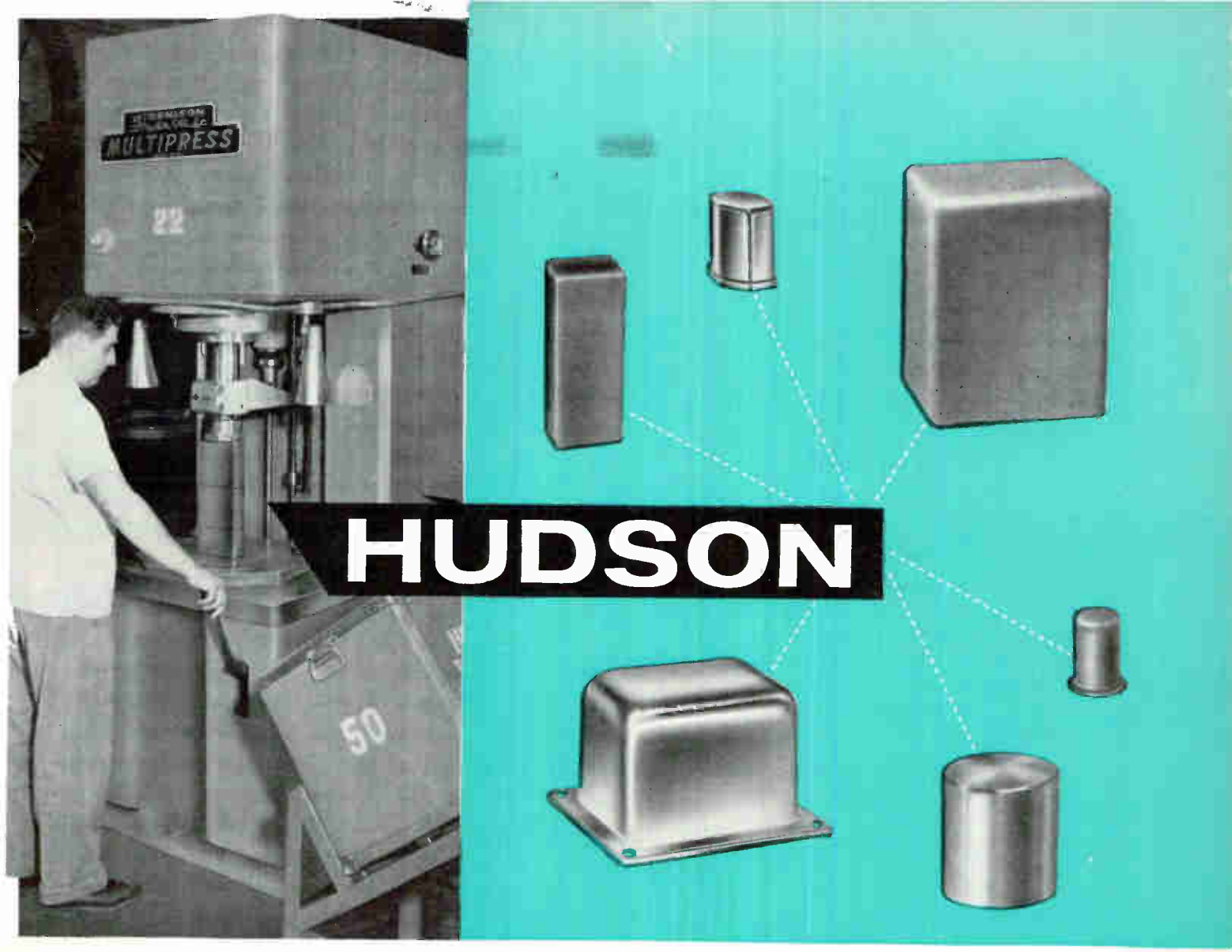


FIG. 4—The minimum d-c gain, β_{min}, needed to obtain a given σ, is determined from this normalized plot



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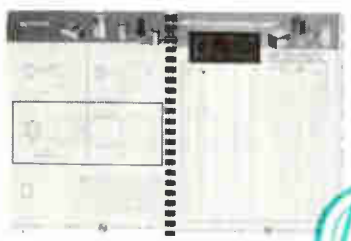

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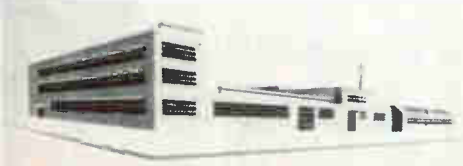
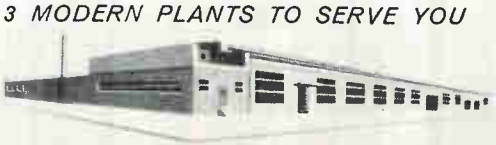




Reducing Relay Pull-In Drop-Out Gap

By RONALD L. IVES Palo Alto, Calif.

RECENT experiments indicate that close differential operation of stock relays is possible using low-voltage relays operated from a high-voltage supply. Zener diodes are used as voltage-dropping elements and permit substantially constant operating differential with wide variations in supply voltage.

Present Approaches

Relays that pull in dependably at 115 v, drop out dependably at 110 v and have a tolerance of not more than one volt either way are expensive and hard to get.

Commercial relays generally have a pull-in/drop-out voltage ratio of about 5/3. A nominal 6-volt relay pulls in at about 5.5 v and drops out at about 3.3 v. Operating differential is only about 2.2 v, but a method of using it for higher voltages must be found.

Operation of low-voltage relays from a high voltage with a nonlinear voltage-dropping resistor, such as a lamp, can produce interesting changes in operating differential, but all are not useful. Improvement of operating differential is obtained with voltage-regulator tubes, and this improvement falls far short of that usually desired because of the large difference between starting and operating potentials of the regulator.

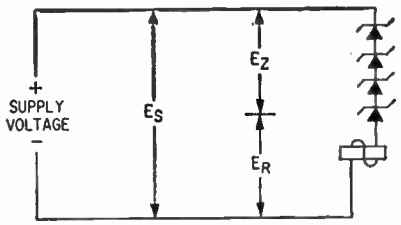


FIG. 1—Closer differential operation of relays are obtainable with lower voltage stock relays and Zener diodes

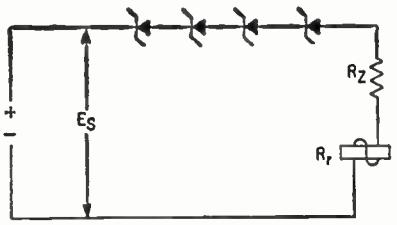


FIG. 2—Conducting resistance of Zener diodes is largely compensated by adding resistor R_r

Zener Diode Method

Experiments were conducted in which low-voltage relays were operated from a high-voltage supply with Zener diodes as voltage-dropping elements. These experiments show that absolute value of operating differential can be held substantially constant at any supply voltage. The percentage operating differential declines as supply voltage is increased, making close differential operation of stock relays possible in many instances.

Fundamental circuit is shown in Fig. 1. If the Zener diode had infinite resistance in the nonconducting state and zero resistance when conducting, pull-in supply voltage E_{sp} would be relay pull-in voltage E_{rp} plus Zener voltage E_z. Drop-out supply voltage E_{sd} would be relay drop-out voltage E_{rd} plus Zener voltage E_z. This simple relation does not prevail, however, because available Zener diodes have finite resistance when conducting. Resistance of commercial 5-watt diodes is about 2 ohms/rated volt at 20 percent of maximum current.

To compensate resistance of the conducting Zener, the circuit was modified as in Fig. 2. Zener conducting resistance is designated R_z and relay resistance R_r. Relay pull-in supply voltage is about $E_{sp} = E_z - R_z E_{rp}/R_r - E_{rp}$. Drop-out supply voltage is similarly shown by $E_{sd} = E_z - R_z E_{rd}/R_r - E_{rd}$.

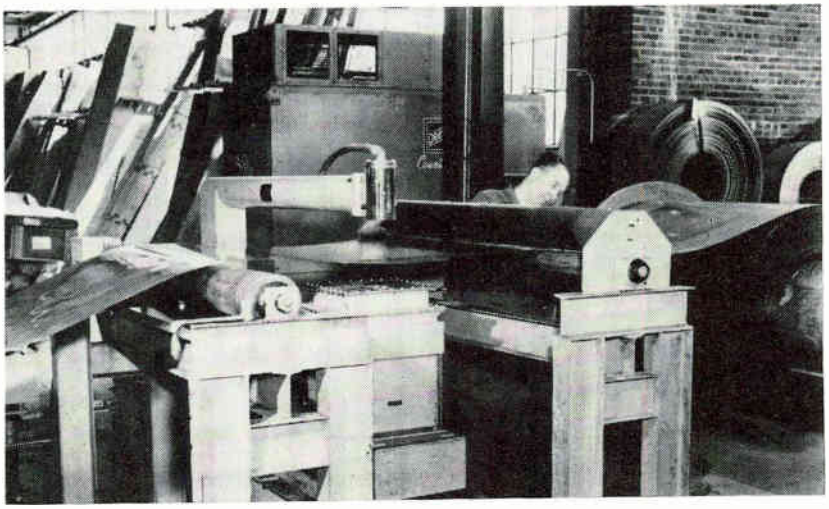
Operating voltage differential is closely approximated by $E_{sp} - E_{sd} = [(R_z - R_r)/R_r]\ (E_{rp} - E_{rd})$. Relative spread of relay operating differential caused by adding resistance R_z is $(R_r - R_z)/R_r$.

High-Resistance Relays

To make maximum use of the voltage differential of a relay, relay resistance must be high relative to ohmic resistance of the Zener diode. Therefore, high-resistance, low-current relays should be used with the lowest current Zener diodes. This arrangement results in a considerable financial saving.

Tests of several relays show that

X-rays Gage Metal Thickness



Thicknesses of foil of 0.00025 in. to plate of 1.5 in. are measured by Daystrom pulsed x-ray. Pencil beam gages thickness of hot and cold rolled metals at up to 6,000 ft/min

these formulas work quite well under a variety of conditions. A 6-volt relay coil with 22 ohms resistance was adjusted for a pull-in voltage of 5.5 v and a drop-out voltage of 3.3 v. When operated around 115 v, computed differential was 9.7 v. Measured differential was 10.3 v. Tests with similar relays gave comparable results.

A similarly adjusted 5,500-ohm relay coil was tested in the same way. An increase in Zener diode voltage compensated the smaller drop through R_z. This arrangement would not work with 10 or 5-watt Zeners, but performed satisfactorily when 750-milliwatt Zeners were used. Computed differential was 2.3 v, while measured operating differential was 2.7 v. A tolerance of about 10 percent in pull-in and drop-out voltages was noted.

Additional tests with very high resistance relays indicate that Zener diodes do not work very well if current through them is much less than about 1 ma/rated watt. Operation seems intermittent when the lower current limit, different for each diode, is approached. Shunting the coil with a resistor to raise Zener current above critical corrects the difficulty.

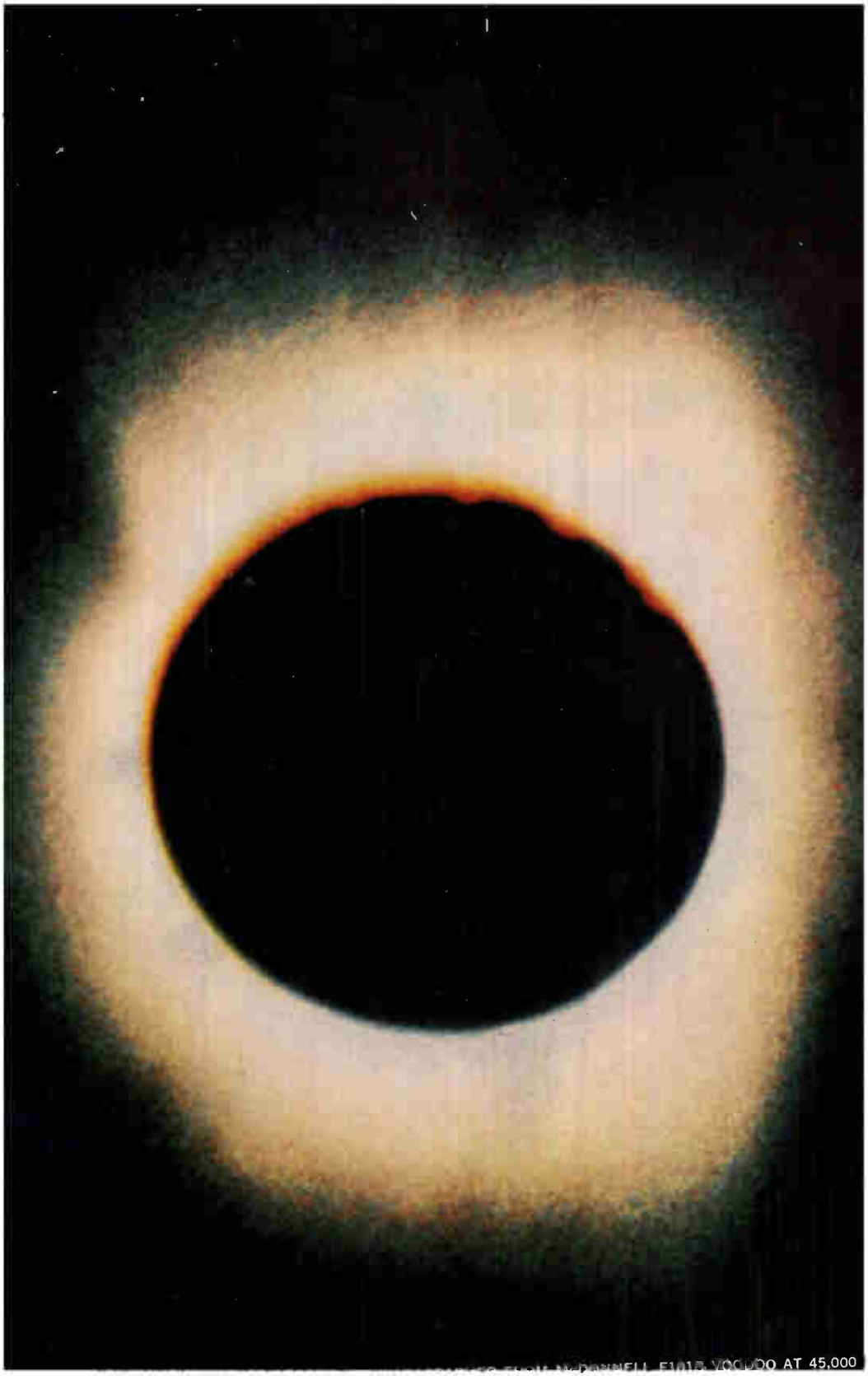
A relay operated in the circuit in Fig. 2 can be desensitized to line surges by shunting the coil with a capacitor. If r-f pickup is a problem, filters should be placed on the supply side of the Zener diodes. Since Zeners are rectifiers, the relay may be biased by rectified r-f.

A-C Relays

Although the same general principles can be used to operate a close-differential system from a-c using dual-base Zener diodes and a low-voltage a-c relay, behavior of the system is not too satisfactory. Better results are obtained if a bridge rectifier is connected across the supply line, and a d-c close-differential system is fed from it.

Radiation Monitor For AEC Test Station

DATA GATHERING and logging system will provide continuous surveillance of nuclear radiation levels and weather conditions surround-



sion s[illegible] Station, near Idaho Falls, Idaho. The system developed by Motorola, Inc., uses radio transmitted bursts of audio tone corresponding to binary coded digital information.

The system will enable either continuous, a selected lesser rate or manual interrogation of up to 256 remotely located weather reporting or radiation monitor counting devices. All 256 channels will be interrogated and monitored in a period of two minutes. The information will be read out by an automatic typewriter.

Operation

The central station generates and transmits a sequence of tone bursts corresponding to the binary code call number assigned to a particular remote station. When received, the call number starts a storag cycle in which output from th radiation detection device is monitored and then stored for 3 seconds.

A second call number from th master station is received whic causes transmission of the store data in the binary code form o tone bursts by the particular re mote station. To interrogate al 256 channels in the two-minut period, the storage call number fo one channel is also the report cal for another.

Geiger-Mueller counters, scintillation detectors and weather reporters provide a digital readou that is translated directly to binary code for transmission at the remot stations. Ionization chambers, however, provide an analog readout tha must be digitized. Automati alarms are triggered if radiatio exceeds preset levels.

The system will also allow manua control of gas pump motors at remotely located air-sampling sta tions. The motors may be started initiating dust collection, and the stopped from the master station before a field team collects sample for laboratory evaluation.

The system evolves about a transistorized digital interrogation system recently developed by Motorol and is compatible with standar

Microminiature radio size of sugar lump developed by Army Signal Corps and RCA

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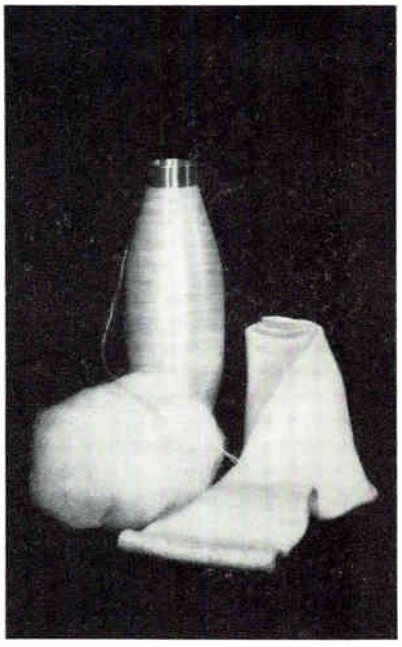

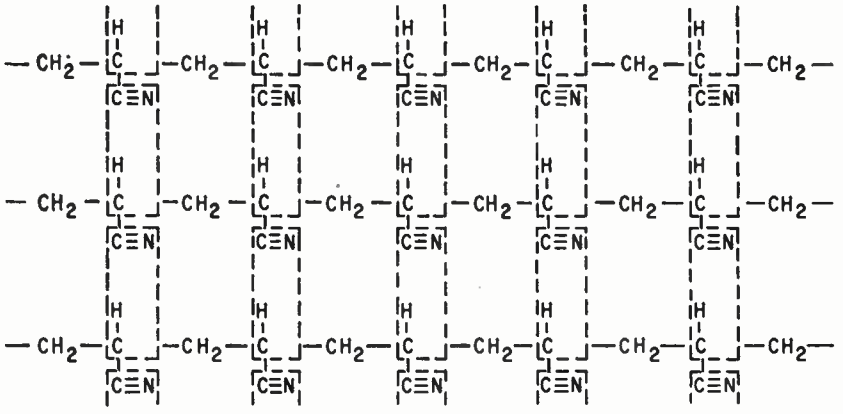

FIG. 1—Structural model of ORLON, a Du Pont product that belongs to the acrylonitrile family of plastics. The attractive force holding the atoms together, and indicated by a straight line, is called a bond or linkage. Dotted lines show a natural affinity of certain atoms to group together. Organic chemistry is full of such complicated chains that have similar chemical properties. Many of these substances can be made semiconductive by application of heat or irradiation

Base materials used to spin synthetic fibers and yarns such as these, are now found to possess exciting potentialities for electronics.

Report on Semiconductive Plastics

By MICHAEL F. TOMAINO, Associate Editor

A NEWS ITEM from the U.S.S.R. that came over our teletype lines just before Christmas (ELECTRONICS p 11, Jan 1) is stirring up a great deal of interest in both the electronics and chemical industries. Tass reported the development of a transistor* made of polyacrylonitrile that is as good as those made of germanium.

The acrylonitriles belong to the family of plastics that are used to make synthetic fibers widely known in this country by trade names such as ACRILAN, ORLON and CRESLAN.

At this writing ELECTRONICS was not able to obtain direct confirmation and verification of this announcement from the Soviet principals mentioned.

Astonishing Properties

What makes the Tass story particularly noteworthy is the announcement that the synthetic "transistor" was developed by the well known Soviet scientist Nikolai Semyonov. At Moscow's Eighth Mendeleyev Chemical Congress, held last spring, Nobel Prize winner Semyonov disclosed that "astonishing properties" of certain polymers had been discovered with the help of paramagnetic resonance instruments, and that polymers also possessed semiconductor properties. Semyonov won the Nobel Prize in Chemistry in 1956. He has been a Professor at Moscow State University since 1945, has done work in the fields of chain reactions, problems of chemical kinetics and reactivity, and has penned over 200 articles in the field of chemical physics.

At the time of the Chemical Congress meeting in Moscow, Victor Fedorov, chairman of the State Chemistry Committee, said that polymers have a high priority in future Soviet research. He also pointed out that this branch of chemistry "has been placed on a firm scientific basis," as a result of "such theoreticians as Semyonov."

Last week ELECTRONICS talked with several top U. S. materials research men in chemistry and electronics about this development. Opinions were varied, as the Soviet story didn't give them much factual material to go by. But one thing is sure: this claim bears watching. Plastics are continuously taking over more room on the materials research bench.

A search of literature, made here, fails to uncover reports of work on the actual construction of a plastic semiconductor device.

The organic compounds consist of long chains, see Fig. 1, and oxygen can penetrate the internal structure of these compounds quite easily. (Oxygen can't go very far into germanium and silicon.) So, in the case of the polymers, both external and internal problems have to be considered. Also, the carriers, in the polymers, have very low mobilities, and preliminary experiments show that the average lifetime of these carriers is not very long.

Conductivity of Plastics

Work on organic polymer irradiation goes back about five years—to the experiments of Meyer, Bouquet and Alger in this country,

* The original Russian word may have been POLUPROVODNIK which actually means semiconductor. This could have been translated into our word transistor. If the news item meant *semiconductor* and not transistor, then electronics research men here wouldn't have been shaken up nearly as much. In the U. S. researchers have been doing a lot of work on semiconductive plastics (see references 1, 2, 3, 4). And the area of organic semiconductor devices is not being neglected either. (POLUPROVODNIKOVIY TRIOD is Russian for transistor, the actual device).

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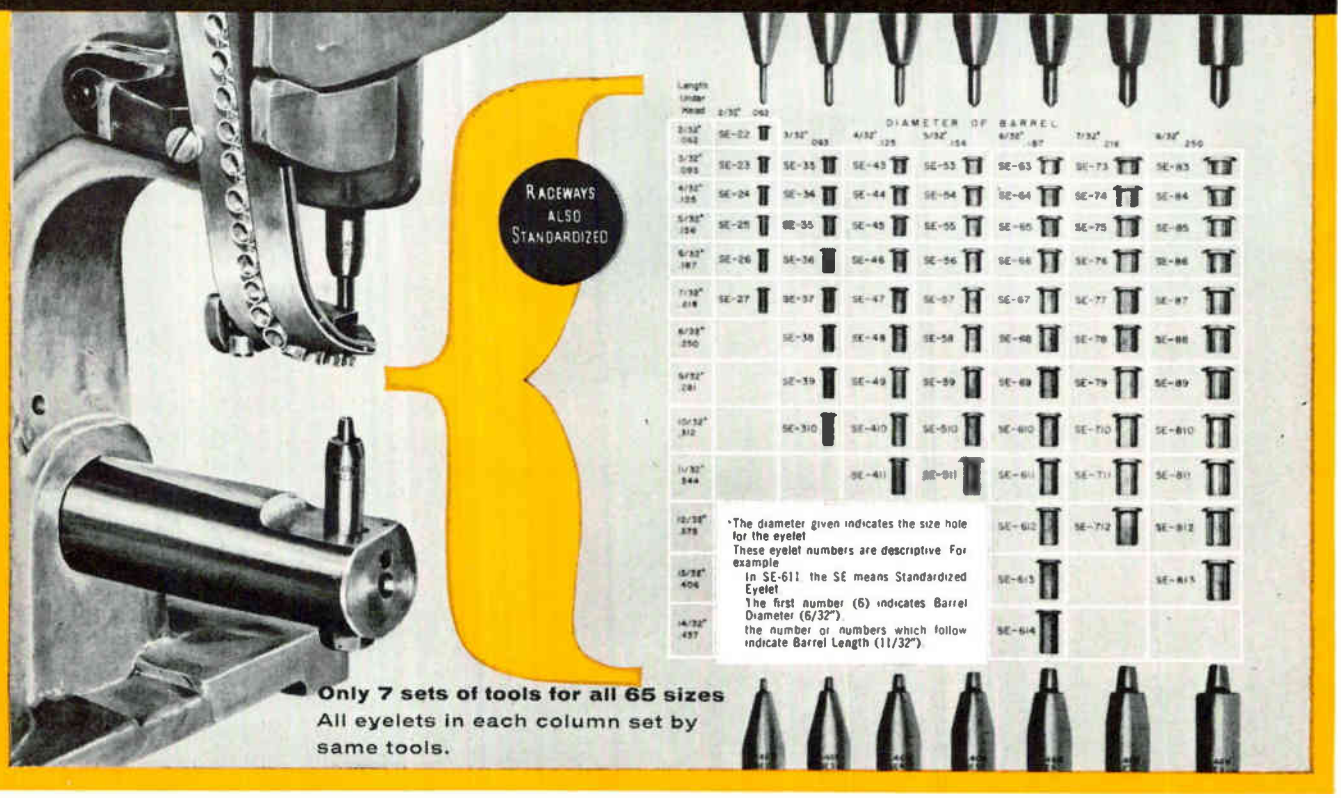

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and Fowler and Farmer in England[1]. This work indicated that irradiated Teflon possessed increased conductivity during irradiation. This effect lasted for a short time, and the conductivity fell off gradually. Investigations since then have shown that semiconductors like silicon and germanium, and irradiated synthetic materials like the nitriles, have certain basic electronic properties and activities in common.

The acrylonitriles and other plastics have free electron groups. This means that electron bombardment would make these free electrons behave like the semiconductor metals.

High Heat

According to some sources who have been experimenting with polymers at high temperatures, these polymers also take on semiconductor properties under high heat. But the physical state of the conductive polymer might render it useless as a semiconductor. However, the Soviet approach, through radiation, may be the answer. Enough work has been done to indicate semiconductive effects and possibly transistor action. It is logical to assume that good ohmic contacts can be made, and that it would be possible to get diode type action and transistor action. But not enough work has been reported to indicate how close U. S. research is to the actual plastic transistor.

ELECTRONICS finds a great deal of active interest and investigations conducted in the field of organic polymer irradiation, thermoelectric applications of the polymers, and incipient research in organic semiconductors generally.

One company is said to be working on the use of organic polymers as semiconductor materials, but have not been using radiation to make the plastic conductive. They have been approaching the problem from another direction. At this time we have no clues as to how they plan to do this. But back in 1948 and through 1953, Bell Laboratories did work on the pyrolysis of polymers, that is to say the effects of heat on such substances as polyvinylidene chloride (SARAN) and polydivinyl benzene. These experiments imparted semiconductive properties to these materials[2]. Also,

polystyrene was heated and the resulting carbon residue showed semiconductive properties[3].

C. G. B. Garrett of Bell Laboratories, in his paper on semiconductivity and photoconductivity in organic materials[4], lists 112 references. The first reference goes back to 1906—photoconductivity discovered in anthracene by A. Pochettino.

Back last May, Union Carbide Corp. reported that a recent Australian patent application (41,236/58) made metalloceramic polymers by irradiation. This process involved irradiating a mixture of one or more metal or metal oxides, silicic acid and an organic hydroxy compound with 100-400 million roentgens/gram until a solution is formed. This is followed by polymerization of the solution at elevated temperature.

Acrylonitrile was first produced domestically by American Cyanamid, and the material was used initially in GR-N rubber.

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(3) N. Pape, W. Matreyek, F. H. Winslow, W. O. Baker, Formation and Properties of Polymer Carbons, *J of Polymer Sci.*, p 101-120, Apr, 1955.

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More Even Control of Semiconductor Doping

A NEW GOLD-ANTIMONY alloy for transistor manufacturers has been developed by the Baker Contact Division of Engelhard Industries, Inc., Newark, N. J. Available in rod or whisker wire in diameters from 0.25 inch down to 0.001 inch and in sheet down to 0.0015 inch thickness, the new material consists of high purity gold containing 1 percent antimony and is unique in the completely homogeneous dispersion of the antimony-rich phase throughout the gold matrix.

Designated as alloy No. 1549, the material imparts a controlled impurity (antimony) into a semi-conductor crystal, usually silicon, by evaporation techniques.

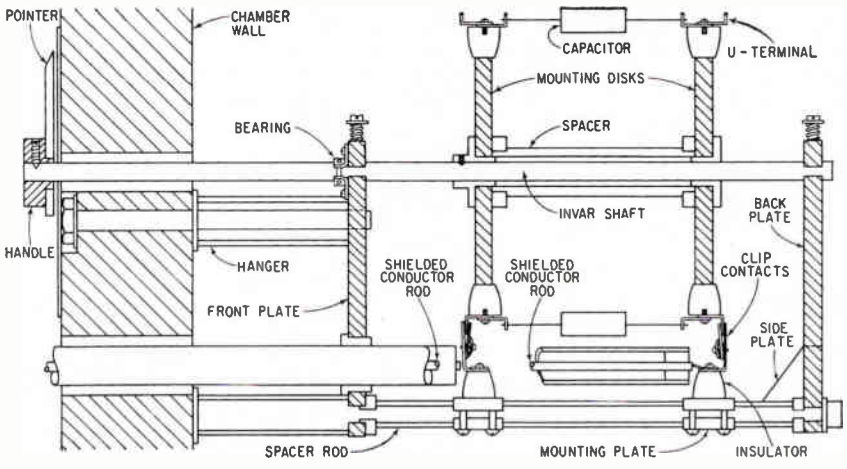


FIG. 1—Assembly details of environmental testing fixture

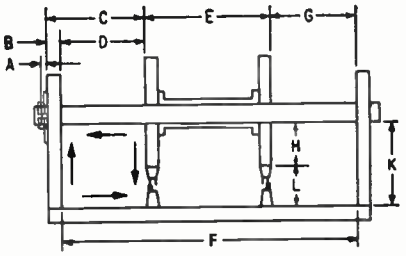


FIG. 2—Location of the critical dimensions described in Fig. 3

Test Fixture Cancels Its Own Capacitance

SELF-COMPENSATING fixture which permits testing of 24 capacitors at a time in an environmental test chamber has been developed by United States Testing Co., Hoboken, N. J. The fixture, primarily used in determining temperature coefficients of capacitance, permits a single setup for measurements at various temperatures.

The proportions of the fixture cancel out temperature-induced changes in the capacitance of the fixture, so that fixture capacitance remains essentially constant over a wide temperature range.

NAME	DIM	EXP COEF
BEARING SPRING	A	α
FRONT PLATE	B	β
SHAFT (FRONT)	C	γ
CRITICAL DIM	D	0
MTG DISC SPACER	E	ϵ
BASE PLATE	F	P
CRITICAL DIM	G	0
MTG DISCS	H	ϵ
BACK PLATE	K	β
CRITICAL DIM	L	0

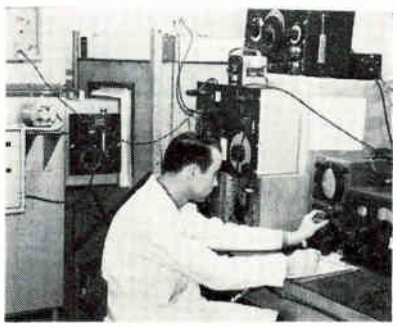
CRITICAL DIMENSIONS D, G AND L ARE HELD CONSTANT BY USING THE FOLLOWING FORMULAS:

(D) $C\gamma = A\alpha + B\beta$

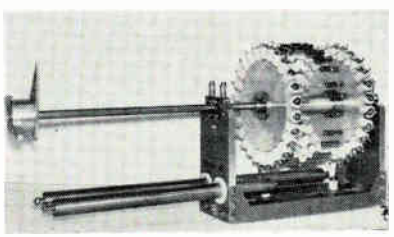
(G) $E\epsilon = FP$

(L) $H\epsilon = K\beta$

FIG. 3—Critical dimensions and formulas for holding them constant



Capacitor test setup. Fixture is hanging in temperature chamber at rear



Fixture holds 24 capacitors

A side view of the overall fixture, as installed in an environmental chamber, is shown in Fig. 1. The fixture is normally hung vertically by the hangers. The pointer and its handle are on the outside of the chamber roof. A dial placed under the pointer tells which capacitor is at the clip contacts in measuring position.

Capacitors are soldered to the inner legs of the insulated U-terminals of the mounting disks. Turning the handle rotates the outer legs of the terminals, bringing any selected inner terminal legs into the phosphor-bronze spring clip contacts.

Fixture Design

The Invar shaft is fitted into the front and back plates. Bearings are spring-loaded so that the shaft remains free to rotate despite dimensional changes in the plates. The ball bearings rotate in an annular groove in the shaft.

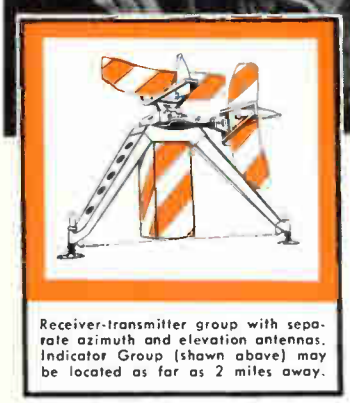
Mounting disks and spacer are made of aluminum. Plates are steel. Conductor rods are brass, shielded by steel tubes. All corrosive metallic parts are cadmium plated.

Critical dimensions and the proportioning method of keeping them constant are outlined in Figs. 2 and 3. As temperature increases, the expansion in the lower portion of the fixture is from front to back. At the same time, the growth along the shaft is from back to front. The plates grow from bottom to top while the mounting disks grow toward the clip contacts.

These relationships are shown for one portion of the fixture by the arrows of Fig. 2 (considering the lower left corner as the zero position). The dimensions may be varied according to the formulas of Fig. 3.

Net effect of the design technique is a stable three-dimensional configuration at the clip contacts. Since stray capacitances remain essentially unchanged, they can be balanced out by bridge techniques as capacitance is measured at various temperatures. The brass conductor rods are connected to the bridge and the shielding tubes to the bridge guard terminals. Other instrumentation may also be connected to vary electrical conditions and frequency. The rods are iso-

New LFE precision GCA *provides instant control of Jet traffic*

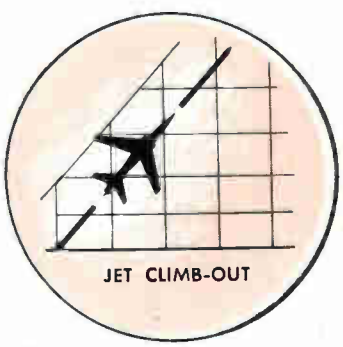


Receiver-transmitter group with separate azimuth and elevation antennas. Indicator Group (shown above) may be located as far as 2 miles away.

Latest in the LFE series of Ground Control Approach Systems is the new ECR (Extended Coverage Radar) . . . a compact, high power, high precision system capable of controlling Jet traffic quickly and accurately on any one of four runways.

Four modes of control are displayed on a single indicator . . . Airport Surveillance (ASR) from 1 to 40 miles . . . Precision Approach (PAR) from 1 to 40 miles . . . and Slant Flight Control (SFC) from 0 to 50,000 feet. Jet climb-out can also be controlled in the SFC mode. Elevation scan is $-1°$ to $+30°$ in all modes. Azimuth scan is 45° in PAR and SFC modes.

The system provides a large volume of instantly accessible coverage in 3 dimensions. Significant benefits include: reduction of contact time required from controller to aircraft . . . allowance for adequate warning time in the event of confusion in aircraft course . . . elimination of interference caused by terrain and precipitation characteristics.



Specific features include: electronically computed pre-determined cursors to indicate elevation and azimuth approach to touchdown . . . also establish center, floor or ceiling of any slant flight corridor. Remote bearing readout provides quick, positive dial indication of center of SFC zone for complete coverage of departure by high performance jets.

The foregoing briefly describes this highly versatile system's many advanced features. It serves to exemplify LFE capabilities for meeting new problems with new concepts . . . from proposal-to-prototype-to production.

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lated from the tubular shields by Teflon bushings and spacers.

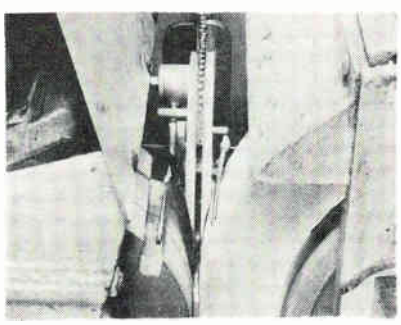
3-Dimensional X-Rays Pinpoint Failures

STEREOSCOPIC X-RAYS can be made with standard x-ray inspection equipment. Two films are taken of each component to be studied. These films, termed left eye and right eye negatives, are taken at slightly different angles. The films are studied in 2 modified x-ray film viewers and a mirror system in which 2 mirrors are set at a 45-degree angle to each other, forming a V-shape.

The observer places his head against the point of the V so that each eye looks into a different mirror. He then adjusts the mirrors so that the images are superimposed in the mirror reflectors.

Convair (Astronautics) Division, General Dynamics Corp., San Diego, Calif., uses the method to check Atlas missile components. Component failures can be diagnosed more readily, or the component opened without damaging the failure evidence, when the exact location of the failure is known.

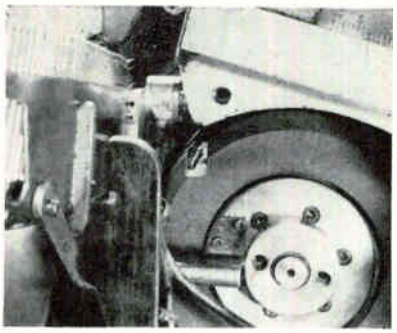
Drop-Feeding Parts Automates Grinder



Front view, showing mechanism which releases stop pin in gravity feed chute

DROP-FEEDING and unloading of workpieces on a centerless grinder has stepped up production of synchro shafts at Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J. Shaft shape and tolerances required on shaft bearing diameters made through-feeding or in-feeding impractical.

The shafts, turned on a Swiss automatic, are delivered from a



Rear view of grinder and feeder. Regulating wheel removes finished shaft while another is ground

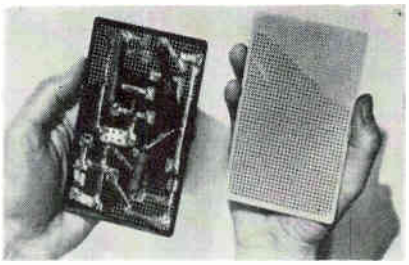
Shaft drops into trough as regulating wheel completes revolution

vibratory bowl into the grinding position on the work rest. Each shaft drops from the bowl down a gravity chute to a stop pin in the chute. An actuating cam attached to the grinder's regulating wheel strikes a spring-loaded arm at each turn of the wheel. A second arm attached to the first turns a spring-loaded wheel. A third arm, attached to the wheel, extends over the gravity chute. As the last arm swings down, it releases the stop pin in the chute. A cutout on the work rest locates the shaft for grinding.

The shaft is supported in grinding position by the grinding wheel, regulating wheel and work rest and blade. The regulating wheel makes 1 revolution per shaft. When the shaft is ground, it rolls backward into a notch cut in the regulating wheel. The shaft is carried up and around by the regulating wheel until it drops in a trough below the wheel. The high-speed grinder used is made by Van Norman Machine Co., Springfield, Mass.

Shafts were previously turned to a tolerance of 0.0002 inch and the bearing surfaces finished by manually-fed burnishing operations at a rate of 50 an hour. The grinder finishes shafts turned to 0.0005 inch at a rate of 600 an hour.

On The Market



Grid Board
for prototype work

CORNING GLASS WORKS, Corning, N. Y. Resolderability allows use of p-c layouts over and over again with a new grid board. The blank grid board is made of high strength, high temperature Fotoceram, clad with copper on both sides. Without using special equipment, designers can obtain their desired layouts by etching and then easily install components in the grid's holes by either hand or dip soldering. It is designed as a valuable tool for high quality prototype work.

CIRCLE 301 ON READER SERVICE CARD

Frequency Standard
no moving parts

DESIGNERS FOR INDUSTRY, 4241 Fulton Parkway, Cleveland 9, Ohio. Model F frequency standard uses solid state temperature control. It has five outputs, single and three-phase. It is accurate to ±0.001 percent with phase accuracy of 1 deg

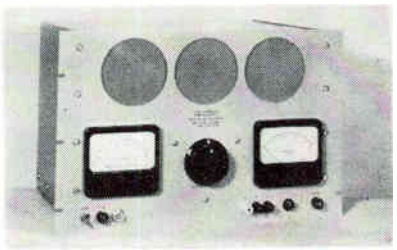
in missile environment. Unit is dip-potted, weighs 11 oz and is in a 5 by 3 by 1 in. envelope. Printed circuitry and silicon transistors are used throughout. Output frequencies are 9.6 kc square wave, single phase; 4.8 kc square wave, single phase; and 400 cps square wave, three phase.

CIRCLE 302 ON READER SERVICE CARD

Tape Degausser
weighs 8½ lb

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y. Model HD-11 bulk tape demagnetizer reduces the residual sound level of typical previously unrecorded tape by 3 to 15 db, dependent on its previous exposure to stray magnetic fields in transit. It provides a 75 db minimum erasure of saturated magnetic tape. These db levels were determined by running fresh unrecorded and saturated tape through a model 300 Ampex tape recorder. Tests were made at 1 kc and read through a 1 kc band-pass filter.

CIRCLE 303 ON READER SERVICE CARD



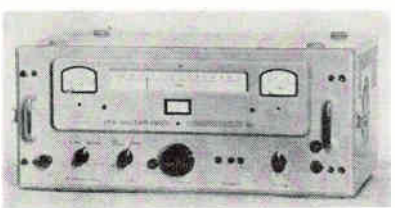
D-C Power Supply
transistorized

UNIVERSAL ELECTRONICS CO., 1720 Twenty-Second St., Santa Monica, Calif. Completely transistorized power supplies are high current type. Model LQ5-32-25 has a voltage range of 5 to 32 v d-c at 0 to 25 amperes. Regulation, line or load, is 50 mv; ripple, less than 2 mv; response time, less than 50 μsec; output impedance, less than 0.005 ohm; rack mounting size, 12¼ by 19 by 14¾ in. deep.

CIRCLE 304 ON READER SERVICE CARD

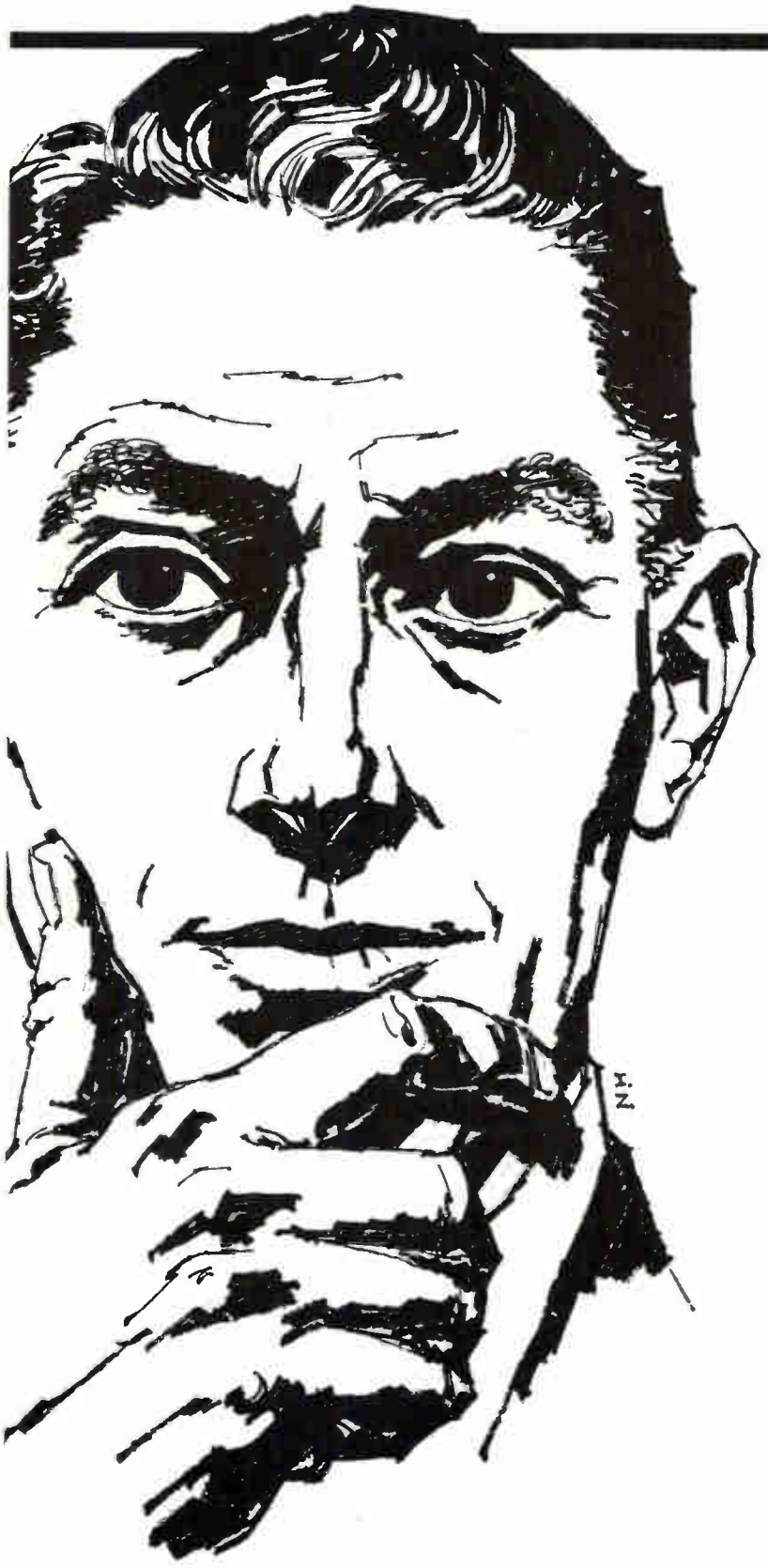
VHF/F-M Receiver
in three versions

ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N. J., announces type ESB vhf/f-m communications receiver. Applying the relay reception method, the receiver picks up a program from the master transmitter and passes it on to a slave transmitter. High reliability, dis-



tortion-free transmission of the complete band from 30 to 15,000 cps and elimination of cross-modulation are the major characteristics. Type ESB is available in three versions: (a) Relay receiver for broadcasting; (b) long-distance link receiver for carrier frequency systems or transmission of radio programs over wide areas; (c) short-distance link receiver for carrier frequency or radio relay links. For standard ESB types, representative frequency ranges (mc) include 87.5-100; 41-68; 60-88; 156-174; 174-

Let's look at it from your point of view, Mr. Engineer



You're in demand, there's no doubt about that, and rightly so. Want ad, after want ad, dangle promise and reward for your talents. Many firms offer challenges, and it's hardly one that doesn't have opportunities.

So we begin by admitting that these are the facts. And we frankly asked ourselves what do we, Raytheon Missile Systems Division, have to offer a person like you.

We believe we have something more to offer. It's a management policy. It's summed up in the phrase, "Raytheon creates a climate for talent." We feel this is a plus someone like you would want to look into. It's not a slogan, it's a fact. A fact that Raytheon Missile Systems Division management has made a policy that is adhered to.

If it's opportunities you seek, they're certainly here. Raytheon's Missile Systems Division is the largest division of the Raytheon Company — and it is one of the fastest growing divisions too. We think this fact is proof of our policy.

If it's a challenge you want, Raytheon is the world's only purely electronic company with prime responsibilities for two major missile systems — the challenge here is great.

Perhaps it is better living conditions that would be a great deciding factor. New England offers seashores, mountains, and excellent suburban living, and we are in the heart of New England.

So we have the many things you're probably looking for in a position — but most important we have a policy that allows for *you* — we create a climate for talent. Maybe that's the reason we have grown so quickly. Perhaps that, and the other reasons we've stated, are reasons enough for you to investigate us more thoroughly. Do you meet these requirements?

Call collect CRestview 4-8884 for further information and an interview appointment. Ask for Mr. Jerry Morris. If you prefer, address your postcard or letter to Mr. Jerry Morris, Professional Employment, Raytheon Company, Bedford, Massachusetts.

Circuit Design Engineers . . . with experience in design of high-speed switching circuits, pulse techniques, and computer logic in one or more of the following areas: navigation, guidance, control circuits, CCM, FM, PCM, PDM, and fusing circuitry.

Data Handling Engineers . . . with experience in high-speed, analog-to-digital conversion techniques, logic design, converter and buffer design. Should have thorough knowledge of tape recorder techniques and digital, servo, and digital-computer design.

RAYTHEON MISSILE SYSTEMS DIVISION

. . . creates a climate for talent.

220; 50-80. Maximum swing (kc) specs are 50; 75; 150. Modulation frequency ranges are 30-15,000 cps; 300 cps-60 kc; 300 cps-120 kc.

CIRCLE 305 ON READER SERVICE CARD

Free Gyros highly accurate

KEARFOTT CO., INC., Little Falls, N. J. The A2322-01 and A2311-04 free gyros are hermetically sealed, ruggedly constructed devices specifically designed to operate in extreme vibrational environments. Containing remotely operable caging and uncaging mechanisms, these units have 360 deg of gimbal freedom about their outer axes, and ± 85 deg of freedom about their inner axes, and they may be variously mounted to provide output signals of either pitch, roll or yaw. Their quick-starting motors make them particularly suited for applications in missiles and other high performance vehicles requiring guidance or stabilization.

CIRCLE 306 ON READER SERVICE CARD

Silicone Greases for insulation

GENERAL ELECTRIC CO., Silicone Products Dept., Waterford, N. Y. Two new soft, workable silicone dielectric greases are chemically inert and can be used over a broad pH range. The XS-4006 and SS-4005 maintain their consistency from −65 F to 400 F. Thus they can be used in many applications where conventional greases would either solidify or be subject to oxidation, evaporation and excessive bleed losses. Both offer excellent dielec-

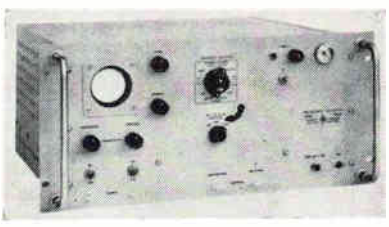
tric properties as well as good water repellency and oxidation resistance.

CIRCLE 307 ON READER SERVICE CARD

Digital Encoder magnetic readout

ASCOP, A DIVISION OF ELECTRO-MECHANICAL RESEARCH, INC., P. O. Box 44, Princeton, N. J. Model EP-13B shaft-position digital encoder with 13 bit binary output employs a noncontacting magnetic readout. Only bearings and gears affect life. This permits its operation in any environment, at speeds up to 10,000 rpm, and with any number of read-outs without effect. Only passive circuitry is involved in readout. Typical applications will be to equipment used in military and industrial environments such as radar, tracking, fire control, and navigational equipment; machine tool controls; and other industrial controls and data loggers. Parallel output is in binary code and total count is reached with 64 turns of the input shaft. Lead-lag head arrangements permit minimum external decision circuitry.

CIRCLE 308 ON READER SERVICE CARD



Frequency Standard highly stable

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Compact, precision frequency standard provides a stability of $5/10^{9}$ parts per week and $3/10^{9}$ over short in-

HERE'S WHY CENTRICORES ARE PROBABLY THE MOST CONSISTENTLY UNIFORM CORES YOU CAN BUY:

The exceptional uniformity you get in tape-wound Centricores is not easy to come by. It's the result of painstaking precision at every stage of the manufacturing process —and, in fact, *before* manufacturing. Three principal factors help produce Centricore uniformity:

Careful classification of materials—Raw alloys are first "pedigreed"—meticulously selected, then tested for some 14 parameters, and classified by magnetic properties. We're the largest buyer of nickel alloy magnetic materials in the world . . . which permits us to choose material for Centricores from an unusually wide distribution of magnetic properties.

Special winding machines—We build our own machines, to die-making tolerances, for winding magnetic alloy tape into cores. We also build our own machines for applying insulating coating to the tape. These machines give us far greater uniformity in dimensions, insulation and ultimate performance of Centricores.

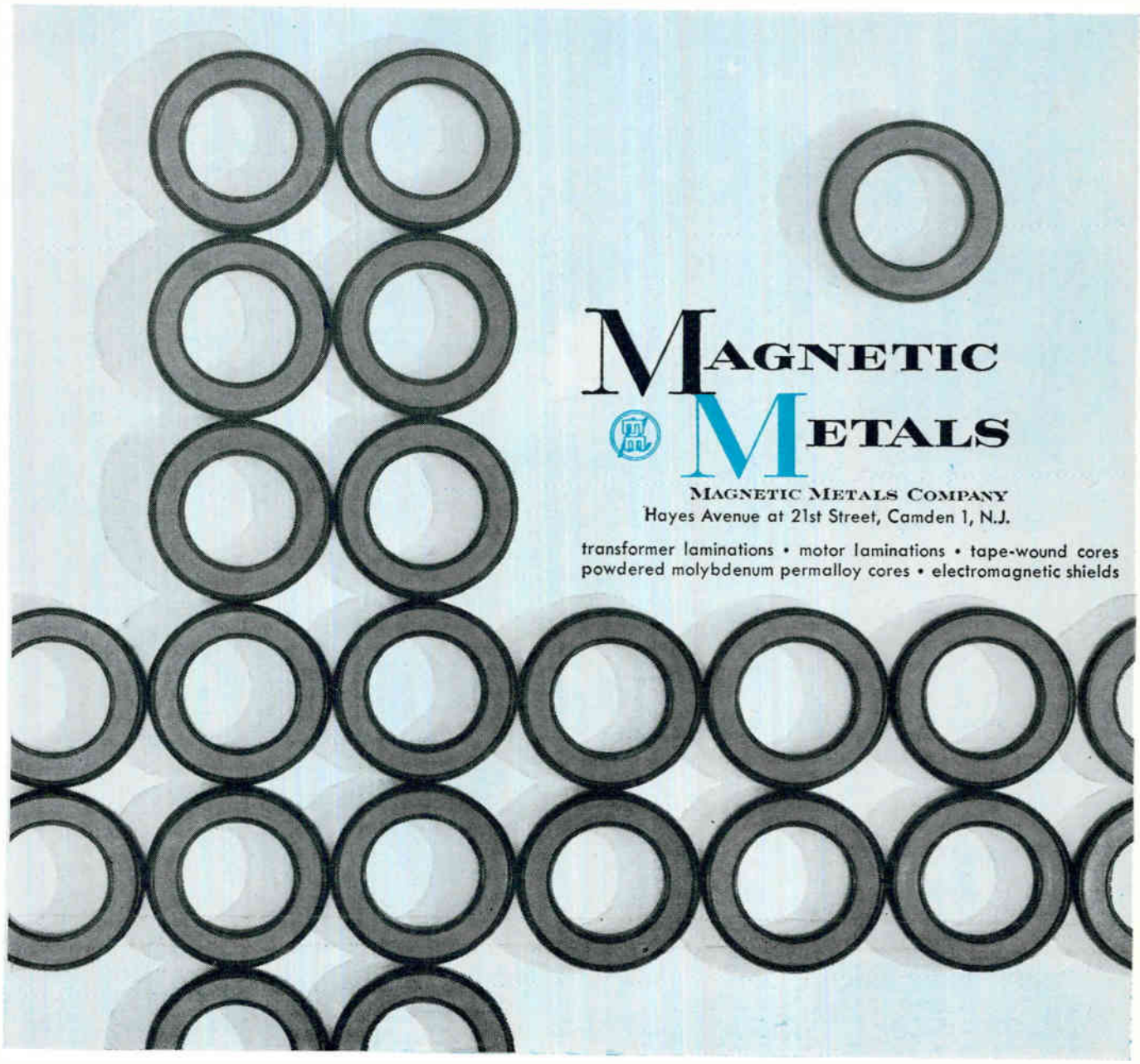
Closely-controlled annealing—Annealing—perhaps the most critical phase of the core-making process—is done under precisely regulated atmospheric and temperature stabilized conditions to hold Centricore magnetic performance to uniformly high levels.

Exceptional uniformity from core to core and lot to lot is further assured with Super Squaremu "79", a new high-performance alloy we've developed. It has outstanding magnetic qualities and is remarkably uniform in squareness, thermal stability and gain. Super Squaremu "79" offers an effective solution to problems of variation in magnetic performance.

WRITE FOR BULLETIN C-3

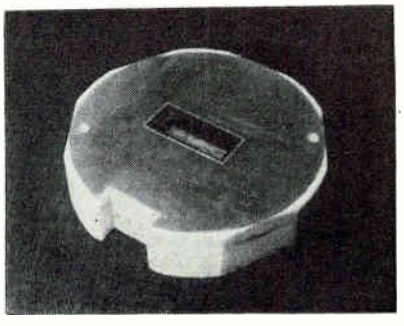
SIZE	MATERIAL	THICKNESS
1	HIGH NICKEL Hymu 80 Squaremu 79 Super Squaremu 79	.001"*
THRU	LOW NICKEL Squaremu 49 Carpenter 49	THRU
225	GRAIN-ORIENTED SILICON Crystaligned Microsil	.004*

**Special sizes, shapes and thicknesses quoted on request.*



tervals. Model 100ER also offers a wide variety of output signals. Signals available include six sinusoidal frequencies (10 cps, 100 cps, 1 kc, 10 kc, 100 kc and 1 mc) and four pulse signals (10 cps, 100 cps, 1 kc and 10 kc). These may be distributed for use at many different stations on a production line or in the laboratory. Rated load of the instrument is 50 ohms at 1 mc and 100 kc, and 5,000 ohms at the lower frequencies. Unit measures 8¾ in. high, 19 in. wide and 18 in. deep; weighs 35 lb. Price is $900.

CIRCLE 309 ON READER SERVICE CARD



Command Receiver subminiature

AERO GEO ASTRO CORP., 1200 Duke St., Alexandria, Va. The CR-100/T command receiver is a completely transistorized, double superheterodyne unit having low power drain to fulfill missile and satellite command receiver functions. An audio tone modulation of the carrier is employed as the command signal to activate an on-off relay. It has a frequency range of 100 to 150 mc and a sensitivity of −90 dbm. Its weight potted is 9 oz and the nominal size is 5.30 in. in diameter by 1.180 in. Unit is capable of withstanding present day missile environment.

CIRCLE 310 ON READER SERVICE CARD

Transistor military-type

BENDIX AVIATION CORP., Red Bank Division, 201 Westwood Ave., Long Branch, N. J. The 2N1120 is a germanium *pnp* audio switching transistor meeting the specification MIL-T-19500A/68 (Sig C). Maximum collector-emitter voltage rating is 70 v d-c, and maximum col-

INTERNATIONAL RECTIFIER CORPORATION

A WORLD OF DIFFERENCE THROUGH RESEARCH

RECTIFIER NEWS

Military Type High Temperature Silicon Power Diodes Operate to 165° C

For military or industrial applications where high temperature operation is a must, International Rectifier offers two series of axial lead, hermetically sealed power diodes. Both supply full rated power under convection cooling without a heat sink.

JETEC series 1N536-1N540 and 1N1095-96 operates at −65°C to +165°C with output currents to 750ma. PIV ratings from 50 to 600v. Bulletin SR-202A describes them.

For power supply or magnetic amplifier use, 16 JETEC types are listed in Bulletin SR-132E. Ratings: 50 to 600v PIV at 300ma. Temperature range: −65°C to +150°C.

The high forward conductance and extremely low leakage of these diodes permits rectification efficiencies to 99% at power frequencies; up to 70% at 50kc.

CIRCLE READER SERVICE CARD NO. 54

JAN DIODES

Now available — such high reliability, high temperature JAN Types as the JAN 1N538 and 1N547 axial lead silicon diodes, and JAN 1N253, 1N254 and 1N255 stud mounted silicon power diodes.

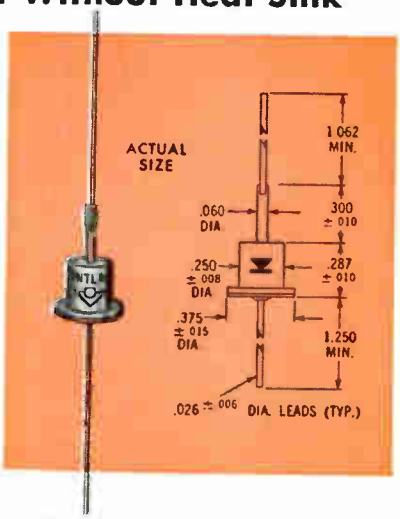
Hermetically Sealed Industrial Silicon Diodes Provide 750ma Output Without Heat Sink

Diodes in this series have been designed to provide optimum reliability and efficiency to your industrial or commercial equipment circuits. By eliminating the space consuming heat sink, you can also realize economies in equipment size as well as assembly time and costs.

Rectified dc output current ratings to 750ma at 50°C can be obtained with PIV voltages ranging from 100 to 500v.

The diode junction is hermetically sealed in an all-welded, shock-proof housing . . . a mechanical construction assuring physical strength and a positive safeguard against contaminants. This adds up to the really important feature — long term reliability! For complete specifications . . .

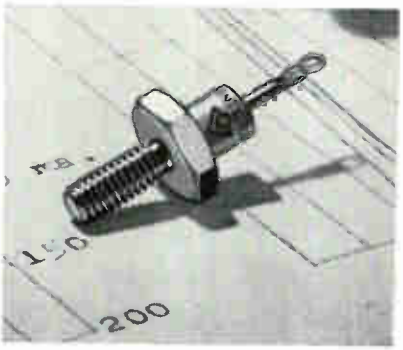
CIRCLE READER SERVICE CARD NO. 53



Absolute Maximum Ratings (at 60 cps. Resistive or Inductive Load)

DIODE TYPES	SD-91	SD-92	SD-93	SD-94	SD-95	SD-91A	SD-92A	SD-93A	SD-94A	SD-95A
Peak Inverse Voltage, Volts	100	200	300	400	500	100	200	300	400	500
RMS Input Voltage, Volts	70	140	210	280	350	70	140	210	280	350
Continuous D.C. Voltage, Volts	100	200	300	400	500	100	200	300	400	500
Rectified D.C. Output Current, ma. at 50° C Ambient	550	550	550	550	550	750	750	750	750	750
at 100° C Ambient	300	300	300	300	300	500	500	500	500	400
Max. Surge Current (1 cycle), Amps.	10	10	10	10	10	15	15	15	15	15
Max. Operating Frequency, Kilocycles	50	50	50	50	50	50	50	50	50	50
Ambient Operating Temperature, °C	−65°C to +125°C					−65°C to +125°C				
ELECTRICAL CHARACTERISTICS										
Max. D.C. Forward Voltage Drop at 25°C	1.5 volts @ 550 ma dc (all types)					1.3 volts @ 750 ma dc (all types)				
Min. Series Resistance (Capacitive Load) (ohms)	6.8	6.8	6.8	6.8	6.8	4.7	4.7	4.7	4.7	4.7
Max. Leakage Current (mA.) at Rated Continuous D.C. Voltage at 100°C	1.0	1.0	1.0	.80	.65	0.5	0.5	0.5	0.4	0.3

High Temperature Stud Mounted Silicon Diode Series Includes Nineteen JETEC and JAN Types.



These silicon power rectifiers are designed for conduction cooling by mounting directly onto the chassis. Ratings from 400ma to one amp. are possible at PIV ratings of from 50 to 600 volts.

Power supply types 1N607 thru 1N614 and magnetic amplifier types featuring low leakage current and high forward conductance are included in Bulletin SR-135C.

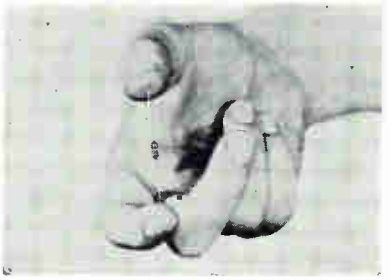
FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

NEW YORK CITY: 1580 LEMOINE, FORT LEE, N. J., WINDSOR 7-3211 • SYRACUSE, NEW YORK, 2366 JAMES STREET, HEMPSTEAD 7-8495 • CHICAGO, ILLINOIS: 205 W. WACKER DRIVE, FRANKLIN 2-3884
CAMBRIDGE, MASS., 17 DUNSTER ST., UNIVERSITY 4-6520 • ARDMORE, PENNSYLVANIA, SUBURBAN SQUARE BLDG., MIDWAY 9-1428 • BERKLEY, MICHIGAN: 1799 COOLIDGE HIGHWAY, LINCOLN 8-1144
CANADA: 1581 BANK ST., OTTAWA, ONTARIO, REGENT 3-6880

lector current rating is 10 amperes. Unit will readily dissipate 45 w at 25C mounting base temperature. High current switching, audio amplification, small motor and servo drivers are typical applications.

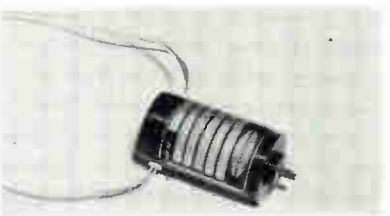
CIRCLE 311 ON READER SERVICE CARD



Silicon Mesa Diodes
four-millimicrosec

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas. The 1N914 and 1N916 diffused silicon mesa computer diodes switch from 10 ma forward current to 6 v reverse in 4 millimicrosec maximum. They have an extremely low capacitance of only 2 $\mu\mu$f maximum. For frequencies up to 100 mc, they provide a minimum rectification efficiency of 45 percent and have a guaranteed maximum leakage of 25 milliμa at 20 v. They feature a high piv of 75 v. Both will dissipate 250 mw of power at 25 C and highlight a guaranteed minimum forward voltage of 1 v at 10 ma. Operating range is −65 to 150 C; maximum storage temperature, 200 C. They can withstand 20,000 g's during acceleration and 1,000 g's during shock.

CIRCLE 312 ON READER SERVICE CARD



Synchronous Motor
dual speed

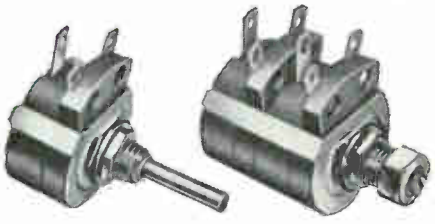
SERVOMECHANISMS, INC., Mechatrol Division, 1200 Prospect Ave., Westbury, L. I., N. Y. A combination 4 and 8 pole dual speed synchronous motor contained in a size 11 frame and within a length of less than 2 in. is capable of operating in an am-

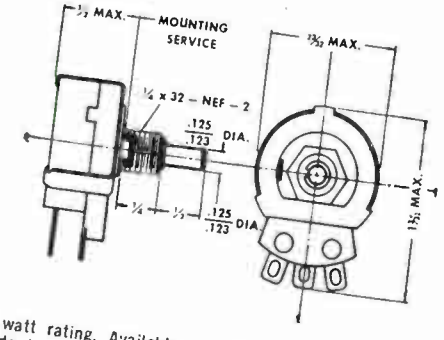
THERE'S NO SPEC LIKE SUCCESS...

CLAROSTAT®

performance-proved* miniature potentiometers

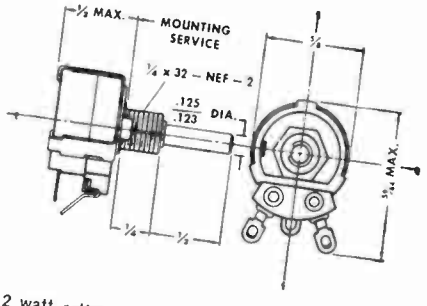
WIRE-WOUND SERIES 49M





1.5 watt rating. Available in single or dual units, with standard or locking bushing. Plus/minus 5% resistance tolerance. Linear resistance range from 1 to 20,000 ohms.

COMPOSITION-ELEMENT SERIES 48M



0.2 watt rating. Available in single or dual units, with standard or locking bushing. Plus/minus 10% resistance tolerance to 100,000 ohms; 20% in higher values. Resistance range from 200 ohms to 5 megohms.

*

PERFORMANCE-PROVED

Hundreds of thousands of these units in everyday use prove their reliability and long life.

CLAROSTAT®

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

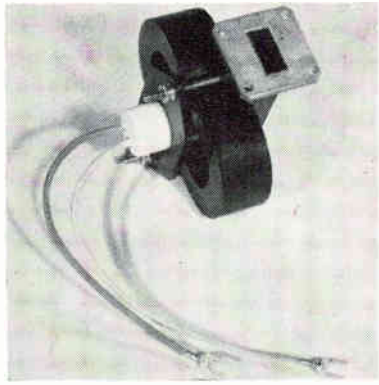
direct line service

IMMEDIATE DELIVERY!

Your Clarostat Industrial Distributor has these units ready for immediate delivery—right off the shelf. Give him a ring...

bient temperature range of −55 C to +85 C. Designed to meet requirements of MIL-E-5400 and MIL-E-5272. Input voltage for either 12,000 rpm or 6,000 rpm speeds is 115 v, 400 cycles, single phase. Pull-out torque for the 8-pole unit is 0.10 oz in. and the 4-pole unit 0.2 oz in.

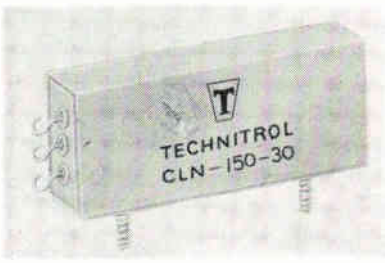
CIRCLE 313 ON READER SERVICE CARD



X-Band Magnetron nonintegral magnet

RAYTHEON MFG. CO., Waltham 54, Mass. The QK798 X-band magnetron is designed for commercial applications such as small boats and small plane radars. It is a fixed frequency pulsed magnetron of the nonintegral magnet type with a probe output. Heater voltage is 5.0 v; heater current, 0.65 ampere; pulse duration, 0.2 μsec; duty cycle, 0.0003; peak anode voltage, 5.0 kv; peak anode current, 3.5 amperes; minimum peak power output, 3.0 kw; frequency, 9410 ±50 mc; life, 500 hr minimum.

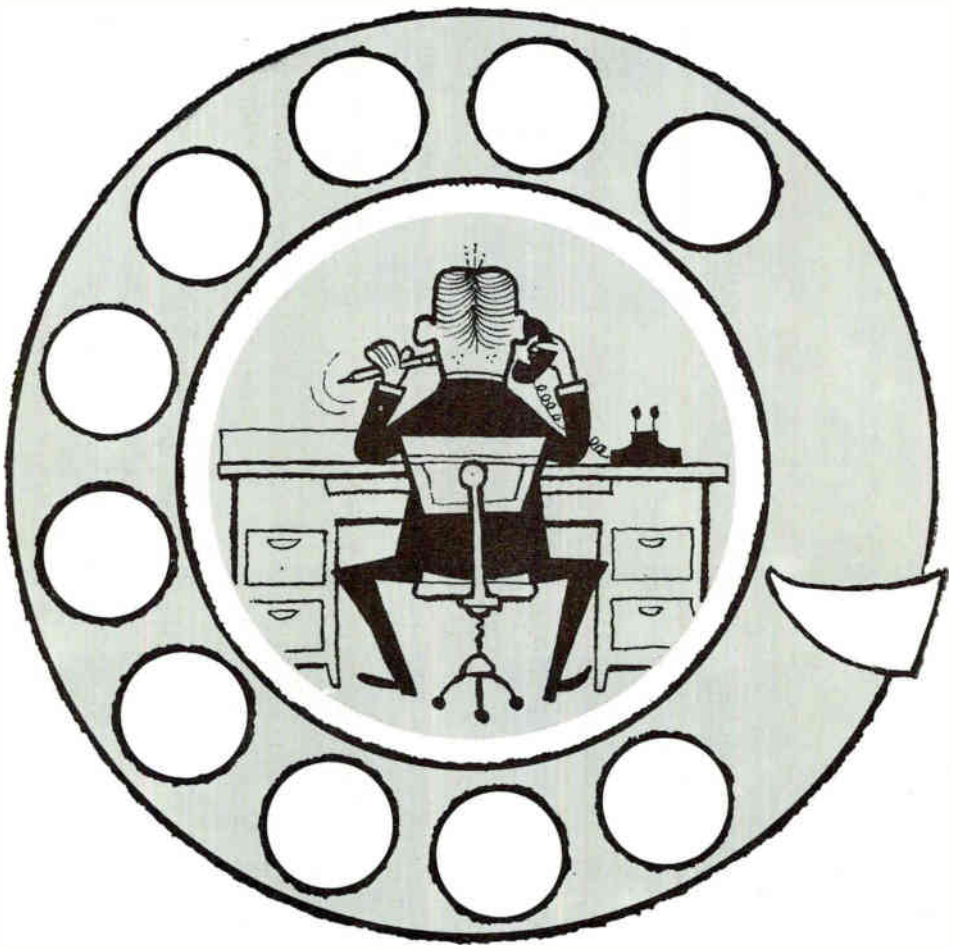
CIRCLE 314 ON READER SERVICE CARD



Delay Line lumped constant

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Pa. The CLN-150-30 delay line has a delay time of 0.3 μsec ±5 percent. It has an impedance of 150 ohms

Who's the local rep? What's his number?

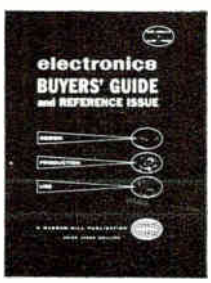


LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find the local representative . . . his name, telephone number . . . his address. You'll find such detailed information about more than 25,000 local sales offices of more than 4,000 major manufacturers.

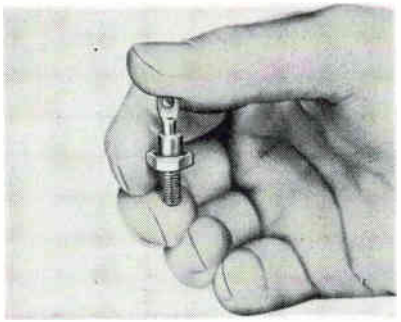
There's also a wealth of reference data about markets, materials, components and applications that make buying easier. Catalog information on nearly 700 different advertised products (that's about 42% more than you'll find anywhere else). Also complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of electronic and related products. Tells what you want to know . . . *when you're ready to buy.*



ABC ABP A McGraw-Hill Publication • 330 West 42nd Street, New York 36, New York

and a maximum rise time of 0.08 μsec. Pulse attenuation is 1.0 db maximum and operating temperature ranges from −55 C to +85 C. Unit is packaged in a hermetically-sealed metal case 2⅜ in. long, ⅜ in. wide and 1 11/32 in. high including threaded mounting studs on the underside of the case.

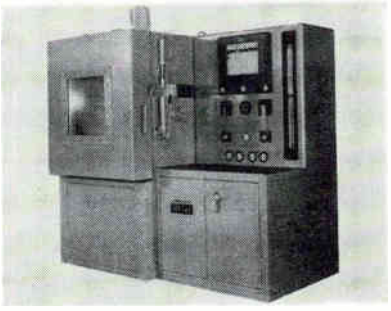
CIRCLE 315 ON READER SERVICE CARD



Silicon Rectifier small size

SYNTRON Co., 241 Lexington Ave., Homer City, Pa. Style-21 silicon power rectifier is rated at 13.5 amperes average at 25 C ambient on a 3 in. by 3 in. by 1/16 in. copper heat sink. Its piv range from 50 to 400 v, in 50 v steps. The complete diode, with a 7/16 in. hex stud base, has a maximum height of 1 5/16 in. A typical forward dynamic resistance of 0.009 ohm is achieved by diffused junction techniques.

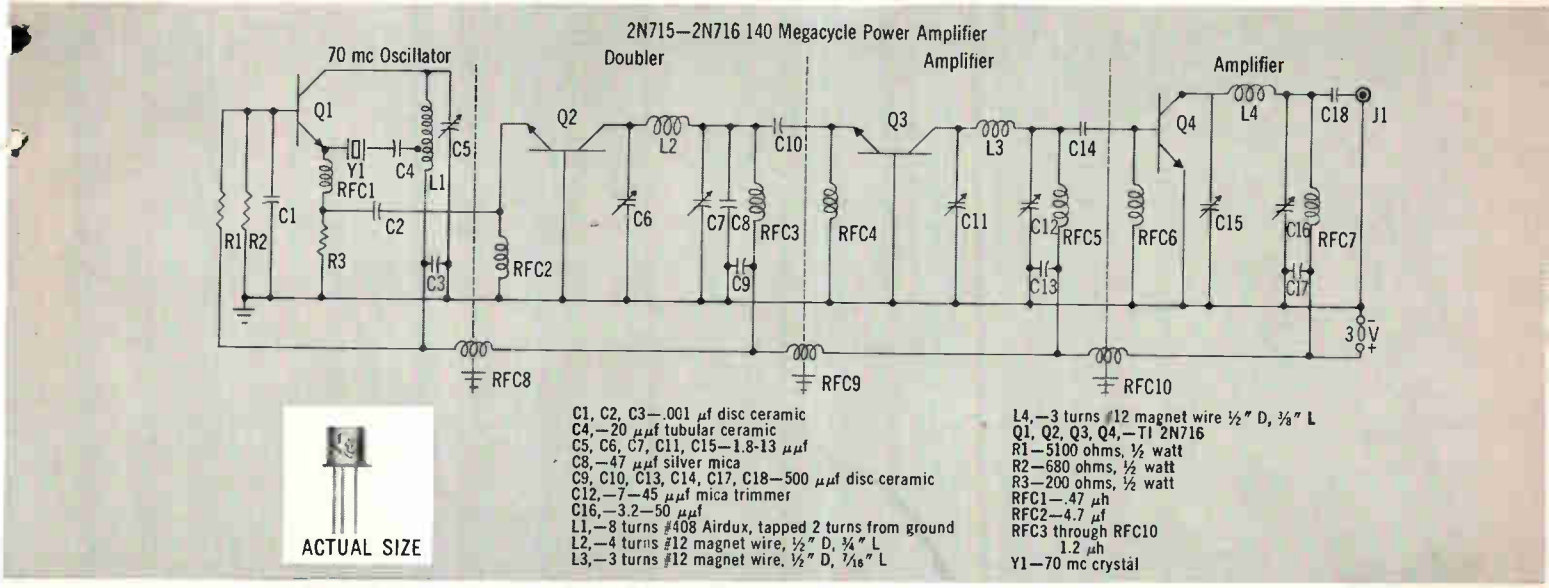
CIRCLE 316 ON READER SERVICE CARD



Test Chamber 27 cu ft

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model FH-27 temperature altitude test chamber features hydraulic action positive vacuum door locks, and strip chart recording controlling of temperature. Standard available ranges are

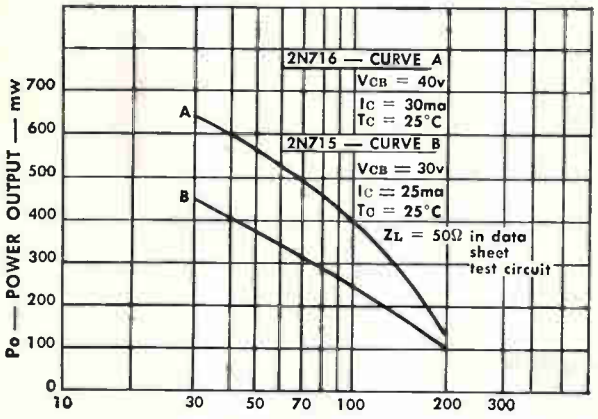
How to design 250 mw at 140 mc transistorized power amplifiers



ACTUAL SIZE

C1, C2, C3—.001 μf disc ceramic
C4,—20 μμf tubular ceramic
C5, C6, C7, C11, C15—1.8-13 μμf
C8,—47 μμf silver mica
C9, C10, C13, C14, C17, C18—500 μμf disc ceramic
C12,—7—45 μμf mica trimmer
C16,—3.2—50 μμf
L1,—8 turns #408 Airdux, tapped 2 turns from ground
L2,—4 turns #12 magnet wire, ½" D, ¾" L
L3,—3 turns #12 magnet wire, ½" D, 7/16" L
L4,—3 turns #12 magnet wire ½" D, ⅜" L
Q1, Q2, Q3, Q4,—TI 2N716
R1—5100 ohms, ½ watt
R2—680 ohms, ½ watt
R3—200 ohms, ½ watt
RFC1—.47 μh
RFC2—4.7 μf
RFC3 through RFC10
1.2 μh
Y1—70 mc crystal

...with NEW TI 2N716 silicon mesa transistors



OSCILLATOR POWER OUTPUT vs. FREQUENCY

Now . . . silicon high frequency transistors *specifically* designed for your VHF power circuits . . . another addition to the industry's broadest line of silicon mesa transistors (now 16 TI types!).

TI 2N715 and TI 2N716 *guarantee 500-mw amplifier output at 70 mc* and provide *100-mw typical power output at 200 mc.*

These subminiature (TO-18) silicon units feature . . . 1.2-w dissipation at 25°C case temperature . . . 10-50 beta spread . . . collector reverse voltages of 50 and 70v . . . maximum collector reverse currents of 1.0 μa (25°C) and 100 μa (150°C).

Check the guaranteed specs below and take immediate advantage of advanced performance in your designs. Both units are ready for your orders in every TI distributor's stocks today, and in quantities of 1,000 and up from your nearest TI sales office.

Tentative Specifications 2N715 - 2N716

1 P_C T_C = 25°C watt	Tstg °C	2 V_{CB} v dc	2 V_{EB} v dc	3 V_{CE} v dc
1.2	−65 to + 175	+70 (2N716) +50 (2N715)	+5	+40 (2N716) +35 (2N715)

Parameter	Test Condition	2N715 Min	2N715 Typ	2N715 Max	2N716 Min	2N716 Typ	2N716 Max	Units
**BV_{EBO}	I_{EBO} = 100 μ a I_C = 0	5			5			v dc
***BV_{CBO}	I_{CBO} = 10 μ a dc I_E = 0	50			70			v dc
*h_{FE}	V_{CE} = 10 v dc I_C = 15ma dc	10		50	10		50	
*V_{CE}(sat)	I_C = 15ma I_B = 3ma	1.2			1.2			v dc
C_{ob}	V_{CB} = 5 v dc I_E = 0 F = 1 mc		3	6		3	6	μμf
Amplifier Power Output and	(V_{CB} = 40 v dc (I_C = 30 ma dc (P_o (AC) = 500 mw (F = 70 mc				500 4	600 7.5		mw db
Transducer gain	(V_{CB} = 30 v dc (I_C = 25 ma dc (P_o (AC) = 300 mw (F = 70 mc	300 4	400 8					mw db

1 This power rating for 1000 hours expected life at a case temperature of 25°C derated linearly to +175° case temperature at the rate of .125°C per mw.
2 Maximum voltage ratings at an ambient temperature of +25°C.
3 BV_{CEO}: This is the voltage at which h_{FB} approaches one when the emitter-base diode is open circuited. This value may be exceeded in applications where the dc circuit resistance (R_{BE}) between base and emitter is a finite value.
When the emitter-base diode has a reverse voltage applied, peak collector to emitter voltage equal to BV_{CBO} minus V_{EB} may be allowed. Such conditions may be encountered in class B or C amplifiers and oscillators.
*Pulse Measurement
**Specify I_{EBO} on commercial data sheet
***Specify I_{CBO} on commercial data sheet

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

the first silicon transistor manufacturer

−100 F to +300 F or to +500F. Cooling rates: to −70 F in 38 minutes. Heating rates: from −70 F to ambient in 14 minutes, from ambient to +300 F in 20 minutes and to +500 F in 45 minutes. The chamber is designed for testing aircraft, electronic, and missile components in actual flight simulation.

CIRCLE 317 ON READER SERVICE CARD

Diode
millimeter wave

PHILCO CORP., Philadelphia, Pa., announces a new millimeter wave diode, the 1N2792, for extremely low noise mixer performance at 70,000 mc. This crystal is of integral waveguide construction with the germanium point contact structure mounted in a section of RG-98/U waveguide. The 1N2792 is primarily designed for radar and space communication applications. It is also well suited for ehf video detector applications. A crystal noise figure maximum of 13 db with this hermetically sealed unit assures lowest possible noise performance at 70 kmc.

CIRCLE 318 ON READER SERVICE CARD

Multistylus Recorder
immediate printout

RADIATION INC., P. O. Box 37, Melbourne, Fla. The Radicorder plays an important part in almost limitless systems applications requiring versatile, real-time data presentation, plus a permanent record for post-event analysis. Primarily, it allows the monitoring of digital

data in visual form. In situations where the phenomena being monitored supply power directly to the direct-writing styli the Radicorder can be used without intermediate writing circuits. The recording-styli head is constructed of individual modules. Maximum capacity of 646 styli is obtained by the assembly of 19 molded modular units, each of which contains 34 styli. The plug-in modular-head construction provides economy, plus flexibility of arrangement and easy replacement.

CIRCLE 319 ON READER SERVICE CARD

A-M/F-M Generator
rugged unit

PHILIPS EINDHOVEN, EMA Dept., Netherlands. Type GM2621 a-m/f-m generator supplies a signal in the frequency range of 4.5-300 mc (in 7 overlapping ranges) with an accuracy of 1 percent and a drift of 0.005 percent in a 10 minute period. Modulation possibilities: Internal—a-m/f-m 1,000 cps and f-m at line frequency with or without blanking; external—a-m/f-m 30 cps-25 kc. With a-m the modulation depth is adjustable between 0-30 percent and with f-m the frequency sweep is variable between 0-250 kc.

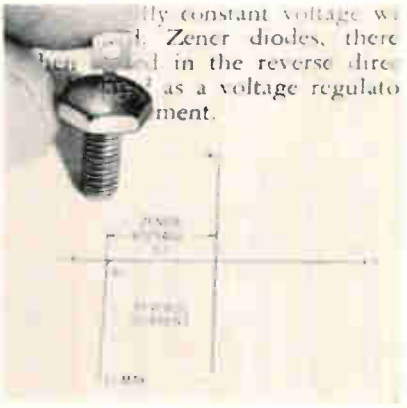
CIRCLE 320 ON READER SERVICE CARD

Low-Pass Filter
13-element

FREQUENCY STANDARDS, a Division of Harvard Industries, Inc., P. O. Box 190, Red Bank, N. J., has available a new 13-element low-pass filter that features a more compact design. Model FS-23L has a 1 db down frequency of 2,300 mc and a power handling capacity up to 2

kw peak. Maximum insertion loss is 0.5 db in the pass-band; input vswr is 1.5:1 below the 0.1 db.

CIRCLE 321 ON READER SERVICE CARD



Silicon Zener Diode
10 w rated

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Low-cost 10-w rated Tri-Sealed silicon Zener diodes feature a three-layer seal providing high resistance to temperature extremes, humidity and shock. Designed specifically for commercial equipment applications, these diodes demonstrate low Zener impedance values and sharp Zener "knees". They are available in standard RETMA 10 percent voltage steps from 5.6 to 27 v.

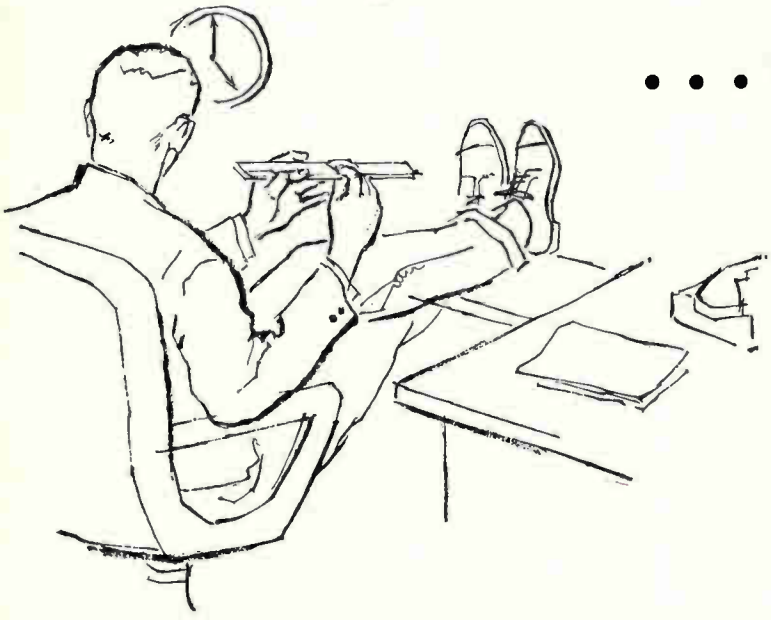
CIRCLE 322 ON READER SERVICE CARD

Lubrication
solid film

POLY CHEM, 541 S. Webster, Indianapolis 19, Ind., announces a new development in the field of solid film lubrication. This specially prepared formulation of molybdenum disulfide, Poxylube, is easily applied by any of the usual methods of painting such as spraying, brushing, or dipping. The dried film provides permanent lubrication on all types of rotating and sliding bearing surfaces. It is claimed that Poxylube produces outstanding lubricity, and formerly unobtained adhesion, to metals with no more surface preparation than simple degreasing. This property enables industrial users to adapt this lubricating system to existing products without major production modification.

CIRCLE 323 ON READER SERVICE CARD

Will tomorrow be a challenge ...or a bore?



If you feel that your present job is not fully tapping your potential, here are 4 new career opportunities for Electronics Engineers that have every bit of the challenge you may be looking for . . .

1 *Site Systems Reliability Engineer:* This position calls for a seasoned engineer capable of integrating and directing on-site reliability assurance activities necessary to secure customer acceptance of the detection system. Unusual combination of technical ability, relations and communications (written and spoken) is required. Desirable experience includes approximately ten years in design and field installation of transmitters on electronic systems with ability in both electronic and mechanical fields. Ability to motivate technicians for optimum performance is necessary. Salary structure is equal to the challenge.

2 *Radar Equipment Systems Specialist:* This position calls for a creative engineer capable of conceiving and directing the design of long-range radar systems. Desirable experience includes around ten years in at least one of the following: radar systems design, antenna systems, R.F. components, radar receiver systems or radar data processing systems. Salary structure is equal to the challenge.

3 *Advanced Systems Engineer:* This position calls for a creative engineer capable of defining future defense and space detection problems as well as the ability to conceive and establish the feasibility of optimum systems solutions to these problems—making use of the most advanced techniques and understanding. He must recognize the need for and coordinate the development of new techniques and the exploration of new phenomena in the area of detection systems. Background desired: Bachelor degree plus a combination of advanced training and several years experience in both the theoretical and practical aspects of detection systems engineering. A desire to work in the conceptual phase of system design with the analytical ability required to evaluate and demonstrate the effectiveness of proposed systems.

4 *Advanced Radar Systems Analysis and Development Engineer:* Engineers are needed who are able to visualize and define future defense and space problems—conceive advanced radar systems to solve them. An advanced degree and/or strong background in system analysis and design is essential. Assignments open include: analyze and define requirements for advance detection systems and determine broader parameters for such systems, establish their feasibility; analyze long range missile detection systems and specify optimum configuration on the basis of utility, performance, cost and delivery. 228-9

All of these openings are on General Electric missile and satellite detection projects and will be filled with engineers having the capability and desire to make creative contributions.

Write in confidence to T. M. George, Supervisor—Personnel Administration

Missile Detection Systems Section
HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

SYRACUSE, NEW YORK

Literature of the Week

PULL-PUSH SWITCHES. Chicago Telephone Supply Corp., Elkhart, Ind. An advance data sheet contains dimensional drawing and technical description of two new 13/16 in. diameter pull-push switches of simple design.
CIRCLE 350 ON READER SERVICE CARD

DRY CALORIMETRIC POWER METERS. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. PRD Report, Vol. 6, No. 3, entitled "Dry Calorimetric Power Meters," discusses a more accurate method for the measurement of microwave power at higher frequencies.
CIRCLE 351 ON READER SERVICE CARD

ELECTROMECHANICAL COMPONENTS. Sterling Precision Corp., 17 Matinecock Ave., Port Washington, L. I., N. Y., has compiled a complete 512 page catalog featuring over 20,000 standard precision electromechanical components.
CIRCLE 352 ON READER SERVICE CARD

MAGNETIC TAPE RECORDER. Ampex Data Products Co., 934 Charter St., Redwood City, Calif. A 20-page booklet covers the FR-100B, a high-performance, general purpose recorder/reproducer.
CIRCLE 353 ON READER SERVICE CARD

PRODUCTS CATALOG. EEMCO, Div. of Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif. Catalog EE-100 covers motors, actuators and electromechanical systems. Copies are available by writing on company letterhead.

ELECTRICAL INSTRUMENTS. Muirhead Instruments Ltd., Stratford, Ontario, Canada, has available a condensed catalog illustrating and describing a line of precision electrical instruments.
CIRCLE 354 ON READER SERVICE CARD

MINIATURE ROTARY SWITCHES. Electro Switch Corp., 167 King Ave., Weymouth 88, Mass. Bulletin 14A contains detailed information on the expanded line of ESCO switches based on the type MA-12 miniature rotary selector switch.
CIRCLE 355 ON READER SERVICE CARD

MAGNETIC CLUTCH. Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y. A data sheet on the C-18 magnetic clutch featuring new electromagnetic design is now available.
CIRCLE 356 ON READER SERVICE CARD

CAPACITORS. Electra Mfg. Co., 4051 Broadway, Kansas City, Mo. An 8-page catalog describes a complete line of ceramic disk and plate capacitors.
CIRCLE 357 ON READER SERVICE CARD

RELAYS. Hi-G Inc., Bradley Field, Windsor Locks, Conn. Catalog No. 259 is a 20-page description of a wide line of rugged rotary action relays.
CIRCLE 358 ON READER SERVICE CARD

SILICON TRANSISTORS. Texas Instruments Inc., 13500 N. Central Expressway, Dallas, Texas. A recent mailing piece lists more TI silicon transistors that meet Navy specs, and the 2N118 which now meets JAN specs.
CIRCLE 359 ON READER SERVICE CARD

FILTER DATA. Control Electronics Co., 10 Stepar Place, Huntington Station, N. Y., has available data sheet No. 601 on a line of high, low, bandpass and telemetering filters in custom or standard designs.
CIRCLE 360 ON READER SERVICE CARD

LINEAR AMPLIFIER. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. Form 3014-9C describes the model 851 DD-2 non-overload linear amplifier.
CIRCLE 361 ON READER SERVICE CARD

GOVERNMENT SPECIFICATIONS. Magic Chemical Co., 121 Crescent St., Brockton 2, Mass., has published a new edition of its catalog listing 1,000 official U. S. Government specifications covering adhesives, sealants, paints, cleaning compounds, and chemical compounds.
CIRCLE 362 ON READER SERVICE CARD

Electronic Specialty Expands

ELECTRONIC SPECIALTY Co., Los Angeles, Calif., has completed a major phase in its expansion program by the enlargement of its Radiating Systems Laboratory and Test Facilities.

Ben J. Ciscel, senior vice president, says: "The expanded facility has tripled the lab's former size and includes complete new antenna pattern measurement ranges and built-in fixed ground planes. The complete installation has been scientifically constructed to eliminate all interference, stabilize frequency and provide a new flexibility in testing advanced antenna and microwave systems of all types."

The Radiating Systems division, which has been a major factor in the company's communications and countermeasures activities, is also augmenting its engineering personnel and capabilities.

The new facility has been planned to enable the company to undertake major programs for the location, design, testing, development and production of any magnitude and scope.

The design of this modern laboratory was patterned after the Avionics Systems and Components Laboratory completed last June. Operating methods in that new facility resulted in greatly increased efficiencies and expanded engineering activity, says Rollin M. Russell, executive vice president.

Stavid Hires Martinovitch

VADIM N. MARTINOVITCH has joined Stavid Engineering, Inc., Plainfield, N. J., as engineering consultant in high power modulator and radar systems design. He was formerly senior project engineer at FXR Inc., Woodside, N. Y., where he was engaged in the manufacture of custom-made test equipment and high power modulators, and in the development of high power pulsed radar transmitters.

Analab Forms New Division

FORMATION of a Special Products division was recently announced by Morton G. Scheraga, president, Analab Instrument Corp., Cedar Grove, N. J. Heading up this program is Max Schneiderman, who comes to Analab from the Electronic Tube Corp., where he was chief engineer.

According to Scheraga, Analab is designing its oscilloscopes on a modular basis and setting up its production control and manufacturing facilities so as to be able to handle readily special versions of its standard line. By staffing separately for this activity, the company will not have to tie up its design engineering department which is concentrating on proprietary catalog items.

Hoffman Promotes H.F. Schoemehl

NEW DIRECTOR of engineering of Hoffman Electronics Corporation's semiconductor plant in Evanston, Ill., is Henry F. Schoemehl. Formerly the plant's marketing director, he succeeds J. R. Madigan, resigned.

Before joining Hoffman in 1955, Schoemehl was a supervisory design engineer at the U. S. Naval Avionics Facility, Indianapolis, Ind.

Lenkurt Elects Two Officers

ELECTION of William H. Heflin as a vice president and a director, and of Lee G. Phillips as treasurer and controller of Lenkurt Electric Co., Inc., San Carlos, Calif., was recently announced.

Both new officers are long-time Lenkurt employees. Heflin has been

general manager of the Commercial Products division the past year, while Phillips has been controller and head of all accounting operations.

ERA Subsidiary Gets President

ABRAHAM B. COHEN was recently appointed president of Advanced Acoustics Corp., Nutley, N. J., new wholly owned subsidiary of Electronic Research Associates, Inc., Cedar Grove, N. J.

Advanced Acoustics specializes in the development and manufacture of high fidelity reproducers, industrial sound equipment, and ultrasonic transducers and apparatus.

Cohen has been active in the fields of theoretical and applied acoustics for over 25 years. For the last 12 years he was with University Loudspeakers, Inc., where he last served as engineering manager.

Daystrom Ups Querner

EDWARD J. QUERNER has been named manager of manufacturing of Daystrom Transicoil, a division of Daystrom Inc., Worcester, Pa. Before joining Daystrom a year ago, he was for five years vice president of manufacturing and engineering of Fischer & Porter Co., Hatboro, Pa.

Querner has served as Transi-

coil's assistant manager of manufacturing since February 1959.

News of Reps

Acton Laboratories, Inc., Acton, Mass., has appointed **Lowry Dietrich Co.** of Cleveland, Ohio, to represent ALI's complete line of electronic laboratory test instruments in Ohio, Kentucky, West Virginia, and western Pennsylvania.

Chemtronics Inc., Brooklyn, N. Y., appoints **Stanley K. Wallace Associates, Inc.** of Lutz, Florida, to cover Alabama, Florida, Georgia, Mississippi, North and South Carolina, and Tennessee.

Leo Jacobson Co., Inc. of Buffalo and Scotia, N. Y., is named to represent Robins Industries Corp., Flushing, N. Y., in state of New York except metropolitan area.

Community Engineering Corp., State College, Pa., announces the following sales rep appointments for the company's line of low noise vhf and uhf preamplifiers, and wide band distributed amplifiers:

William R. Lehmann Co. of Orlando, Fla., covering Florida, Alabama, and Georgia; **Philip Nesbitt Co.** of Bethesda, Md., covering Maryland, Delaware, Virginia, Washington, D. C., lower New Jersey and eastern Pennsylvania.

New sales reps appointed by Technology Instrument Corp., Acton, Mass., are:

Kinrick of St. Louis, Mo., Missouri and Kansas; and **Jim Morrow Sales** of Highland Park, Mich., for Michigan.

Ballantine Laboratories, Inc., Boonton, N. J., has appointed manufacturer's reps in three areas.

Bayly Engineering, Ltd., of Toronto, Canada, is named for Ontario and provinces of eastern Canada.

Ohio Instrument Co. of Dayton, Ohio, will cover Ohio and the Pittsburgh area of Pennsylvania.

Gaine Engineering Co. of Detroit, Mich., is rep for the Michigan area.

COMMENT

A Favor

. . . If you really want to do the industry a favor, help promote the dictionary word *minify* and eliminate the unnecessary, ugly and illegitimate word *miniaturize*.

FRANK C. SMITH, JR.
SOUTHWEST INDUSTRIAL ELECTRONICS
HOUSTON, TEXAS

Strictly speaking, "minify," which would mean "make small," is certainly more accurate a description of the operations now described by "miniaturize," which at best can only mean "make miniature." However, usage governs; and the normative function of the editor does not extend to using terms which no one understands. We're for minification, at least academically. Any takers?

Transformerless Supplies

As I was going over past issues of your magazine, I ran across the ELECTRONICS Reference Sheet entitled "Transformerless Supplies," in the June 26 '59 issue (p 56). This interested me, because there would be no heat dissipation involved. Upon reading the article, something didn't ring true . . .

When a capacitor is placed in series with a resistor, and the combination connected to a 117-volt 60-cps voltage, the voltage drop across the resistor and the capacitor combine *vectorially*, not algebraically. Therefore, since in a series circuit the same current flows through each circuit element, the impedance triangle is similar to the voltage triangle.

I thought that surely the inaccuracy in the text did not accurately reflect the thinking of the author, F. G. Kelly. Upon checking the nomograph, which I reasoned would be accurate even though the text was in error, I found that it too was wrong.

I submit that the equation buried in the text is inaccurate, in that the voltage used is not the voltage drop across the capacitor. The equation given is

$$C = \frac{I_h \times 10^6}{\omega\,(117 - E_h)}$$

which is incorrect; $(117 - E_h)$ is not the voltage drop across the capacitor. The voltage drop across the capacitor is $\sqrt{(117)^2 - E_h^2}$, and

$$C = \frac{I_h \times 10^6}{\omega \sqrt{(117)^2 - E_h^2}}$$

in microfarads is the correct equation.

JOHN SUTHERLAND
BOEING AIRPLANE CO.
SEATTLE, WASH.

. . . The algebraic voltage difference assumed by the author is not valid for reactive circuits. The capacitor value found by his nomograph should be multiplied by $\sqrt{(117 - E_h)/(117 + E_h)}$.

For a 12.6-volt filament the error is +10 percent. Tolerances are also important; a slightly bigger capacitor reduces appreciably the tube life.

JULES O'SHEA
BOEING AIRPLANE CO.
SEATTLE, WASH.

Tubes in Environmental Extremes

Congratulations on the very fine review in the Dec. 4 '59 issue "Materials for Environmental Extremes," (p 81). I would like to suggest that the paragraph on electron tubes (p 93) might well have contained additional pertinent facts.

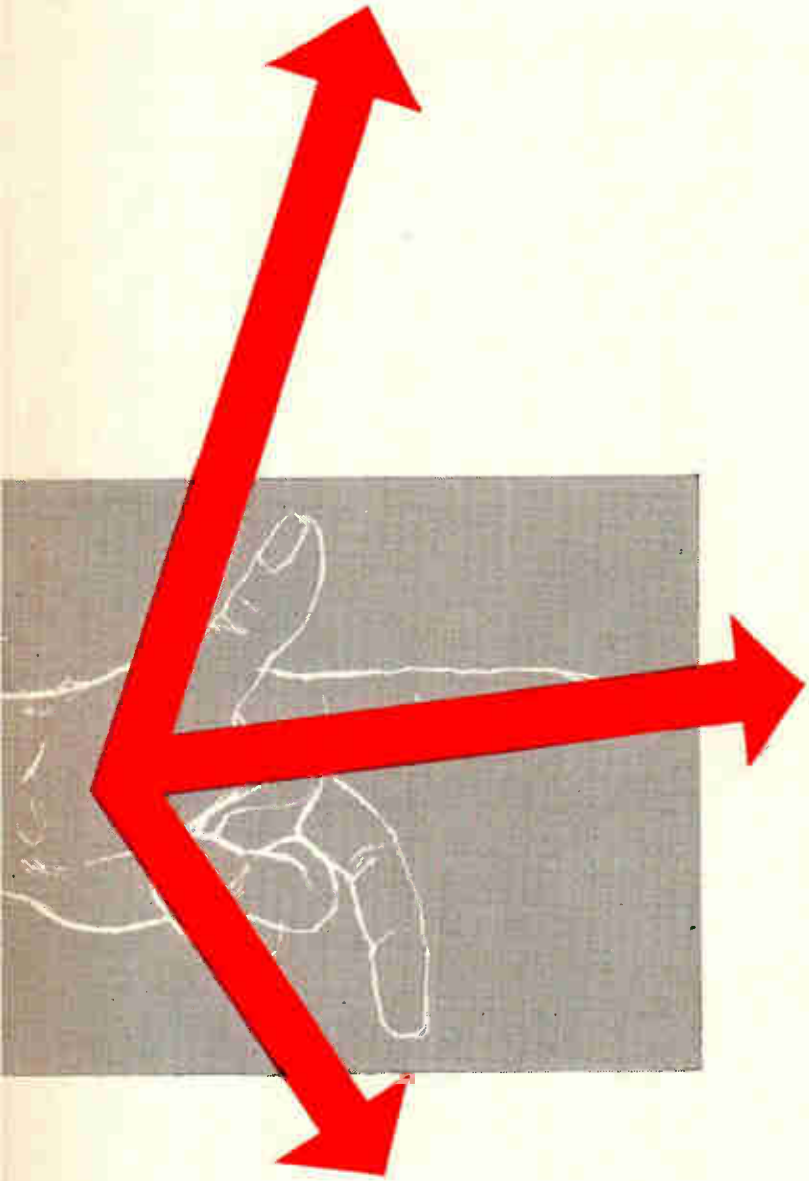
Standard electron tubes currently operate in temperatures up to 125 C and special high-reliability glass tubes are rated for bulb temperatures to 225 C. Use of new high-resistivity glasses is reducing electrolysis and still further improving performance and life expectancy in subminiature tubes. Ceramic receiving tubes now registered and available in quantities are rated up to 300 C. Further improvements in these performances can be expected.

Use of composite metals consisting of bonded layers of iron, aluminum and copper as anodes in standard receiving tubes has improved internal heat conduction and radiation and thus effectively raised dissipation ratings. New metals are being developed for other receiving-tube elements with similar improvements in mind. Electron tubes are also highly resistant to nuclear radiation.

S. E. MCCALLUM
GENERAL ELECTRIC
OWENSBORO, KY.

IBM

offers a free hand to creative engineers and scientists in IBM's new Advanced Systems Development Division



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WRITE, outlining your background and interests, to:
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IBM Advanced Systems Development Div.
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Yorktown Heights, N. Y.

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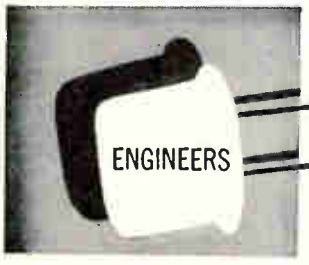

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RADAR AND REVOLUTION

One sweltering July afternoon in 1789, a tattered raggedy mob appeared outside the gates of the Bastille, the formidable prison of Paris, and demanded entrance.

"Go away," the guard shouted, "or we'll have to arrest you."

"That's exactly the idea!" a voice came back. "We're starving to death. All we want is a little of that moldy bread and canal water you feed your prisoners!"

Word was passed to the prison commandant, one Maurice Antoinette. "If they want their just desserts," he smiled, "let them eat cake!"

It was this remark that sparked the Revolution. The mob grew ugly. "Force the gate!" shouted a sickle-wielding daughter of France named Brigitte Sourdough. A radar controlled battering ram, appropriated from the local armory, swung into play. In moments, the Bastille gate had been hammered into shambles, and the unfortunate Maurice Antoinette was at the mercy of the mob.

"Observe the instrument of your defeat!" sneered Brigitte Sourdough, pointing at the radar.

"Pfui," the commandant replied, calm and disdainful. "No Beaumac (French for Bomac) tubes."*

Brigitte was furious. "The commandant wants 'Beaumac'? He shall have Beaumac!"

With that, Antoinette was led to a second instrument of the people — a device consisting of a heavy blade, poised between grooved uprights. It had no tubes at all.

"This is your Beaumac?" the commandant asked.

"Oui, monsieur," Brigitte Sourdough leered. "This is Beau Mac — the knife!"

No sooner had Maurice Antoinette heard these words than his icy calm vanished.

Matter of fact, he lost his head completely.

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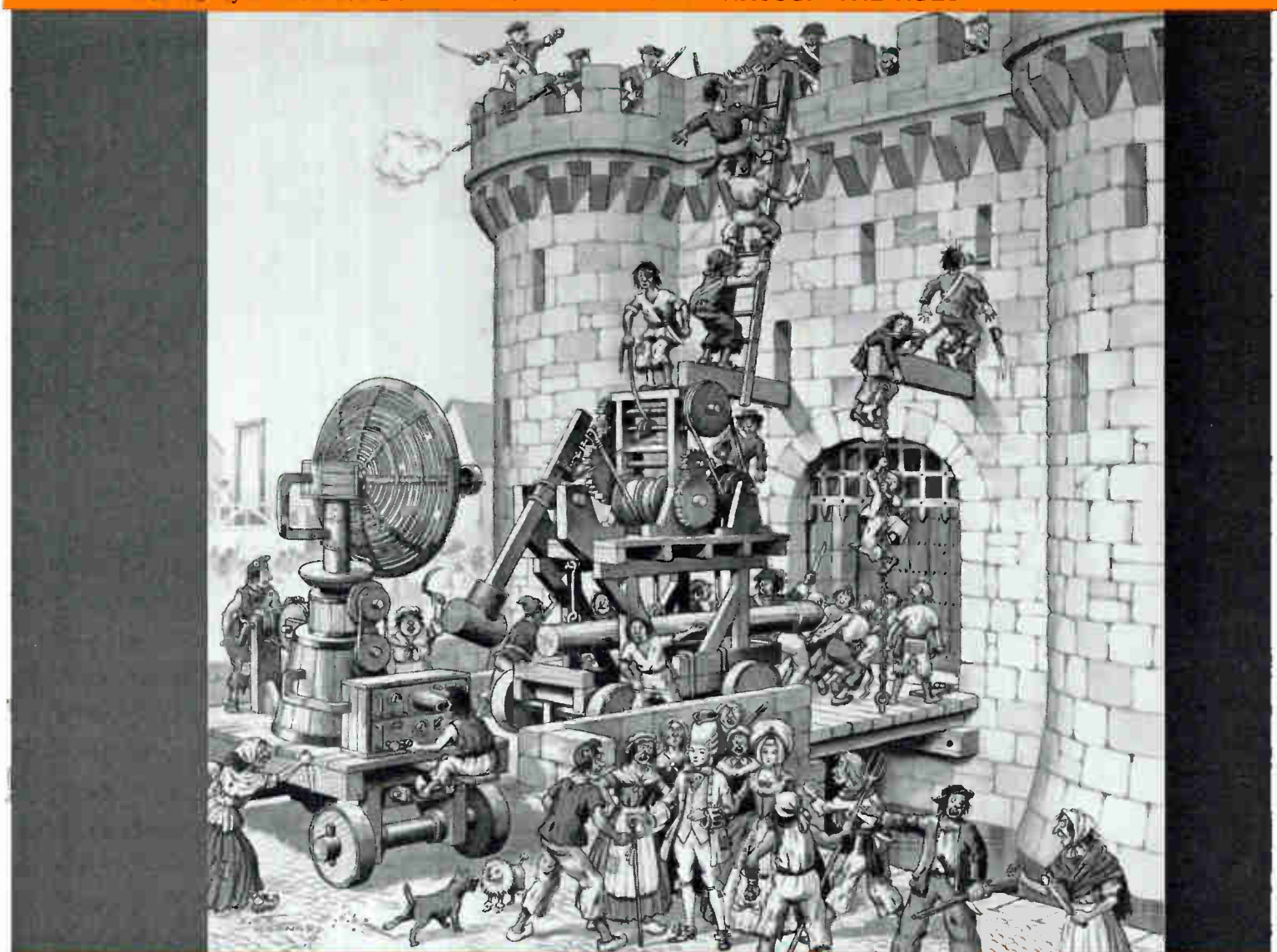

* *Bomac makes the finest microwave tubes and components since the storming of the Bastille*

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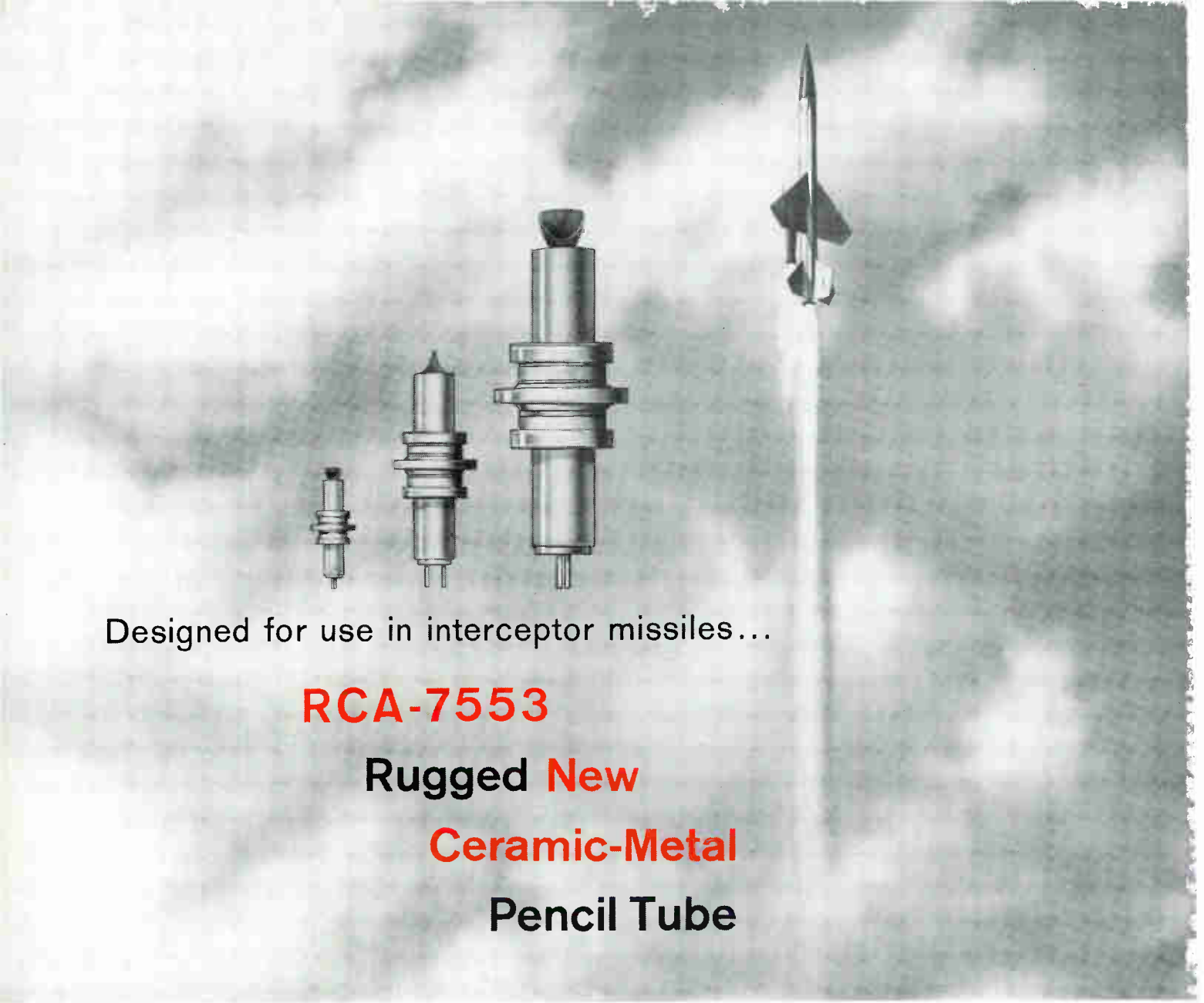

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RCA-7553

Rugged New Ceramic-Metal Pencil Tube

Ten-second cathode warm-up and extremely rugged construction make this small triode a significant contribution to missile technology

RCA's ceramic-metal pencil tubes represent the most exciting recent advance in UHF tube design. Tiny and tough—half the length of an ordinary cigarette—they are designed to operate at altitudes as high as 100,000 feet without pressurization...and at plate-seal temperatures up to 225°C.

RCA-7553—latest addition to this sturdy tube line—was developed specifically for use in missile applications. It offers exceptional resistance to vibration and severe shock, fast warm-up time, and high reliability.

If you are designing miniaturized UHF equipment for operation at frequencies up to 3000 Mc and above, consider using RCA's ceramic-metal pencil tube family. When low heater power, fast warm-up and high thermal stability are essential, these versatile tubes are your obvious answer.

Get in touch with your RCA Field Representative now for complete information on ceramic-metal pencil tubes, including the new developmental type A-15208. This ruggedized S-band integral-cavity tunable oscillator can withstand 10,000 g's of acceleration in missile and rocket beacon applications.

Check these outstanding Ceramic-Metal Pencil Tube Features!

- Large cathode area: about three times more cathode area for the same heater power than comparable planar types.
- Fast warm-up time: 1/3 the warm-up time of comparable planar types—12 seconds to reach 90% of operating dc plate current (only 10 seconds for RCA-7553).
- Thermal stability: output and noise factor remain essentially constant over ±10% heater-voltage fluctuations.
- Small size: maximum length 1 5/8"; maximum diameter (at grid flange) 9/16"; weight only 0.3 oz.
- Less affected by nuclear radiation: evidence indicates that ceramic-metal construction has greater endurance to nuclear radiation than glass-metal construction.
- Cantilever arrangement of coaxial elements: provides low interelement leakage, permits good efficiency, and resists shock and vibration.

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