

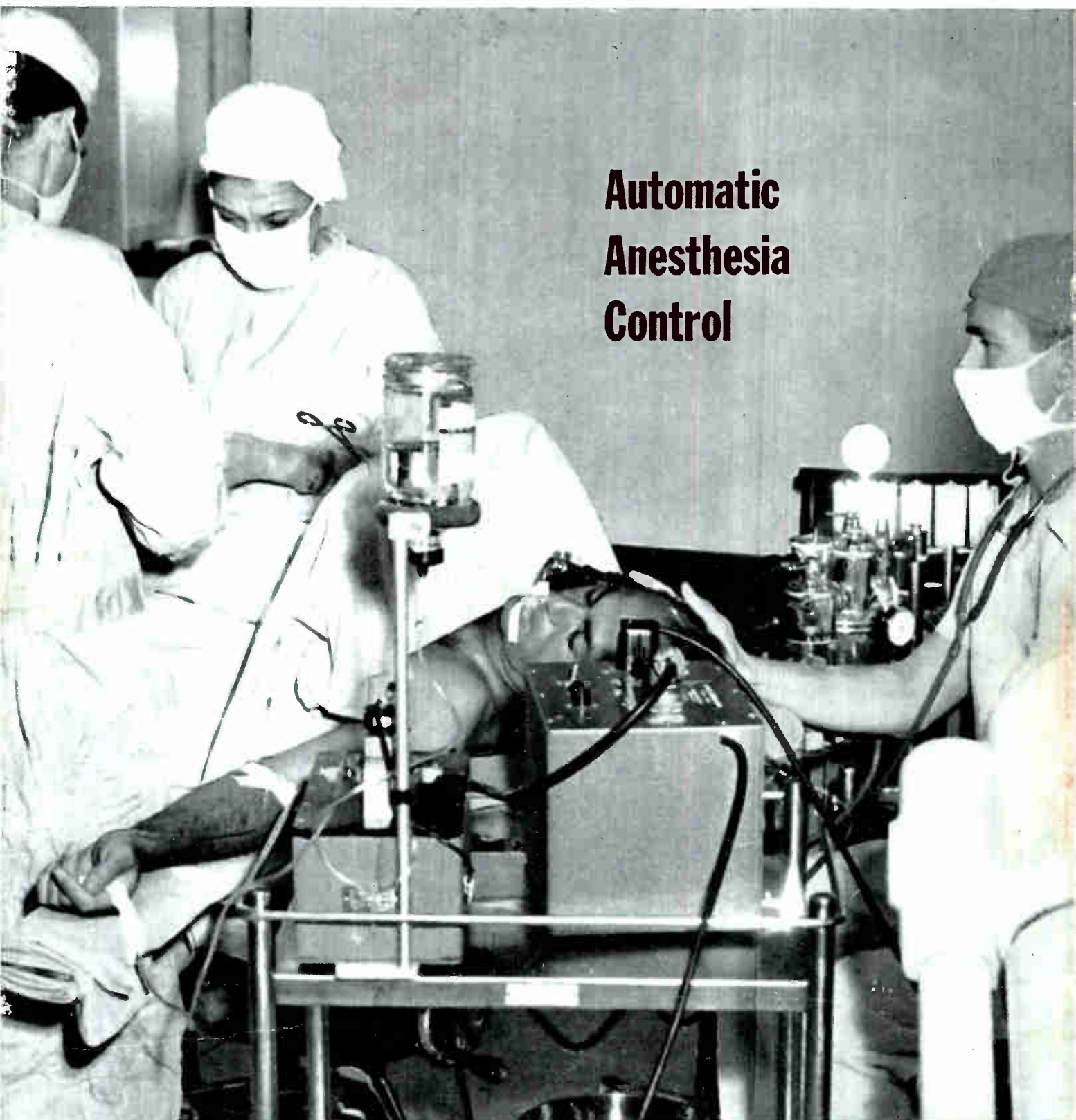
JANUARY 30, 1959

# electronics

A MCGRAW-HILL PUBLICATION

VOL. 32, No. 5

PRICE SEVENTY-FIVE CENTS



## Automatic Anesthesia Control

What's Ahead in Standards for Stereo



# For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

## FILTERS

All types for frequencies from .1 cycle to 400 MC.



400 — telemetering, 3 db at + 7.5%, 40 db at 230 and 700 —,  $\frac{3}{8}$  x  $1\frac{1}{4}$  x 2"

15 — BP filter, 20 db at 30 —, 45 db at 100 —, phase angle at CF less than 3° from -40 to + 100° C.

LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.



Tuned DO-T servo amplifier transformer, 400 — 5% distortion.



Toroid for printed circuit, Q of 90 at 15 KC.



Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.



HVC tapped variable inductor for 3 KC oscillator.

## HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.

## SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.



RF saturable inductor for sweep from 17 MC to 21 MC



Voltage reference transformer 05% accuracy.



Multi-control magnetic amplifier for airborne servo.



Input, output, two tuned interstages, peaking network, and BP filter, all in one case.



Wound core unit .01 micro-second rise time.



Pulse current transformer 100 Amp.



Pulse output to magnatron, bifilar filament.



Precise wave shape pulse output, 2500 V. 3 Amps.

## PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.

## POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.



Multi-winding 140 VA, 6 KC power transformer  $1\frac{1}{4}$  x  $1\frac{1}{4}$  x 1"



200° C. power transformer, 400 —, 150 VA.



400 — scope transformer, 20 KV output.



60 — current limiting filament transformer, Sec. 25 Mmf., 30 KV hipot.

# UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y.,  
CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

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A MCGRAW-HILL PUBLICATION  
Vol. 32 No. 5

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Paul Odessey takes the

stand for **electronics**

"We are our own best customer," is a phrase heard often in the electronics industry. This means that electronics equipment manufacturers buy component parts, materials and services from fellow suppliers in the field.

Polarad Electronics Corporation is an electronics equipment manufacturer producing microwave signal generators, receivers, spectrum analyzers, test equipment, microwave accessories and antennas and is a major government supplier for research and development. Paul H. Odessey, Executive Vice President of Polarad, is a graduate engineer who has been with the firm since 1945.

How long have you been reading electronics, Mr. Odessey?

*Since 1935.*

Over the past ten years electronics has passed through a remarkable period of growth and development. Would you comment on electronics magazine's contribution to the expansion of the industry it serves?

*Well, it has brought together the products of the entire industry in an integrated organized fashion so that engineering or management could know what the progress of any aspect of their industry was at the time. For example, in transistors, the appearance of new manufacturers in the magazine brought attention to management of many new sources of supply not known. For the small company it became important to be seen in electronics in order to become known in the industry. For the big company it is a matter of maintaining prestige and position and calling attention to the product lines. To the individual engineer, it is a matter of personal accomplishment to have a paper published, or a news item appear relevant to his standing in the field. electronics is the important source for purchasing electronic components, materials and services.*

If it's about electronics, read it in electronics

# electronics

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# What's New

## IN VARIABLE TOROIDS

Burnell Adjustoroids® are always new because they are always being designed for newer and broader electronic and mechanical applications.

**NEW** Burnell's complete line of encapsulated Adjustoroids are particularly adaptable to printed circuit use.

**NEW** A screw mount PC type Adjustoroid for greater durability in high acceleration, shock and vibration environments.

**NEW** 'Pot' mounting Adjustoroids for panel mounting and knob adjustment wherever slotted controls are difficult to reach.

**NEW** Continuous internal improvements including adjustment range, Q, size, etc. Burnell Adjustoroid engineers are constantly seeking solutions to space, accessibility and performance problems.

Burnell Adjustoroids and sub-miniature Adjustoroids are supplied hermetically sealed to meet government specifications MIL E 15305A or encapsulated in many sizes and shapes to meet the application. If your Adjustoroid needs can't be met from our stock catalogue, we'll be glad to manufacture to your specifications. For additional information, write for Adjustoroid bulletin.

	Length/ Dio.	Width	Hgt.	Wt.	Useful Freq. Range	Mox Q	Mox L in hys
AT-0	1 1/16		1"	2 oz	1 kc to 20 kc	10 kc	3 hys
AT-1	1 3/4	1 3/4	1 1/4"	7.25 oz	2 kc to 10 kc	4 kc	15 hys
AT-2	2 3/4	2 3/4	2 1/4"	24 oz	Below 2.5 kc	2.5 kc	125 hys
AT-4	1 1/4		1 1/4"	4 oz	1 kc to 16 kc	6 kc	15 hys
AT-6	1 1/16		1"	2 oz	10 kc to 100 kc	30 kc	.75 hys
AT-10	1 1/4		1 1/4"	4 oz	3 kc to 50 kc	20 kc	.75 hys
*AT-11	4 5/16	4 5/16	3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
*AT-12	4 5/16	4 5/16	3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys
AT-15	1 3/16		1 7/8"	14 oz	Below 5 kc	4 kc	125 hys
AF-51	1 1/4		2"	5 oz	30 cps to 500 cps	120 cps	1000 hys
AF-52	1 1/4		2"	5 oz	50 cps to 1 kc	250 cps	1000 hys
*AF-87	4 5/16	4 5/16	1 1/4"	1.7 oz	90 cps to 2 kc	400 cps	* 80 hys
*AF-88	4 5/16	4 5/16	1 1/4"	1.7 oz	.16 kc to 4 kc	800 cps	42 hys
†ATE-11	3/4		3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
†ATE-12	3/4		3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys

\*Special "pot" type sub-miniature Adjustoroids are not available with AT-11, AT-12, AF-87, AF-88.

†Special screw mountings are available with the ATE-11 and ATE-12 in printed circuit applications for "plug in" types. Where vibration and shock are significant considerations, mounting screws serve as terminal connections.

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# SHOPTALK . . .

## electronics

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Member ABP and ABC

**STEREO STANDARDS**—There is something new in radio these days. It is stereophonic sound. And stereo may have a wide-ranging effect on the whole industry.

Stereo broadcasts are not uncommon. Usually they involve putting one stereo channel on f-m, the other on a-m. Sometimes it's one channel on a television sound channel, the other on either f-m or a-m.

Next step in stereo broadcasting will be to put both stereo channels on one transmission. There are at least six proposals afoot to do this. Three of the proposals relate to transmitting two stereo channels on one f-m channel—using some sort of multiplexing arrangement. Two proposals involve transmitting two a-m stereo channels on one wavelength—using a double single-sideband arrangement. One proposal concerns tv sound.

Eventually, the FCC must set transmission standards to which all stereo broadcasters will have to conform. Getting an early start in this direction, the Electronic Industries Association has set up the National Stereophonic Radio Committee, a representative industry-wide group similar to the National Television Systems Committee that helped set transmission standards, first for monochrome tv, later for color. NSRC will work, in a like manner, to obtain industry-wide agreement on transmission standards for stereo radio.

Details of how this committee is getting to work appear in Associate Editor Emma's story on p 26. Further information on stereo radio, a field that promises to unlock vast new markets for home-entertainment and broadcast equipment maker alike, is on the way.

**ELECTRONICS FOR BOATS.** To the fast-at-the-helm boating enthusiast, these are waiting and thinking days—waiting for warm weather, thinking ahead to using new equipment. Associate Editor Mason attended the 49th National Motor Boat Show held in New York City last week. You'll probably enjoy his story on what's new in electronic gear for boats. It shoves off on p 34 and docks—snugly—on p 35.

### Coming In Our February 6 Issue . . .

**EXPLORER I.** When the Army launched America's first successful satellite last winter, it sent with it a complex package of electronic equipment for the gathering and telemetering of data on cosmic rays and micrometeorites.

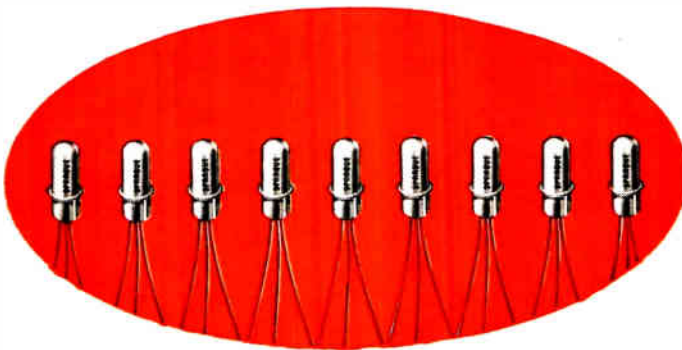
Jet Propulsion Lab scientists H. L. Richter, W. Pilkington, J. P. Eyraud, W. Shipley and L. W. Randolph describe details of the design philosophy employed in readying Explorer I for launching, and how design decisions were made based on predicted environment.

**PRECISION RECORDING.** Magnetic recording of analog signals with accuracies within 0.1 percent presents formidable problems. H. L. Daniels and D. K. Sampson of the Remington Rand Univac division of Sperry Rand in St. Paul, Minn., have come up with a relatively simple yet highly stable system which achieves the required precision.

Method was developed as part of a device to simulate transport delays in continuous processing operation. Sufficient precision was required to permit complete and accurate analog computer simulation to aid in the design of the plant.

**STABLE OSCILLATOR.** Modern communication and radar systems require highly-stable oscillators. A novel 1-mc oscillator using a transistor has been designed by J. F. Mercurio of MIT's Lincoln Labs. The compact unit offers a frequency stability of one part in 10<sup>9</sup> at room temperature.

## new transistors from Sprague\*



# SUPER HIGH-SPEED SWITCHING TRANSISTORS TYPE 2N501

	Typical	Maximum	Units
Rise Time ( $t_r$ )	9	18	$\mu\text{sec}$
Storage Time ( $t_s$ )	9	12	$\mu\text{sec}$
Fall Time ( $t_f$ )	7	10	$\mu\text{sec}$

In circuit with current gain of 10 and voltage turnoff.

Also available as special type 2N501A for  
100° C. maximum storage and  
junction temperatures.

This table tells the story. Sprague Type 2N501 germanium micro-alloy diffused-base transistors are the fastest mass-produced transistors available anywhere! They are unexcelled for high-speed computer applications. The ultra-low rise, storage, and fall time cannot be matched by any other transistor.

Ultra-precise process control in manufacture results in superb and consistent high quality. The basic electrochemical process of fabrication takes the guesswork out of transistor manufacturing. The result is outstanding uniformity of product.

Because of the electrochemical process, Sprague is able to fabricate a graded-base transistor with no intrinsic base region. The Type 2N501 can thus maintain its super high-speed switching characteristics right down to its saturation voltage, providing all the advantages of direct-coupled circuitry with no impairment of switching speeds.

Type 2N501 Transistors are available from Sprague now at extremely reasonable prices. They are transistors you can use today! You need not delay your development work for the future when you design high-speed switching circuits with Type 2N501 Micro-Alloy Diffused-Base Transistors.

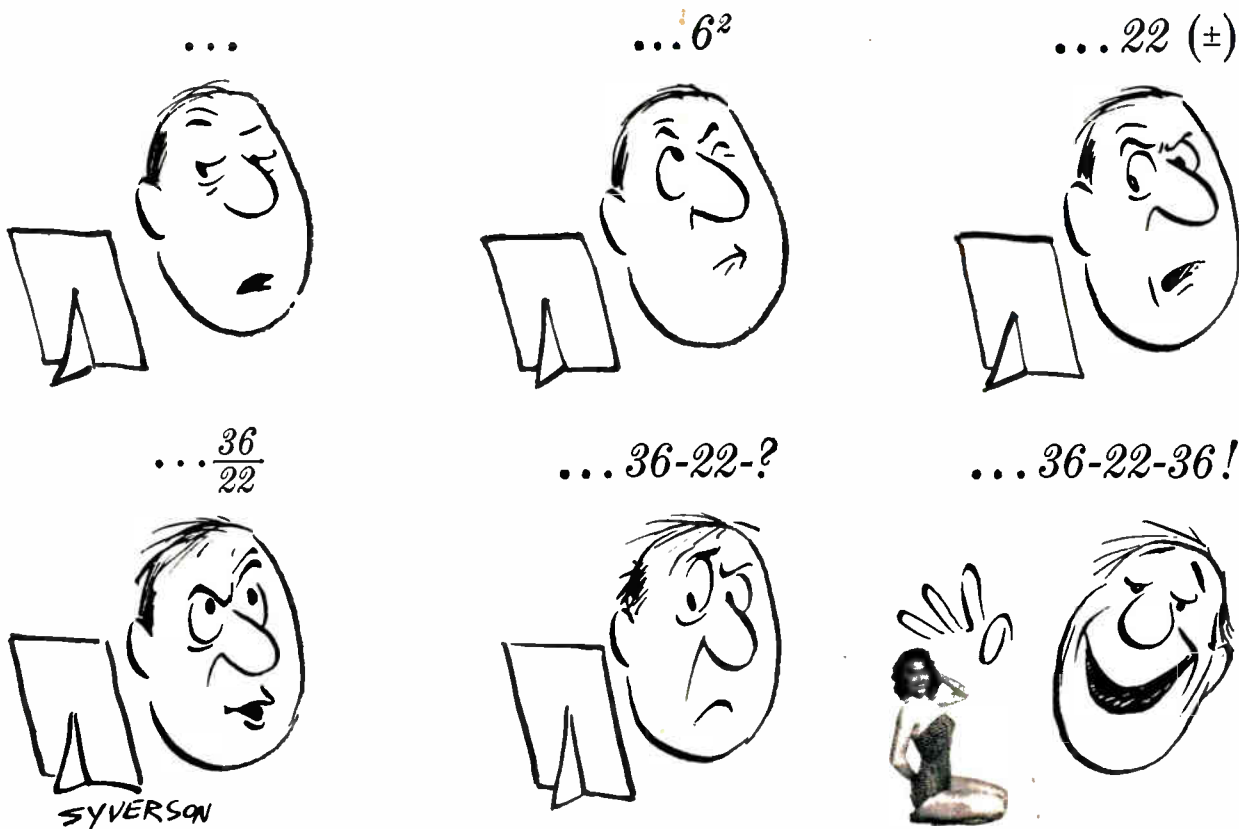
Write for complete engineering data sheet to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

\* *Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.*

### SPRAGUE COMPONENTS:

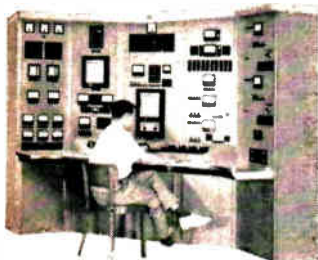
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Engineers desiring a special reprint of the cartoon above should write to "36-22-36," c/o Inet Division, Leach Corporation.

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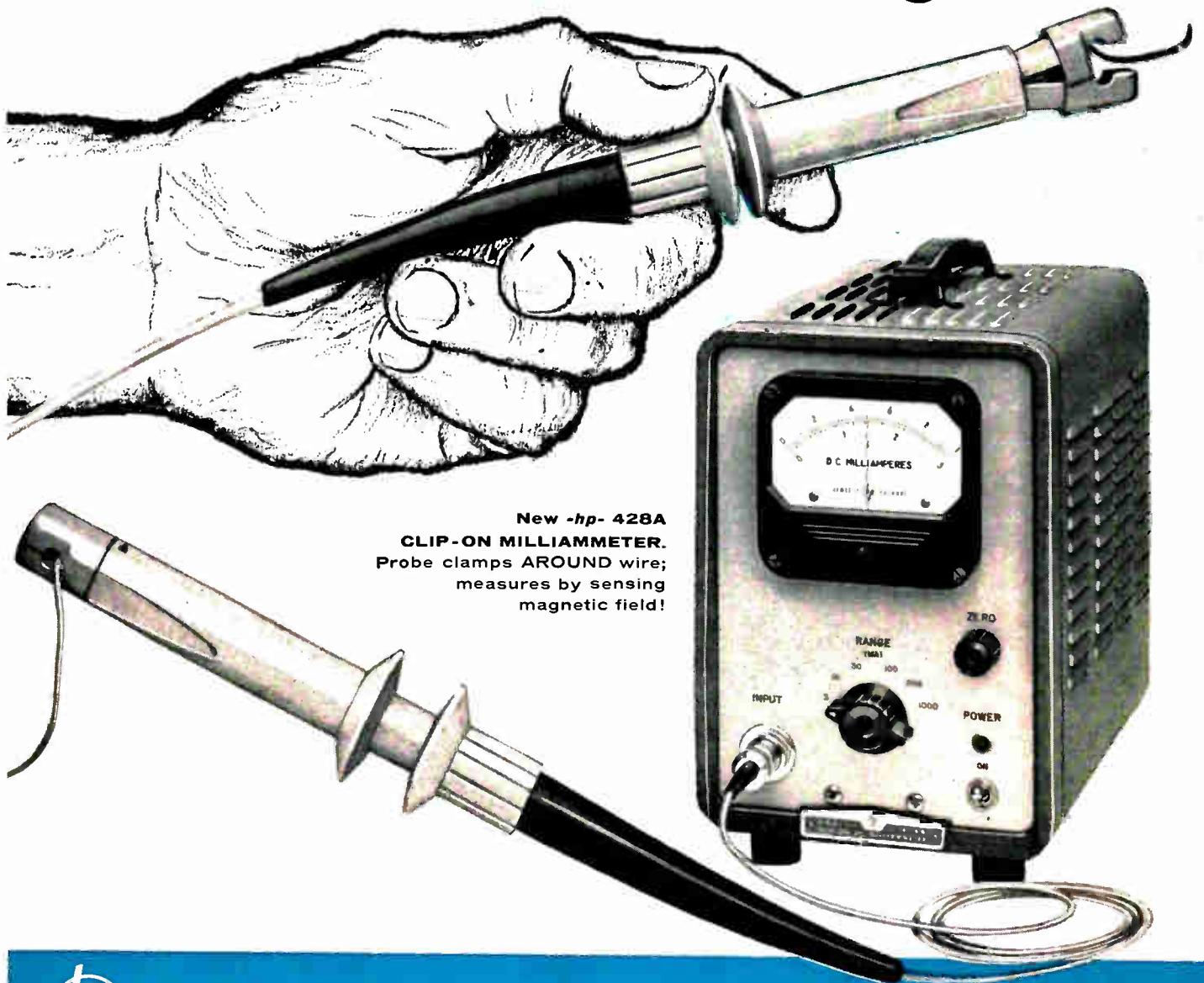


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# LOOK!

Measure dc currents 0.3 ma

# No Breaking of Leads No DC Connection No Circuit Loading



New -hp- 428A  
CLIP-ON MILLIAMMETER.  
Probe clamps AROUND wire;  
measures by sensing  
magnetic field!



over 30 new major instruments

## to 1 ampere with

Think of the measuring convenience, time saved and accuracy gained when you don't have to break into a circuit, solder on a connection, or worry about probe loading.

With the new *-hp-* 428A Milliammeter and its new probe, you literally "*clamp around*" and read! You get maximum accuracy because there is no effective circuit loading from the 428A's dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to insure safe measurements at all normal voltage levels.

For extremely low current level measurement, sensitivity can be increased by looping the conductor through the "jaws" of the 428A probe two or more times.

Current ranges are from 3 ma to 1 ampere in 6 steps, and accuracy is 3% of full scale  $\pm 0.1$  ma. This holds true despite line voltage changes, variations in probe closure, instrument aging and effects of the Earth's magnetic field.

Brief specifications are given here; for complete details and demonstration *on your bench*, call your *-hp-* representative or write direct.

### SPECIFICATIONS

**Current Range:** Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp: 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

**Accuracy:**  $\pm 3\%$   $\pm 0.1$  ma despite line voltage variations of  $\pm 10\%$ , probe closure, aging or Earth's magnetic field.

**Probe Inductance:** Less than 0.5  $\mu$ h maximum.

**Probe Induced Voltage:** Less than 15 mv peak.

**Effects of ac in circuit:** Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

**Power:** 115/230 v  $\pm 10\%$ , 95 watts.

**Size:** Cabinet mount, 7 $\frac{1}{2}$ " wide, 11 $\frac{1}{2}$ " high, 14 $\frac{1}{4}$ " deep. Weight 24 pounds. Rack mount, 19" wide, 7" high, 12 $\frac{1}{2}$ " deep. Weight 35 pounds.

**Probe Tip Size:** Approximately  $\frac{5}{8}$ " x  $\frac{3}{16}$ ". Wire aperture diameter  $\frac{3}{16}$ ".

**Price:** (Cabinet) \$475.00; (Rack) \$480.00.

Data subject to change without notice.  
Prices f.o.b. factory.

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# in '58—and more on the way!



## 15,000 WATTS P. E. P. New Ceramic Tetrode for SSB

Eimac's new, high-power 4CW10,000A is ideal for use in Class AB<sub>1</sub> single sideband service. This new tetrode is a water-cooled version of the widely-used Eimac 4CX5000A, with plate dissipation capability increased to 10,000 watts and a peak envelope power of 15,000 watts. Water-cooling makes the 4CW10,000A excellent for heavy duty applications where reserve plate dissipation is required.

Eimac offers the most complete line of tetrodes with the high-power gain, low distortion and excellent

stability required in Class AB<sub>1</sub> operation. Each has proved reserve ability to handle the high peak powers encountered in single sideband service. Efficient integral-finned anode coolers on the air-cooled types keep blower requirements to a minimum, allowing compact equipment design.

Ceramic-metal design means compactness, ruggedness, high performance, and reliability. These proved advantages of Eimac ceramic tetrodes make possible more compact, efficient single sideband equipment.

Write our Application Engineering Department for a copy of the technical bulletin "Single Sideband."

**EITEL-McCULLOUGH, INC.**  
SAN CARLOS, CALIFORNIA

*Eimac First with ceramic tubes that can take it*



Cable address  
**EIMAC**  
San Carlos

### CLASS AB<sub>1</sub> SSB OPERATION

	4CX250B	4CX300A	4CX1000A	4CX5000A	4CW10,000A
Plate Voltage . . . . .	2000 v	2500 v	3000 v	7500 v	7500 v
Driving Power . . . . .	0 w	0 w	0 w	0 w	0 w
Peak Envelope Power . . .	325 w	400 w	1680 w	10,000 w	15,000 w

**ELECTRONICS NEWSLETTER**

**COLD CATHODE AMPLIFIER TUBE** was announced last week, the culmination of research in field emission by Tung-Sol Electric and the U. S. Army Signal Research and Development Laboratory. New tube, whose cathode is coated with high-purity, porous magnesium oxide, is said to be 15 times more efficient in its use of power than a thermionic tube; one tube has emitted for more than 14,000 hours with no apparent deterioration. Tung-Sol says the new tube equals transistor advantages of low power drain, instant starting and long life; an edge is claimed over transistor in ability to withstand radiation and in operating temperature range -179 C to red hot. Tube uses small tungsten filament as starter, requires 300 v on plate. Firm demonstrated a power output tube that puts out 900 milliwatts of audio and reported it's developing a cold cathode preamplifier tube.

**SOLID-STATE AIRBORNE** multichannel analog-to-digital converter using pulse code modulation to attain 0.2 percent accuracies has been developed by C. G. Electronic Corp., Albuquerque, N. M., a subsidiary of Gulton Industries. Seven-pound unit of modular construction contains automatic error checking system and digital read-out. It is adaptable to on-line entry into digital computers. Scan rate ranges from 100 to 300 cps, with possible response rates as high as one mc.

FCC this week is considering possible amendments to its proposed allocation of frequencies for space communications following expiration of the period for filing comments on the subject. FCC would draw on government services for frequencies for outer space tracking, telemetering, command and communication.

*Red Chinese semiconductor research has reached world standard in production of pure germanium, according to German scientific newsletter, Hochschul-Dienst.*

**ELECTRON TUBE** sales in 1959 should rise to \$866 million from about \$800 million in 1958. Estimate comes from Douglas Y. Smith, vice president and general manager of RCA Electron Tube Division.

**MERGER NEGOTIATIONS** have been completed by Varian Associates, Palo Alto, Calif., and Bomac Laboratories, Beverly, Mass. Announcement says that, subject to final legal and accounting settlement, the firms will combine operations through an exchange of common stock. Varian will acquire 80 percent interest in Bomac, with option to acquire the balance of outstanding Bomac common stock.

**EXPERIMENTAL** automatic ground/air/ground communication system is being developed for Federal Aviation Agency's bureau of R&D by RCA. System will permit both interrogation of up to 500 aircraft and replies on a single channel in two minutes or less. Traffic-control link will operate in both vhf and uhf bands, allow choice of fsk-carrier or fsk a-m modulation modes. Binary data is multiplexed at 750 bits-per-second rate.

*Temperatures at 100 different points between uranium bars of nuclear test reactor are shown simultaneously as radial lines on single-beam French Thomson-Houston oscilloscope wired for ppi display.*

**ELECTRONIC PRINTOUT** gear with speed of 20 lines a second or 91,000 characters per minute has been developed in Japan by Nippon Telegraph and Telephone, in cooperation with Oki Electric and Nippon Electric. Printer uses three-line belt which moves horizontally so two lines can be printed at once with a space between them.

**BRITISH** Ministry of Transport and Civil Aviation invited the world's major airlines, including USSR's Aeroflot, to demonstrations of the Decca/Dectra navigation system before February's International Civil Aviation Organization meeting. Meanwhile, B. O. A. C. ordered the equipment for its North Atlantic Fleet of Comet 4 jets, but declines to give cost or delivery date.

*Computer conference held in Prague last December reportedly laid the groundwork for production of computers for controlling machines. Czechs say ferrite elements will substitute for magnetic drum memory in future medium-sized computers.*

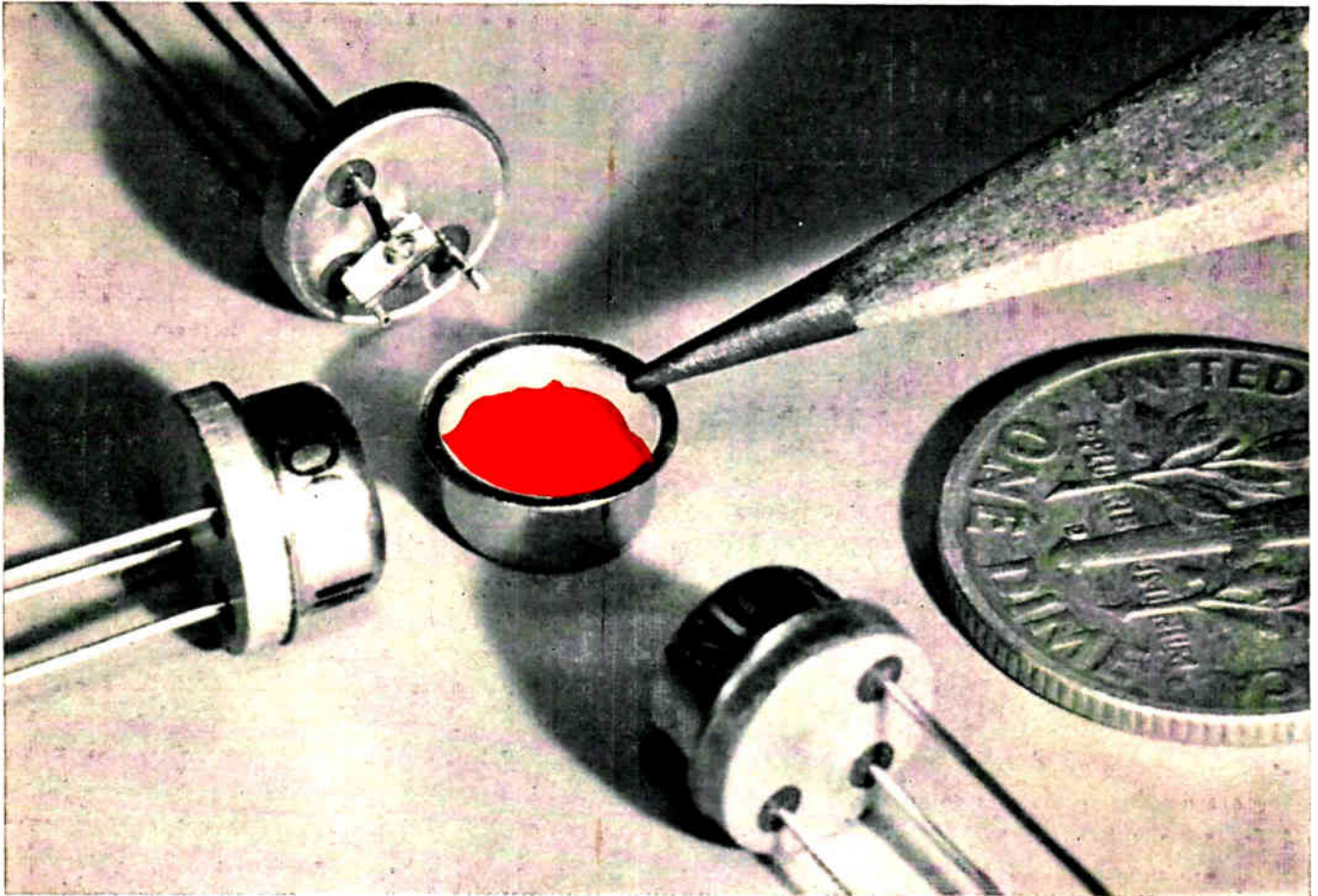
**RADIATION WARNING ALARM DEVICE** that could be attached to a radio or tv set has been developed by Tracerlab, Inc., Waltham, Mass. Used with an auto radio or small battery-operated set, the device—called the BANSHEE—can guide a family away from dangerous fallout, it is claimed. Firm says device can be made sensitive to as little as 100 milliroentgens of radiation per hour. Estimated retail cost: \$5.

**20-POUND MEDICAL INSTRUMENT PACKAGE** to measure six physiological parameters of a man in space has been developed by Vibro-Ceramics Division, Gulton Industries. Package records and relays data on blood pressure, heart rate, heart sounds, respiration rate and depth, skin temperature from many points on the body and galvanic skin resistance.

Design better products with

# DOW CORNING SILICONE COMPOUNDS

improve transistor performance



Made by Industro Transistor Corp., these miniature transistors are potted with a Dow Corning silicone compound to cushion vibration, improve heat dissipation, prevent contamination of the junction.

#### TYPICAL PROPERTIES OF DOW CORNING COMPOUNDS

Color	colorless, translucent
Penetration (ASTM D216-52T)	
unworked	200 to 240
worked, maximum	300
Electric Strength, volts per mil, at 10 mils	500
Dielectric Constant at 23 C (ASTM D150-54T)	
at 100 kc	2.85
Condition C-96/23/96†, at 100 kc	3.00
Dissipation Factor at 23 C (ASTM D150-54T)	
at 100 kc	0.0009
Condition C-96/23/96†, at 100 kc	0.003
Arc Resistance, seconds (ASTM D495-58T)	80

† Condition C, tested after 96 hours at 96 percent relative humidity and 25 C.

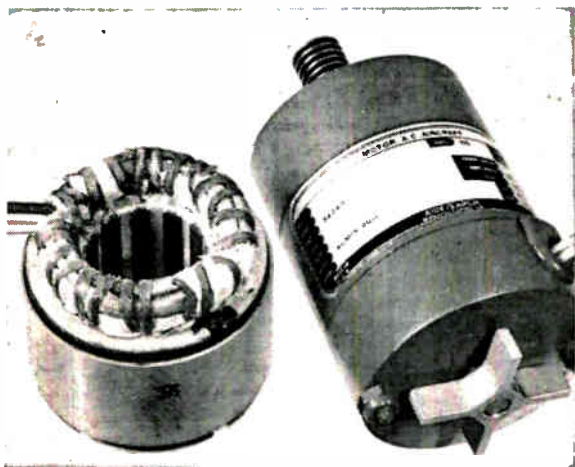
Used for potting transistor junctions, Dow Corning silicone compounds improve heat dissipation, serve as damping agents to cushion vibration, prevent metallic contamination when covers are welded in place. Silicone compounds are inert, nonmelting, nongumming . . . maintain their grease-like consistency over a temperature span from as low as -75 C to 200 C and higher. In addition to transistor potting, Dow Corning silicone compounds are used in a wide variety of electronic components and devices to protect against arcs, grounds, shorts; impart a high order of surface resistivity. Silicone compounds apply easily, need no cure. Free sample available.

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**Dow Corning CORPORATION**  
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# Dow Corning Silicone Dielectrics

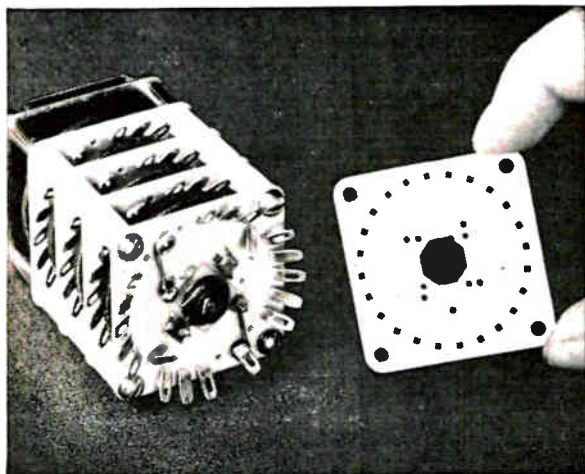


AiResearch miniature motor combines Sylkyd wire and silicone varnish.

## REDUCE SIZE, WEIGHT WITH SILICONE INSULATING MATERIALS

Specify Sylkyd® enameled magnet wire to help reduce the size and weight of transformers, servo motors, and other devices by as much as 50%. Equal in diameter to Class A magnet wires, it serves at 180 C . . . withstands the higher temperatures of miniaturization. Impregnated with Dow Corning 997 Varnish, Sylkyd enameled magnet wire and other silicone insulating components are bonded into moisture resistant insulation systems having high dielectric strength, maximum reliability over a wide range of temperatures and environmental conditions. Write for new, illustrated brochure.

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Shallcross Manufacturing rotary switch decks.

## SILICONE-GLASS LAMINATES RESIST CONTINUOUS 250 C HEAT

Laminates made of glass cloth bonded with Dow Corning silicone resins provide heat-stable structural and insulating materials . . . withstand soldering heat during assembly of electronic equipment . . . resist continuous exposure to temperatures up to 250 C. Silicone-glass laminates resist moisture, arcing, corona. They are lightweight, strong, rigid . . . supplied in many shapes and forms by leading laminators.

CIRCLE 105 READER'S SERVICE CARD

## SILASTIC ENCAPSULATION ABSORBS VIBRATION, SHOCK

Sensitive electronic parts withstand vibration and shock longer when encapsulated with Silastic®, the Dow Corning silicone rubber. That's because Silastic retains all its superior properties on aging. Silastic has low moisture absorption, stays resilient over a wide temperature range . . . is easy to apply. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes.

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Electronic tube encapsulated with Silastic.

# WASHINGTON OUTLOOK

PERENNIAL RUCKUS over the military budget has broken out with greater intensity than in any year since the start of the Eisenhower administration.

Although electronics stands out as a program that will be accelerated next year (see p 30), from an overall view defense spending is being increased just \$145 million—to a total of \$40.9 billion.

As some critics in Congress and the Pentagon see it, the increase won't even be enough to handle normal inflationary cost hikes. In effect, these critics claim, the new defense spending plans will mean cuts in general weapon procurement and development. For the most part, though, electronic items will probably escape the cuts.

Over the past few years, Pentagon budget experts concede, inflationary cost rises have added some three percent to annual defense spending. The new budget, critics say, fails to take into account such potential cost increases—which, based on previous experience, would mean a \$1.2-billion rise next year just to maintain production at current levels.

The President stresses plans to boost missile production and space exploration. However, critics point out two items they consider evidence of a "lack of urgency" in the administration's program:

1—While missile production spending will be increased next year—reflecting the rate of shipments on outstanding orders—the Defense Dept. seeks only \$3.5 billion in new funds for missile procurement in fiscal 1960. This is \$600 million less than the last appropriation and suggests an early leveling-off in missile deliveries.

2—At the same time, the Pentagon is reducing the volume of new contracts on military astronautic projects next year—from \$345.9 million this year to \$309.1 million.

As criticism mounts, odds are that Congress will add funds to the Pentagon's budget request. Senate Majority Leader Lyndon Johnson will soon begin a broad investigation of the administration's defense policies to determine the "adequacy" of the military program.

Johnson's investigation will be along the lines of the highly-publicized probe he conducted last year which led to the addition of some \$900-million to the fiscal 1959 appropriation for extra arms production and development.

In laying out next year's budget plans, however, the Pentagon reveals that only one-third of these extra funds will be committed by June 30—almost all for the Polaris program. The administration has ordered the Pentagon to credit the remaining extra money—earmarked by Congress for the Minuteman and Hound Dog missiles, tanker and transport planes, and other weapons—to next year's budget.

- Missile procurement plans cover the Atlas, Titan, Bomarc, Falcon, Mace, Quail and Hound Dog. Thor and Jupiter IRBM's will be phased out over the next 18 months unless new foreign treaties are signed to provide for more than the eight IRBM squadrons now scheduled for overseas installation.

Minuteman, Sergeant, Pershing and Nike-Zeus will be pushed with new R&D contracts. So will the B-70 bomber, the Dynasoar boost-glide bomber, new Navy antisub and fleet air defense aircraft and Army vertical and short takeoff aircraft.

Bureau of Ordnance missile orders cover Sidewinder, Talos, Tartar, Terrier and Polaris.

New orders for the B-52 bomber, KC-135 jet tanker plane and the B-58 supersonic medium-range bomber are slated to be increased; B-58 had earlier been scheduled for severe cuts.



The Westinghouse hermetically sealed, Polyclad Hipermag core is the newest development in cores for magnetic amplifier applications. Applied over a new specially designed aluminum box housing the core, Polyclad insulation hermetically seals the core and allows encapsulating, casting or impregnating without altering magnetic properties. This special core:

- Stops magnetic amplifier rejects caused by changed magnetic values.
- Is suitable for all environmental conditions — high temperatures, humidity and high-voltage stress.
- Eliminates costly core taping.
- Is tested by Roberts constant-current, flux reset technique, or to your specification.

Available in production lots with normal delivery, these cores are supplied in special sizes or in standard AIEE sizes.

For more information about these or other Hipermag or Hipersil® cores, call your Westinghouse representative . . . or write Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania. J-70855

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MTR28-2	24-32	2
MTR28-5	24-32	5
MTR28-10	24-32	10
MTR28-30	24-32	30
MTR28-100	24-32	100

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AT LAST!! — A POWER SUPPLY WITH PRECISE  
REGULATION THAT IS UNAFFECTED BY LINE AND  
LOAD TRANSIENTS . . . INSTANTANEOUS CHANGES IN  
LINE AND LOAD WILL NOT CAUSE TRANSIENT  
VOLTAGE "SPIKES" IN THE D. C. OUTPUT.

## SPECIFICATIONS

<b>D. C. OUTPUT:</b>	6-36 Volts @ 15 Amperes
<b>A. C. INPUT:</b>	105-125 Volts, 1 phase, 60 cps
<b>STATIC REGULATION:</b>	Line — $\pm 25$ MV; Load — $\pm 50$ MV
<b>DYNAMIC REGULATION:</b>	Line: $\pm 50$ MV; Load: $\pm .75$ V. No Load to full load & FL to.NL
<b>RIPPLE:</b>	5 MV RMS Maximum
<b>DYNAMIC IMPEDANCE:</b>	50 Milliohms (0 CPS to 20 KC)
<b>PROTECTION:</b>	Short Circuit Proof — Automatic Current Limiting at 18 Amperes. (Short Circuits and Overloads can be sustained indefinitely without damage to the power supply.)
<b>WEIGHT:</b>	Approximately 125 Lbs.
<b>DIMENSIONS:</b>	19" W x 15" D x 12 $\frac{1}{4}$ " H (Rack panel mount) 20 $\frac{1}{2}$ " W x 16 $\frac{1}{4}$ " D x 14" H (in cabinet)
<b>SPECIAL FEATURE:</b>	Through the use of a special combination magnetic amplifier-transistor circuit and conservative design techniques, this power supply provides full load output even in the case of a transistor failure.

REPRESENTATIVES IN PRINCIPAL CITIES

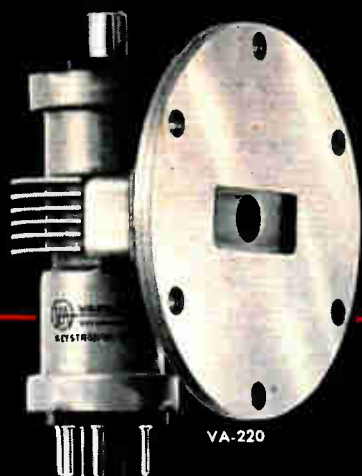
# PERKIN

VARIAN

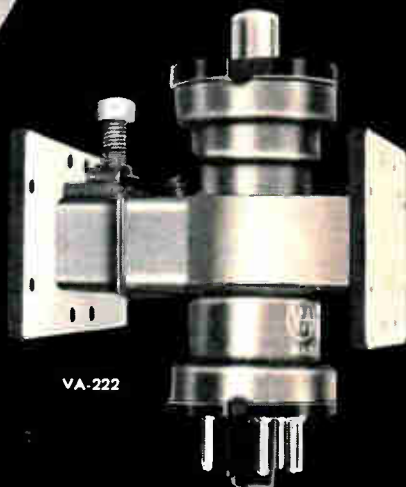
PRESENTS



VA-225



VA-220



VA-222

A COMPLETE COMPLEMENT OF 1 WATT RELAY TUBES

...WITH FREQUENCY RANGES COVERING THE COMMON CARRIER, STL, AND GOVERNMENT BANDS

The well known VA-220 Klystron series, long the accepted standard of the relay industry, is now guaranteed for 3000 hours.

The VA-222 series has all the desirable qualities of the VA-220 series but it is conduction cooled making possible added economies in equipment design...no cooling blower required.

Write for free comprehensive catalog on Varian Microwave tubes, produced by the world's largest manufacturer of Klystrons.

The VA-225A and B are the newest additions to this group of efficient Klystrons. Each provides a 1000 megacycle tuning range within the 7.0 kMc to 8.5 kMc range. The electrical specifications are similar to those of the VA-220.



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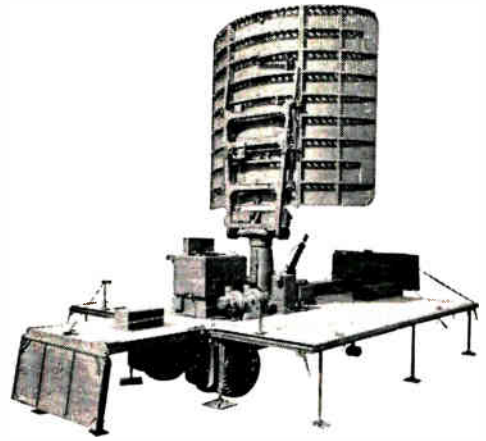
Representatives in all major cities

MECHANICAL TUNING RANGE

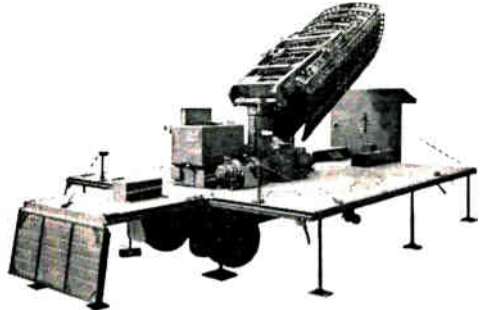
VA-220A and VA-222A	7423-7730 Mc
VA-220B and VA-222B	7725-7423 Mc
VA-220C and VA-222C	8573-7723 Mc
VA-220D and VA-222D	8573-8573 Mc
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VA-220F and VA-222F	5923-8573 Mc
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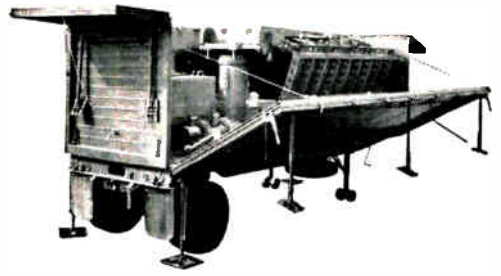
# 3-D



# RADAR



# ON



# WHEELS



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And then they made this complete radar and data handling system mobile. The radar scanning antennas (shown above) can be converted for travel on the road in minutes. The complete data processing and radar scanning systems, with all of their wide capabilities, have been engineered to occupy only a few standard size army van trucks.

The research, development and production of this advanced system is typical of

the creative engineering now underway at Hughes in Fullerton. If creative engineering is your forte, you will find abundant aesthetic and monetary reward at Hughes. To investigate write to Mr. L. P. Wike at the address below.

## HUGHES

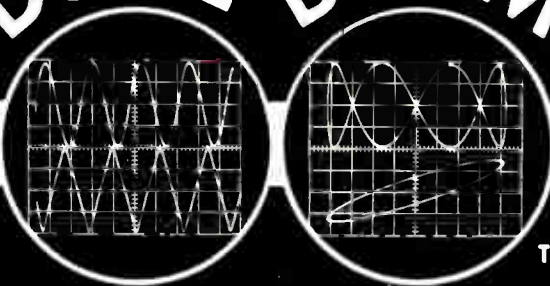
GROUND SYSTEMS  
Personnel Selection and Placement  
Hughes Aircraft Company  
Fullerton, Orange County, California

# NEW DUAL BEAM

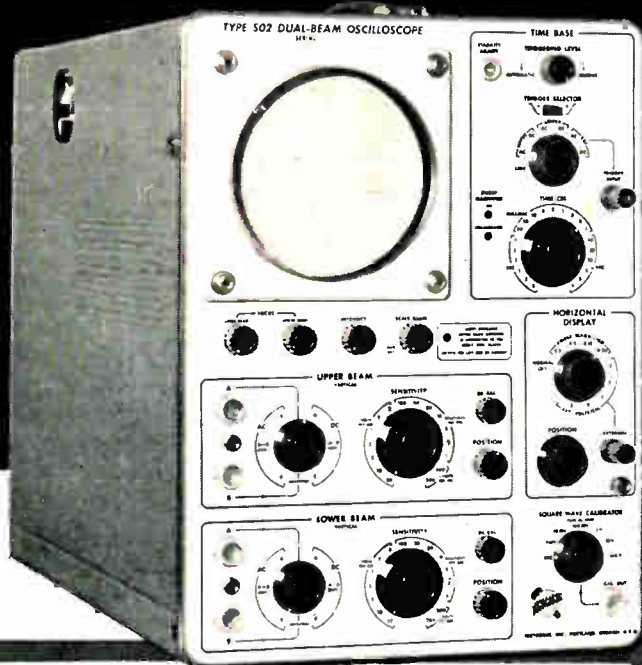
# TYPE 502 OSCILLOSCOPE



Dual display on linear time base.



Dual display for X-Y curves.



## TYPE 502 CHARACTERISTICS

### HIGH-GAIN AMPLIFIERS

200-microvolts/cm deflection factors, both dc-coupled and ac-coupled. 16 calibrated steps from 200  $\mu\text{v}/\text{cm}$  to 20  $\text{v}/\text{cm}$ .

Passbands—dc-to-100 kc at 200  $\mu\text{v}/\text{cm}$ , increasing to dc-to-200 kc at 1  $\text{mv}/\text{cm}$ , dc-to-400 kc at 50  $\text{mv}/\text{cm}$ , and to dc-to-1 mc at 0.2  $\text{v}/\text{cm}$ .

Differential Input, Both Channels—Rejection ratios: 1000-to-1 at 1  $\text{mv}/\text{cm}$  or less, 100-to-1 at 0.2  $\text{v}/\text{cm}$ , 50-to-1 at 5 to 20  $\text{v}/\text{cm}$ .

Constant Input Impedance, 1 megohm, 47  $\mu\text{f}$ , both channels.

### WIDE-RANGE SWEEP CIRCUIT (Common to both beams)

Single-knob control for selecting any of 22 accurately-calibrated sweep rates from 1  $\mu\text{sec}/\text{cm}$  to 5  $\text{sec}/\text{cm}$ .

Sweep Magnification—2, 5, 10, and 20 times, accurate within the maximum calibrated sweep rate.

Automatic Triggering—fully automatic, or preset with amplitude-level selection when desired. Sweep can also be operated free-running.

### X-Y CURVE TRACING OPERATION

Horizontal-input amplifier permits curve-tracing with both beams simultaneously at sensitivities to 0.1  $\text{v}/\text{cm}$ . For curve-tracing at higher sensitivities (to 200  $\mu\text{v}/\text{cm}$ ) with one beam, one of the vertical amplifiers can be switched to the horizontal-deflection plates.

### OTHER FEATURES

Amplitude calibrator, 1 mv to 100 v in decade steps—square wave, frequency about 1 kc.

3-kv accelerating potential on new Tektronix 5" dual-beam crt. 8-cm by 10-cm linear-display area, each beam, 6-cm overlap.

Electronically-regulated power supplies. Price . . . . . \$795

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**200  $\mu\text{v}/\text{cm}$  SENSITIVITY, BOTH BEAMS.**

**DIFFERENTIAL INPUT, ALL SENSITIVITIES.**

**2, 5, 10, and 20 TIMES SWEEP MAGNIFICATION.**

**X-Y CURVE TRACING with TWO BEAMS—(horizontal input sensitivity to 0.1  $\text{v}/\text{cm}$ ).**

**SINGLE-BEAM X-Y CURVE TRACING at 200  $\mu\text{v}/\text{cm}$ , BOTH AXES.**

**EXTRA FEATURE—Both amplifiers have transistor-regulated parallel heater supply.**



**Here are a few uses for the Type 502:**

**IN ELECTRONICS**—Use the Type 502 as a general-purpose oscilloscope and also to show simultaneously the waveforms at any two points in a circuit, e.g. input and output, opposite sides of a push-pull circuit, trigger and triggered waveform, etc.

**IN MECHANICS**—Display, compare, and measure outputs of two transducers on the same time base; plot one transducer output against another—pressure against volume or temperature for instance; measure phase angles, frequency differences, etc.

**IN MEDICINE**—Display, compare, and measure stimulus and reaction, or the outputs of two probes, on the same time base; use differential input to cancel out common-mode signals, or to eliminate the need for a common terminal; use in routine investigations, etc.

**IN ALL FIELDS**—The Type 502 can save you more than its cost in time—in as little as one application!

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Tektronix is represented in 20 overseas countries by qualified engineering organizations.

# Rallies Lift Hopes, Earnings

COMMENTS AND REPORTS from electronics firms during this first month of 1959 stand out in sharp contrast to last year's first quarter financial statements by virtue of the growing optimism they show.

With few exceptions firms both small and large are noting rising income curves that bid fair to keep climbing. Some gages on the shape of our industry are:

• **Perkin-Elmer, Norwalk, Conn.**, reports net sales of \$4,285,348 for the three months ending on October 31, 1958. Firm says it is a record high for any first quarter in company history and an increase of 32 percent over same period a year before. Final results for the quarter were influenced by such military contracts as orders for guidance alignment systems for the Jupiter missile.

• **Baird-Atomic, Inc., Cambridge, Mass.**, also computes a sharp increase in earnings over 1957 with record sales of \$6,744,800 during the fiscal 1958 period. Net earnings for the year were \$125,000 or 53 cents a share, compared to 1957 earnings of \$18,600 or 8 cents a share. Baird is a producer of military infrared systems, nuclear instrumentation gear and special electronic optical systems.

• **Electronic Engineering Co., Santa Ana, Calif.**, along with its wholly-owned subsidiary, **Engineered Electronics Co.**, reported the best net profit ever for the third quarter of 1958. Total net was \$79,000, as compared with \$28,907 for the same period in 1957. The profit for July to September of 1958 was double the amount for the preceding quarter. Company officials anticipate a good fourth quarter as well. The company is engaged in military R&D work, while its subsidiary manufactures vacuum tubes and transistor plug-in circuits for both military and industrial users.

• **Stockholders of Consolidated Electronics Industries Corp.** were

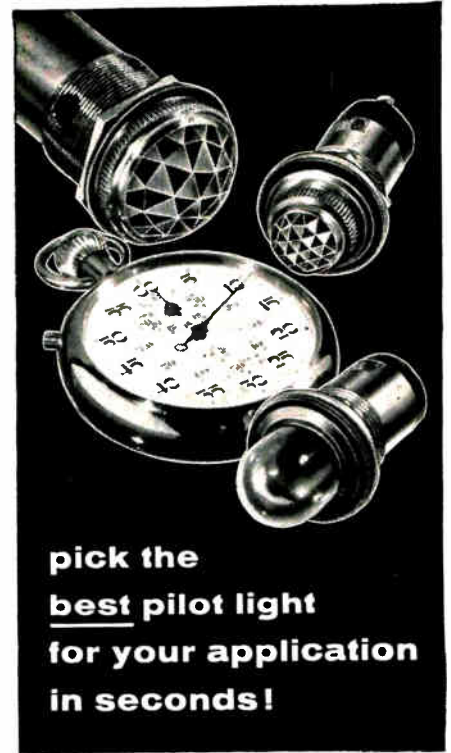
told by president Pieter van den Berg that CEIC "has enjoyed considerable rise in volume" during the past several months. He said the company will continue to follow a policy of growth and expansion.

• **Reports from RCA** are that the new year may set new peaks. A year-end spurt brought 1958 totals close to previous 1957 highs. RCA's government sales were about \$300-million, up 14 percent from 1957.

## OVER THE COUNTER

1958 BIDS		COMMON STOCKS	WEEK ENDING	
LOW	HIGH		Jan. 9 BID	Jan. 16 BID ASKED
33 1/2	20 1/2	Acoustica Assocs	22 1/4	19 24 1/8
1 3/8	3	Advance Industries	27 1/8	27 1/8 37 1/8
3 1/8	6 5/8	Aerovox	6 1/8	6 1/2 7 1/4
20 1/2	33	Amer Res & Dev	36 1/2	37 1/4 39 1/2
16 3/4	24 1/4	AMP Inc	22	22 24 3/8
17 5/8	69	Ampex	62 3/4	67 77 1/4
5 1/2	15	Appl'd Sci Princet	9 3/4	11 12 1/8
1 1/4	8 7/8	Avien, A	9	9 10 7/8
6 3/4	24	Baird-Atomic	22 3/4	27 1/2 33
9 3/4	13 3/8	Burndy	13 3/4	14 3/8 15 1/4
6 3/4	9	Cahu Electronics	6 1/4	6 7/8 7 1/2
11	22 1/2	Collins Radio, A	21 3/4	21 5/8 27 3/4
10 1/4	22 1/4	Collins Radio, B	21 1/2	22 3/4 27 3/4
4	7	Craig Systems	6 1/4	6 3/8 7 3/8
30	50 1/2	Dictaphone	47 1/2	48 1/2 51 7/8
17 5/8	25 3/8	Eastern Industries	20	20 21 3/4
22 3/4	29	Eitel-McCullough	26 3/4	26 30 3/8
10 1/2	21	Electro Instr	23 1/2	22 1/2 27 1/4
34	49	Electronic Assocs	50 1/2	52 58
5	11	Electronic Res'rch	11 1/4	12 15 3/8
8 1/2	12 3/4	Electronic Spec Co	12 1/4	14 15 7/8
15 1/4	49 1/2	Esco, Inc	39	43 48 3/4
5 1/2	9 3/8	Erie Resistor	8 3/4	8 3/4 11 1/4
10	17 1/2	Fischer & Porter	16 1/2	16 3/4 18 3/8
36 3/4	50	Foxboro	50 1/2	48 53 1/2
5 1/2	10 1/2	G-L Electronics	10	10 11 1/4
12	27	Giannini	28	29 1/2 35 1/8
30	39 1/2	Hewlett-Packard	39	40 1/2 48
23 1/4	48	High Voltage Eng	50	61 70 1/2
1 3/4	3	Mycon Mfg	3 1/8	3 1/2 4 1/4
1 1/8	5 1/8	Industro Trans'tor	27 1/8	3 4 3/4
11 1/2	4 3/4	Jerrald	37 1/8	4 4 3/8
21	30	D. S. Kennedy	26 1/2	28 38 1/4
3 3/4	29	Lab For El'tronics	27 1/4	27 1/4 29 5/8
19 1/4	28	Leeds & Northrup	27 1/2	28 1/2 31 1/2
2	3 1/8	Leetronics	2	2 2 3/8
5	18 3/4	Ling Electronics	17 3/8	19 3/4 21 7/8
16	20 1/2	Machtett Labs	21 1/2	22 25 5/8
3 1/4	8 1/4	Magnetic Amplifiers	8 1/8	8 8 3/4
27 1/8	4 1/2	Magnetics, Inc	3 5/8	3 5/8 4 1/8
4 3/8	12	W. L. Maxson	11 3/4	12 1/2 15 7/8
10 5/8	29	Microwave Assocs	32	36 3/8 41 7/8
5 1/4	11 3/4	Midwestern Instr	11 7/8	11 3/8 14 1/4
1 1/8	7	Monogram Preci's'n	7 1/4	9 11
3 1/2	7 1/4	Narda Microwave	9	6 7/8 7 5/8
9 3/4	16	National Company	15	16 3/4 19 3/8
14 1/4	56	Nuclear Chicago	29	26 32
14 1/2	29 3/4	Orradio Industries	26 1/4	29 3/4 33 1/4
4 1/2	7 3/8	Pacific Mercury, A	8	9 1/2 11 1/2
10 1/8	27 1/2	Packard-Bell	28	28 1/2 33 1/4
4 1/4	9 3/8	Panellit, Inc	8 3/4	7 1/4 9 5/8
21	53 3/4	Perkin-Elmer	50	52 57 1/2
11 3/8	19 1/2	Radiation, A	17 1/4	18 19 3/8
2 1/8	7 3/8	Reeves Soundcraft	6 5/8	6 3/4 8 3/8
13	32 1/2	Sanders Associates	29	34 39 7/8
7	12	SoundScriber	14 3/4	14 1/4 16 1/4
22 3/4	40	Sprague Electric	40 1/4	41 1/2 45 1/8
26	35	Taylor Instruments	34	34 37 1/2
5 1/2	15	Technical Operat'ns	15 1/4	15 1/4 18
5 1/2	15 3/4	Telechrome Mfg	15 1/4	15 1/4 17 1/2
3 1/4	7 3/4	Telecomputing	8 1/4	8 1/2 9 1/8
1 1/8	2 3/4	Tel-Instrument	2 3/4	2 3/4 3 1/2
8 3/4	16 1/4	Topp Industries	13 1/8	12 7/8 15 1/2
3 3/4	10 3/4	Tracerlab	11	12 14 3/8
1 1/8	3 3/8	Universal Trans'tor	2 3/4	2 5/8 3
14 1/4	40	Varian Associates	43 1/4	48 1/2 56
12 1/2	18 1/2	Vitro Corp. Amer	15 3/8	15 3/8 17 1/8

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION of SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.



**pick the  
best pilot light  
for your application  
in seconds!**

**Johnson pilot lights**  
*immediately available  
for original equipment  
or in-the-field replacement!*

Choose your next group of panel indicators from E. F. Johnson's "preferred" line—over 47 separate assemblies carefully selected from Johnson's standard line by many of the nation's top design and development engineers. Available in a wide variety of types, these "preferred" units may be obtained from stock at parts distributors throughout the country for original equipment or in-the-field replacement. Write for your free copy of Johnson's newest pilot light specification catalog—see how easy it is to select the *right* pilot light . . . fast!

### Select the right pilot light...fast!

Complete pilot light catalog 750a contains detailed specifications, prices, and technical data . . . everything you need to select the best unit for your particular application. Write for your free copy of Catalog 750a today!



Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass; and lucite jewels in clear, red, green, amber, blue, or opol. Specials, including those meeting military specifications, also available in production quantities.



**E. F. Johnson Company**

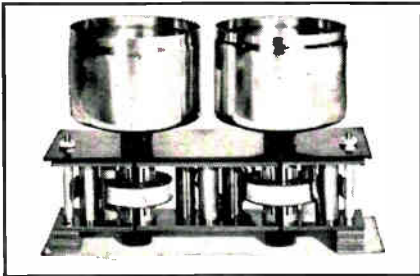
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CIRCLE 16 READERS SERVICE CARD

# Nickelonic News



DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



"A" Nickel laminations produce high-frequency vibrations in these cleaning and rinsing pots of the "Watchmaster" unit, developed by American Time Products, Inc.

## High magnetostrictive effect of Nickel proves useful in new ultrasonic cleaners

NEW YORK, N. Y.: The large magnetostrictive effect of Nickel makes possible the development of ultrasonic cleaners with a great range of usefulness. In radioisotope laboratories and other atomic energy installations, for example, these cleaners remove radioactive particles from equipment. In hospitals, they clean surgical instruments.

One ultrasonic cleaner, developed by American Time Products for cleaning watches, can also be used to clean tiny component parts in electronic equipment.

ATP's chief engineer writes: "Electronic-Grade "A" Nickel enables us to produce a simple, economical transducer for converting electrical energy into high-frequency vibrations. The Nickel withstands high heats, mechanical abuse and corrosive solutions, providing a long, stable life."

**Pertinent Literature:** Write for "Design of Nickel Magnetostriction Transducers". "Circle (107, 108) Readers Service Card"

## Three Inco Nickel Alloys help push life of magnetron to 6,000 hours

HARRISON, N. J.: Commercial airlines need reliability and long life in components for weather radar equipment. Especially in high power tubes. And they've been getting it with the type 6521 magnetron made by the Electron Tube Division of the Radio Corporation of America. Tube 6521 delivers a peak power output of 85 kilowatts and has a normal operating life of 6,000 hours.

RCA designers give much credit for the tube's long life to outstanding properties of Inco Nickel Alloys:

**Monel "403" low-permeability nickel-copper alloy, used for the cathode sup-**

**port, provides high strength, corrosion resistance and low magnetic permeability certified not to exceed 1.1 in a field of 0.5 oersted. Monel "403" alloy has the dimensional stability needed to maintain the cathode centered in the anode over many heating cycles. It also offers easy machining and retains its non-magnetic characteristics after cold-working and forming so that high-strength parts can be assembled without annealing.**

**Monel\* nickel-copper alloy, used for the output flange and the mounting plate, provides the strength, toughness and corrosion resistance required to help push the magnetron's life into the 6,000 hour class.**

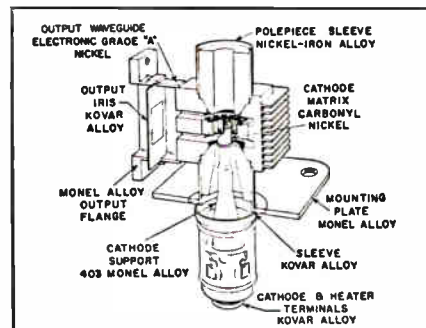
**Electronic-Grade "A" Nickel, used for the cathode foundation, supports the electron-emitting carbonyl nickel cathode matrix. The "A" Nickel provides essential strength to prevent distortion and purity to prevent contamination of the vacuum and the cathode matrix at high temperatures.**

**Two other Nickel-containing materials are also used to assure tube reliability and long life: Kovar\*\* nickel-cobalt-iron alloy, a glass sealing material, for the output iris, cathode sleeve and heater terminals; a magnetic nickel-iron alloy for the polepiece sleeve.**

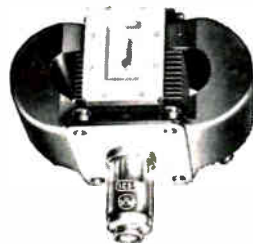
**Pertinent Literature:** Write for "Basic Data - Monel "403" Low-Permeability Nickel-Copper Alloy" and Bulletins T-5 and T-15.

"Circle (107, 108) Readers Service Card"

\*Trademark, The International Nickel Company, Inc.  
\*\*T.M. of Westinghouse Electric Corp.



Cut-away shows where Inco Nickel Alloys buttress construction of RCA magnetron.



## Forecast of Nickel availability spurs design of tubes with Inco Nickel Alloy parts

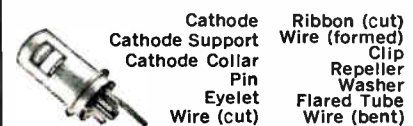
WALTHAM, MASS.: Notice that the production of Nickel exceeds all anticipated demands for future years is a big reason why designers at Raytheon Manufacturing Company make many klystron parts of Electronic-Grade "A" Nickel. For example, the two Raytheon tubes at right, designed for operation at 8500-9660 megacycles, have twenty-one "A" Nickel parts.

Plenty of "A" Nickel right from warehouse stocks in a wide range of

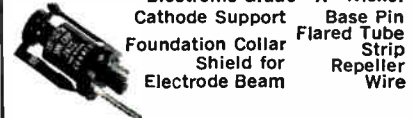
mill forms permits Raytheon designers to take advantage of this material's excellent vacuum and mechanical properties . . . and gain the benefits of simplified production and processing as well.

Electronic-Grade "A" Nickel, and other Inco Nickel Alloys, are supplied as wire, rod, strip, tubing, ribbon, clad-copper wire, bimetallic strip and wire, wire cloth, knitted mesh and a variety of other forms.

Thirteen 2K45 Klystron Components made of Electronic-Grade "A" Nickel



Eight 2K25 Klystron Components made of Electronic-Grade "A" Nickel



THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.



# WESTINGHOUSE SILICON POWER RECTIFIERS



**302** Up to  
35 amperes  
half-wave. Weight:  
0.65 ounce.



**303** Up to  
18 amperes  
half-wave. Weight:  
0.65 ounce.



**304** Up to  
12 amperes  
half-wave. Weight:  
0.25 ounce.

For efficient medium-power rectification on land, at sea and in the air

Westinghouse types 304, 303, and 302 rectifiers offer a range of current and voltage ratings which are ideal for efficient medium-power rectification.

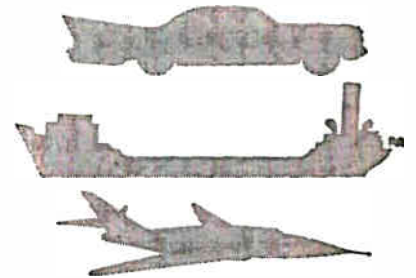
All three types are immediately available from stock—and at an attractive price! They are characterized by long life, high efficiency, low regulation, low cost, and operation at high ambient temperatures (up to 190° C junction temperature). They meet or exceed requirements of all applicable military tests. And they are available in a variety of rectifier assemblies.

Listed below are some suggested applications.

- DC power supplies for ground and airborne

- 6-12-24-48 volt AC-DC generator systems
- Battery chargers
- Small plating supplies for laboratory use
- Power supplies for business machines
- Computer power supplies
- Transistor power supplies
- Telephone exchange DC power supplies
- Power supplies for marine smallcraft
- Electronic tube filament supplies

For further design data, contact your Westinghouse representative or write to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.

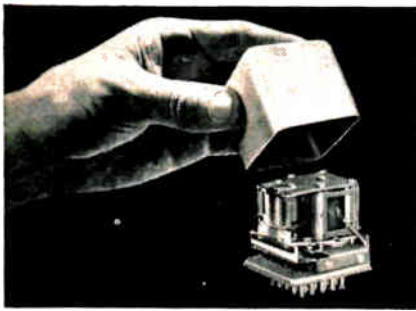


**SILICON POWER RECTIFIERS • GERMANIUM TRANSISTORS • SILICON POWER TRANSISTORS**

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

COMING SOON—HIGH-SPEED GERMANIUM  
DYNISTOR SWITCH

featuring low stand-by currents, low internal power loss, and switching time in the milli-microsecond range. Watch for announcement of availability.



## HOW TO USE REGOHM

the plug-in device that regulates input voltage down to  $\pm 0.05\%$

Wherever system performance requires precision regulation of input voltage, REGOHM earns a place. And wherever circuitry includes vacuum tubes, REGOHM will substantially extend tube life. The REGOHM is a voltage regulator of great sensitivity and stability, providing stepless continuous control over a wide frequency range. Light in weight, low in cost, its applications are almost unlimited. Here are typical applications:

- General Electric Co.—for Halogen Leak Detectors
- Empire Devices Products Corp.—for Noise & Field Intensity Meters
- Consolidated Electrodynamics—for Diatron Mass Spectrometers
- Stoddard Aircraft Radio—for Power Supplies
- Hevi-Duty Electric Company—for Airport Lighting Brightness Control

How you may use REGOHM in your own applications will become clear to you from design data, performance specs and case histories, available to you on request.

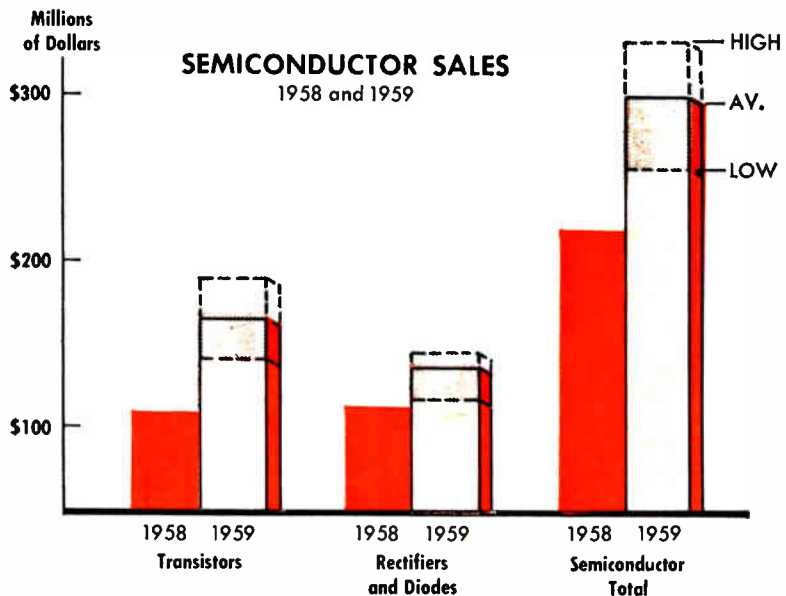


# REGOHM



**ELECTRIC REGULATOR CORPORATION**  
NORWALK CONNECTICUT  
CIRCLE 19 READERS SERVICE CARD

## MARKET RESEARCH



## Semiconductor Sales Mount

SEMICONDUCTOR SALES total in 1959 should hit about \$300 million, a poll of semiconductor manufacturers indicates.

Sales estimates for the family of transistors, rectifiers and diodes range from \$255 million to \$335-million.

Semiconductor sales were about \$218 million last year.

Opinions on transistor sales for this year center at \$165 million. Some see prospects for sales as high as \$190 million while others look for a somewhat lower total, about \$140 million. Transistor sales in 1958 totaled about \$108 million. Actual count had not been reported at press time.

Transistor unit sales this year probably will reach some 73 million. High-low unit sales range is between 84 million and 62 million. About 45 million transistors were sold last year.

Decline in average transistor prices is expected to continue this year. One manufacturer anticipates a seven-percent price fall. However, price changes will vary according to users. Consumer product transistor prices are expected to decline. But prices of industrial and military types are expected either to remain the same or to increase.

Behind the overall transistor pic-

ture for 1959 are expectations of more sales to military and industrial users. Military sales are expected to be up 40 percent. In the industrial field, computer sales are expected to double. Because of the relatively lower cost of tube circuits, transistors are expected to make little progress in penetrating the television market.

Consensus is that combined rectifier and diode sales will amount to \$135 million this year. However, opinions range between \$115 million and \$145 million.

In comparison to this, rectifier and diode sales were about \$110 million in 1958.

### FIGURES OF THE WEEK

#### LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Jan. 9, 1959	Dec. 12, 1958	Change From One Year Ago
Television sets	91,212	97,172	-20.3%
Radio sets (ex. auto)	254,021	318,894	+17.1%
Auto sets	107,875	122,914	+24.6%

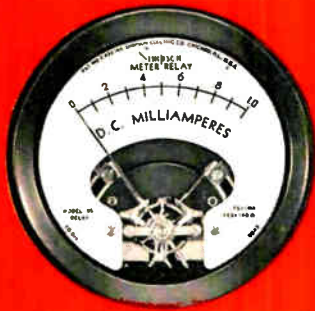
#### STOCK PRICE AVERAGES

(Standard & Poor's)	Jan. 14, 1959	Dec. 17, 1958	Change From One Year Ago
Electronics mfrs.	75.40	71.05	+41.0%
Radio & tv mfrs.	83.20	80.16	+85.3%
Broadcasters	78.42	77.98	+33.9%

#### LATEST MONTHLY SALES TOTALS

(Add 000)	Nov. 1958	Oct. 1958	Change From One Year Ago
Transistors, value	\$12,442	\$13,462	+78.0%
Transistors, units	5,441	5,595	+52.0%
Rec. tubes, value	\$29,854	\$34,362	-10.0%
Rec. tubes, units	35,640	41,540	-16.8%
Pic. tubes, value	\$15,008	\$19,398	-0.9%
Pic. tubes, units	789	969	+2.1%





Meter Relays: 2" and 3"; AC and DC

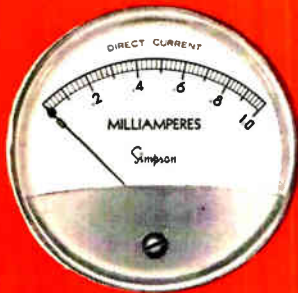


Edgewise: Vertical, DC

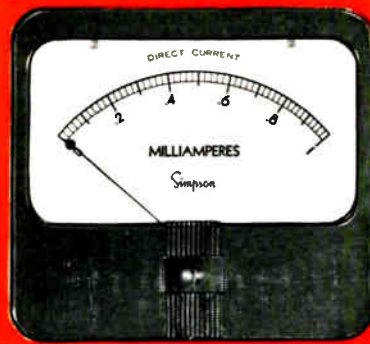


Wide-View: 2½", 3½", 4½"; AC and DC

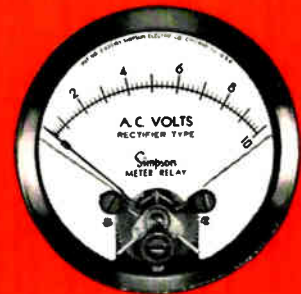
These are *Simpson* panel instruments...



Round: 3", DC

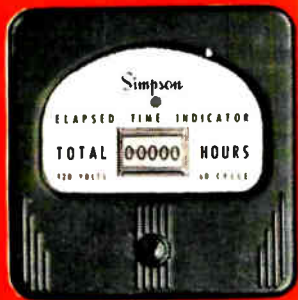


Rectangular: 4", 4½", 5½", AC or DC, RF; 7" and 9", DC or RF

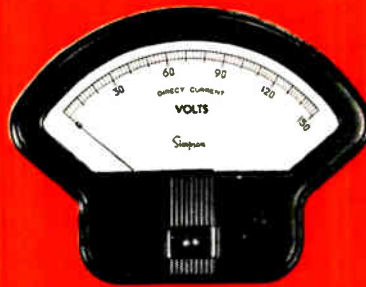


Front Adjust Relay: 2½", 3½", 4½"; DC. Rectangular also.

engineered and built to stay accurate...



Elapsed Times: 3½"; 60-cycle AC



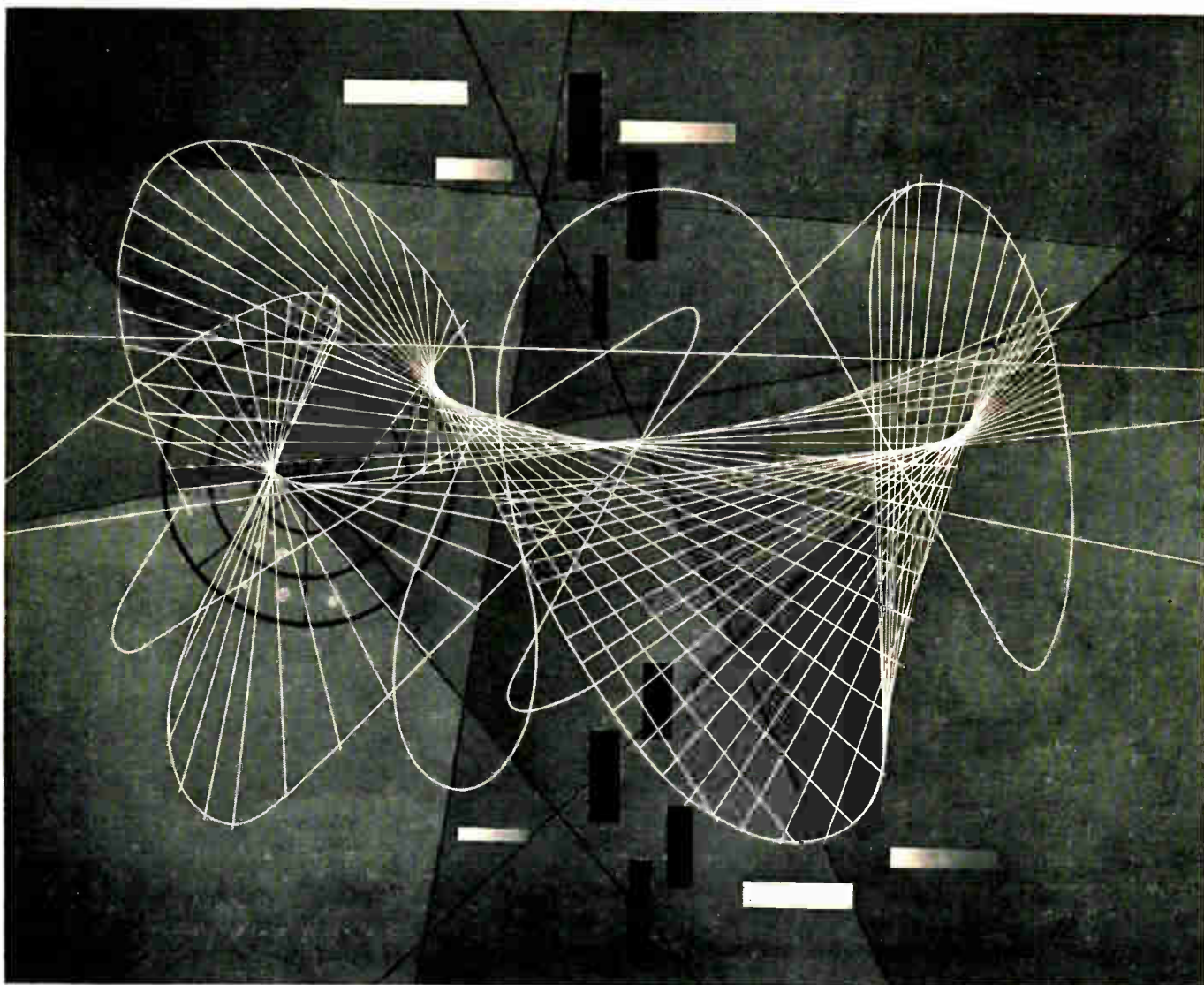
Fan Shape: 4½", AC or DC



Modernistic: 2½", 3½", 4½", 5½"; AC, DC, RF

available from stock  
or custom-built

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As the domestic research organization of the world-wide International Telephone and Telegraph Corporation, we are carrying on our tradition of pioneering in electronics. As our engineering responsibilities have increased so our organization has grown. Today, in addition to our main laboratories in New Jersey, laboratories in Ft. Wayne, Chicago and in California are pursuing projects of great magnitude and importance.

You will find in our staff the same fine creative thinking and engineering imagination which brought distinction to our old names. Formerly Federal Telecommunication Laboratories and Farnsworth Electronics research laboratories, our names have been changed to identify us clearly with our parent company, and to reflect our expanded responsibilities and growth.

Electronic engineers will find here opportunity to express initiative and competence in such areas as long range radar systems, digital computer applications to data processing and communications, space technology, microwave tube research and missile systems instrumentation. We are continuing our work in air navigation and control, and in electronic systems . . . and making new contributions to electronic theory and techniques. In fact, it would be hard to find another research organization that offers the engineer such a wide scope of activities.

*Engineers interested in discussing professional positions with our staff are invited to write Mr. T. C. Allen, Manager, Professional Staff Relations.*

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ALSiMag Alumina parts have exceptional tensile, compressive and flexural strengths . . . superior resistance to impact and thermal shock. A rare and important extra . . . these "super ceramics" maintain their excellent physical and electrical properties in ambient temperatures in the 1000° F. range with relatively little "tapering off!" Several ALSiMag Alumina compositions are safe for operation at continuous temperatures well above 2500° F.

Smooth, uniform surfaces. Precision tolerances. Flatnesses within light bands are possible on many parts; so are faces parallel within .0005". Complete production facilities for speedy shipment in any quantity. Prototypes for test if you wish.

The industry's widest choice of special-purpose ceramic materials. Send blueprint or sketch with details of operation for complete data on the ALSiMag Alumina best suited for your purpose.

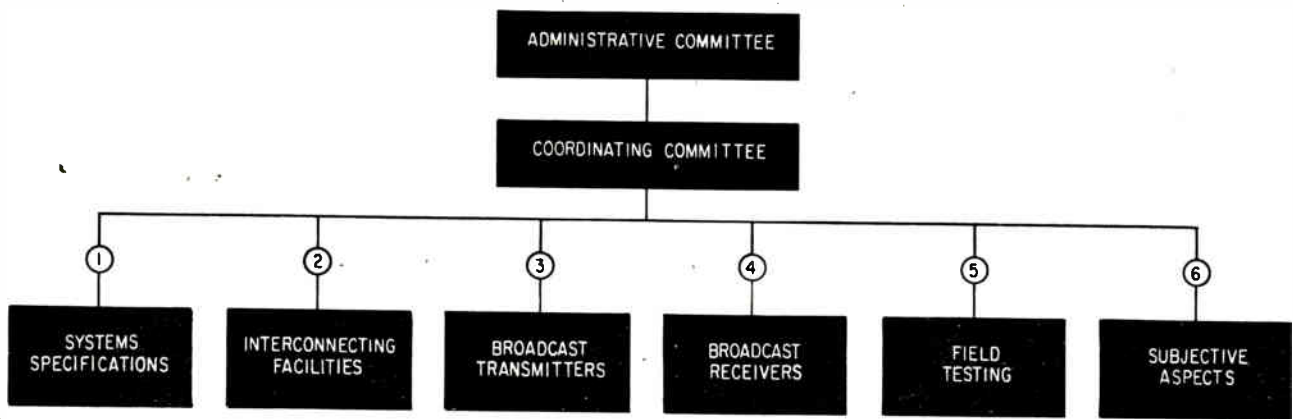
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Organizational chart of new National Stereophonic Radio Committee

# Stereo Specs Due This Year

**Electronic Industries Association establishes six panels and names study areas for each. Industry awaits committee deliberations on a-m, f-m and tv stereo standards**

STEREOPHONIC broadcasting will have a firm set of standards by the end of this year if all goes well. That's the word this week from a spokesman for the newly-formed National Stereophonic Radio Committee.

A mid-month meeting in the New York headquarters of the Electronic Industries Association has determined the basic shape and scope of the group.

Chairman of the administrative committee is W. R. G. Baker, who will be remembered as organizer and director of the standards setting committee for black and white tv in 1941, and for color tv in 1953. Baker is now president of Syracuse Research Corp. of Syracuse University. Vice chairman of NSRC is David B. Smith, vice president in charge of research for Philco.

## Immediate Goal

Reporting to the administrative committee will be a coordinating committee having C. Graydon Lloyd, of General Electric, as chairman. The coordinating committee will oversee the activities of six panels: System Specifications, Interconnecting Facilities, Broadcast

Transmitters, Broadcast Receivers, Field Testing and Subjective Aspects (see chart above).

Immediate goal of the group will be to outline answers to questions that may be asked when stereo broadcast standards are discussed with Federal Communications Commission officials later in the year.

A Washington, D. C., spokesman for EIA says other questions raised by industry members will be handled "as the need arises" within the existing panels. Additional assistance will be given by existing EIA groups, as well as by the Institute of Radio Engineers, which has pledged support to NSRC and will be represented on the committee.

EIA officials have declined to name panel members at this time. They point out that the exacting professional requirements of the work to be done make it difficult to find industry members who combine technical proficiency with available time to serve on the committee.

Intended scope of NSRC will be stereophonic broadcasting for a-m and f-m radio, and for television. Discussions on broadcasts originating from two different sources—

such as combinations of a-m and f-m transmissions or a-m and tv mixes—will not fall in the province of committee activity unless requested by FCC.

## Firms to File

Although written confirmation has not yet been filed in all cases, a number of firms are considered certain to file specification proposals with NSRC.

Among those expected to file on a-m stereo methods are Radio Corporation of America, Kahn Labs and Philco Corp. For f-m stereo, names being mentioned are Crosby Laboratories, Harkins Radio, Multiplex Services, and General Electronic Laboratories.

Television with stereo sound will be discussed in proposals by Motorola, which demonstrated a system earlier this year in Chicago (ELECTRONICS, p 27, Jan. 23).

Although general proceedings of NSRC will in some ways resemble activities of National Television Systems Committee which ended its studies in 1953, the stereo committee has incorporated a recommendation in its records that it shall "conserve manpower and time" by

compartmenting the areas of its studies.

The panel system is expected to go far in bringing this about. Although some changes in details may be made, essential phases of panel activities have been decided. These will be as follows:

- Panel 1 — Systems Specifications, will concern itself with identifying system proposals, evaluating system performance, and formulating transition proposals for use while adoption of firm specifications are awaited.

- Panel 2 — Interconnecting Facilities, will study and receive proposals regarding interconnections between studio and transmitter proper.

- Panel 3 — Broadcast Transmitters, will study design and performance specifications of transmitters, evaluate changeover costs and make recommendations in this area.

- Panel 4 — Broadcast Receivers, will study receiver designs for a-m, f-m and tv receivers and make recommendations to the coordinating committee.

- Panel 5 — Field Testing, will study and compare systems proposals referred to it by Panel 1 with regard to coverage, interference effects and other matters related to channel utilization. This panel will also conduct field tests.

- Panel 6 — Subjective Aspects, will serve as a reference library group to supply background information to the other panels.

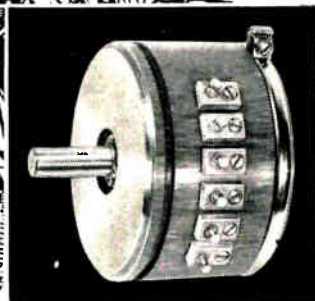
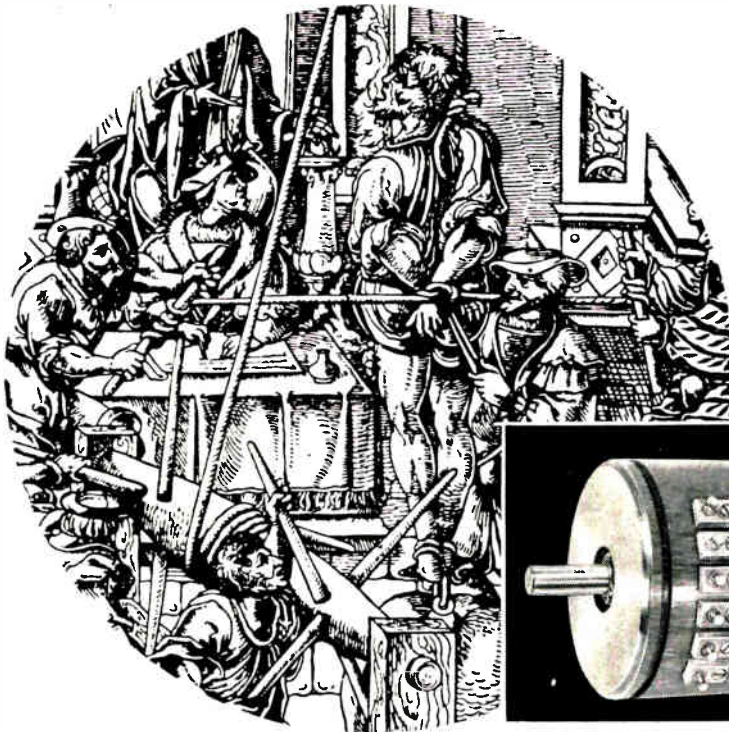
## Moisture Meter



Road builders who must judge moisture content and density of soil being pocked can use radioactive-isotope gages like the Nuclear-Chicago unit shown. Amount of neutron or gamma ray scattering indicates dampness and density of dirt

ELECTRONICS — January 30, 1959

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- ✓ **FAIRCHILD** uses pilot production to insure performance before full production begins.
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Only Fairchild Linear and Non-Linear Pots incorporate all of the above Reliability features. These High Reliability units can be had in  $\frac{3}{8}$ " to 5" diameters, single and multi-turn, in standard and high temp versions and with accuracies as high as .009%.

For more information write Dept. 28E



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Temco's combined talents are being applied continuously to the development of new materials, processes and production techniques. In the field of high temperature structures, integration of skills has resulted in an outstanding development — Temcombing — the company's own unique process for fabricating stainless steel honeycomb. Temcombing permits panels of virtually unlimited size, thus reducing weight and critical tolerance errors. In short, this new Temco development is the fastest, most advanced, most economical method for brazing stainless sandwich developed to date — a notable example of Temco's ability to extend capabilities.

Temco's ability to design, tool and produce the *total package* plus the capability to go beyond the immediate problem have given the spacecraft industry good reasons to team up with Temco.

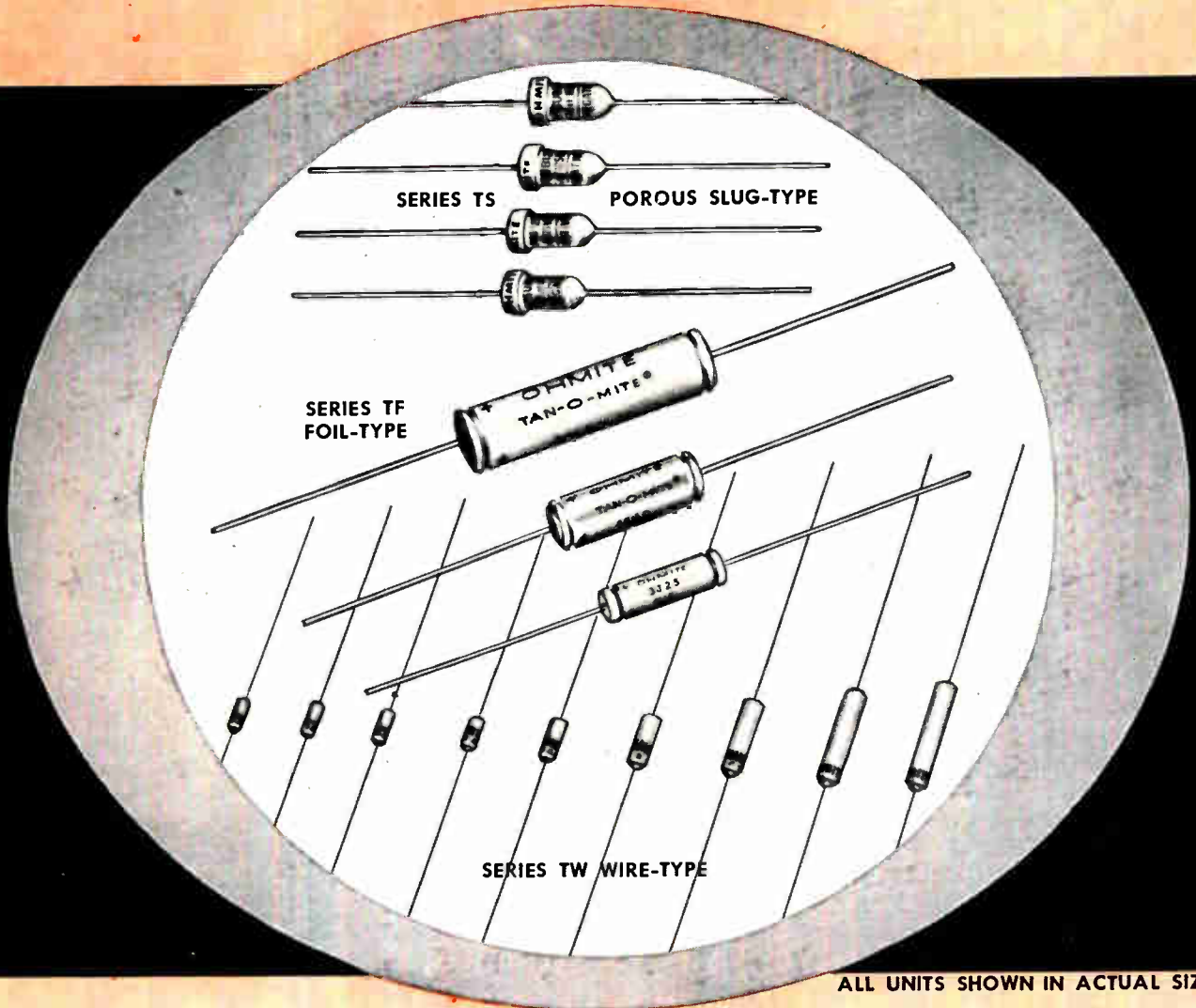
SYSTEMS MANAGEMENT
ENGINEERING
DEVELOPMENT
PRODUCTION



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# OHMITE®

## "TAN-O-MITE" TANTALUM CAPACITORS



ALL UNITS SHOWN IN ACTUAL SIZE

- Stability of Electrical Characteristics
- Long Shelf and Operating Life
- Excellent Performance Under Temperature Extremes ( $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

Ohmite offers you a complete line of quality tantalum capacitors including three types . . . all available from stock in reasonable quantities. **SERIES TS POROUS SLUG-TYPE TANTALUM CAPACITORS** employ a porous anode of sintered tantalum sealed into a fine silver case, externally uninsulated. Size "U" unit offers a range of 1.75 microfarads to 30 microfarads. Working voltages to 125 are available, depending upon capacity. These capacitors are polar units intended for d-c applications. BULLETIN 159.

**SERIES TF FOIL-TYPE** These capacitors are tantalum foil, electrolytic units for low-voltage, a-c and d-c applications. Three sizes now available; .25 to 140 mfd over-all capaci-

tance range. Standard tolerance is  $\pm 20\%$ . Working voltages up to 150. Polar and nonpolar units available. BULLETIN 152.

**SERIES TW WIRE-TYPE TANTALUM CAPACITORS** These Mylar® insulated, subminiature, wire-type units feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperature as compared to other kinds of electrolytics. Ultrasmall for low-voltage, d-c, transistorized electronic equipment. Available in nine subminiature sizes; .01 to 80 mfd over-all capacitance range. Smallest size is .080 x .203 inch; largest is .134 x .812 inch. BULLETIN 148.

QUALITY Components **OHMITE®** Manufacturing Company 3610 Howard Street, Skokie, Illinois

RESISTORS RELAYS TAP SWITCHES RHEOSTATS TANTALUM CAPACITORS R. F. CHOKES VARIABLE TRANSFORMERS DIODES

## MILITARY ELECTRONICS SPENDING Fiscal Years 1960-1959

	Expenditures (Shipments) (in \$ Billions)		New Appropriation Requests (in \$ Billions)	
	FY '60	FY '59	FY '60	FY '59
<b>Aircraft Electronics</b> .....	1.7	1.6	1.6	1.6
<b>Missile Electronics</b> .....	1.3	1.2	1.0	1.1
<b>Shipborne Electronics</b> .....	0.144	0.126	0.117	0.180
<b>Other Electronics &amp; Communications</b>	1.1	0.735	1.4	1.2
<b>R&amp;D Electronics</b> .....	0.650	0.575	0.675	0.650
<b>Total Military Electronics</b> .....	<b>4.9</b>	<b>4.2</b>	<b>4.8</b>	<b>4.7</b>
<b>Total Military</b> .....	<b>14.6</b>	<b>14.2</b>	<b>14.4</b>	<b>15.3</b>

Here's a breakdown of increases in Pentagon programs that produce big contracts and subcontracts for electronics firms

# Budget: Record \$ for Us

**Federal military electronics spending for fiscal 1960 will hit \$4.9 billion—about 17 percent over current rate. Electronics and astronautic projects are key programs being pushed**

WASHINGTON — The Defense Dept. budget for fiscal 1960, starting next July 1, lays out plans for spending some \$4.9 billion on military electronics—a record rate running roughly 17 percent over current spending.

The sum—reflecting the rate of shipments from producers and research and development effort—is based on unofficial Pentagon estimates that 25 percent of aircraft production, 35 percent of missile production, 9 percent of shipbuilding, and 25 percent of R&D costs involve electronic equipment.

Over-all, next year's defense budget totals \$40.9 billion in expenditures, up \$145 million over the current rate of spending. Electronics stands out with missile and astronautic projects as the key programs to be pushed in fiscal 1960.

The outlook is for a congressional drive to tack on extra funds to the new defense budget. Electronic items are certain to figure prominently in any push for more military money.

In addition to the Pentagon's plan for increased electronic spending, procurement of elec-

tronic equipment by federal civilian agencies will also be boosted. The acceleration of civilian-directed space exploration, federal-financed modernization of the nation's civil airways system, and the growing use of electronic data-processing machines by the government in general, are key factors in the over-all rise in Washington's stepped-up electronic buying.

### Services' Plans

• **Army**—Plans to buy \$1.4 billion worth of military hardware—\$100 million more than this year. Of this sum, \$538.3 million is earmarked for missiles—of which 35 percent is likely to be spent on electronic apparatus.

Although the Army doesn't break down its other hardware purchases by item, its procurement program includes increased sums for fire-control equipment, airborne electronic gear, ground communications systems, radar warning equipment, data-processing machines, and other types of both fixed and portable electronic equipment.

• **Navy**—Plans for procurement

of aircraft, missiles, and related equipment total \$2.1 billion for next year, \$200 million under this year's volume of new orders.

But the amount earmarked for major electronics will rise from \$124.4 million to \$160.3 million. Funds will be spent on new air search radars; advanced submarine-borne communications gear; variable-depth underwater sound equipment for submarine detection by surface vessels; and new electronic countermeasure gear with "unique capabilities."

• **Air Force**—New orders for aircraft will drop from \$4.7 billion to \$4.6 billion—with an increasing chunk of the dollar (roughly 25 percent) to be spent on airborne electronics. Missile orders will be pushed from \$1.2 billion to \$2.6 billion—with roughly 35 percent earmarked for electronics.

New orders for ground communications and electronics will rise from \$710.2 million this year to \$870.4 million. At least one-third of ground electronic procurement funds will go for the Ballistic Missile Early Warning and Sage air defense system.



How the COPPER METALS can often help  
you resolve the dilemma of...

# MINIATURIZATION VS. TEMPERATURE

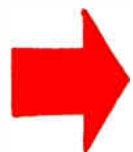
The miniaturization of many electronic components and systems has precluded many of the old materials of design -- but not copper. The centuries-old properties of the copper metals seem to become more important and more useful with each new design achievement.

Control circuits and connections must, of course, be miniaturized along with components, and here copper's conductivity is vital. Also, the resultant problems of temperature and production are bringing new importance to other properties of copper and its alloys:

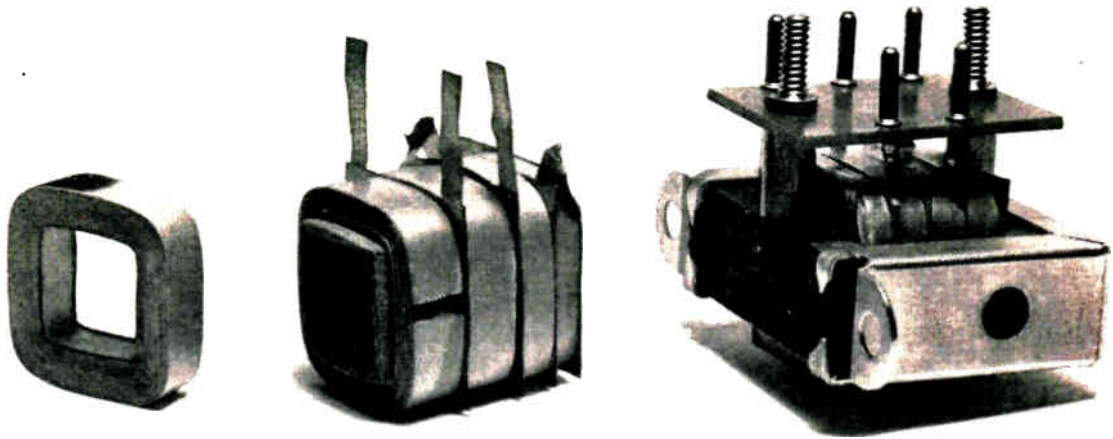
At higher ambient and operating temperatures, chemical stability becomes critical. High-purity copper or one of the special corrosion-resistant alloys often solves the problem. Copper's thermal conductivity is often used to protect delicate parts from high temperatures, and to reduce electrical conductivity losses due to higher operating temperature.

In production, the good joining properties of copper become essential. Connections can be resistance-welded without melting the minute parts, or readily dip soldered or spot soldered. Ductility helps, too. Many applications depend on thin-gage copper foil that must be uniform in thickness and free of discontinuities.

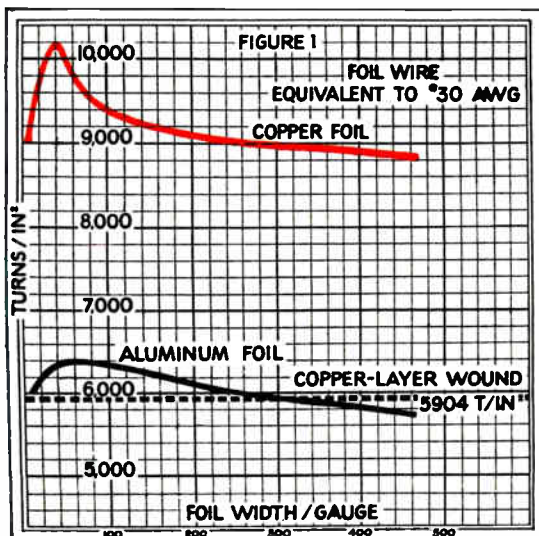
For these reasons, the copper metals are making news in this era of smaller sizes and higher temperatures. On the following pages are a few examples...



# COPPER meets both size



**REDUCED ONE-THIRD.** Ribbon-type wafer coil, assembly of coils with soldered leads brought out, and assembled transformer with leads connected directly to the terminal board – all shown actual size. Copper ribbon decreases weight and volume of the transformer by about one-third because of its high conductivity and optimum stacking factor.

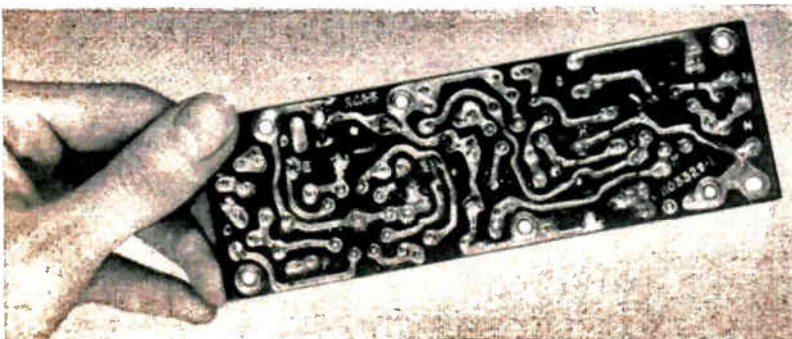


**COMPARISON OF TURNS/AREA FACTORS** of copper and aluminum foil equivalent to No. 30 AWG magnet wire. Copper ribbon permits significant miniaturization, and increases the efficiency of the transformer at the higher ambients caused by miniaturization.

## Design Problem— Miniature foil transformer

Miniaturization of transformers is brought to the level of other system components by the use of ultra-thin gage copper ribbon as a conductor. The design requirements included a one-third reduction in size and weight, ability to withstand the resultant higher operating temperature, and *mechanized* production. The answer called for high-purity rolled copper.

This copper has the tensile strength (57,000 psi) and ductility to make ultra-thin ribbon practical. It is available in production quantities in gages as thin as .0005". It can be wound into wafer coils with an exceptionally high space factor. High electrical and thermal conductivity are, of course, also important, as are the high melting point and oxidation temperatures of the metal. (Photo, and graph courtesy American Machine & Foundry Company)



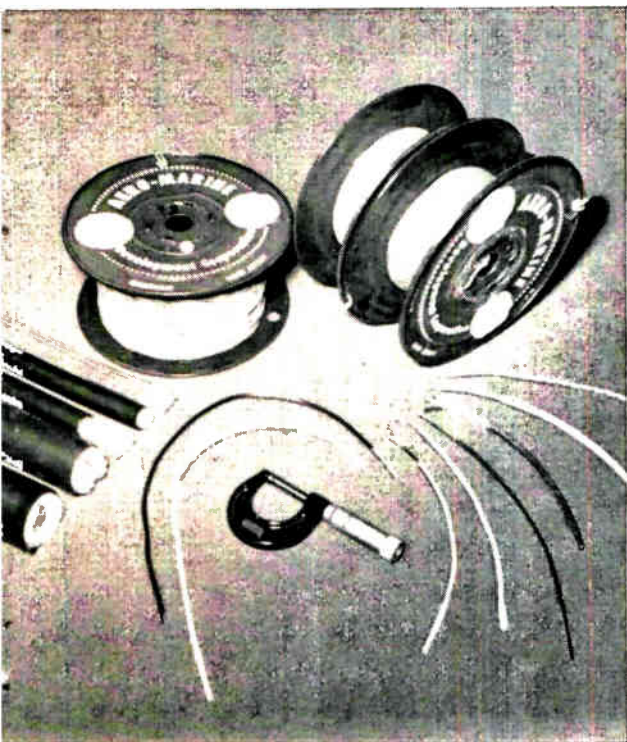
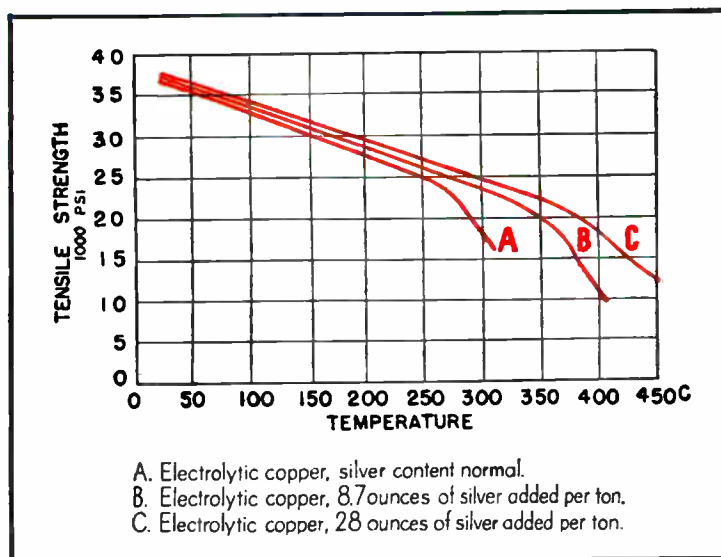
## Design Problem—Printed circuits

**THE BASIS OF MINIATURIZATION** is frequently a printed circuit. You need a good electrical conductor, of course, with good bonding properties, uniform thickness and freedom from impurities or discontinuities. Here, again, copper plus imagination meet the design requirements. Copper's soldering properties simplify production, too. The photo shows the back of a printed circuit after automatic dip soldering.

# and temperature requirements

## Materials Problem— Strength vs. temperature

**STRENGTH RETENTION AT ELEVATED TEMPERATURES** is improved by the addition of small amounts of silver, chromium or zirconium to electrolytic copper. Applications include windings, collector rings, commutators and other parts subject to heavy loads or high ambients, where both conductivity and strength are important. The graph represents strength tests of silver-bearing copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.

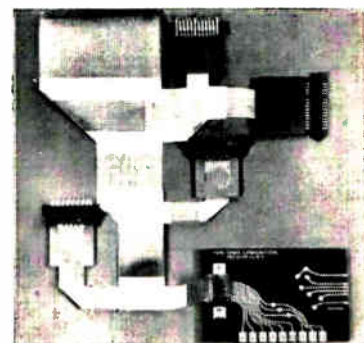


## Design problem—High temperature wire

700 to 800°F is the operating range of a Teflon-insulated wire recently announced by Aero-Marine Development Corporation. For dependable performance, the conductor had to have good impact strength and creep resistance. It could not deteriorate at high temperatures. The answer was oxygen-free, high-conductivity copper. Its good high temperature characteristics are enhanced by its freedom from oxygen traces. This purity, protected by impervious Teflon, eliminates oxidation and scale formation and reduces conductivity losses.

## Design problem—minimum weight, minimum bulk connections

**FLAT, FLEXIBLE** 50-conductor wiring harness of Tape Cable. This tape weighs only 2½ pounds per 100-ft. roll. The standard size of each of the rectangular copper conductors in the tape is 0.0015 in. by 0.03 in. Conductivity, ductility and good high-temperature characteristics are vital with such small cross sections.



## Design Problem—Yours

Whenever you need a multi-function material — for miniaturization *plus* temperature stability, for reliability *plus* workability, you should investigate the copper metals. The Copper & Brass Research Association, 420 Lexington Avenue, New York 17, New York, will be happy to cooperate in your investigation.

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Manufacturers of electronic equipment have come to depend on Curtis for precision-made non-magnetic universal joints of 18-8 Type 303 stainless steel, in the sizes most frequently used in the industry. Other sizes are also readily available; also bronze joints.

Curtis joints benefit by a rigid insistence on uncompromising inspection and quality control at every stage of manufacture, insuring minimum backlash.

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# New Electronic Gear

Sales of equipment for pleasure craft have soared 230 percent in 5 years. For '59: New key market, design trends



Transistorized 20-w unit is Raytheon's radiotelephone. Depth sounder is on right

NEW YORK—A close look at the new, impressively-styled, electronic marine gear shown at the 49th National Motor Boat Show here in the Coliseum last week reveals a number of important market and design trends.

Industry has no doubts about the continued expansion of all sectors of the marine market—ocean vessels, pleasure boats, commercial fishing vessels and work boats. Faith in new business is shown by the expanded product lines exhibited by established marine gear firms and by the number of new firms that have entered the field.

Most of the gear on display at the show was designed for the ever-growing fleet of pleasure boats. Boat sales in this category have jumped 130 percent over the past five years and electronic equipment for them, almost double that.

### Sees Sales Boost

Bendix pegs industry's gross from the recreational boat market

last year at \$10 million—mainly for sonar, radiotelephones, radio direction finders, radar and autopilots. Increase expected this year: 15 percent.

Bendix also predicts a big jump in sales to the commercial fishing business, particularly for radar and special sonar.

Reasons for the large buildup in the pleasure boat market include: bigger incomes, fact that banks will now finance boats, and the improved power of new outboard motors.

Increased performance of outboards has widened the small boat market. Expensive inboards are no longer a requisite for high-performance boating.

A healthy interest in both safety and convenience has helped build up electronic sales in the recreational field, as well as the other categories. Free courses offered by the U. S. Power Squadrons and the U. S. Coast Guard have made many private owners safety conscious.

Since outboards make up 71 per-

# for Boats

cent of the current pleasure boat fleet, designers have focused their attention on that market. Here are some features the small boat owner wants in electronic equipment design, and is getting:

Smart styling and simple "one knob" operation are necessary for sales. Increased number of women buyers, or buyers influenced by women, has turned thumbs down on drab, functional black boxes.

## Less Maintenance

Other features being stressed include miniaturization and reliability. Transistorization has made possible small, lightweight gear that is detachable and portable. Maintenance needs are also fewer.

Power requirements are kept low to reduce drain on the boat's battery. Also popular with buyers are self-contained units equipped with their own batteries.

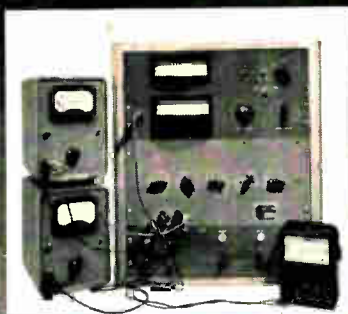
Most exhibiting firms are offering radiotelephones, neatly designed, lightweight, and some of them transistorized. Raytheon, showing 12 new electronic products, is expecting large volume sales from radiotelephones and from the firm's new low-priced depth sounder and recorder. Raytheon is also offering for the first time an electronic automatic pilot.

RCA named four products that should bring in big sales: 8-lb radiotelephone, 22-lb depth recorder, electronic megaphone and transistorized radio direction finder.

Bendix is offering at least eight new or improved products including autopilot, depth recorders, radiotelephones, portable generators and inverters and a short-range radar indicator.

Aiming at the new outboard market, Sperry is offering a low-priced radio direction finder and a 5-in radar that will retail for around \$1,495. Future plans include a 3-in radar scope that will sell for under \$500. For larger boats, Sperry is offering a 38-lb loran unit with a 3-in scope, a new autopilot and an engine analyzer.

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with trio labs' BUILD-IN instruments*



**BEFORE** . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.



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AC VTVMs \$160.



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ruggedized  
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J Series  
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multi-range  
DC VTVMs \$450.



**COMMERCIAL**

E Series  
Single-range  
AC VTVMs \$99.50



Model 109-1  
low-level  
multi-range  
AC VTVM \$199.



F Series  
single-range  
DC VTVMs \$84.50



Model 125-1  
Null Meter \$125.



By building-in trio labs' panel-mounting instruments you . . . customize test systems, set-ups and instruments; save space (average model is 4" x 4" x 4"); save time with at-a-glance monitoring; save money; make monitoring foolproof ("go-no go"); improve system reliability; increase overall design freedom. Choose from many "standard" or "special" models — or consult us for new designs for your needs. Write for free "how to" Engineering Guide to Dept. E-1A.

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Trio Laboratories, Inc. Plainview, Long Island, New York

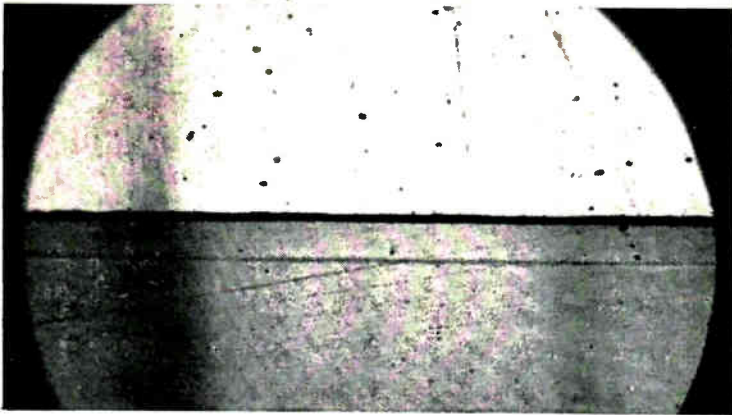
News about

**RAYTHEON'S**

**SEMICONDUCTOR DIVISION—the place for the man**

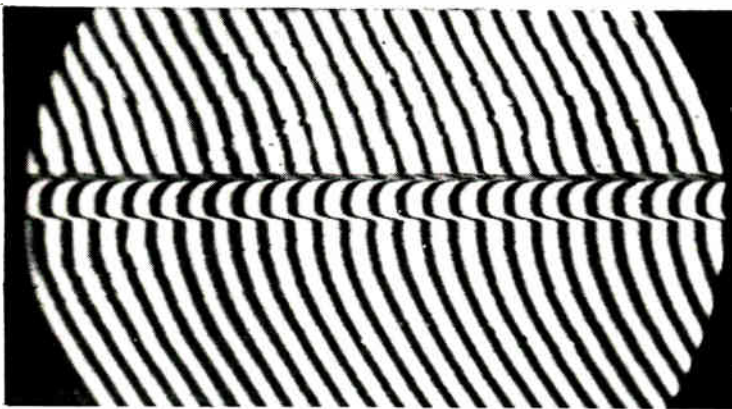
**who is growing faster**

**than his associates**



Bright Field ↑

↓ Interference



INTERFERENCE FRINGES are useful in determining slight changes in elevation and measurement of thin coatings such as those that might be laid down by vacuum evaporation. The above photomicrographs (112x) show gallium diffused silicon used in making Raytheon diffused base NPN silicon high frequency transistors. The silicon is at the bottom of each picture. The depth of the gallium penetration is .0007". The height of the junction step after etching is .0000088". The bright field picture shows how the junction looks normally under a metallurgical microscope. The interference picture shows how this same junction looks under an interference microscope.

**STRICTLY IN CONFIDENCE . . .**

If you would like to explore the growth possibilities for yourself, please send your resume to Mr. Allen Moorhead, RAYTHEON MANUFACTURING COMPANY, Semiconductor Division, 150 California Street, Newton 58, Mass.

Here is where transistors were first mass-produced to open up the fast-growing semiconductor industry... where a major "all-out push" is under way... where 1,008 new people were added in the last half of 1958... where 220,000 sq. ft. of new modern facilities are being added... where management says: "Here are the tools you asked for!"... where men with growth potential play a *recognized* role.

In the major league now with a broad line, Raytheon's Semiconductor Division will continue to be a leader in the research, engineering and manufacture of semiconductors.

For the man who is growing faster than his present associates and who seeks diversified assignments, there are exciting growth opportunities in:

- **Device Design and Development**
- **Material Development**
- **Product Design**
- **Product Evaluation**
- **Mechanization**
- **Automatic Electronic Testing**
- **Application Engineering**

If you are looking for a place to grow faster, there's plenty of elbow-room for you at Raytheon's Semiconductor Division.

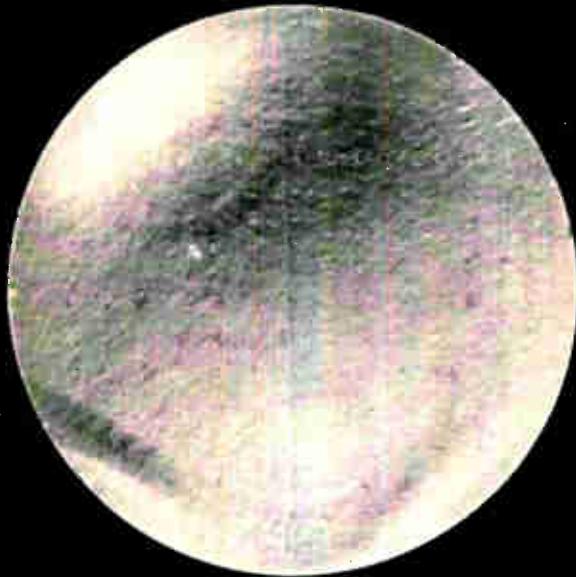
*"The place for the man who is growing faster..."*  
**SEMICONDUCTOR DIVISION of**



*Excellence in Electronics*

# USE **Coors** CERAMICS

**WHERE YOU WANT RELIABILITY**



### USE THIS

This is an unretouched photo of a broken 3" thick section of Coors high alumina ceramic, formed by the *Isostatic Process*\*. It fractured smoothly and shows a completely homogeneous structure. There are obviously no voids or hidden stresses to cause failure.



### NOT THIS

This is an unretouched photo of a broken 3" thick section of high alumina ceramic, formed by the conventional wet process. It clearly shows typical voids and hidden stress patterns inherent in all conventionally made, wet process ceramic parts.

## **COORS TECHNIQUE PRODUCES UNIFORM PARTS WITH NO HIDDEN VOIDS OR INTERNAL STRESSES**

Design uncertainties of ceramic strength and uniformity are completely eliminated by the use of Coors Alumina Ceramics formed by the *Isostatic Process*\*. There are no variations in properties between one ceramic part and another. This is the only ceramic forming technique that can guarantee uniformity between ceramic parts.

Outside of the spark plug field, Coors has pioneered in isostatically forming high alumina ceramics. In this forming technique, blanks are initially produced by pressing dry, unfired powder in a rubber mold under high

hydraulic pressure. An accurate inside contour can be formed by pressing the powder around a metal arbor. The uniform pressure from all directions provides uniform compactness and complete homogeneity. The final outside shape is formed by machining the blanks.

In a wet process, the ceramic parts, once formed, must be dried. This drying action causes hidden stresses to develop. And finally, the volume occupied by the water is replaced by air, forming hidden voids and weak spots.

Since the powdered ceramic material used in the *Isostatic Process* is dry be-

fore it is formed, the machined blanks go directly into the high temperature kilns. Unpredictable drying necessary in wet processes is thus eliminated.

With Coors Alumina Ceramic parts made by the *Isostatic Process*, the engineer can accurately design for mechanical and electrical properties—an impossibility with any ordinary methods of forming ceramic. For complete mechanical and electrical properties, send the coupon below. Parts to test your design will be furnished at nominal cost.

\*Coors Porcelain Company operates under license for this patented process from Champion Spark Plug Company, Toledo, Ohio.

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# New Indium-Bonded Computer Diode Design Proves More Reliable

The diameter of the whisker in new CBS-Hytron indium-bonded diodes is 2.5 times that of other bonded diodes. And the sharp point of the whisker is pressed against the germanium under a force 32 times greater. This results in a contact pressure of about 400,000 pounds per square inch. More positive contact is assured during manufacture, installation and use.



Computer diodes must be reliable . . . with a small fraction of 1% failures. Opens and shorts usually account for the majority and CBS-Hytron indium-bonded junction diodes are designed to eliminate them. That they do is proved daily by CBS-Hytron shock and vibration tests more severe than military tests. And by freedom from failure in actual equipment.

## Now 49 types

Type	Min. Forward MA @ +1V	Reverse Recovery KΩ	Reverse Recovery μS	Reverse Ohms	Resistance -Volts	Type	Min. Forward MA @ +1V	Peak Reverse Volts	Reverse Ohms	Resistance -Volts
<b>COMPUTER</b>						<b>HIGH CONDUCTANCE</b>				
1N276	40	80	.3	500K	10-50	1N107	150	15	50K	10
1N631	100	80	.3	500K	10-50	1N273	100	30	1M	20
1N632	7.5	50	.3	500K	10-60	1N279	100	35	100K	20
1N633	150	25	.3	500K	40-90	1N281	100	75	100K	50
1N699	100	50	.3	300K	75, 70°C	1N283	200	20	500K	10
1N770	15 @ .5V	15	.35	250K	10, 40°C	1N454	200	75	1M	50
	Min. Forward MA @ +1V	Peak Reverse Volts		Reverse Ohms	Resistance -Volts	LD-70	100	15	120K	10
						LD-123	100	35	280K	20
						LD-130	200	60	1M	15-50
						LD-142	200	100	200K	100
<b>HIGH REVERSE RESISTANCE</b>						<b>GENERAL PURPOSE</b>				
1N99	10	100		1M	5-50	1N95	10	75	62K	50
1N100	20	100		1M	5-50	1N96	20	75	62K	50
1N289	20	85		1M	50	1N108	50	60	250K	50
1N449	50	50		1M	10-30	1N117	10	75	500K	50
1N452	100	50		1M	30	1N118	20	75	500K	50
1N497	100	30		1M	20	1N287	20	60	33K	50
1N498	100	50		1.6M	40	1N288	40	85	140K	50
1N499	100	65		1.6M	50	1N292	100	75	250K	50
1N500	100	75		1.5M	60	1N298	30 @ 2V	85	160K	40, 50°C
						1N447	25	50	500K	10-30
<b>HIGH VOLTAGE</b>						LD-71	2 @ .4V	15	500K	12
1N97	10	100		500K	50	LD-125	10	75	100K	50
1N98	20	100		500K	50	LD-141	20	80	100K	10
1N291	40	120		1M	100	LD-143	40	75	500K	50
1N448	25	120		1M	30-100					
1N450	50	120		1M	30-100					
1N453	100	120		1M	30-100					
1N634	50	115		1M	45-100					
<b>ELEVATED TEMPERATURE</b>										
1N277	100	125		300K	50, 75°C					
1N278	20	60		330K	50, 75°C					
LD-134	10 @ .45V	40		187K	10, 65°C					

Many types have been added to meet growing demand for these inherently more rugged and reliable diodes. Check the 49 types in six major classifications. Order the ones you need . . . or write for Bulletin E-314 giving complete data . . . today.



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# Soviets Rush Computers

Seven-year plan calls for rise in unit output by 4½ times; cybernetics stressed

SOVIET COMPUTER manufacture will increase more than 4½ times by 1965, Tass said recently in reporting new details of the USSR's seven-year economic plan. This goal is said to be the pace required to meet the automation requirements set forth by Premier Khrushchev.

To achieve this, the Russians are leaning heavily on theory as they have in the earth satellite race. In fact, Tass says that the principal means of "achieving 100 percent automation in various branches of industry and transport services" will be "a comprehensive theory of cybernetics." The USSR Academy of Sciences is now working on the theory.

"Self-adjusting systems, designed on the basis of the theory," says Tass, "will be able to analyze the most intricate processes and to indicate the most economical operating conditions to the performing parts."

"A small number of devices, replacing the ever-increasing number of instruments controlling separate values, will control a single composite index such as the specific consumption of raw material, efficiency or the quality of the finished product."

## Railroad Uses

Report suggests the Russians are moving faster than the U. S. in replacing train engineers with control devices and slower in applying large-scale electronic control systems for railroads.

This year, says Tass, underground and suburban electric trains will be run by "automatic drivers" as the first step in automating transportation. Next transportation application of cybernetics will be electronic controls for locomotives and freight yards.

High-speed electronic computers designed for more than 10,000 arithmetical operations a second, and with a bigger memory than present units, will be manufactured

"on a large scale," says Tass. One such machine is said to be operating at the computer center of the Academy of Sciences.

## High-Speed Computers

General-purpose computers capable of 20,000 and 100,000 operations a second are also contemplated, along with even faster special-purpose computers.

Cybernetic theory will be applied most widely, according to Tass, in steel making, power engineering, chemical plants and transport.

Steel-sheet rolling mill application is planned. Electronic controls will operate flying shears used for trimming metal and will eliminate waste. Ingot pit operations will also be computer-controlled, says Tass, with 10 parameters taken into account by a cybernetic machine.

## Stereo Record Standards Set

STANDARDS for stereophonic records have now been approved by the board of directors of the Record Industry Association of America.

Definition arrived at by the group is:

"A true stereophonic disk record has two distinct orthogonal modulations derived from an original live recording in which a minimum of two separate channels were employed."

The association's engineering committee further recommends that all stereo disks conforming to RIAA specs be identified as such on the label or the record jacket.

Association spokesmen say many manufacturers will emphasize the distinction between stereo and monaural disks by also using labels reading "monophonic" or "monaural" for single-channel records they make.



## TRANSISTORIZED D-855 GAUSSMETER

- Complete portability for use in field or lab
- Reads flux fields up to 30,000 gauss
- Can be equipped to read Earth's field flux density
- Probe is only .025" thick
- Active area of probe .01 square inches
- Fully transistorized
- Power Supply: selective from 105-125 volt 50-60 cycle line or internal batteries
- Net weight: 8-3/4 lbs.
- Overall size: 13-1/2" high, 8-3/4" wide, 7-1/4" deep

Precision built, completely transistorized, the new D-855 Gaussmeter accurately measures flux density and determines "flow" direction. Ideal for measuring and locating "stray fields", plotting variations in strength and checking production lots against a standard. It's simple to operate. The Dyna D-855 doesn't require jerk or pull, gives no ballistic reading. Can be operated in the field with batteries which are enclosed in rugged protective carry case. This is an improved version of the pioneering D-79 Gaussmeter (Pat. #2,707,769) which has modernized magnetic flux measurement for the past six (6) years.



CIRCLE 34 READERS SERVICE CARD

# BIRD

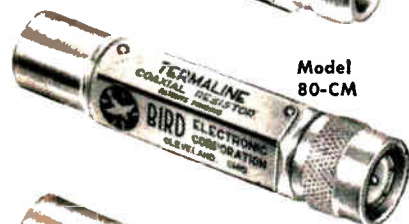
## "Termaline" 50 ohm Coaxial Line 5-WATT LOAD RESISTORS



Model  
80-M



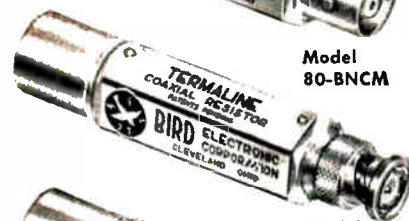
Model  
80-F



Model  
80-CM



Model  
80-CF



Model  
80-BNCFM



Model  
80-BNCF

### A Known Factor

In measurements of 50-ohm coaxial systems, the Bird 5-watt coaxial terminations provide a known factor.

As primary test equipment in field or laboratory, they are used as . . .

- 50-ohm impedance standards;
- terminations for slotted lines;
- measurements of filter characteristics.
- terminations for insertion loss measurements, and;
- other measurements where an accurate and reliable 50-ohm termination is required.

The low VSWR of the 5-watt "Termaline" resistors, their ability to withstand vibration, and their compactness in size makes their use applicable to a variety of electronic systems where a reliable 50-ohm termination is required.

### SPECIFICATIONS

**POWER RATING:** 5 Watts Max.

**NOMINAL IMPEDANCE:** 50 ohms

**USEFUL FREQUENCY RANGE:** 0 to 11,000 mc

**VSWR:** 1.2 Max. to 4000 mc  
1.1 Max. under 1000 mc

**SPECIAL VSWR:** Can be provided

**OPERATING POSITION:** Any

**CASE:** Brass **FINISH:** Silver Plated

**LENGTH:** 3-3/8" Max.

**WIDTH:** 11/16 Hex.

**WEIGHT:** 4 ounces

#### OTHER BIRD PRODUCTS



"Termaline"  
RF Load  
Resistors



Coaxial  
RF Filters



"ThruLine"  
Directional  
RF Wattmeters



Coaxial  
RF Switches



"Termaline"  
RF Absorption  
Wattmeters

## MEETINGS AHEAD

Jan. 29-30: Long Distance Transmission by Waveguides, Institution of Electrical Engineers, London, England.

Feb. 1-6. American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, N.Y.C.

Feb. 12-13: Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Penn., Philadelphia.

Feb. 12-13: Electronics Conference, AIEE, IRE, ISA, CPS, Eng. Soc. Bldg., Cleveland.

Feb. 16-20: Western Audio Convention, Audio Eng. Soc., Biltmore Hotel, Los Angeles.

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, Los Angeles.

Mar. 5-7: Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.

Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad Hilton Hotel, Chicago.

Mar. 23-25: Flight Testing Conf., ARS, Daytona Beach, Fla.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 26: Quality Control Clinic, ASQC, Univ. of Rochester, Rochester, N. Y.

Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N.Y.C.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, Department of Electrical Engineering, College Station, Tex.

Apr. 14-15: Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 78.



**BIRD ELECTRONIC CORP.**  
Express 1-3535  
1800 E. 38 St., Cleveland 14, Ohio  
Western Representative:  
VAN GROOS COMPANY, Woodland Hills, Calif.



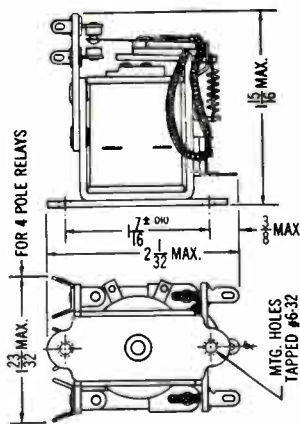
## KL-A VERSATILE, RELIABLE, LOW COST P & B RELAY for communications and automation

**ECONOMY** and versatility distinguish our KL series relays. Contact arrangements are available up to 4 pdt in either AC or DC versions. Sensitivity of 100 milliwatts per movable arm is available.

Stationary contacts and terminals are mounted on a phenolic front of high dielectric strength, thus adding to the utility of the relay. Conveniently located terminals and easy-to-mount base greatly simplify installation on long production runs.

KL relays may be hermetically sealed or furnished in metal dust covers.

This is one of a "family" of fine P&B relays. Others, with similar configurations but various electrical and switching capacities, are shown below. Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



### KL ENGINEERING DATA

**GENERAL:** Breakdown Voltage: 500 volt rms, 60 cycle between all elements standard 4 pole relay; 1500 volts rms, 60 cycle on special 3 pdt relay.

Temperature Range:  $-45^{\circ}\text{C}$ . to  $+85^{\circ}\text{C}$ .

Pull-In: Approx. 75% of nominal dc voltage.

Approx. 78% of nominal ac voltage.

Terminals: Pierced solder lugs for two #20 AWG wires.

Enclosures: Metal can  $2\frac{3}{8}$ " high x  $2\frac{1}{8}$ " long x  $2\frac{1}{16}$ " wide with actal plug or multiple solder header.

**CONTACTS:** Arrangements: up to 4 pdt.

Material:  $\frac{1}{8}$ " dia. gold-flashed silver. (Others available.)

Load: 5 amps @ 115 volts, 60 cycle resistive loads.

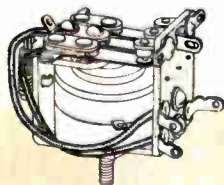
**COILS:** Resistance: 60,500 ohms max.

Power: 100 milliwatts per movable arm.

Duty: Continuous; coils will withstand 6 watts @  $25^{\circ}\text{C}$ .

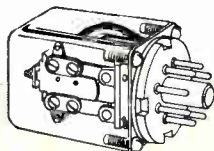
Voltages: up to 110 volts dc.  
up to 230 volts ac.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



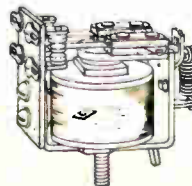
**KR SERIES: SMALL, 5 AMP RELAY**

Ruggedly constructed for long life and dependability. Available up to 3 pdt.



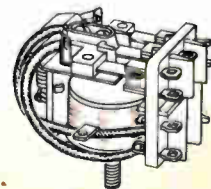
**KCP SERIES: SENSITIVE 3 PDT RELAY**

Far plate circuit applications requiring low cost, sensitive relay. Polyethylene dust cover.



**KT SERIES: ANTENNA RELAY**

Insulated to minimize RF losses. Designed to switch 500 watts RF input to 300 ohm line.



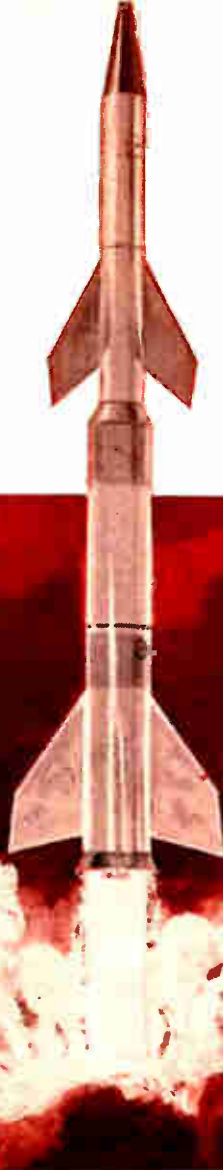
**KA SERIES: GENERAL PURPOSE**

Compact, light-duty relay. U/L approved. Meets 1500 volts rms breakdown requirement.



# POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

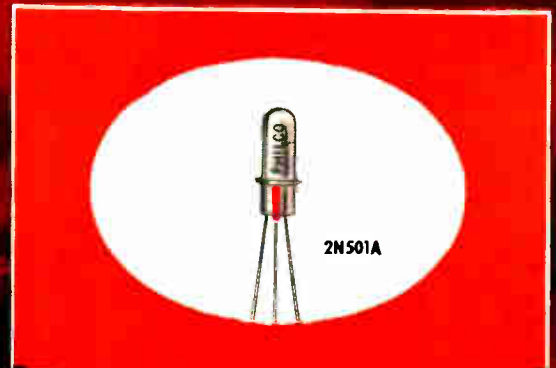


# PHILCO

## MADT\* Transistors

# RATED AT 100°C

## deliver outstanding switching performance



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

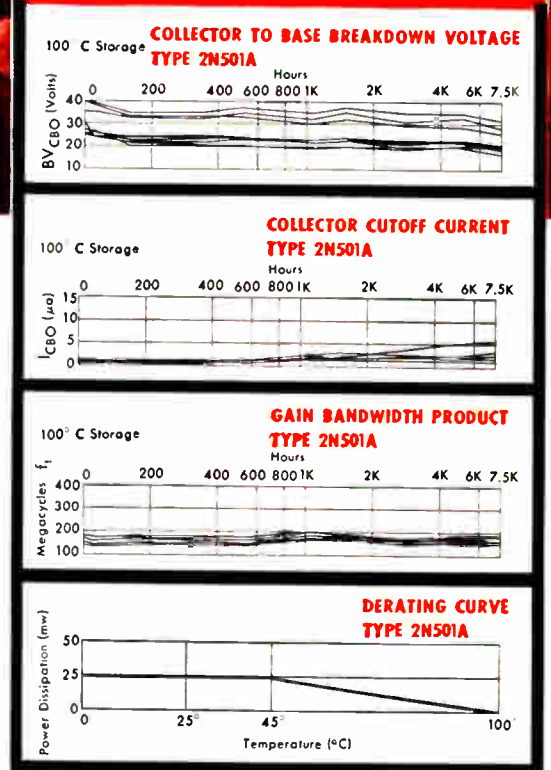
Modern advances in electronics necessitate highest possible temperature performance from germanium transistors. Philco 2N501A transistors are designed for switching speeds of less than 18 milli-microseconds rise time, 12 mμsec. storage time and 10 mμsec. fall time . . . AND STORAGE TEMPERATURES UP TO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

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

*Make Philco your prime source for all Transistor information.*

Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. E 159

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

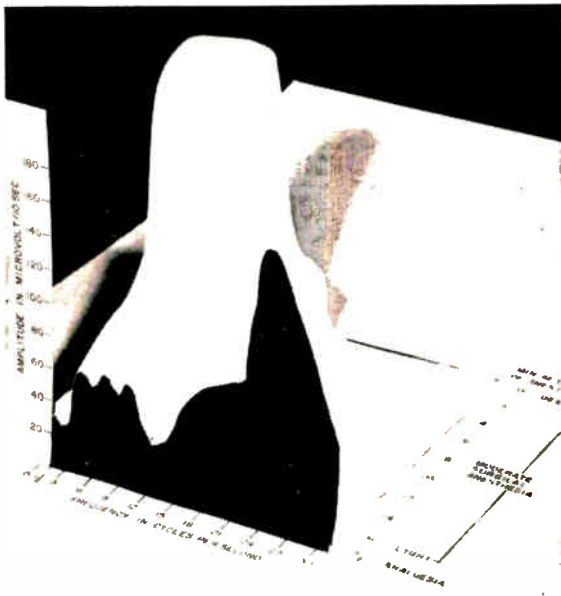


# PHILCO CORPORATION

## LANSDALE TUBE COMPANY DIVISION

### LANSDALE, PENNSYLVANIA





Three-dimensional model shows frequency components in the eeg spectrum. Vertical ordinate represents electrical activity, abscissa covers frequency range, and ordinate shows depth of anesthesia

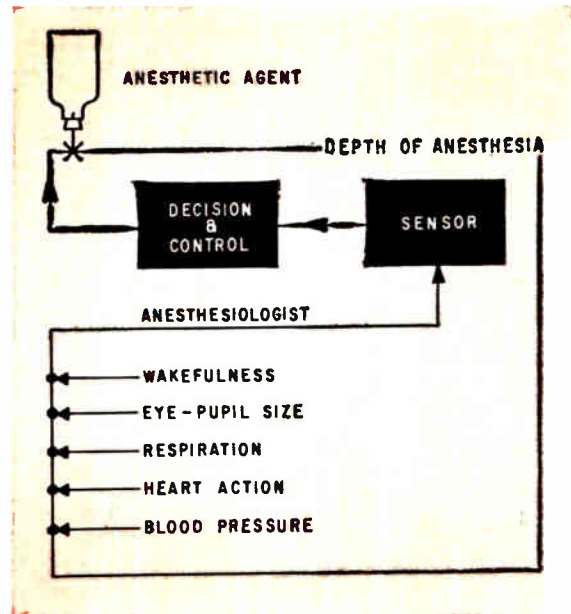


FIG. 1—Administration of anesthetic agent is ordinarily accomplished by a trained anesthesiologist who observes the patients condition and regulates the amount of anesthetic being administered

# How Electronics Controls Depth of Anesthesia

Automatic controls continuously monitor border-of-wakefulness of patient who is undergoing a surgical operation. Servo-driven system supplies anesthetic at a fixed level, proportional to the cortical activity of the brain

By **J. WELDON BELLVILLE, M. D.**, Clinical Assistant Anesthesiologist, Sloan-Kettering Institute, N. Y. C. and **G. M. ATTURA**, Chief Engineer, Industrial Control Company, Ligonhurst, N. Y.

DURING THE SURGICAL PROCEDURE, a trained anesthesiologist administers the proper amount of anesthetic to the patient and carefully observes the patient's responses. Respiration rate and depth, muscle tone, blood pressure, eye-pupil size and other variables are correlated with an intimate understanding of the human body. The anesthesiologist controls the supply of anesthetic during the entire operation and varies the amount of anesthetic as indicated by the patient's condition.

Figure 1 illustrates this procedure controlled by

the anesthesiologist and lacks only an electrical signal, proportional to wakefulness, for conversion into an automatic control system.

One of the variables, the level of wakefulness, is sensed by the electroencephalograph or eeg. The eeg produces a complex electrical waveform that contains frequency components whose amplitude is a measure of the level of the patients wakefulness. If these eeg components are filtered and rectified, they can serve as the command signal to a servo system that will control the amount of anesthetic supplied

to the patient. Controlled by the eeg signals, anesthetic is supplied to the patient at a fixed rate proportional to the electrical activity of the cerebral cortex.

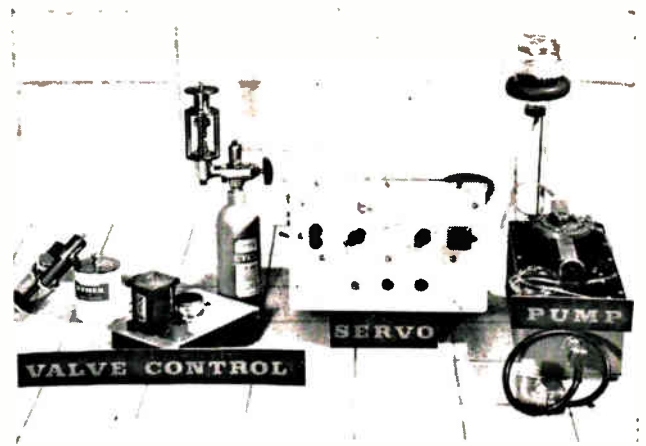
Even though this servo responds more quickly and controls the depth of anesthesia more accurately than the human operator, this device senses only one variable—the eeg signal components. The skilled anesthesiologist senses many variables and correlates his observations with the requirements of the surgeon.

**THE EEG**—The electroencephalogram, or eeg waveform, represents the summation of cortical activity. This waveform has peaks which at times reach amplitudes of  $300 \mu\text{v}$ . Epilepsy, alertness, sleep, anger and pathological brain conditions are recognized by a trained interpreter of the eeg signal. The spectrum of interest to the neurophysiologist ranges from a fraction of a cps to as high as 50 cps.

Minute voltages, generated across electrodes placed in well-defined positions on the scalp, are amplified by sensitive and low-noise electronic amplifiers and displayed on pen recorders and cathode-ray oscillographs, or recorded photographically.

Certain areas of the eeg spectrum reflect the depth of anesthesia. The three-dimensional curve in the photograph illustrates this relation. The vertical ordinate represents electrical activity, and is calibrated in  $\mu\text{v}$  of signal accumulated in a ten-second interval. The abscissa covers the range from zero to 30 cps and the remaining axis represents the depth of anesthesia. The photo shows that the patient is analgesic after 18 minutes have elapsed. If it is assumed that the level of anesthetic agent falls off at a somewhat constant rate, then the time axis becomes also calibrated in depth of anesthesia or level of wakefulness.

Data were gathered by subjecting the patient to deep ether anesthesia and measuring the spectral distribution of the eeg at specified intervals after the instant when the flow of either had stopped. As the



Equipment used for automatic anesthesia control shows the valve controls, servo and pump

level of wakefulness rises, the 24-cps activity also rises and if the rectified 24-cps signal is used, more anesthetic is administered to restore the initial level.

The electrical isolation of the 24-cps region of the spectrum as a positive index of anesthesia level for ether, and the 16-cps region as a good index of anesthesia level for pentothal or cyclopropane are important.

**SYSTEM TYPES**—The block diagrams of Fig. 2A and 2B illustrate the systems for intravenous injection of barbiturates or for ether inhalation. To be accurate, a separate servo loop establishes tight correspondence between the filtered eeg output signal, and the valve or pump motion. The fluid pump delivers a rate proportional to pump speed and requires a velocity servo to correlate pump speed to eeg output. In the other system, valve position determines the rate of flow of anesthetic agent, and requires a positional servo if the valve position is to follow the eeg output.

In each system, a reference control sets the depth of anesthesia which the system reaches in a steady

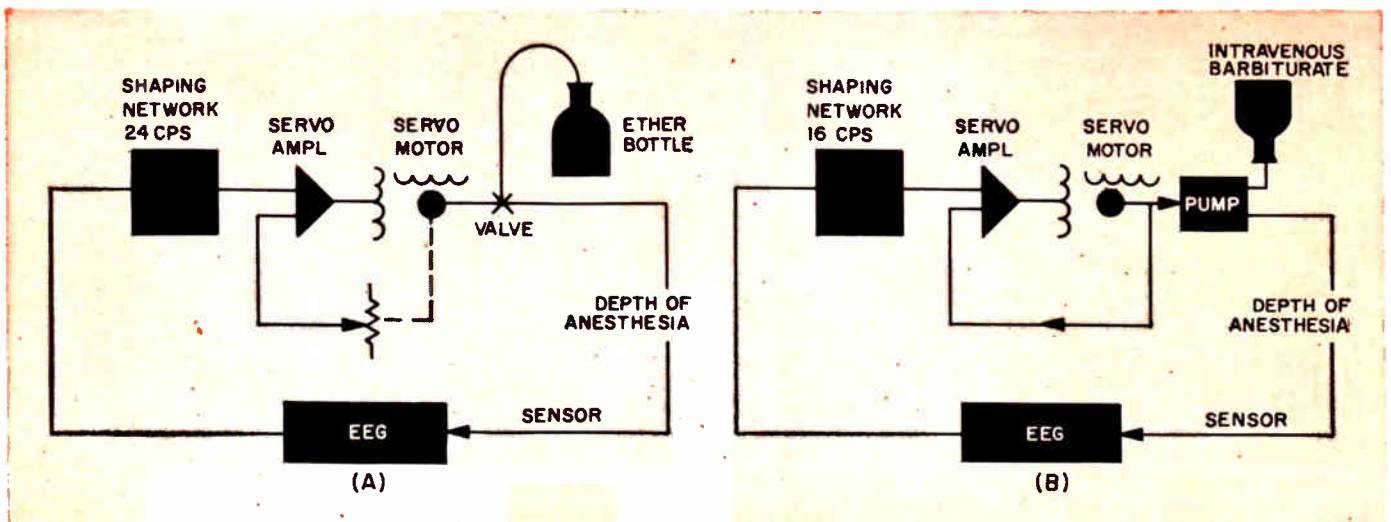


FIG. 2—Feedback loops illustrate the systems used to regulate the control of ether (A) and intravenous barbiturate (B). The eeg signal determines the level of wakefulness

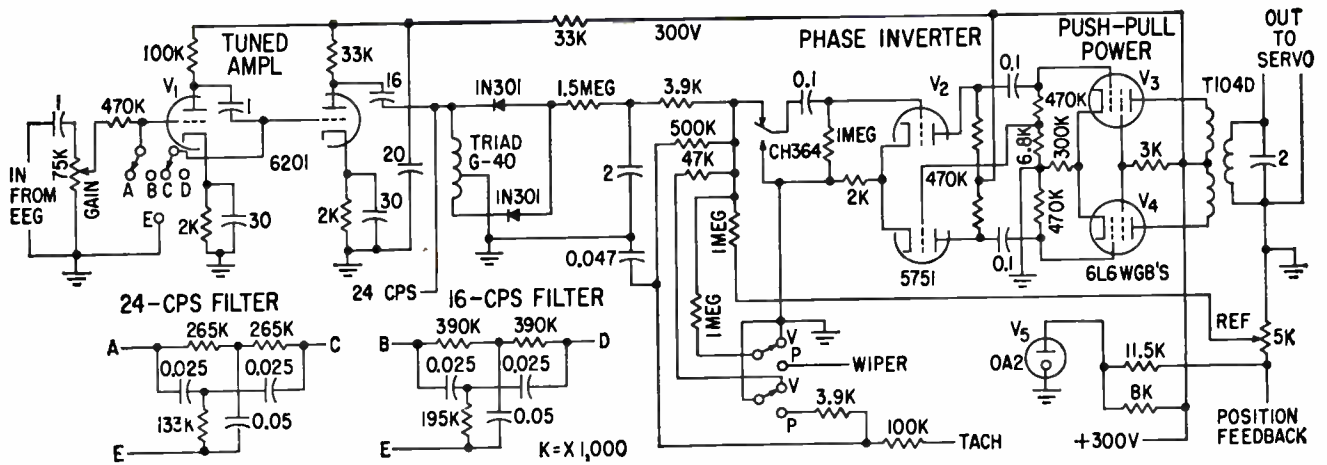


FIG. 3—Automatic anesthesia control circuit drives a servo motor in response to the signal response of the electroencephalograph and serves as the command signal for a pump or valve drive

state. If the reference control is not present, the system continues to feed the agent as long as there is any eeg activity and if the gain is high enough; dangerous high concentrations of the drug can result.

The reference control biases the system to a certain level, so that no action takes place and no drugs are injected as long as the depth of anesthesia remains at this level. By varying this control, the depth of anesthesia of the patient is varied, and the level proper for the particular surgical procedure established.

**SERVO CONTROL**—The schematic for the servo-drive amplifier is shown in Fig. 3. The shaping circuits raise the signal level from the eeg, filter out all but the desired frequency, and rectify it. The resultant d-c voltage is filtered to reduce ripple and serves as the command signal for both pump and the valve drive.

For the pump, the servo is set up in the velocity mode. The command signal from the shaping network is compared to the feedback from a precision d-c tachometer in a summing network and the resultant error used to drive the motor amplifier itself. In the positional mode, to drive the valve, the same command signal is compared to the wiper voltage of a potentiometer coupled to the valve body and excited with a d-c voltage. The servo is stabilized in this mode by feedback from the same tachometer used in the velocity mode. In both cases the reference control voltage is introduced into the summing circuits where it acts to offset the null point of the system.

**PUMP**—The pump driven in the velocity mode is a positive displacement type. This is necessary to maintain an accurate relationship between pump speed and volume of agent injected. It consists of a length of tubing arranged in a channel or raceway, connected between the source of anesthetic agent and a needle taped to the patient's arm and feeding a vein.

The pump rotor consists of a number of rollers which bear against and compress the tubing shut, so that as they turn they carry a fixed quantity of fluid with them. The system in this mode cannot be re-

versible, for if the pump were allowed to reverse its direction of rotation, it would pump the patient's blood from his vein to the reservoir of the anesthetic agent. A one-way, nonreversible clutch between the motor drive and the pump rotor prevents this condition. Actually, from a servo standpoint, the system need not be reversible for the rate of drug injection is always balanced out against the metabolic rate.

The gas valves for the inhalation agents are constructed so that there is an exact correspondence between valve opening and gas flow. They require about half a turn to go from full on to closed, and are driven by the positional servo over this span with good accuracy. To reduce the equipment concentration around the operating table, the valves themselves are driven by a servo gear box through a length of flexible cable.

**CIRCUIT OPERATION**—The anesthesia-control circuit drives a servo motor in response to the eeg output.

A two-stage tuned amplifier,  $V_1$ , with parallel-T feedback, peaks sharply at the frequency of interest. This output goes into a transformer and full-wave, amplitude-sensitive rectifier, made up of a transformer and two 1N301 rectifiers. The negative d-c voltage is closely proportional to the amplitude at the chosen frequency. This is followed by a two-stage filter.

The rest of the circuit consists of the servo amplifier and the power supply. Four channels accept and mix the command signal from the rectifier, a feedback or stabilizing signal from the potentiometer, a reference signal to set the level of operation through proper offset and the feedback signal from the external potentiometer when necessary.

These summed signals are modulated into a 60-cps a-c voltage by the chopper. The a-c signal is amplified by  $V_2$ , which drives a push-pull power stage,  $V_3$  and  $V_4$ . The output, through a suitable matching transformer, drives the servo motor.

#### BIBLIOGRAPHY

- J. W. Belleville, J. F. Artasio, Jr., Electroencephalographic Frequency Spectrum Analysis during Ether and Cyclopropane Anesthesia, *Anesthesiology*, 17, p 653, 1956.

Solid-state devices continue making inroads in the area of display and/or storage panels. A cadmium-sulfide photorectifier panel array shows promise for storage, picture quantizing, page reading and character recognition. Electroluminescent panels with photoconductive control are outlined

By RONALD K. JURGEN, Associate Editor

# Solid-State Panels for

**P**ANEL-DISPLAY and panel-storage devices are receiving considerable attention for such applications as tv screens, computer storage and amplifying X-ray panels. Among the many variations under investigation are the following: crossed-grid electroluminescent panel; persistent-emission displays combining both electroluminescent and photoconductive layers; ferroelectric displays using a variable capacitor as a control element; electroluminescent feedback storage; fiber optics and gas photorectifier arrays.

## Photorectifier Array

Under joint Army, Navy and Air Force support, a so-called photo-rectifier has been developed.<sup>1</sup> A transparent ohmic contact was applied to one surface of a sintered CdS cell and a rectifying contact to the opposite surface. The re-

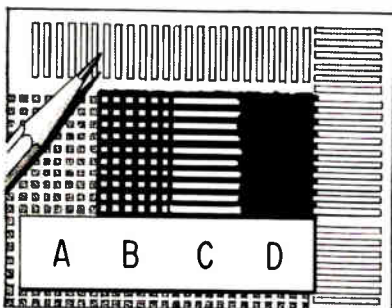


FIG. 1—Photorectifier array construction techniques

sulting photo-rectifier acts as a diode with a rectification ratio of about 1,000 when the transparent conductor is exposed to illumination. In the dark, the photo-rectifier (unlike a photodiode) is an open circuit or, more precisely, a linear resistance with a value of hundreds of megohms.

Arrays of the photo-rectifiers can be constructed in an X-Y matrix fashion with packing densities of more than 256 per sq in. Logical networks for computers can be connected by selecting the required photo-rectifiers in an array with an appropriate light mask. The only action necessary to change the network is to change the mask. This flexibility eliminates the need for soldering diodes into the array. A punch card or a photographic negative can be used as the mask.

If a single photo-rectifier cell is four mils thick, its spectral response peaks at about 6,700 Å. It takes about 100 millise- c for the photo-rectifier to go from the high-impedance state to the diode state. Response as a diode is less than a  $\mu$ sec, permitting fast switching. Illuminated, forward impedance is 10,000 to 20,000 ohms at 10 v.

Figure 1 shows a portion of an actual array of 10 cells per in. and a total of 1,224 cells. Various stages of development are illustrated: the diced photo-rectifier on the transparent conducting strips; with the

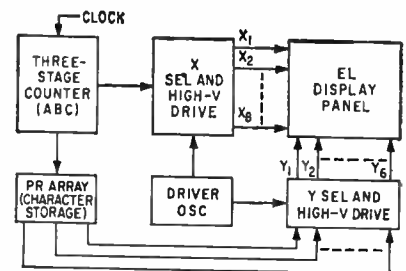


FIG. 2—Block diagram of system using photo-rectifier array and electroluminescent display panel for a character generator

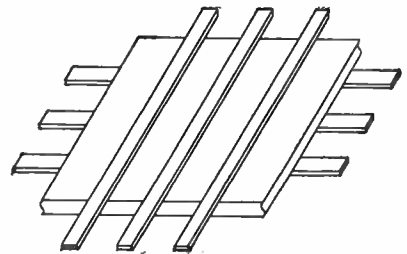


FIG. 3—Portion of a cross-grid electroluminescent panel

filler added; with the top conductor applied and with the top coating of epoxy resin applied to protect the cells from moisture.

## Control Matrix

Figure 2 illustrates how a photo-rectifier array can be used as a control matrix for a character generator. The electroluminescent panel is driven at 1,000 v peak-to-peak by ferrite switch cores used as saturable transformers. Since the cores are square-loop ferrites, they select as well as drive. The three-



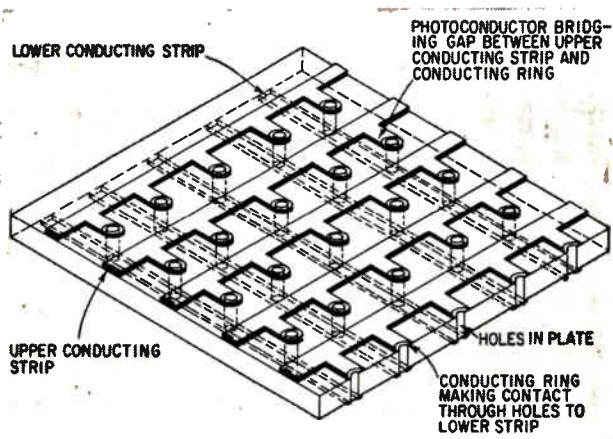


FIG. 4—Cross-grid panel employing photoconductors

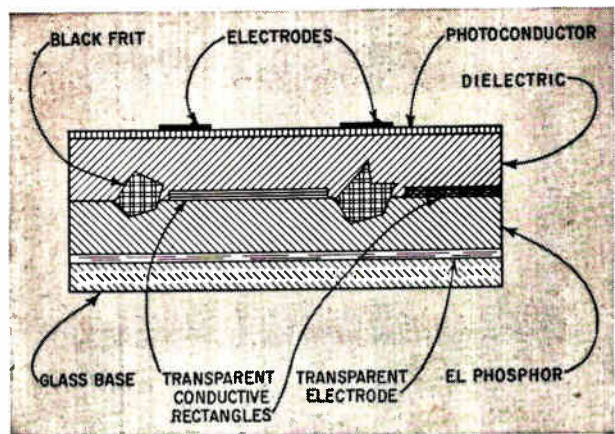


FIG. 5—Cross-section of combination display screen

# Display or Storage

stage program counter provides a sequential line scan in the X direction. The Y drivers are controlled independently with their control functions generated by the photo-rectifier array.

## Other Applications

Application of the array as a fixed or semifixed storage device might be as function tables where the function can be changed (sine to tangent, for example) by changing the mask. Another application of this type would be as a fixed program storage in a computer.

Still another application would be any situation where a stationary or slowly changing light pattern has to be scanned and converted into a train of electrical pulses. Typical specific uses in this area would be picture quantizing, page reading, character recognition and film data processing.

In a discussion of pickup panel displays combining electroluminescence and photoconductivity,<sup>2</sup> different modes of operation of such devices were described.

The pickup panel as the term is used here is a device in which the light sum of light level radiated in a definite time interval is increased over the light sum of light level incident on the panel in the same or prior time interval. It is, therefore, different from the so-called light amplifier.

Figure 3 shows a typical crossed-grid electroluminescent panel. Figure 4 illustrates a similar device using photoconductors.

Both electroluminescence and photoconductivity are combined in the display screen shown in Fig. 5. This panel may be operated in two modes. In the first mode, for long-duration storage, the photoconductor acts partially as the plate of a capacitor in series with the electroluminescent layer. In the second mode, volume conductivity is used for photoconductor operation by replacing the dielectric shown in Fig. 5 by photoconductive material. In this type of application, controlled persistence is obtained. Primary usage for such a device is to replace long-persistence screens in cathode-ray tubes.

## Medium Light Levels

For medium-light-level displays with storage, the conducting rectangles shown in Fig. 5 are omitted. On the top surface of the glass dielectric, the thin photoconductive layer makes contact with the top electrode. Because of feedback, the glass dielectric is transparent and extremely thin. When pulsed with a light sum of about 0.3 ft-candle-sec, the photoconductive layer becomes highly conducting. It remains so during an interval of the order of the decay constant or about 150 millise. In this period,

the displacement current through the glass dielectric is sufficient to bring the electroluminescent panel associated with it up into the 12 ft-candle brightness state.

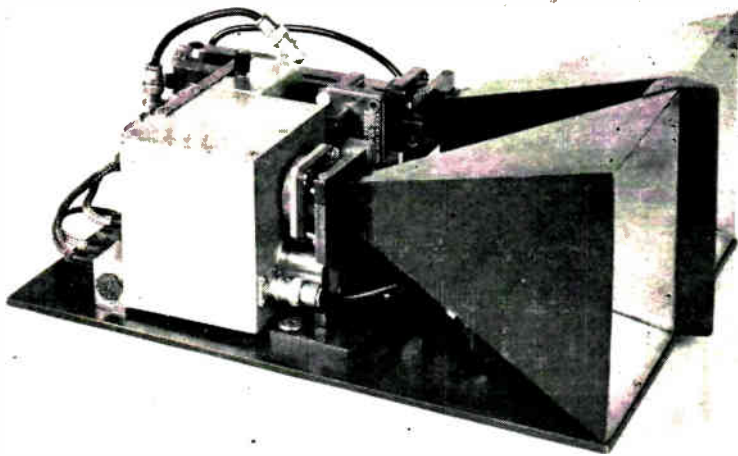
## Low Light Levels

In the low ambient state with the photoconductor in the insulating condition, the displacement current is carried partly by the parasitic capacitance across the glass dielectric from the top electrode. To maintain the light sum needed to trigger on the display at a suitable value (0.3 ft-candle-sec), resistance of the photoconductive layer cannot be allowed to rise into a truly insulating condition in the off state. To maintain this situation, a flood beam illuminates the element.

To make the controlled-persistence panel a practical device, the panel itself can be used as the screen in a cathode-ray tube. If the electron beam is allowed to bombard directly the photoconductive layer of the panel, bombardment conductivity induced in the layer modulates the display. One difficulty with this technique is maintenance of an adequate vacuum.

## REFERENCES

- (1) F. L. McNamara and R. R. Billups, The Properties of Cadmium Sulfide Photo-rectifier Arrays and Their Possible Influence on Computer Design, 1958 Electron Devices Meeting, Washington, D. C.
- (2) A. Bramley, Pick-Up Panel Display, 1958 Electron Devices Meeting, Washington, D. C.



Compact X-band radar assembled as a miss-distance indicator. Transmitter delivers peak power of 150 w at 100-kc repetition rate. Package volume is 40 cu in.

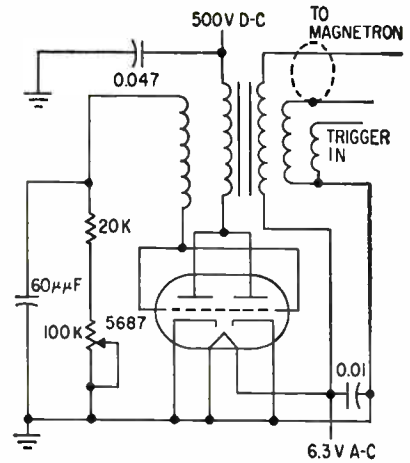


FIG. 1—Blocking oscillator modulator uses high-permeability ferrite core

# Miniature X-Band Radar

**D**EMAND FOR PULSE radar systems of high resolution has brought about a continual reduction in transmitted pulse widths. While it is possible to effect pulse-width reduction with conventional pulse-forming line and thyatron methods, new modulator techniques are required to make a compact system realizable.

Previous efforts were limited by the large size of tubes, capacitors and power supplies required by conventional high-powered radar. Efforts were therefore made to develop a high repetition rate modulator to achieve adequate average signal strength from smaller, medium-power microwave sources. One successful modulator design uses a blocking oscillator with a ferrite-core transformer. The high permeability of the ferrite allows the use of a small number of coil turns; thus capacitance is held to a minimum, and narrow pulses are produced.

## Miniature Magnetron

A miniature X-band magnetron, the L3028A, is used as the microwave generator, and the modulator design adapted to it. Characteristics of the magnetron allow the use of the miniature 5687 twin triode as the modulator tube, thus effecting a considerable economy in the size of the modulator. The mag-

netron is a rugged tube developed for military use. It has an efficiency of 35 percent, and produces a peak power of 150 w with 900 v applied; it is capable of delivering 2 w of average power. Although the rise time specification for the applied pulse is 50 millimicrosec, no difficulty has been encountered with a much shorter pulse from the blocking oscillator modulator.

The short rise time achieved with this tube is attributed to its low-voltage, small-gap (15 mils) design. Significantly, the 10-millimicrosec r-f pulse is generated by an applied modulator pulse with a slope of only 50 kv/ $\mu$ sec.

## Transmitter Design

Transmitter design objective was a small, rugged, and efficient package consisting of a self-triggering modulator and a miniature magnetron. The final transmitter unit delivers 10-millimicrosec pulses of X-band energy at a peak power of 150 w and a repetition rate of over 100 kc. The repetition rate is limited by power dissipation of the modulator and may be increased by using a larger tube. At a 100-kc repetition rate the unit operates with a total plate input power of 7 w (14 ma at 500 v). The present package occupies a volume of 40 cu in.

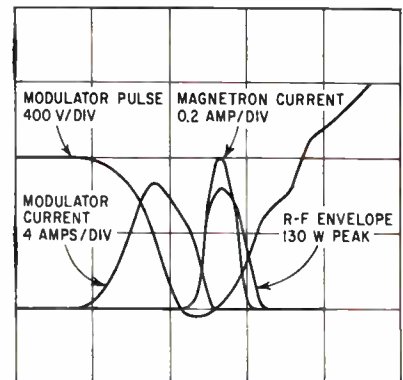
Figure 1 is a circuit diagram of

the modulator; pulse waveforms of the modulator and magnetron are illustrated in Fig. 2.

## Receiver

Wide-band i-f circuits in conventional high-resolution radar systems with more than 50-mc bandwidth often use relay racks of distributed amplifiers or large triodes with forced-air cooling. Neither approach lends itself to miniaturization.

The new receiver has an i-f section incorporating 6299 ceramic triodes. These tubes have a gain-bandwidth of 300 even when used in lumped-constant circuits. In this application, the i-f amplifier design produces 100-mc bandwidth with a gain of 9 db/stage and



TIME SCALE = 25 MILLIMICROSEC/DIVISION

FIG. 2—Typical pulse waveforms of modulator and magnetron

Compact X-band pulse radar detects targets at 1,000 feet to 5 miles depending on antenna gain. Accuracy is within 1 foot. Ceramic triodes in receiver i-f produce 9 db gain per stage at 100-mc bandwidth. Unit has applications in low-range altimetry, fire control, surveillance and aircraft landing guidance

By **CLYDE D. HARDIN** and **JAMES SALERNO**, Diamond Ordnance Fuze Laboratories, Washington, D. C.

# Has High Resolution

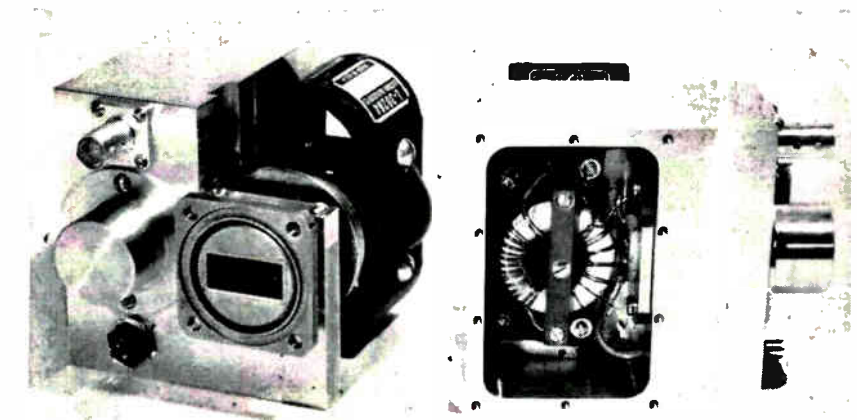
50-mc bandwidth with a gain of 13 db/stage. The required plate power is one w/tube. This makes possible a miniature, rugged i-f amplifier with efficiency comparable to conventional radar receivers, but yielding a bandwidth more than an order of magnitude greater. Figure 3 shows an amplifier of this type.

An i-f of 400 mc creates a large separation of i-f and video-frequency components, yet maintains a good noise figure (5 db) and reasonable percentage bandwidth so that required circuit Q's are readily realizable.

## Gating Techniques

The selection of a relatively high i-f results in improvement of system gating characteristics. The i-f amplifier can be switched on or off by a video gate in the minimum time permitted by the interstage network Q's. The frequency spectrum of the switching gate waveform contains no energy in the region of the amplifier bandwidth. A video gate applied to the plate or cathode of a tube switches that stage but is prevented from coupling to the next stage by the interstage network response. This gating technique avoids the use of video coincidence tubes which require high signal level and accurately controlled gate amplitudes.

Gating is accomplished early in



Heart of the radar transmitter shown in these views is the miniature magnetron developed for military use. Small-gap design of this tube permits rapid rise time of applied pulse to produce sufficient power to obtain 5-mile radar range

the system and large target signals not of interest are removed before they overdrive the amplifiers and obscure smaller adjacent targets. Antenna leakage is such an undesired large signal. The leakage energy of the main transmitted pulse in the miniature radar has been eliminated without sacrifice of in-range capabilities by an off gate applied to the i-f amplifier during the time of the transmitted pulse.

Bracketed ranges may also be accurately selected by an on gate which allows the amplifier to function for a fixed time interval following the main transmitted pulse. This technique is used in a miss-distance indicator application; the

range cutoff exceeds 10 db/ft at the range gate and tests have shown the statistical accuracy of the equipment to be about 1 ft.

## Servo

Because of inherently wide receiver bandwidths in the short-pulse radar system, stringent frequency control of the local oscillator is not required. A simple three-tube mode centering servo, as shown in Fig. 4, is the only control required on the VA-201 local oscillator klystron.

A low-frequency, low-voltage modulation (3 v at 30 kc is typical) is placed on the klystron repeller. This introduces a small amount of

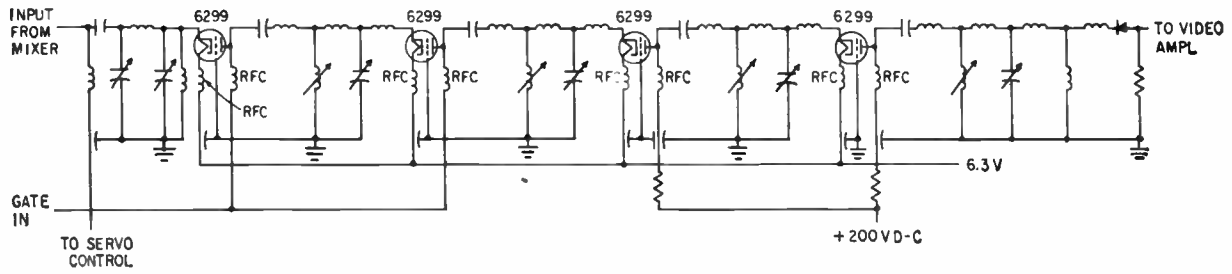


FIG. 3—Circuit of 4-stage i-f strip ceramic triodes, provides 9-db gain/stage at 100-mc bandwidth

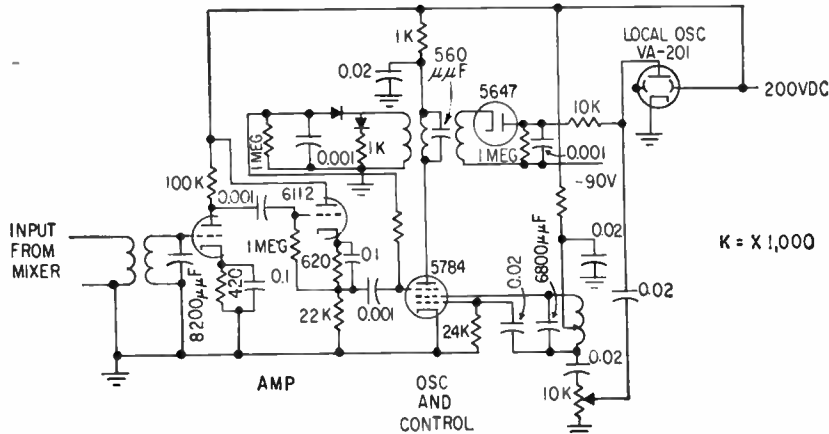


FIG. 4—Servo circuit for mode centering of klystron local oscillator

a-m on the klystron output. As long as the d-c position of the repeller is at mode center, the detected a-m contains no energy at the fundamental modulation frequency—this energy is primarily at the second harmonic. If the operating point of the klystron shifts to either side of the mode center, the detected output is primarily fundamental, and has a phase depending upon which side of the mode center the new operating point lies. A phase detector produces a positive output when the two signals (modulation and detected outputs) are in phase, and a negative output when out of phase. This voltage added to the d-c center value of the repeller gives the mode-centering required.

#### Mixer

The balanced mixer helps to suppress video components of the antenna leakage signal and facilitates matching the impedance of the receiver. Special measures reduce crystal mount capacitance to approximately  $4 \mu\text{f}$ ; this is also required to match the 400-mc i-f input.

Experiments with the short-pulse radar have been made with both

dual and single antenna configurations. A ferrite circulator duplexer feed is used with the single antenna. Minimum range is dependent upon the antenna send/receive decoupling ratio, as shown in Fig. 5. Maximum range is dependent on antenna gain. Tangential sensitivity corresponds to 125 db of



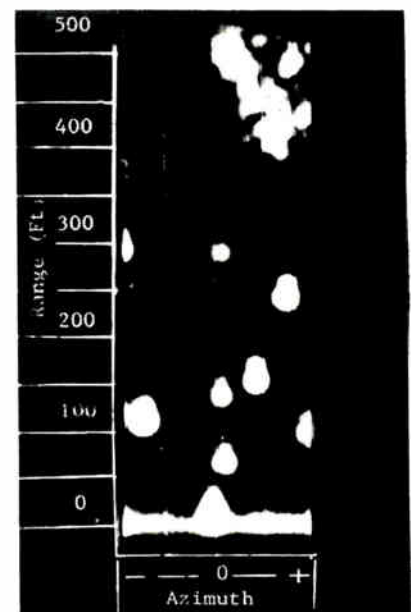
With radar installed behind home plate, lab personnel deployed on baseball field (left) show time exposure taken while men on field pace out letters 45 ft high. Tests determined feasibility

loop attenuation. With an 18-in. parabola, the maximum range in detecting aircraft is about 5 miles.

Obvious applications of this miniature system are surveillance, altimetry, miss-distance indicators and scorers, range finders and fire control, radar mapping, radar cross-section studies and time measurements. General use of these applications has been limited, but some laboratory work has been performed. A low-range altimeter has been built which has a full-scale range of 30 ft calibrated in 6-in. intervals. A reflectometer for calibrating position and reflection coefficient of waveguide delay-line discontinuities has been developed and described.<sup>1</sup>

#### Hit-Miss Scorer

When the range-gated radar system locates a target in a precisely defined range, a thyatron fires. This feature can be used directly as a hit-miss scorer, with the thy-



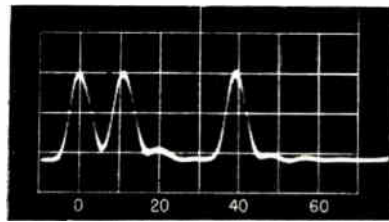
atron ignition modulating a telemetry link, or firing a smoke puff for visual observation. Such a scorer can work (with antennas that establish a planar pattern in space) at any preset distance to 1,000 feet with small aircraft, or 100 ft with rockets. It requires 50 w of input power and occupies less than 0.5 ft<sup>3</sup> of space.

### Miss-Distance Indicator

Since the radar ranging rate is 100 kc, it is possible to sweep the range gate in and out at rates up to 10 kc. This may be done by an electronic variable delay between trigger and gate generator, such as a phantastron provides. This technique is used in the short-pulse radar altimeter previously described. Such a swept range gate provides exact miss distance.

A simpler method uses a stepped range gate. A block diagram of the system is shown in Fig. 6. This particular system is a hybrid between a hit-miss scorer and a miss-distance indicator. The gate generator activates the receiver for a 20-millisecond period following each transmitted pulse. The range-step generator in combination with phase shifters  $\phi_1$  and  $\phi_2$  and diodes 1 and 2, sequentially selects 0, 20 or 40 millimicrosec delays; i.e., ranges of 0-10, 10-20, or 20-30 ft.

In this model, the repetition rate is 100 kc and the range-step gener-



A-scope presentations of near-target echos. Range increments are in feet

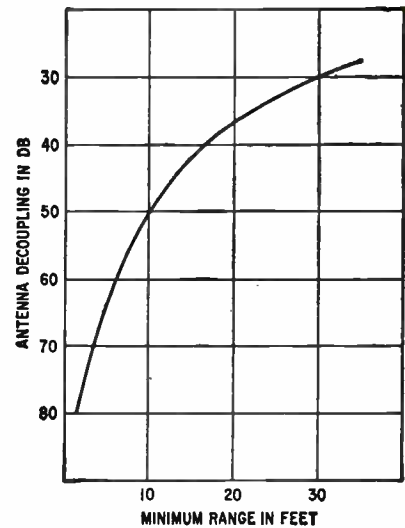


FIG. 5—Minimum range plotted as a function of antenna send/receive decoupling ratio

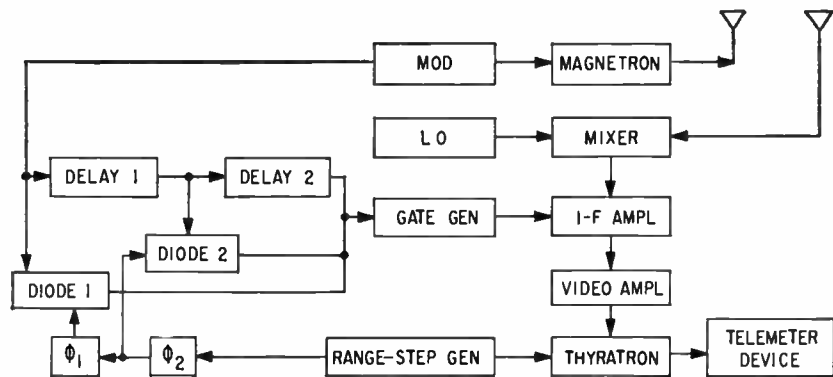


FIG. 6—Block diagram shows use of stepped range gate in a miss-distance indicator. This is one of many methods whereby a radar may be used to detect the presence of a target in a bracketed range.

ator frequency is 400 cps. Thus, the radar is pulsed at 100 kc while first range-gated from 20 to 30 ft. This goes on for 417  $\mu$ sec (60 deg of the 400 cycle wave). If a target exists within the range gate, the thyatron fires and stays fired for a full 1,250  $\mu$ sec. If there is no target, at the end of 417  $\mu$ sec the voltage out of phase shifter  $\phi_2$  enables diode 2 and delay 2 is shorted out. For the next 417  $\mu$ sec, the radar is range-gated from 10-20 ft. If a target exists in this range, the thyatron fires but for only 834  $\mu$ sec. Then, 417  $\mu$ sec later, delay 1 is also shorted out, gating the radar from 0-10 ft. The thyatron fires for 417  $\mu$ sec if a target appears.

Thus the range interval in which the target appears may be recognized by observing the width of the thyatron current pulse. There is about a one-foot overlap between ranges.

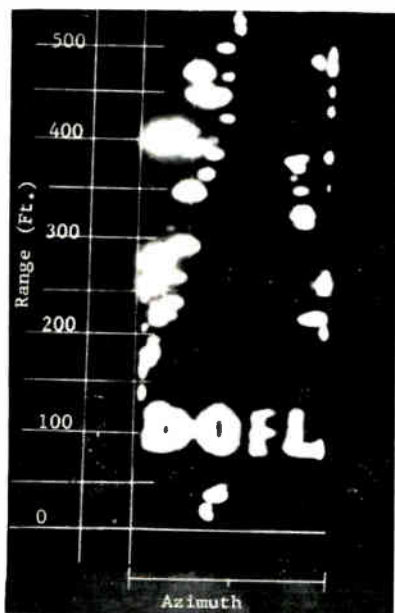
An application with dramatic as well as valuable potential combines the functions previously described into a blind landing radar. A simple B-scan arrangement presents the pilot with a highly defined electronic picture of the airfield on approach. The runways are clearly accentuated by the installation of small corner reflectors along the runway lights.

The limitations usually found in azimuthal resolution of small X-band antennas is of little consequence to effective operation; the runway is smeared into a single line at large distances, but the B-scan opens up the runway picture as the plan comes down.

The authors gratefully acknowledge the support of H. P. Kalmus and the many contributions of F. T. Liss and C. L. Coleman.

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as blips on B-scope (center). At right is a using radar in surveillance

# Cathode-Ray Storage

By **ARTHUR S. KRAMER,**

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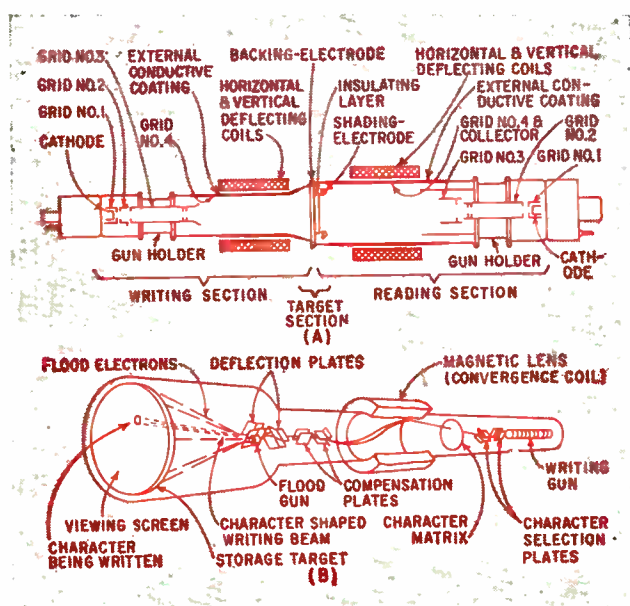


FIG. 1—Diagrams illustrate electrode arrangement in two types of special-purpose tubes; RCA 6896 Graphicon scan-converter tube (A); Hughes 6577 Typotron character-writing tube (B)

IN A PREVIOUS ARTICLE (ELECTRONICS, Jan. 23, p 40), it was shown that storage tubes available today fall into one of five major categories and a table of the most important characteristics of the direct-view type of storage tube was presented. This article tabulates available information on the remaining four types which include data storage tubes, computer storage tubes, scan converter storage tubes and character-writing storage tubes.

There are distinct differences between the appearance of most special-purpose storage tubes and that of the direct-view types. All direct-view tubes have a phosphorescent screen of one color or another on the output end, whereas among the special-purpose types, only the Hughes 6577 Typotron character-writing tube and the RCA 6571 computer storage tube have such screens.

Data storage tubes are generally characterized at their target end by the presence of terminal pins or a coaxial connector, either of which serves to convey the output signal to its proper load circuit. The RCA 6571 computer storage tube mentioned previously is connected into the computer

TABLE 1—Type and Characteristics of Representative Special Purpose Storage Tubes

Tube Type/Mfr	Description	Deflection/Focus	Defl Factor	Reading and Writing Methods
RCA 6571	3-in. dia, single-gun computer storage tube	Both electrostatic	33.5-53 v/in. per ultor kv	Uses redistribution writing; capacitance discharge reading
Dumont K-1584, K-1326 Radechon	3-in. dia, single-gun charge storage tube	Both electrostatic	184-248 v/target dia	Discrete charges deposited and removed from dielectric surface
Raytheon QK411A	3-in. dia, single-gun recording storage tube	Both electrostatic	570 v/screen dia	Write with control grid at cutoff; read with 2- $\mu$ A beam current
Raytheon RK6835/QK464A	3-in. dia, single-gun recording storage tube	Both magnetic	—	Same as QK411A
RCA 6499 Radechon	3-in. dia, single-gun charge storage tube	Both electrostatic	91 v/in.	Nonequilibrium writing; capacitance discharge reading
Westinghouse WL-7225 Radechon	3-in. dia, single-gun barrier grid storage tube	Both electrostatic	—	Similar to RCA 6499
RCA 6896/1855 Graphicon	2-in. dia, 2-gun signal converter storage tube	Magnetic deflection Electrostatic focus	—	Writing beam modulated by video; separate read gun
Hughes 6577 Typotron	5-in. dia, 2-gun character-writing storage tube	Both electrostatic Magnetic convergence	101-134 v/in.	Pulses drive writing gun control grid; reading is visual

# Tubes For Special Purposes

Important characteristics of four major categories of storage tubes that differ in their application from the direct-view types described in a previous article

system by capacitively coupling its internal screen through the glass envelope to an external electrode shaped to cover the front end of the tube. The scan-converter storage tube is a double-ended tube with a gun and envelope neck at each end and the target structure in the center, as typified by the RCA 6896/1855 Graphecon, shown in Fig. 1A.

**APPLICATIONS** — Probably the greatest differences between the direct-view and special-purpose storage tubes occur in their applications. Some direct-view types are capable of extremely bright displays of about 3,000 foot-lamberts and thus can be used under high ambient light conditions. Where the direct view types may be used in aircraft cockpit radar, weather radar, closed circuit tv, instrumentation and process monitoring, curve plotting, transient studies and half-tone storage, the special purpose group is not so versatile.

Of the latter, the data-storage types are used for simple analog signal reproduction, binary digit storage, signal-to-noise ratio improvement and analog-to-digital conversion. The computer storage

tube, typified by the RCA 6571, is used for storage of binary digital data in digital computer systems. In this application, its representative access time and its random access time compare favorably with magnetic drum and core computer memory systems.

**SCAN CONVERSION**—The double-ended storage tube finds its greatest application as a device for converting a radar ppi or C-scan display to a tv scan. Finally, the character-writing storage tube, typified by the Hughes 6577 Typotron can be used for high speed readout from digital computers and for displaying computed radar-tracking information. This tube cannot display complete pictures such as a ppi presentation affords, but instead is arranged to give an alphanumeric display by use of an internal matrix of numbers and letters through which the electron beam passes and is shaped before impinging on the screen, as shown in Fig. 1B. Compared with direct-view tubes, the resolution of the special purpose tubes is of the same order of magnitude, except the Raytheon RK6835/QK46A which resolves 600-lines.

Resolution	Erase Data	Applications and Features
————	Old pattern must be erased before rewriting	Used for storage of binary digital data in digital computer systems. Has short access time. Requires external signal electrode
200 lines/target dia	Erasing takes place immediately after reading	Used for signal conversion, analog and digital storage, improvement of S/N ratio by integration. K-1584 has coaxial output. Halftones available
400 lines nom	Erase by writing in a d-c signal into the tube	Signal conversion, analog and digital storage. Microsecond access to stored information. Many readings possible without regeneration
600 lines min	Same as QK411A	Same as QK411A
400 lines/target dia	Erasing takes place during reading	Analog and digital storage, S/N ratio improvement by integration, picture storage, coordinate transformation of stored pictures
130 spots/target dia	————	Application similar to RCA 6499. Target material has high secondary emission ratio, permitting high ultor voltages. Has coaxial output
————	Erasing is automatic with reading process	For scan conversion from radar ppi or C-scope to tv scan. Permits mixing of radar signals to give composite display
————	Erase by momentary lowering of collector mesh voltage	Used for high-speed digital readout, display of computed radar tracking data, monitoring analog to digital conversion equipment

# Starved Transistors Raise

Bootstrapped-collector circuit uses starved transistor to provide 500-megohm d-c input resistance with 100-v input signal; a-c resistance is even higher. Circuit operates without periodic adjustment in temperatures up to 60 C. Design criteria and transistor behavior under starved conditions are detailed

By **B. M. BRAMSON**, Project Engineer, Baird-Atomic, Inc., Cambridge, Mass.

**P**HOTOCONDUCTIVE DEVICES and a wide variety of other measuring circuits require transistor buffer stages having high d-c input resistance as well as high a-c input impedance.

The a-c aspect seems to have received the main attention to date and input impedances up to 1,000 megohms have been obtained.<sup>1,2</sup> On the d-c side, 0.4-megohm input resistance has been reported<sup>3</sup> for a system of short-term stability and relatively low input signal.

## Input-Current Limitations

As the input resistance depends on the d-c current drawn by the first stage, this current must be kept to as low a value as possible.

The input resistance for the circuit of Fig. 1 is

$$R = V_{sig}/I_s$$

where  $I_s$  is the current drawn by the first stage and has a minimum value that is dictated by several considerations. D-c beta falls off continuously as  $I_c$  is reduced and there is no advantage in operating the transistor at a beta of nearly unity. Also, there seems to be a minimum  $I_c$  for proper operation whose value at this time is based on intuition, caution and suspicion. A third factor is temperature range, which affects both  $I_c$  and beta.

About the most that circuitry can expect to do is to permit the initial base current to be the minimum practical, not allowing it to increase appreciably with increasing input signal. This is equivalent to saying that  $I_c$  for an optimum circuit should remain practically constant regardless of signal input. Therefore, from Eq. 1,  $R$  is almost pro-

portional to  $V_{sig}$ ; this is basic feature of such circuits.

As  $I_s$  flows in signal source resistance,  $R_s$ , in Fig. 1, it produces a spurious voltage drop  $V_r$ , that is reflected in output voltage  $V_o$  of the system.

The percentage inaccuracy this introduces is

$$[V_r/(V_{sig} + V_r)] 100$$

As  $V_r$  remains of the same order

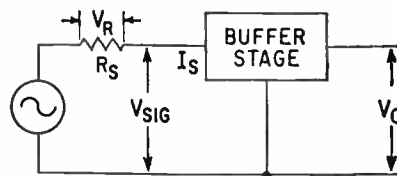


FIG. 1—Basic input configuration

independently of  $V_{sig}$  the voltage-transfer accuracy is roughly proportional to signal input voltage when  $R > R_s$ . This is another basic feature of such arrangements.

## First-Stage Transistors

Some investigations on low-current operation of silicon transistors were made a few years ago.<sup>4</sup> The semiconductor art has since advanced to the stage where transistors are available with a 25 C d-c beta greater than 20 at  $I_c = 10 \mu a$ , 60 C  $I_c$  less than 100 millimicroamp at  $V_c = 3 v$ , 25 C  $I_c$  approximately 5 millimicroamps and a-c small signal beta higher than the d-c beta. Two commercially available transistors with these characteristics are the X284 and the ST1028. The circuitry to be described was developed about these units.

Probably the simplest circuit for

obtaining high d-c input resistance with transistors is the grounded collector in Fig. 2, operating under starved conditions. For maximum d-c input resistance, regardless of signal level, the d-c voltage drop across  $R_1$  should be high compared to the maximum signal swing. The input current will then only swing by a small percentage and hence remain closer to the practical minimum.

With this circuit, a-c input impedances of 100 megohms may be obtained at audio frequencies. This is possible because of the considerable increase in collector impedance  $Z_c$  that occurs at low  $I_c$ . The input impedance almost equals that of the collector capacitance at frequencies below beta cutoff and is much increased at low  $I_c$ . Units in the 2N-336 class give around 5-kc cutoff and the 2N338 type around 30 kc at  $10 \mu a$  of  $I_c$ .

Collector breakdown voltage limits the signal swing obtainable with this method.

It is sometimes desirable to cascade another grounded-collector stage to that in Fig. 2;  $R_1$  is then

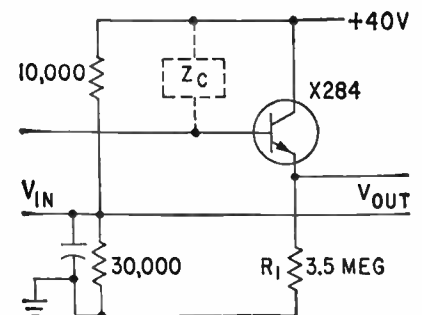


FIG. 2—Grounded-collector circuit for small signals operates under starved conditions for high input impedance



# D-C Input Resistance

disconnected. The 10  $\mu$ a emitter current of the first stage will then be just right for normal operation of the second transistor.

## Large-Signal Circuit

In the circuit of Fig. 3A, the collector of the first stage is bootstrapped to the outer emitter. By this means the first-stage collector-emitter swing is so reduced that a  $V_c$  of 5 v accommodates a 100-v signal. This configuration also raises the effective first-stage base-collector impedance, giving considerably higher a-c input impedance to the system.

A curve of d-c input resistance obtained with a circuit of this type is shown in Fig. 3B. The input current varied from about 0.2 ma at 100-v signal to 0.1 ma at 10 v. This represents a resistance variation from 500 megohms at 100 v to 100 megohms at 10-v input signal.

The a-c input impedance will be higher than 10 megohms at 10 or 20 kc and in the 1,000-megohm region at low frequencies.

## Maximum Signal Swing

If  $R_p$  is the parallel value of  $R_1$  and  $R_2$  in Fig. 3A, the relationship  $R_p/(R_p + R_3)$  equal to or greater than  $V_{a-c,p}/(V_{a-c})$  must be satisfied where  $V_{a-c,p}$  = peak a-c signal voltage and  $V_{a-c}$  = d-c signal voltage. Otherwise peak clipping will result due to  $C_1$  in accordance with r-c coupling theory.

For best circuit performance the d-c voltage across Zener diodes SV8 and SV11 should remain constant regardless of signal level. Therefore, the d-c current through them should remain as constant as possible. One simple way to insure this without the use of high d-c supply voltages is to use a floating supply XY. This approach has the further advantage that changes in  $V_{XY}$  and components cannot change the d-c operating point of the 953 emitter, a condition which can be objectionable at low signal levels.

The d-c current through the SV8 and SV11 Zener diodes should be at

least 100  $\mu$ a and preferably about 1 ma so that  $(V_{XY} - V_{ZD})/(R_4 + R_5) \geq 100 \mu$ a, where  $V_{XY}$  is the floating power supply voltage and the voltage drop across the SV8 and SV11 diodes is 20 v. Capacitors  $C_2$  and  $C_3$  maintain the voltage across the SV8 and SV11 diodes under a-c conditions where these diodes would be driven below their minimum operating current.

The minimum instantaneous signal that should be applied to the circuit during operation is about

components, connected to the output terminal, will assist considerably in keeping the input impedance high at higher frequencies.

For low ambient temperatures where beta might fall off somewhat, the transistors can be housed in a small temperature-controlled oven that will insure they will not fall beneath 25 C.

When using silicon transistors at low currents to obtain high d-c and a-c input resistance the following points may be helpful: d-c

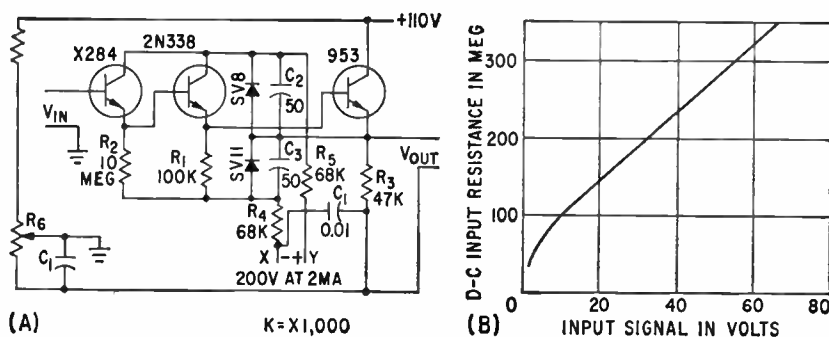


FIG. 3—Bootstrapping collector of first stage reduces collector-emitter swing and increases base-collector impedance (A); d-c input resistance varies fairly linearly with input signal level (B)

2 v, the approximate voltage required to overcome the forward voltage drop in the three series-connected emitter junctions.

Potentiometer  $R_6$  is set to meet this requirement for the maximum swing that is anticipated. The zero offset so created is easily corrected at the output if required.

## Allowance

The collector current of the 2N-338 in Fig. 3A is selected to be high compared to the highest  $I_{co}$  that is anticipated for the 953. This current is established by the value of  $R_1$ . If this condition did not appertain, then the circuit would become inoperative at high values of  $I_{co}$  of the 953. Similarly,  $R_2$  is selected so that the X284 takes a greater emitter current than any  $I_{co}$  expected from the 2N338.

A screen around the first stage beta will increase with temperature

and may increase or decrease by a small amount with life;  $I_{co}$  may increase by four times or so during the life of the transistor and also increase rapidly with temperature.

There is no fixed ratio between 1-ma beta and, say, 10- $\mu$ a beta for all units of a particular type; therefore, the beta of each transistor must be tested separately at low current.<sup>5</sup>

The author thanks H. L. Aronson for his many valuable suggestions.

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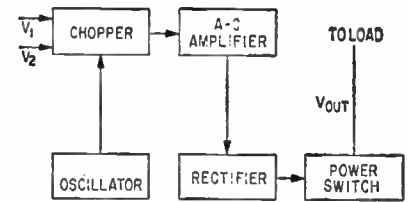
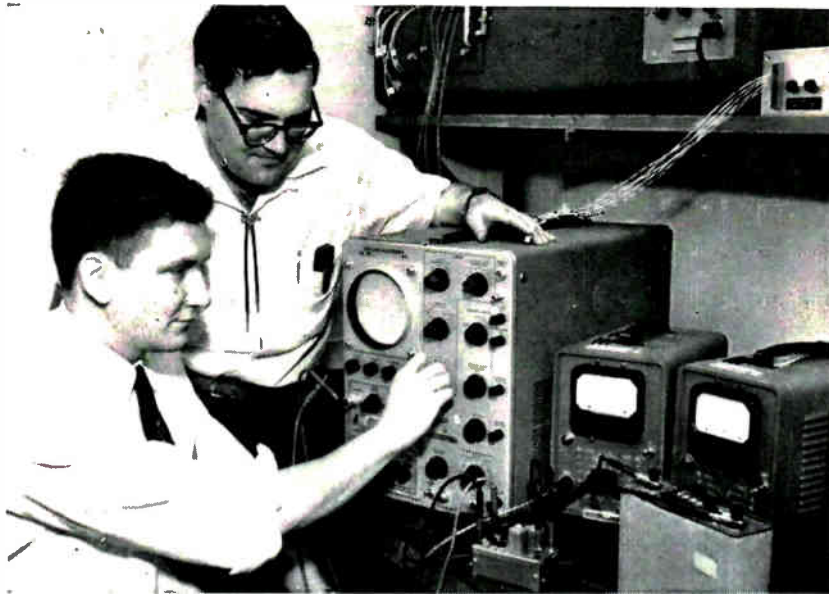


FIG. 1—Basic comparator elements

Checking out circuit module of voltage comparator

# Voltage Comparator with

Transistorized unit continuously monitors two d-c voltages. When difference between voltages exceeds preset threshold voltages of as little as  $100\mu\text{v}$  for  $300\mu\text{sec}$ , transistor switch delivers up to 2 amperes to load. Individual comparator circuits may be used for other applications

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**A**NALOG APPLICATIONS sometimes require d-c voltage comparators that are capable of drift-free, low-level error detection plus high-speed switching of a load current at a preset magnitude.

Conventional carrier-amplifier circuits employ electromechanical choppers to convert d-c error voltages into suppressed carrier outputs. Such devices limit the carrier frequency to a few kilocycles thereby restricting the amplifier bandwidth and response speed. Transistor choppers, however, operate at up to 50 kc on a few milliwatts. Square waves to gate these choppers may be supplied from small, inexpensive square-loop-core oscillators, which operate well up to 20 kc. If higher frequencies are desired, multi-

brators or oscillators with diode clamping can provide square-wave gating voltages.

The combination of a transistor oscillator, chopper modulator and demodulator provides the prime requirements for amplifying d-c with an a-c amplifier. An a-c amplifier placed between the modulator and demodulator provides an excellent driftless d-c amplifier. Since the carrier frequency is high, the bandwidth is increased; if the a-c amplifier is made to pass square waves, the filtering required at the output is negligible.

## Comparator

Figure 1 shows the block diagram of the comparator. The chopper operates with 10-kc square

waves to give fast response while still operating within the limits of the amplifier transformers.

The transistor oscillator, shown in Fig. 2 is of conventional design, using a  $\frac{1}{4}$ -in. Hy-Mu 80 toroidal core. The output windings supply 10-kc square waves at 3 v peak-to-peak to operate the four-transistor chopper.

Although the chopper<sup>1,2</sup> has many desirable characteristics, the designer must be cautious where low-level nulls are desired. The two signal source impedances must be kept nearly equal and small compared with the load impedance so feedthrough voltages do not cause an unbalanced a-c output at null.

The unit was used with source impedances of 1,000-ohms or less,

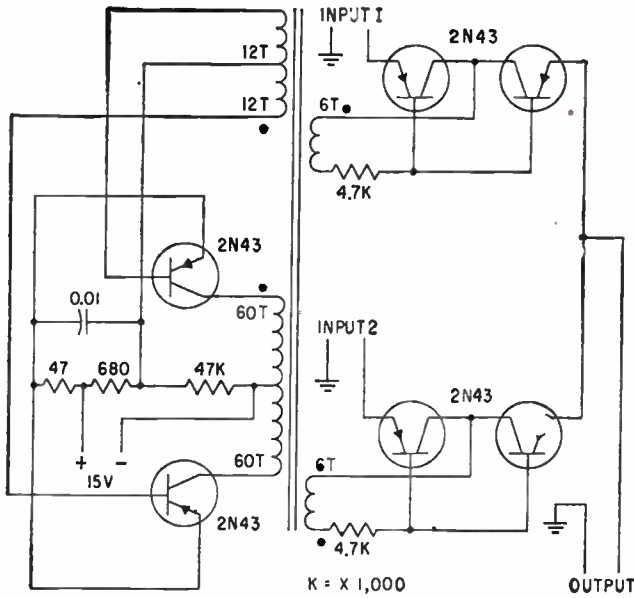


FIG. 2—Transistor oscillator and chopper

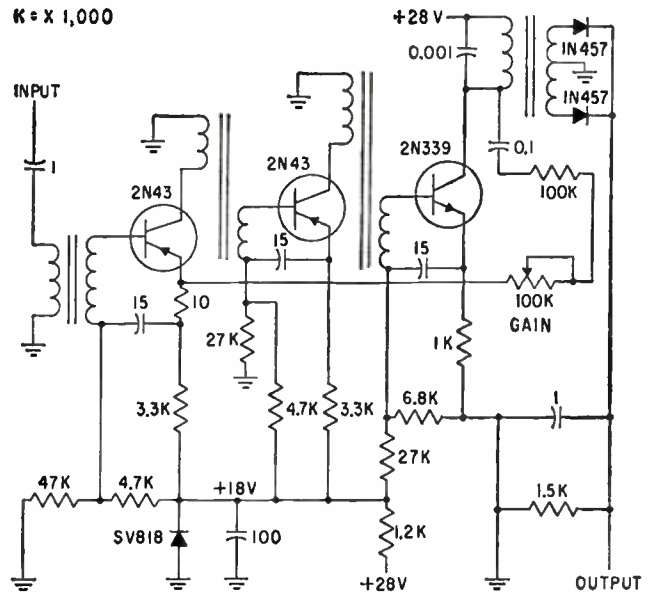


FIG. 3—Amplifier and rectifier provide control signal for switch

# High-Speed Switches

feeding into a reflected impedance of approximately 30,000 ohms. By matching the 2N43 transistors, the chopper nulls may be reduced to 25  $\mu$ v; with no selection, nulls seldom exceeded 200  $\mu$ v. Satisfactory operation was obtained over a temperature range of  $-40$  to  $+75$  C as feedthrough voltages in each chopper leg cancel at the output.

## Stability

The a-c amplifier shown in Fig 3 is a three-stage unit employing negative feedback.

Transformer coupling permits a stability factor of two, which is needed for germanium transistors operated at 75 C. By matching output and input impedances using transformers in each stage, higher power gain per transistor is achieved over capacitance coupling.

A high open-loop gain allows a feedback factor large enough to stabilize the closed-loop gain, while providing the additional benefits of high input impedance and low output impedance. Since the gain without feedback is approximately  $2 \times 10^5$ , oscillation must be guarded against. The last stage collector is decoupled from preceding stages by a Zener diode and a large capacitor.

The transformers operate on low unbalanced d-c currents to minimize phase shifts and distortion. This is accomplished by use of low collector idling currents and phasing the transformer windings so that the d-c currents in the primary and secondary cause opposing flux linkages. Depending on the transformers and circuit layout used, it may also be necessary to add a phase-shaping network to satisfy

the Bode stability criteria for feedback amplifiers.

Feedback was closed on the a-c stages only. The loop may also be closed from the d-c output to the chopper inputs, provided the signal source impedances are constant.

The amplifier output is rectified by the IN457 diodes rather than demodulated, since the magnitude of the error is of concern and not the polarity. To get an indication

Table I—Characteristic Equations for Power Switch of Fig. 4

Cutoff condition for $Q_1$	$E_{d1} + E_{be1} \geq I_{co1} (r_{b1} + R_1 + R_L) + I_{co2} R_L + I_{in} (R_1 + R_L)$	(1)
Cutoff condition for $Q_2$	$E_{d2} + E_{be2} \geq I_{co1} R_2 + I_{co2} (R_2 + r_{b2})$	(2)
Condition for switch turn-on	$E_{input} = E_{zener} + E_{d1} + E_{be1} - I_{co1} (R_1 + R_L + r_{b1}) - I_{co2} R_L + \{ [E_{d2} + E_{be2} - I_{co1} R_2 - I_{co2} (R_2 + r_{b2})] / \beta_1 R_2 \} R_{in1}$	(3)
$E_{d1}, E_{d2}$ = forward voltage drop across $D_1$ and $D_2$	$I_{in}$ = input current to switch	
$E_{be1}, E_{be2}$ = base-to-emitter threshold voltage of $Q_1$ and $Q_2$	$r_{b1}$ = base resistance of $Q_1$	
$I_{co1}, I_{co2}$ = collector cutoff current of $Q_1$ and $Q_2$	$R_L$ = load resistance	
	$r_{b2}$ = base resistance of $Q_2$	
	$R_{in1}$ = input impedance of $Q_1$	
	$\beta_1$ = current gain of $Q_1$	

of polarity of the error, a phase-sensitive demodulator may be substituted for the rectifying diodes; demodulator gating can be supplied by adding windings and power capability to the transistor oscillator.

### Power Switch

The d-c output from the carrier amplifier triggers a power switch, which applies 28 v to the load when its input voltage exceeds a fixed threshold value. The switch, shown in Fig. 4, is a two-stage complementary-coupled nonlinear amplifier, with a Zener diode in series with the input to minimize the effect of drift on the switching point.

Stabilizing diodes in the emitters of both transistors provide a reverse base-to-emitter voltage to prevent  $I_{co}$  amplification.

The equations governing the selection of values for the stabilizing diodes and base-to-emitter resistors are shown in Table I. For high temperature operation of such a d-c amplifier,  $I_{co}$  in each stage must remain unamplified up to the highest ambient temperatures for which it is designed.

Since  $I_{co}$  causes a base-to-emitter voltage drop which tends to turn on the transistor, the base-to-emitter closing resistance must be kept small enough to assure the cutoff conditions of Eq. 1 and 2 at the largest expected value of  $I_{co}$ .

Equation 3 shows that  $I_{co}$  of both  $Q_1$  and  $Q_2$  may cause an appreciable change in the switch operating point. Therefore, it is desirable to have the base-to-emitter resistor of each vary such that the product of its resistance times  $I_{co}$  remains constant with temperature.

Characteristics of thermistors  $R_1$  and  $R_2$  track the respective leakage currents reasonably closely. By careful matching of thermistor characteristics with those of  $I_{co}$ , the change on the switching point due to  $I_{co}$  may be held to less than 0.1 v from  $-40$  to  $+70$  C.

Significantly, the transistor base-to-emitter threshold voltages,  $E_{be}$ , and the stabilizing diode voltage drops,  $E_d$ , have negative temperature coefficients of approximately 2 mv/deg C and, unless compensated, they will cause a drift in the switching point.

In this power switch circuit the effects of temperature induced changes in  $E_{be}$  and  $E_d$  may be compensated by choosing a Zener diode with a positive temperature coefficient of 3 to 4 mv/deg C. Sharp-breaking Zener diodes in the 6- to 8-v range provide best results.

Since the stabilizing diodes are not excited by a bias current, a question may arise concerning the method by which the forward voltage drop across each is developed. If the transistor is completely cut-off, the emitter current is zero. However, if the stabilizing diode drop is zero,  $I_{co}$  will usually be

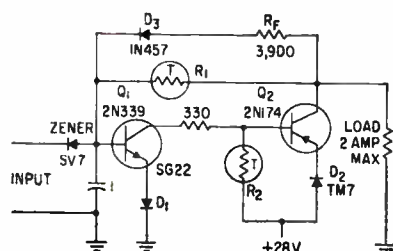


FIG. 4—Two-stage switch can handle up to 2-amp current:  $R_1$  is 100,000 ohms at 25 C with a  $-4.6$  percent/deg C temperature coefficient and  $R_2$  is 100 ohms at 25 C at  $-4.4$  percent/deg C

amplified by a factor approaching the  $\beta$  of the transistor.

In the circuit shown,  $I_{co}$  is amplified just enough to allow an emitter current that will excite the stabilizing diode to a voltage in the region of the knee of its forward conduction curve. At this point, voltage drop  $E_d$  is just enough to meet the conditions of the cutoff equation and  $I_{co}$  cannot be amplified further.

### Diode Selection

In selecting the proper stabilizing diode to match any given transistor, the designer must meet two criteria: the diode must be rated to carry the maximum emitter current during transistor saturation and the current required to excite the stabilizing diode to a voltage necessary to cut off the transistor must be small compared with the emitter current at saturation. Otherwise a resistor must be added to supply the diode with proper bias current.

Use of regeneration makes the switch unusually sensitive, since the input voltage is required only

to drive the unit into its linear state, after which it latches with its own regeneration. Switching time is primarily determined by the power transistor and is approximately 60  $\mu$ sec for the 2N174.

Diode  $D_3$  and resistor  $R_F$  provide a regeneration path capable of supplying base current to  $Q_1$ , which causes saturation of  $Q_2$ . If close temperature compensation of the switching point is not required,  $D_3$  and  $R_F$  may be eliminated by making  $R_1$  a fixed resistor that meets this requirement as well as the cutoff requirement given by Eq. 1. The capacitor connected to the base of  $Q_1$  prevents premature triggering by any transient that may occur when the 28-v supply is connected.

Output current capability may be increased by adding another driver stage or by adding transistors in parallel. The reverse bias technique overcomes  $I_{co}$  amplification so size and cost become the primary limitations on the amount of power to be switched.

### Performance

The completed unit monitors two d-c voltages continuously. When the difference between the voltages exceeds the preset threshold voltage, which may be as little as 100  $\mu$ v for approximately 300  $\mu$ sec, the output switch latches on, delivering up to 2 amperes to a load. Resetting is accomplished by breaking either ground or the 28-v supply.

Since the individual circuits have been developed in module form, they may be used in many other applications with little or no modifications. The oscillator chopper module serves as an electronic replacement for electromechanical choppers, where its limits on voltage and impedance levels are not restrictive. The frequency of the unit may be varied over a range from 200 cps to 20 kc by varying the d-c excitation voltage and the number of turns on the transformer windings.

The a-c amplifier may be used as a gain-stabilized preamplifier for servo systems or voltmeters.

### REFERENCES

- (1) R. L. Bright, Junction Transistors Used as Switches, *AIEE Trans*, Mar. 1955.
- (2) A. P. Kruper, Transistors Used as Replacements for Electromechanical Choppers, *AIEE Trans*, Mar. 1955.

**TABLE 1—Characteristics of Silicon Solar Cells in Commercial Production<sup>a</sup>**

Mfgr.	Dimensions (cm)	Active Area (cm <sup>2</sup> )	Output with Matched Load at 10,000 foot-candles			Avg. Conversion Eff. (%)	Short-Circuit Curr. (ma)	Open-Circuit Voltage (mv)
			(mv)	(ma)	(mw)			
<b>Hoffman Electronics</b>								
2A	2.86 dia.	4.75	400	85	34	5-8.5 <sup>a</sup>	130	550
200A	1/4 of 2A	1.20	400	21	8.4	"	32	550
220C	2 x 2	3.8	400	65	26	"	100	550
120C	1 x 2	1.8	400	34	13.6	9->9	40	550
110C	1 x 1	0.9	400	17	6.8	5-8.5 <sup>a</sup>	20	550
52C	0.5 x 2	0.8	400	15	6.0	"	20	550
51C	0.5 x 1	0.4	400	7.5	3.0	"	10	550
55C	0.5 x 0.5	0.2	400	3.8	1.5	"	5	550
58C	0.5 x 0.25	0.1	400	1.8	0.72	"	3	550
<b>Intern'l Rectifier</b>			Output with Incident Energy of 100 mw/cm <sup>2</sup> (1 sun) <sup>b</sup>					
S1020	1 x 2	1.75	350-400	17.5	7	4	35	480
S1020A	1 x 2	1.75	400	26	10.5	6	40	500
S1020B	1 x 2	1.75	400	35	14	8	48	550
S0520	0.5 x 2	0.75	350-400	7.5	3	4	16	480
S0520A	0.5 x 2	0.75	400	11.2	4.5	6	18	500
S0520B	0.5 x 2	0.75	400	15	6	8	22	550
S0510	0.5 x 1	0.37	350-400	3.8	1.5	4	8	480
S0510A	0.5 x 1	0.37	400	5.6	2.25	6	9	500
S0510B	0.5 x 1	0.37	400	7.5	3	8	11	550

(a) Average range. (b) Energy conversion is: 10,000 foot-candles = 1,000 w/m<sup>2</sup> = 100 mw/cm<sup>2</sup>, of collecting.

# Silicon Solar Cells

Converters of light into electricity, solar cells now in production can provide power for electronic equipment or actuate industrial controls

By **JEROME KALMAN**, Chief Engineer, Solar Products, Hoffman Electronics Corp., Semiconductor Div., Evanston, Ill.

SILICON SOLAR CELLS, developed in 1954 by Bell Telephone Laboratories, are efficient converters of sunlight into usable electrical energy. Table I lists geometries and characteristics of types in commercial production.

Conversion efficiencies up to 10 percent are being obtained with production units compared with 1 percent for thermopiles, 0.6 percent for selenium barrier-layer cells and 0.5 percent for photogalvanic cells.

The solar cell is a photovoltaic (self-generating) device consisting of a silicon *p-n* junction. No external power is needed. Other advantages over photoconductive (cadmium-sulfide, lead-sulfide, germanium photodiodes) types are listed in Table II.

**OUTPUT**—Current output of silicon solar cells is dependent on cell area and available illumination, but is essentially independent of temperature change. Voltage output is independent of cell area, varies logarithmically with illumination level and decreases with temperature rise.

Cells may be wired in series, parallel, or series-parallel to achieve higher output. The short-circuit current is linear with light level hence light levels can be metered by the short-circuit response.

**TABLE II—Design Comparison Data**

Characteristic	Photovoltaic	Photoconductive
Temperature effects	negligible	severe
Position sensitivity	none	some
External power	not necessary	necessary
Aging	no effect	reduced performance
Sensitivity	medium (no external power supply)	high (with external power supply)
Response time	microseconds	milliseconds

# Loop Controls Scatter

System controls output power of uhf tropospheric scatter communications links in accordance with level of received signal at opposite end of link to compensate fading. Use of controlled-carrier operation may effect reductions in transmitted power of 98 percent with consequent savings in fuel

By **LEANG P. YEH** Electronics Division, Westinghouse Electric Corporation, Baltimore, Maryland

**F**ADING IN TRANSMISSION of radio waves may be offset by a system comparable to putting age in the transmitter, rather than in the receiver. Called controlled-carrier communications, the system involves controlling transmitter output power of uhf tropospheric links in accordance with momentary need.

## Reliability

For uhf tropospheric transmissions, it is now generally agreed that fading may be arbitrarily divided into two components—a fast one, believed to be caused by multipath transmissions, and a slow one, caused by changes in conditions, such as index of refraction of the atmosphere. However, instantaneous signal level, subject to the com-

bination of both slow and fast fadings, always fluctuates at a fast rate.

System reliability is usually specified as percentage of time that communication is maintained. To attain it, transmitter power is usually maintained continuously at maximum level.

Statistically, maximum r-f power is required only for a short period of time. Continuous operation at maximum level considerably extends the interference area during good propagation conditions. In addition, average power is much higher than actually necessary. This unnecessary use of power aggravates the fuel supply problem, because of the relative inaccessibility of many sites.

In controlled-carrier operation, transmitter r-f power is changed

as closely as possible with fluctuations in level of received signal. This is done with a closed servo loop, including both ends of the communications link.

## Fading Characteristics

To determine the characteristics of the control variable, a basic analysis of the tropospheric scattering mode of propagation was made. Particular attention was given to instantaneous signal-level distributions, fading rate, depth and duration and other signal variations.

The study indicated that the sampling period of fast-fading Rayleigh distribution is one minute. Also fading rate caused by turbulent and drift velocities at carrier frequencies up to 10,000 mc seldom

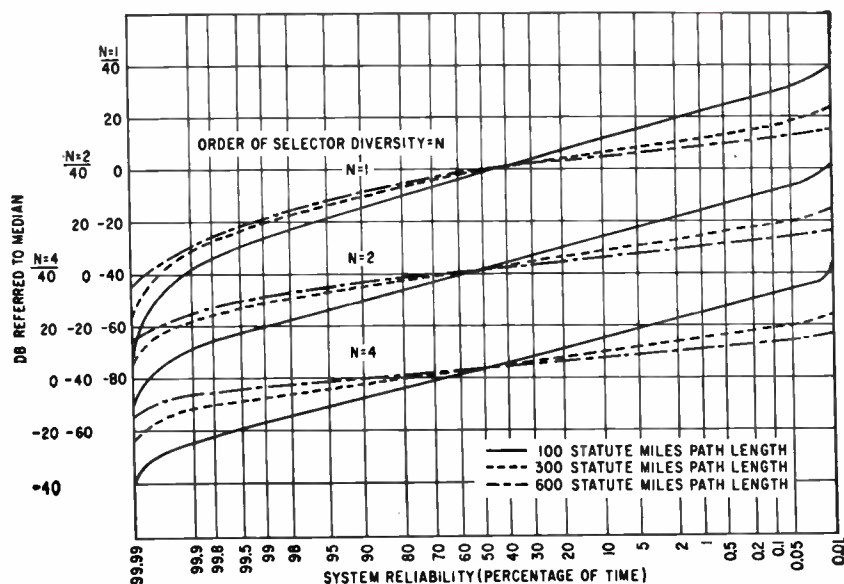


FIG. 1—Long-term instantaneous signal distribution curves permit determination of required dynamic range of transmitter power at different reliabilities, orders of diversity and path lengths for uhf tropospheric communications links

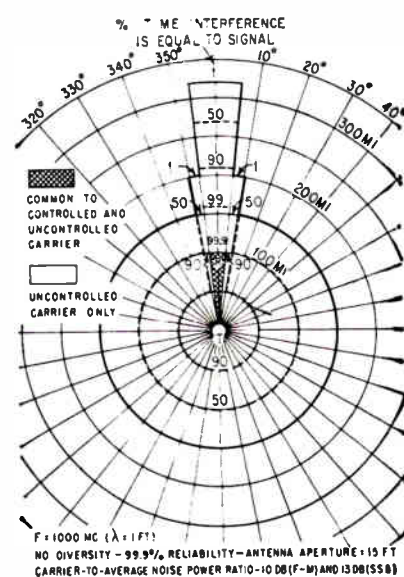


FIG. 2—Interference pattern shows difference in interference areas for controlled and uncontrolled operation

# Power to Offset Fading

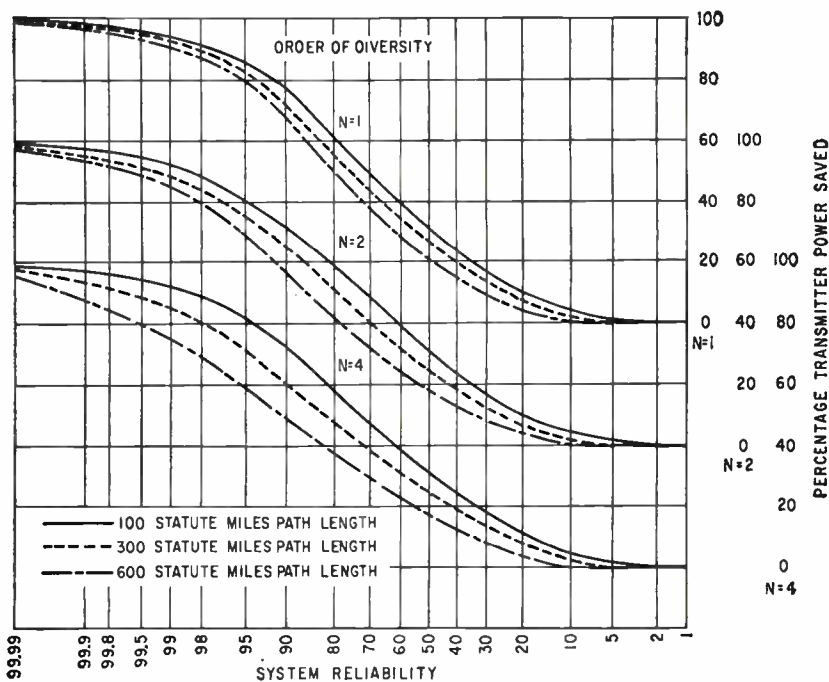


FIG. 3—Plot shows average transmitter power saved using controlled carrier for varying path lengths, orders of diversity and reliabilities

exceeds 10 cps, excluding aircraft effect, and the time constant of a signal-sensing circuit should be about 0.015 sec to respond to a fading rate of 10 cps.

Further, the worst rate of change of signal level is about 50 db at  $\frac{1}{2}$  cycle of 10 cps or 0.05 sec.

Exact data of duration, number and depth of fast fades are not yet available, although some analytical results are. Qualitatively, as fades get deeper, there are fewer of them and they do not last as long.

Since the fast-fading sampling period has been established as one minute, the median signal level should be established on a minutely basis. The minutely median, according to an analysis of a limited number of one-minute totalizer recordings, does change from minute to minute. Distribution also approaches Gaussian. If enough data are taken on a long-term basis (monthly or yearly), minutely median distribution probably would not be much different from the hourly median distribution.

Long-term instantaneous signal distribution (the combination of slow and fast fadings) should be

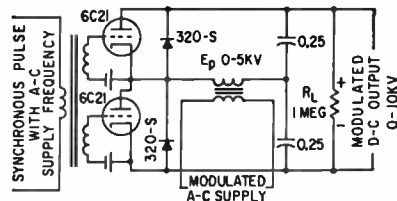


FIG. 4—Pulse demodulator may be used to provide voltage to modulating anode of klystron power amplifier

used as a basis for determining dynamic range of r-f power. These distributions could be obtained experimentally. Without an experimental curve, the probability combination of short-term fading and long-term fading distributions may be used.

A set of long-term probability-combined fading distributions are shown in Fig. 1. Conventional long-term hourly median distributions and short-term distributions for nondiversity and selector diversity operations were used. The long-term distributions were Gaussian with standard deviations of 9, 4 and 1.5 db for path lengths of 100, 300 and 600 statute miles.

A number of experimental non-

diversity long-term instantaneous signal distributions from scatter links follow the curves of Fig. 1 quite closely except for high signal regions. The exception may be caused by enhancement from aircraft effect and ducting. System parameters, such as frequency and path lengths, varied in the links considered.

Required dynamic range of transmitter power at various reliabilities, orders of diversity and path lengths can be determined from Fig. 1.

## Control Requirements

Path reciprocity may happen 99 percent of the time, if tropospheric transmission behaves similarly to ionospheric transmission.<sup>1</sup> Therefore, the control loop should be capable of handling some nonreciprocal effects, such as different fading rate and rate of change of signal level, if higher system reliability is required.

The requirement that transmitter power be controlled at a rate not exceeding 10 cps is limited by present-day high-voltage d-c power supplies and closed servo loops. Provisions must also be made in the control system to exclude aircraft enhancements and to handle some of the nonreciprocal path effects.

The azimuth interference area pattern of one typical system is shown in Fig. 2. Smooth-earth scatter geometry is assumed in the pattern, and only cochannel interference is considered. Interference is measured by a receiving setup identical with that used by the interfering system.

Azimuth antenna pattern is assumed to have four azimuth sectors. The first sector surrounds the main lobe. The second contains the two first side lobes, and the third contains the two second side lobes. The fourth sector includes all other minor side lobes that can be contained in an envelope with no gain (isotropic).

The main lobe of the interfered receiver is pointed to the interfer-

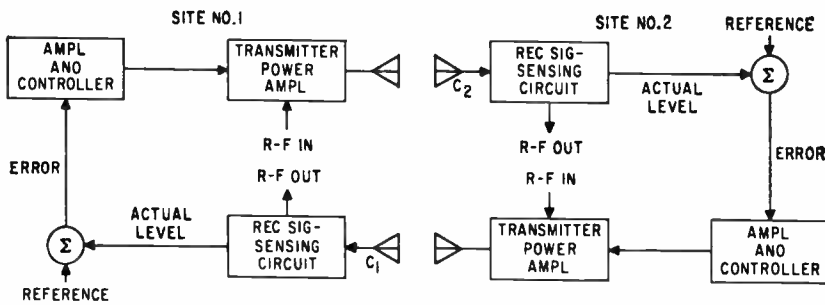


FIG. 5—Direct-type control loop is relatively simple and can be readily adapted to various types of communications systems

ing signal (at the ideal elevation for scattering). Azimuth off-beam effect is neglected.

Average interfering carrier to average noise ratio for ssb is 13 db and for f-m is 10 db. Minimum useable s n per channel, using zero dbm test tone, is 25 db.

Long-term average transmitter r-f power savings for various path lengths, orders to diversity and percentages of reliability are shown in Fig. 3. It can be shown that as system reliability is increased, savings in average transmitter power are also increased. Shortening the path also increases average power savings. On longer paths, however, actual power saved may be much greater (perhaps 50 kw or more), because transmitter power is originally greater.

### Output Control

Several types of amplifiers have been considered for controlling transmitter output power. A klystron having a modulating anode seemed to be the most desirable, since output voltage is directly proportional to modulating-anode voltage.

The modulating anode varies beam density, while beam voltage remains constant. When the modulating anode is operated at the same potential as the klystron body, it has no effect on either beam density or power output.

As the potential approaches that of the cathode, beam density and power output are reduced. Excitation need not be changed with changes in modulating-anode voltage, and focusing adjustments can remain fixed.

To control modulating-anode voltage, a separate supply can be connected between the klystron

body and the modulating anode. Output varies modulating-anode potential relative to the body and to the cathode. Supply voltage need not be as great as beam voltage.

The supply must deliver several hundred watts of well-filtered high-voltage d-c. The d-c can be obtained by rectifying and filtering a-c. D-c level can then be varied by changing a-c amplitude.

Conventional rectifier supplies oppose rapid changes in d-c voltage. The rectifiers prevent rapid discharge of filter capacitors, and the low level of ripple permitted requires the filtering.

It can be shown that maximum modulating frequency (control rate) is about 25 percent of supply frequency. In the present case, modulating frequency is 10 cps, and supply frequency should be 40 cps or higher. Thus, a 60-cps supply is suitable.

If a control rate of higher than

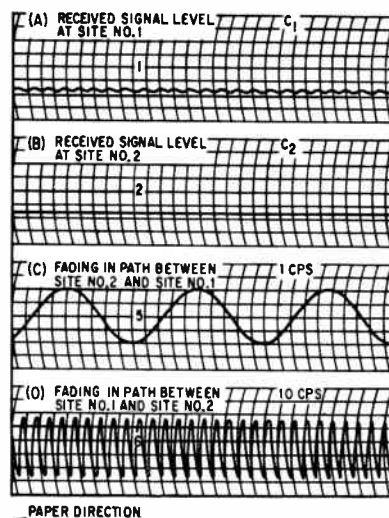


FIG. 6—Reduction of fading in two-way path is shown at (A) and (B) when input fades as shown in (C) and (D)

10 cps is desired, the power-supply frequency is increased or a pulsed-type demodulator supply is used. A typical pulsed-demodulator supply for this purpose is shown in Fig. 4.

### Proposed Systems

A control system that will regulate transmitted power in two-way point-to-point communications loops to compensate fading operates in this fashion. When transmitters and receivers are operating simultaneously over a two-way tropospheric transmission path, the control system detects actual received signal level and compares it to a reference. The error signal is amplified and used to control transmitter output.

The direct control loop is shown in Fig. 5. It is independent of the operation and characteristics of the multiplex and exciter equipments, and automatically and continuously makes adjustments of each transmitter power amplifier to compensate fading. The microwave paths in the atmosphere form part of the feedback loop.

### Verification

Experiments were performed to verify the theory of the direct-control technique. The controlled-carrier loop was simulated on an electronic analog computer (Reac). Variations in level of the received signal at both sites were computed during the presence of reciprocal and nonreciprocal fading.

A typical example of the performance expected during nonreciprocal fading is shown in Fig. 6. A 10-cps fading signal exists in one path, and at the same time a one-cps fading signal exists in the other. Reduction in fading at the receivers is indicated by the recorded values of  $C_1$  and  $C_2$ .

Estimates show that use in the pole-vault system would produce annual savings in diesel fuel close to one-half million dollars.

This work was done under study contract with Air Force Cambridge Research Center, where the concept of controlled carrier operation was initiated.

### REFERENCE

- (1) Meadows, *Proc IEE*, March, 1956.



**New Plasmarc Torch Service for Production Parts from Refractory Metals**—By harnessing the highest controlled temperatures ever used in industry—up to 30,000 degrees F.,—the new *Plasmarc* Torch makes possible the fast and accurate mass production of ultra-hard materials that have been virtually unworkable by any previous means.

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# FOR MEN WITH IMAGINATION

**Three-Level Ruby Maser**—The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of this energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have incredibly low noise levels approaching zero db. Recently a University research laboratory\* used LINDE single crystal synthetic ruby (Al<sub>2</sub>O<sub>3</sub> with Cr<sub>2</sub>O<sub>3</sub> additive) in a three-level solid state Maser. The ruby crystal was placed at the center of the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser successfully amplified signals at 9.3 kMc.



LINDE also supplies other crystals including rutile, spinel and sapphire (Al<sub>2</sub>O<sub>3</sub>). Sapphire is used in infra-red optical systems, windows for high power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C, is hard, inert, non-porous and can be sealed to metals and glasses. Sapphire is currently available in the shape of domes, windows up to 4½ inches in diameter, rods and special configurations.

For further data write to Crystal Products Department BD-15, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

\*"Maser Action in Ruby," by G. Makhov, C. Kikuchi, J. Lambe, and R.W. Terhune. "Physical Review," Volume 109, Number 4, Page 1399, Feb. 15, 1958.

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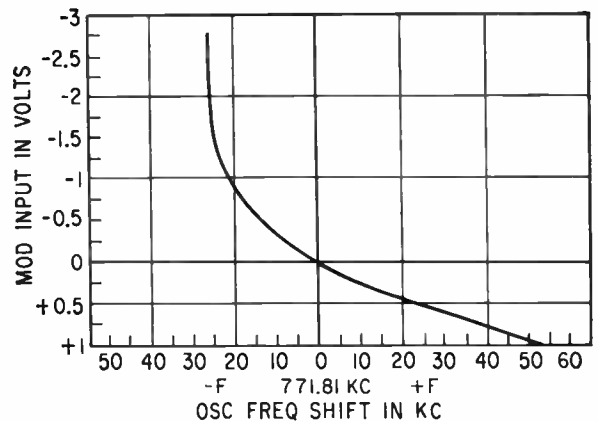
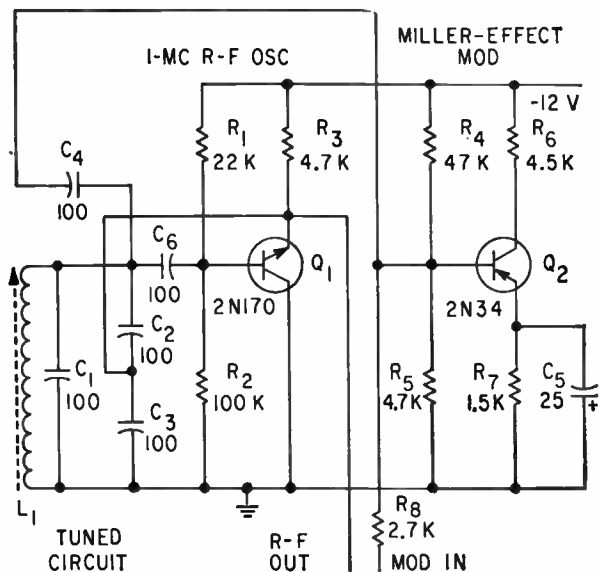


FIG. 2—Frequency shift plotted as a function of the d-c input voltage to the modulator

FIG. 1—A frequency sweep generator was constructed using two of these oscillator circuits and a diode mixer

# Transistorized F-M Oscillator

Two-transistor circuit combines a Q multiplier with the Miller effect to produce a relatively stable but simple f-m oscillator and modulator

By **PAUL W. WOOD**, General Motors Corp., Detroit, Michigan.

**A** SENSITIVE MEANS of controlling or modulating frequency with a low control signal is provided by this transistorized f-m oscillator, Fig. 1. Operating at 1 mc, the configuration is similar to the Harris Q multiplier<sup>1,2</sup>, with sufficient feedback to oscillate.

A low-impedance tap on the tuning coil is unnecessary because of the high input impedance of the emitter follower, Q<sub>1</sub>. Negative feedback of Q<sub>1</sub> makes the circuit relatively stable.

The tuned circuit, L<sub>1</sub> and C<sub>1</sub>, is center tapped by C<sub>2</sub> and C<sub>3</sub>. The signal developed across the emitter resistor R<sub>2</sub> is fed back to the junction of C<sub>2</sub>, C<sub>3</sub>, sustaining oscillation at the frequency determined by L<sub>1</sub>-C<sub>1</sub>, C<sub>2</sub>-C<sub>3</sub>.

Resistors R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> determine the quiescent operating point of the transistor. The oscillator output signal is developed across the emitter load resistor.

The modulator is a conventional audio amplifier using Miller effect<sup>3</sup> to produce a change in the oscillator frequency.

The input capacitance of the common emitter circuit, Q<sub>2</sub>, is approximately equal to the effective emitter capacitance times the transistor current gain. The modulation signal, applied to the base of Q<sub>2</sub>, varies the current gain and thereby varies the input capacitance.

### Frequency Shift

The input capacitance of Q<sub>2</sub> is coupled to the oscillator tank circuit through a small capacitor C<sub>4</sub>. Thus as the gain of the transistor is varied, its input capacitance varies and is coupled to L<sub>1</sub>-C<sub>1</sub>, producing a corresponding shift in oscillator frequency. The values of R<sub>4</sub>, R<sub>5</sub> and R<sub>7</sub> produce class-A operation of Q<sub>2</sub>. Capacitor C<sub>5</sub> bypasses R<sub>7</sub> for audio frequencies. Resistor R<sub>8</sub> isolates the input sig-

nal source from the base of Q<sub>2</sub>.

Figure 2 shows the frequency shift as a function of the d-c input.

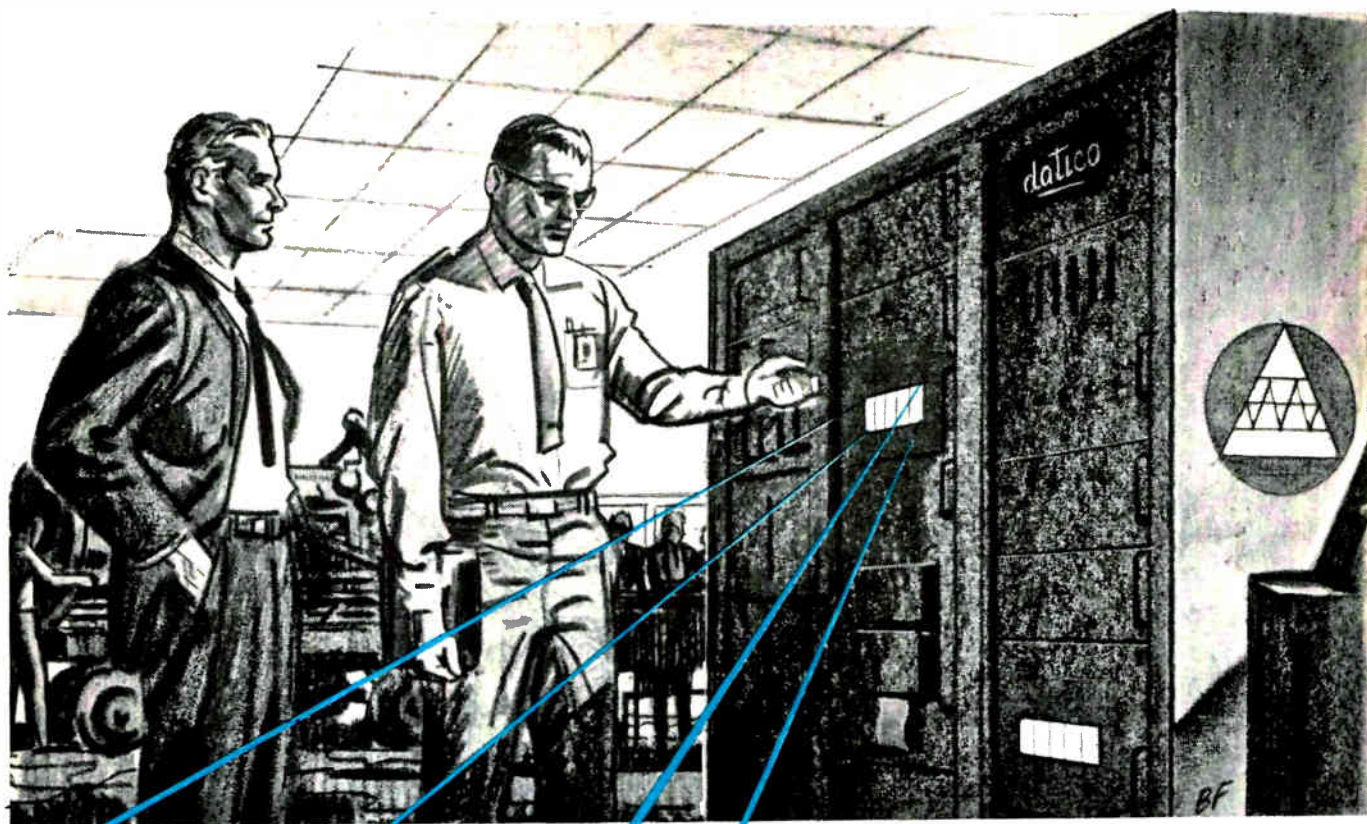
Tests of this circuit, made in a variable temperature chamber, show a 4-kc decrease in frequency as a result of a temperature change from 40 F to 100 F. This temperature stability is good, being about 0.5 percent at 700 kc. Stability could be increased by use of negative temperature coefficient capacitors and thermistors.

A frequency sweep generator was constructed using two of the described oscillators and a diode mixer. One of the oscillators was modulated by a low-frequency sawtooth signal, while the other was operated at a fixed frequency.

### REFERENCES

- (1) H. E. Harris, Simplified Q Multiplier, *ELECTRONICS*, p 130, May, 1951
- (2) G. B. Miller, Transistor Q Multiplier, *Electronic Eng*, p 79, May 1958
- (3) Miller Effect, *Radioelectron Designer's Handbook*, 3rd ed. p 182

# Transistorized NLS M-24 Selected for Missile Checkout System



Analog to digital conversion in Nortronics' Universal Datico is accomplished by the ultra-reliable NLS M-24, the transistorized Digital Volt-Ohmmeter that automatically and accurately measures and displays AC and DC voltages, voltage ratio and resistance.

In Datico, program control is performed by a punched paper tape. Test stimuli are automatically controlled by Datico and output signals (voltage, voltage ratio, and resistance) from the system under test are automatically selected and fed to the NLS M-24. The M-24 digitizes the system outputs to 0.01%, and provides numerical data to the indicator and control chassis for distribution to the data recorder, digital comparator, and visual display on a special NLS in-line readout.

The tape also establishes the go-no-go limits for comparison with the M-24's digital output. It then directs the system to the next channel to be measured.

Operation of the NLS M-24 in this system is completely automatic . . . the instrument is remotely operable, does not require zero setting, and is extremely stable over very long time periods. Over-all system speed is not compromised by analog to digital conversion time, the M-24 making each measurement in just 330 milliseconds.

The NLS M-24 meets the unusually great reliability demanded of automatic test equipment for modern electronic weapons systems. This reliability is assured by transistors, mercury-wetted contact relays (rated at 10 billion measurements), advanced circuit design, and thorough production and field testing.

Proved in the field in a variety of applications, the NLS M-24 Digital Volt-Ohmmeter is in production and ready to go to work for you. Write today for detailed information concerning this outstanding example of NLS leadership in the development and manufacture of digital instruments. A complete catalog of NLS instruments will be sent upon request.



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**NLS — The Digital Voltmeter That Works...And Works...And Works!**

# Soviets Give Data on Sun Satellite

MOSCOW—LAST WEEK the Soviet Union released additional information about instruments, communications and control equipment aboard its moon rocket.

The last stage of the three-stage rocket contained a spherical instrument package under its nose cone. Inside the instrument package were radio-control equipment, telemetering transmitters and scientific instruments. The instrument package, which was detached from the last rocket stage at the end of powered flight, was made of aluminum-magnesium alloy, pressurized to 1.3 atmospheres and maintained at a uniform internal temperature of 20 C. The only external gear on the instrument package were four

rod antennas and a magnetometer probe.

The moon rocket rose to about 400,000 km under closed-loop radio control that made use of a transmitter-receiver working on 183.6 mc. At 113,000 km the rocket's trajectory was confirmed optically when a cloud of sodium vapor was released. A crystal-controlled oscillator was timed to release the sodium cloud.

Three telemetry transmitters used operated on 19.993, 19.995 and 19.997 mc.

Among the scientific instruments carried were two sodium iodide scintillation counters for cosmic ray studies. To prevent overloading the telemetry channel, the counters fed

a neon-tube scaler.

Two proton traps were used to study the composition of interplanetary matter and corpuscular radiation. The traps consisted of a solid semispherical collector electrode surrounded by two concentric semispherical grids.

Two ballistic piezoelectric gages of ammonium phosphate were used to count micrometeorite impacts. The gages fed a three-level pulse-height discriminator. Also the instrument package was a sensitive magnetometer consisting of three mutually perpendicular sensing elements.

The electronic equipment was powered from silver-zinc and mercury-oxide batteries.

# Timer Made More Linear

By RONALD L. IVES, Palo Alto, Calif.

THYRATRON interval timers are used widely in industrial control and as darkroom timers. Nonlinearity errors are usually less than 3 percent up to about 60 sec.

Attempts to extend the range of the timer shown in Fig. 1 to 399 sec, with a maximum error of  $\pm 1$  percent, disclosed consistent non-

linearities caused by grid-current flow (contact potential).

When the basic timer circuit is energized, plate current closes the relay. A-c is applied to the calibration potentiometer and through timing resistor  $R$  to the grid. Rectification charges capacitor  $C$  rapidly to the potential determined

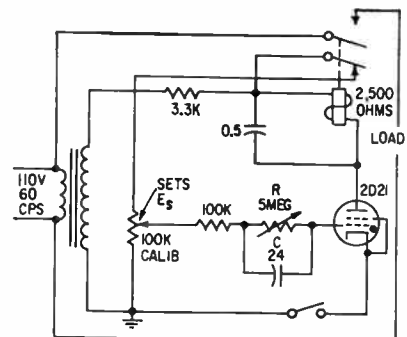


FIG. 1—Conventional thyatron timer is not completely linear partly because of contact potential in grid circuit

# Mobile Antenna Test Mast



Mobile antenna test site used at Goodyear Aircraft's Wingfoot Lake installation near Akron, Ohio. Facilities are used for antenna and microwave R & D projects

by the calibration setting.

When the cathode circuit is opened, the tube stops conducting. The relay opens, energizing the load and removing a-c from the calibration potentiometer. Until the charge leaks away through  $R$ , the thyatron will not conduct.

General formula for this timing circuit is  $T = 2.303 RC \log_{10} (E_s/E_t)$ , where  $T$  is in sec,  $R$  in megohms and  $C$  in microfarads. The quantity  $E_s$  is supply voltage and  $E_t$  is thyatron firing voltage.

Since all values except  $T$  and  $R$

concerned about



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## USE NEW IRC MOLDED METAL FILM PRECISION RESISTORS

If you need the precision of a wire wound resistor, but in a space-saving, weight-saving size, IRC's new Type ME Metal Film Precision Resistors are for you.

Not only do they save weight and space but they are equal or superior to wire wound resistors in many respects as noted at right:

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2. Higher statistical performance on environmental tests
3. Higher ambients, extended lifes, extended moisture and temperature cycling
4. Better RF characteristics
5. Comparable or lower in cost
6. Resistance values are stable—just as stable for a 1% resistor as for a 0.10% resistor—just as stable for low T.C.'s as high T.C.'s.

**TEMPERATURE COEFFICIENT**—In order to meet the variety of T.C. requirements, precision metal films are offered in eight classifications. You may order T.C.'s as close as those for precision wire wounds... or, where it is not critical, T.C.'s up to  $\pm 100$  PPM are available. Classifications are listed below:

Classification	PPM	Temperature span
T-1	$\pm 100$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-2	$\pm 50$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-3*	$-0 + 100$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-4*	$+0 - 100$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-5	$\pm 25$	$+25^{\circ}\text{C} + 105^{\circ}\text{C}$
T-6*	$+50 - 0$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-7*	$-50 + 0$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$
T-8*	$\pm 25$	$-55^{\circ}\text{C} + 165^{\circ}\text{C}$

\*Special types.

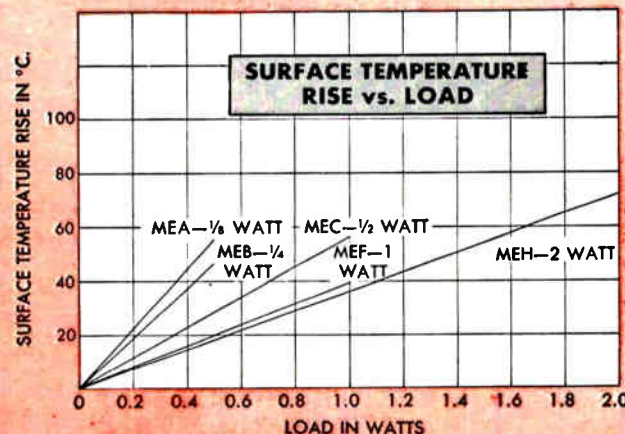
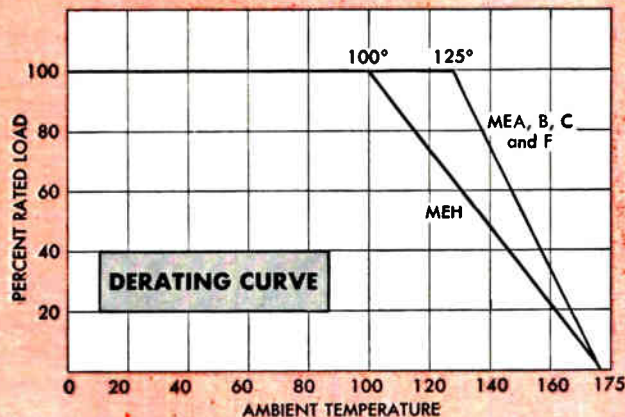
**OTHER CONSTRUCTION ADVANTAGES**—The new IRC Molded Metal Film Resistors eliminate two other bugaboos of wire wound resistors.

1. No cold joint problem. There is no unsolderable resistance wire in the metal film resistor to be soldered to the terminals. 2. No failure due to excess winding stresses because there are no windings.

IRC Type	5 Wattage Ratings (125°C Ambient)	Maximum Continuous Voltage Rating	New Range Minimum** Ohms	New Range Maximum** Ohms
MEA	1/8	250 V	30	500 K
MEB	1/4	300 V	50	1 meg
MEC	1/2	350 V	50	1.5 meg
MEF	1	500 V	50	4 meg
MEH	2*	750 V	100	10 meg

\*\*100°C Ambient Max. below 500 K ohms.

**\*\*NEW EXTENDED RANGES**—These new ranges have lower minima and higher maxima by far than our former corresponding values.



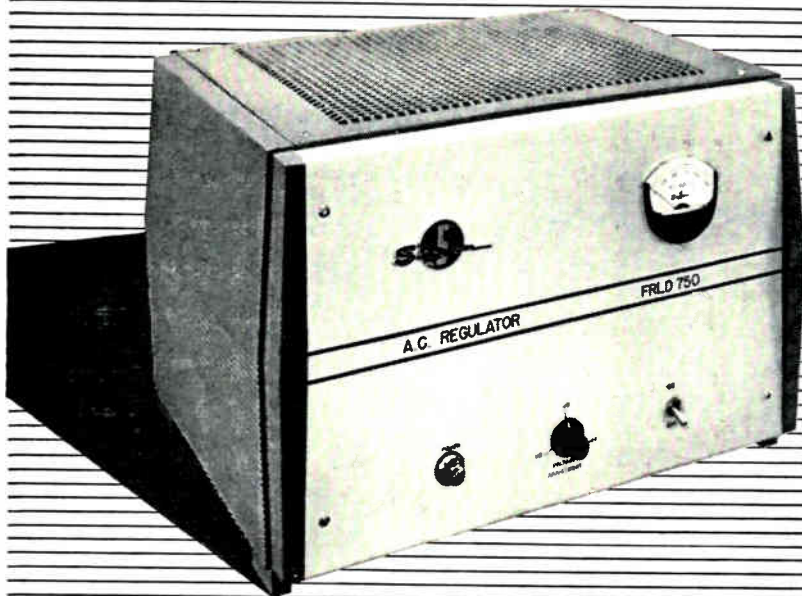
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## NEW IDEAS IN PACKAGED POWER

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## New, fast, a-c regulator cuts line & load transients 18 db

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The new Sorensen Model FRLD750 fast-response, low-distortion a-c regulator is ideal for critical applications like null testing, meter calibration, and the powering of pulse-type circuits, such as those used in computers, where false triggering is not permissible.

Since there is no phase shift between input and output, the FRLD750 can also be used in multiples for the regulation of multi-phase power. Line and load transients are reduced by at least

8:1, regardless of their magnitude. Both cabinet and 19" rack-mounting models available. Write for technical data or see your Sorensen representative.

And don't forget, Sorensen engineers will be glad to discuss your special power requirements with you. They can help you select the proper a-c or d-c power supply, regulator, or frequency-changer from the widest transistorized line on the market, or assist you in designing special power systems. E. 39



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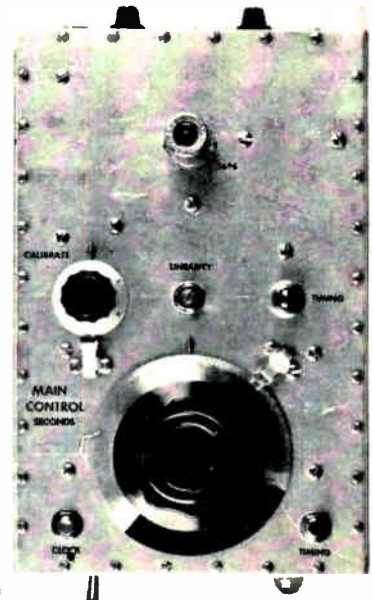
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are fixed,  $dT/dR$  is a constant. Time appears linear with respect to  $R$ , but this is not strictly true.

One source of grid-circuit voltage in the  $R$ - $C$  circuit is explained. A second, contact potential, is a function of grid-to-ground resistance, increasing linearly with time. It approaches firing voltage at several megohms and may exceed it, preventing firing, at about 15 meg.

Contact potential changes the asymptote of the capacitor dis-



Packaged timer includes power supply. Varying capacitance rather than resistance and other minor precautions reduces timing errors to within one percent over range from 1 to 400 sec

charge curve from zero to contact potential, producing errors which increase percentagewise with time. A better formula is  $T = 2.303 RC \log_{10} [E_s / (E_s - KR)]$ , in which  $KR$  is contact potential. Now  $dT/dR$  is not a constant and  $T$  does not vary linearly with  $R$ .

Linearity can be increased if the ratio of contact potential to firing voltage is reduced. This can be done by decreasing  $R$  and increasing  $C$ . This is effective for narrow ranges (1 to 1.5) but not for wide ranges (1 to 400).

However, if  $R$  is fixed and  $C$  is varied, time interval will be a linear function of capacitance. Timing accuracies better than  $\pm 1$  percent were attainable experimentally with capacitors accurate

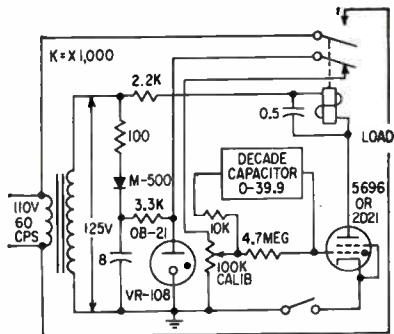


FIG. 2—Improved linearity is obtained by varying capacitance rather than resistance in grid circuit

to  $\pm 0.5$  percent. Consistency at any setting was considerably better with regulated supply voltages. Selected metallized paper capacitors were found suitable.

#### Improved Timer

An interval timer for 1 to 400 sec with a timing error of less than one percent at all settings is shown in Fig. 2. Timing consistency is about one order of magnitude better than accuracy at all settings.

It was also found essential to rectify, filter and regulate timing voltage. Shielding the thyatron against radiation and vibration was found essential. Small thyatrons function as nonselfquenching Geiger tubes when grid bias voltages are very close to the firing point. A normal antimicrophonic lead shield sufficed.

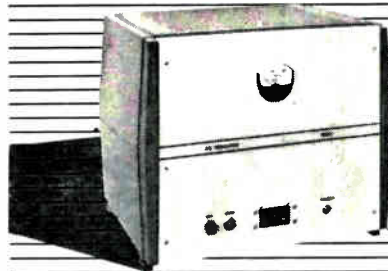
Consistency was enhanced by aging the thyatron about 100 hours before final adjustments, which are quite simple. The timer is run until it reaches equilibrium temperature. Time is set; an electric clock, set to zero, is plugged into the load outlet; and the button is pressed.

The clock reading is then compared with the setting. The difference is compensated by adjusting the potentiometer, which sets  $E_s$ . Final adjustment is best done at a long time interval.

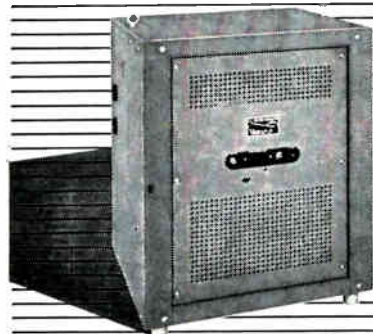
Contact potential and other factors limit the effective value of  $R$  to about 5 megohms, unless additional bias is provided. Additionally, consistency falls off rapidly when the timing interval greatly exceeds the time constant. For most applications, time interval should not exceed about  $3 RC$ .

## NEW IDEAS IN PACKAGED POWER

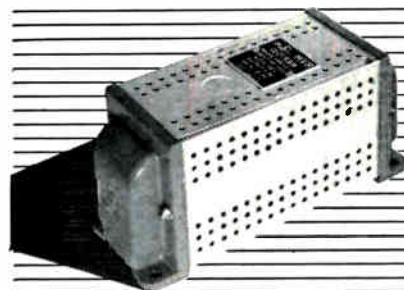
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**New tubeless 0.1% a-c line regulators give up to 5kva out.** High output and fast response result from a unique combination of semi-conductor and magnetic amplifier principles in the new Sorensen Model R3010 and R5010 a-c line regulators. Model R5010 (left) puts out up to 5kva and Model R3010, 3kva. Provision for remote sensing allows you to hold regulation accuracy at the load despite length of output leads, and, with an external transformer, permits regulation of any a-c voltage.



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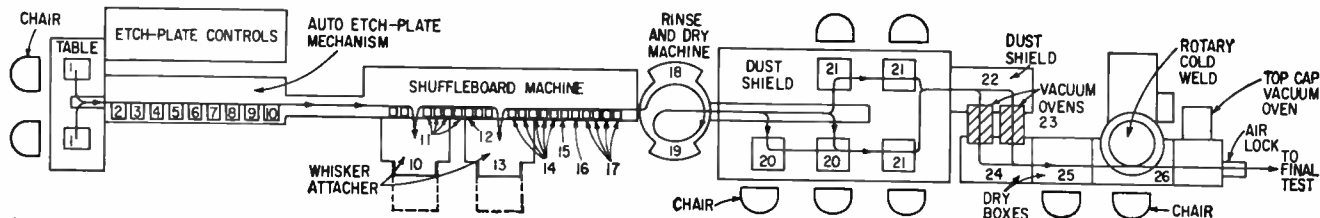
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# Automatic Transistor Manufacture



- |   |   |   |  |
|---|---|---|--|
| <p>1. (a) LOADS TAB INTO CARRIER<br/>(b) SOLDERS GERMANIUM BLANK TO TAB<br/>(c) CHECKS TAB POSITION</p> <p>2. PRECISELY MEASURES BLANK THICKNESS</p> <p>3. ETCHES COLLECTOR, CONTROLLED BY THICKNESS MEASUREMENT</p> <p>4. ETCHES EMITTER</p> <p>5. RINSES</p> <p>6. PLATES EMITTER AND COLLECTOR</p> | <p>7. RINSES</p> <p>8. DRIES</p> <p>9. TESTS DIODE BREAKDOWN</p> <p>10. ATTACHES EMITTER WHISKER &amp; MICRO-ALLOYS</p> <p>11. RINSES AND DRIES</p> <p>12. ROLLS CARRIER OVER</p> <p>13. ATTACHES COLLECTOR WHISKER</p> <p>14. RINSES AND DRIES</p> | <p>15. ELECTROLYTICALLY ETCHES TO CLEAN-UP</p> <p>16. QUENCH RINSES</p> <p>17. RINSES ULTRASONICALLY</p> <p>18. LONG RINSING</p> <p>19. LONG DRYING</p> <p>20. (a) WELDS TAB TO STEM LEAD<br/>(b) SHEARS EXCESS TAB</p> <p>21. WELDS BOTH WHISKERS TO RESPECTIVE STEM LEADS</p> | <p>22. LOADS VACUUM OVEN FROM DUST SHIELD</p> <p>23. VACUUM DRIES</p> <p>24. UNLOADS VACUUM OVEN INTO DRY BOX</p> <p>25. TEST FOR <math>I_{CO}</math> AND <math>I_{EO}</math></p> <p>26. COLD WELDS TOP TO STEM</p> <p>27. FINAL TESTING (NOT SHOWN)</p> |
|---|---|---|--|

**MOST IMPORTANT DRAWBACK** to use of transistors in entertainment devices has been price. Except for the case of portable radios where small size and increased battery life have overruled price considerations, general entertainment use of transistors has been practically nil.

Indication of a change in this situation has come about with Philco's announcement of its new F.A.T. (Fast Automatic Transfer) line. The new production machinery, almost fully automatic, will produce

low-cost, MADT transistors designed specifically for high-frequency and middle-frequency entertainment uses.

Actually a series of machines interconnected, the new line accounts for 33 operations needed in the production of a transistor. The line etches and plates the germanium blank to measurements as thin as 0.0017 in. It forms and attaches whiskers to the electrodes; chemically cleans, washes and dries the assembly; checks itself through

control points that feed back corrective information to previous operations and vacuum dries and bakes the assembly and pressure welds the tops.

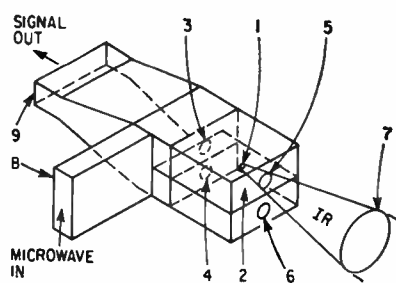
Initial production rate of the line will be 450 transistors per hour. And prices of the transistors to customers will be roughly equivalent to vacuum tubes.

Design of the line was made possible by using a stainless-steel carrier block fitted with a grip-jaw to position the various operations.

# Infrared Detector Is Microwave Energized

**UNUSUAL** in operation, a new infrared detector developed by GB Electronics Corp. uses a gold-doped germanium crystal coincidentally energized by a microwave field. This technique eliminates both the electrical contacts to the semiconductor and the necessity for a d-c bias current.

Conductivity and dielectric constant of the semiconductor, carefully positioned in the microwave field, control tuning of a sharply tuned cavity. Change in the complex dielectric constant is caused by incident radiation, infrared through ultraviolet depending on choice of semiconductor. The system is expected to detect extremely small intensities of infrared radiation. Its wide bandwidth may be used in infrared high-resolution reconnaissance and mapping.



**FIG. 1—Configuration for infrared detector: photosensitive semiconductor—1, 2; apertures—3, 4, 5, 6; infrared lens—7; input arm—8 and output arm—9**

Elimination of noise generated at the contacts of semiconductor detectors and reduction of shot noise, which is proportional to the square of the d-c bias current, reduce overall noise level.

The detector makes use of the total variation of the complex dielectric constant of the photosensi-

tive semiconductor in generating signal voltage. This technique should give the detector an increase in sensitivity.

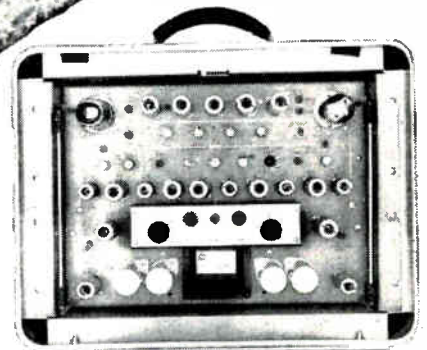
## Detector Assembly

Figure 1 shows the essentials of the detector. Microwave energy is put into one of the arms of an X-band Hughes magic tee while the two collinear arms are terminated by two identical microwave cavities. Signals reflected by the cavities are combined 180 deg out of phase in the output arm. If the system is balanced and the reflected waves from the tuned cavities are the same amplitude and in phase, no power is coupled into the signal output arm.

The semiconductor cubes, about one mm on edge, are suspended within each cavity at points of



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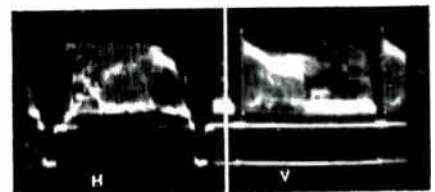


**MODEL 1008A VERTICAL BLANKING INTERVAL TEST SIGNAL KEYS**

Portable or standard rack mounting. Self-contained regulated power supply.



Video picture with multiburst test signal inserted, as seen on picture monitor.



Test signal is thin line between frames. All test signals can be transmitted during vertical blanking portion of video signal.



**1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR**

Completely self-contained, portable. Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite sync. Variable duty cycle. Regulated power supply. 12 1/4" standard rack mounting or in carrying case. Integrates with above model 1008-A Test Signal Keyer.

**1043-DR VERTICAL INTERVAL DELETER-ADDER**

Integrates with model 1008-A to recognize incoming test signals. Deletes incoming test signals and/or adds new test signals.



**VERTICAL BLANKING INTERVAL,  
TEST SIGNAL KEYS  
1008-A**

The Telechrome Model 1008-A Vertical Blanking Interval Keyer is a self-contained portable unit that makes possible transmission of television test and control signals between frames of a TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signals. The keyer will operate anywhere in the TV system and operates from composite video, sync, or H & V drive. The test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

These continuous reference signals may be used in connection with various Telechrome devices for automatic correction of video level, frequency response, envelope delay, differential gain and differential phase.

**IMPORTANT:** Checking after programming is costly and at best highly inefficient since conditions constantly vary. The Telechrome Vertical Interval Keyer minimizes post-program checking and overtime expenses. It provides instant indication of deteriorating video facilities so that corrective measures can be undertaken immediately — manually or automatically during programming.

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- Identifies, indicates and/or eliminates bad data
- Provides complete flexibility — completely independent digital recorder sub-system accepts digital data from any digital source
- Provides optimum reliability and serviceability — via complete logic design, proven building block modules, high quality components and construction

**Epsco**



—First in data control

For complete engineering information write for Mark I Systems Brochure, Systems Division, Epsco, Inc., 588 Commonwealth Avenue, Boston, Massachusetts.

highest interaction with the microwave field. Phase and amplitude of the wave reflected by the cavity back toward the signal source are functions of the resistance and dielectric constant of the suspended semiconductor. As mentioned previously, these semiconductor parameters are functions of the illumination on the semiconductor. If one of the cavities is illuminated while the other is not, both the amplitude and phase of the reflected waves are different. Combining them vectorially does not provide complete cancellation and appreciable signal results in the output arm.

### Output Signals

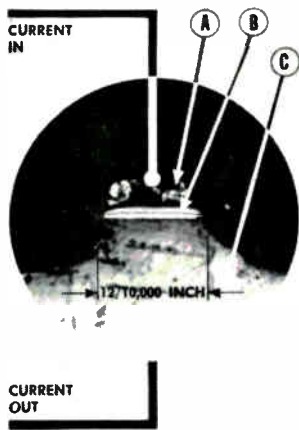
The output signal can be obtained in several different ways. For example, the input infrared radiation can be chopped and a crystal detector and a-f amplifier used to detect and amplify the output signal. Or first one and then the other cavity can be illuminated causing the microwave bridge to operate in push-pull giving twice the signal output. For high-resolution reconnaissance and mapping, the microwave signal derived at the output arm of the tee may be heterodyned with a local oscillation as in radar. In this manner, a wider bandwidth is provided.

### Semiconductor Device Switches in $50 \times 10^{-12}$ Sec

DEVELOPED BY Sperry Rand, a new semiconductor switch operates in only  $50 \times 10^{-12}$  sec. This is a calculated value since presently available instruments cannot measure speeds this fast.

Heart of the new switch is a tiny semiconductor alloy junction formed by fusing a speck of aluminum to a piece of silicon. The entire switching action takes place within the junction layer's diameter of 0.002 in. and thickness of  $4 \times 10^{-6}$  in.

Current flow in the layer is blocked until triggered by a small voltage pulse. The slight increase in voltage accelerates one or more electrons to speeds sufficient to knock new electrons out of their bands. These, in turn, accelerate and knock more electrons free and



Switch mechanism magnified greatly. In off condition, current entering section A is prevented from flowing to C by layer B. When voltage at A is increased slightly, current flows

current is carried across the junction by this avalanche effect.

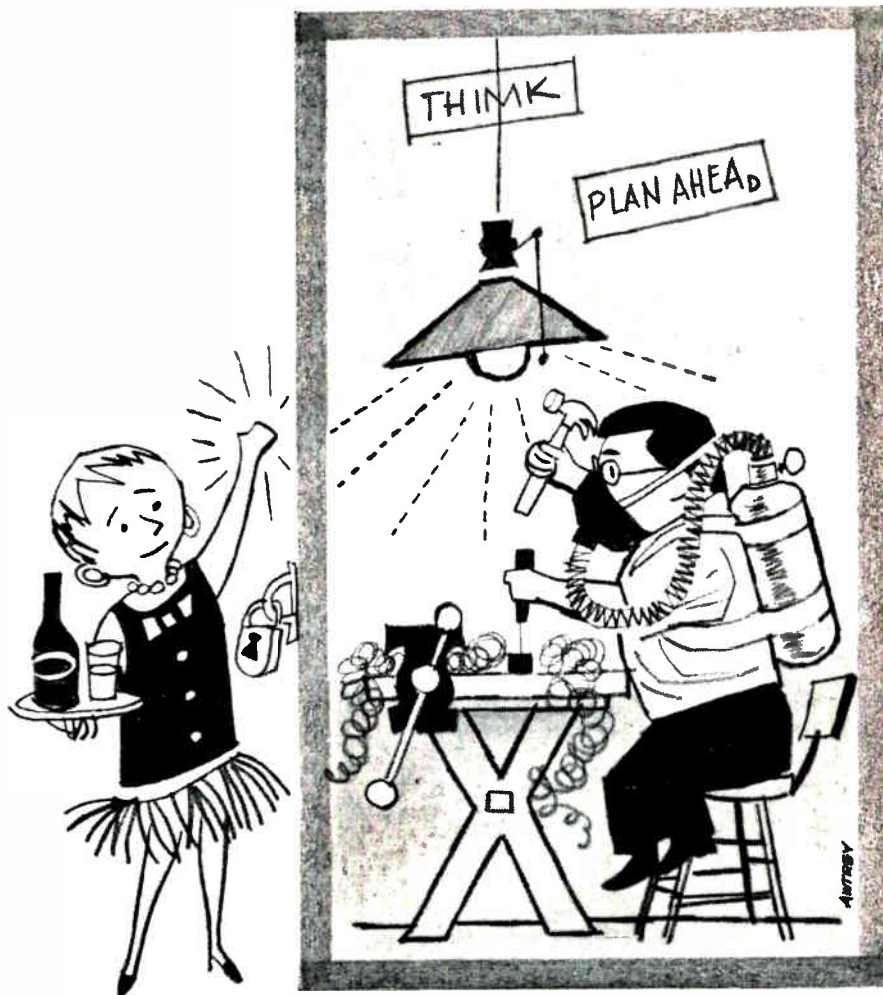
A slight decrease in voltage reduces the speed of the electrons so that they cannot knock other electrons loose. The switch is then off and no current flows.

## High-Temperature Glass Fiber Slewing

BECAUSE of an extrusion manufacturing process, a new silicone-rubber-coated glass fiber slewing, known as Ben-Har 1151, exhibits great mechanical strength.

Manufactured by Bentley, Harris Mfg. Co., the slewing offers resistance to damage and ease of handling comparable to vinyl-coated and neoprene-coated slewings. The production process makes possible continuous inspection of dielectric properties. Also, elasticity of the slewing is such that its diameter may be expanded as much as four times over its original size. This feature enables the slewing to be used to cover the original diameter of the wire, the diameter of the stripped wire and the diameter of the soldered connection.

The new product meets MIL-I-18057A and appropriate NEMA and ASTM standards. It will be available in a full range of sizes and colors. Usable temperature range is from 200 to 250 C.



## your own pots — 100% pure!

Want the purest in potentiometers? Nothing to it — just put on a surgical mask, lock yourself up in a sealed room, and start winding! Of course, you'll need an air conditioning plant to keep the moisture controlled, and the air dust-free. And you'll have to work out some pretty elaborate assembly techniques to keep the whole works uncontaminated. Petty details . . .

You could do all this — but you don't have to — Ace goes to all these extremes of quality control and more! So why not take advantage of our sealed room and our advanced techniques — and eliminate all the fussin'? You'll get the accuracy and reliability you have a right to expect from Ace. So do it the easy way — get Ace pots. See your ACErep now!



Here's one of our pure pots: the 500 Acepot.® Highest resolution, 0.3% independent linearity, 1/2" size, sub-miniature. Special prototype section insures prompt delivery.

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 Acepot® Acetrim® Acecol® Aceohm® \*Reg. Appl. for

# Thin Parts Produced by Etching

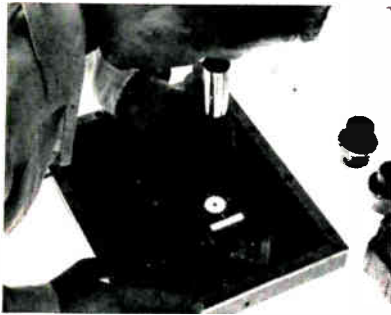
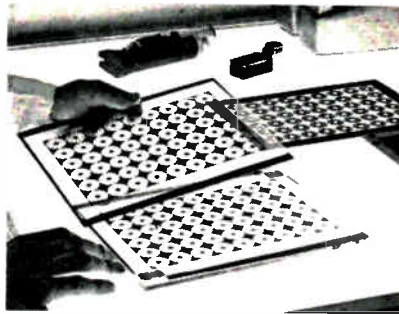
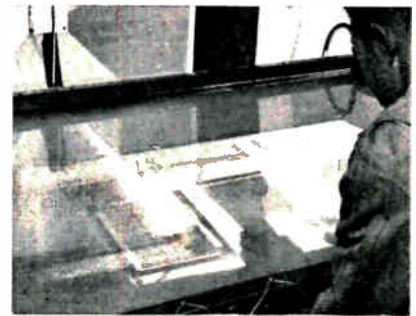


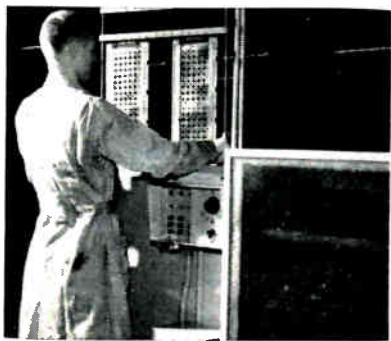
Photo negative is set up on chase for step and repeat operation to make multiple positive



Multiple printing plates are inspected on light table. Glass printing plates are used



Brass sheet is sandwiched between plates in double-sided vacuum frame to expose emulsion



Etched sheets are removed from etching machine



Finished parts are cut from sheet with shears

rated and inspected. Small hand shears may be used to cut apart the etched sheet.

## Work Simplification Program Cuts Costs

WORK SIMPLIFICATION program added to regular industrial engineering program can produce unit savings of pennies which add up to thousands yearly. Such a program encourages production and supervisory personnel to solve minor operating problems which might otherwise go unattended.

One such program is active among supervisory personnel at Beckman Instruments Berkeley Division, Richmond, Calif. In addition to substantial savings, the firm has found it whets employee interest, leading to a steadily increasing volume of improvements.

An example of a work simplification suggestion is a fixture for spotwelding soil moisture detector units. Previously, metal covers were taped around inner wafer and hand-held for welding.

### Clip Ends Taping

New fixture holds pieces together with spring clip, eliminating tape and accurately positioning the sandwich in welding position. The fixture is movable and snaps into each of 5 welding positions. It is attached to the welding machine frame with set screws. Tooling cost of \$85 has resulted in \$300 a year savings in labor and materials and produces neater welds.

Reducing twisting operations to

CHEMICAL BLANKING is considered by Collins Radio Co., Cedar Rapids, Iowa, to be the most economical method of fabricating thin metal parts in small production quantities and low build rates.

Intricate designs may be processed as easily as simple designs. Another advantage is that design changes can be made at very low cost compared to the costs of scrapping or reworking precision dies.

The method is primarily used on copper alloy parts of 0.001 to 0.030 inch thickness. The thickness affects the tolerances which can be held. A tolerance of  $\pm 0.002$  inch is not difficult to hold on material of 0.001 to 0.005 inch thickness, but is not practical on 0.020 inch metal.

### Plate Preparation

Preparation for processing is similar to that used for printed wiring. A draftsman prepares a solid drawing or a heavy outline of the part. The scales generally used by Collins are 4 to 1 or 10 to 1. The drawing is photographed by a

reducing camera, at actual size. Using 10 to 1 reduction, an accuracy of 0.0001 inch is maintained.

A multiple positive or negative is made on a step and repeat machine. Two glass printing plates are made from the multiple positive or negative. The plates are registered on a light table so they will line up exactly.

### Metal Exposed

Sheets of the thin metal are thoroughly cleaned and coated with light-sensitive emulsion which is baked on. The sheet is placed between the printing plates and exposed on both sides simultaneously after the plates are registered. A double-sided vacuum frame with an arc light is used.

The sheet is then developed to remove the unexposed resist. An etching machine which sprays etchant on both sides of the sheet is used to remove the uncoated metal.

After etching, the resist is stripped off and the parts are sepa-



## **Crosley Communications**

**For . . . Today's  
Armed Forces**

Years of experience in communications have made Crosley a name that is respected for both commercial and defense business. Crosley's latest contribution to communications is the VRC-12, designed for use in communicating with practically every type vehicle used by the Armed Services, including tanks, jeeps, ducks, airplanes, helicopters and command cars.

The VRC-12 Ground Communications system provides narrow-band FM communications over 920 channels. The unit is transistorized and miniaturized in a package that is both rugged and light in weight.

Crosley engineering, working from initial concept to the final phase of manufacturing, has developed many new products such as the VRC-12.

### **CROSLEY'S COMPLETE CAPABILITIES**

Together with its associated Avco Divisions, Crosley provides facilities and personnel for:

- *Research, development and engineering of: communications, air traffic control systems, sonar, infra-red, radar, fire control systems, telemetering, automatic test and support equipment, ground handling equipment and logistics.*
- *Production and manufacturing for missiles and aircraft systems.*
- *Weapons system management from initial concept to production.*

If Crosley's capabilities fit your needs, write to: Vice-President, Marketing-Defense Products, Crosley Division, Avco Manufacturing Corporation, Cincinnati, Ohio.

**Avco** // **Crosley**

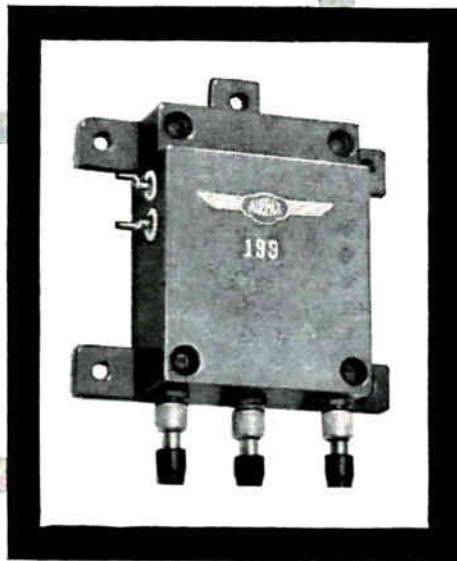


# AIRPAX

## *Coaxial Chopper*

### *for Automatic Direction Finding Equipment*

AIRPAX TYPE 199  
Double-Pole Double-Throw



Designed for use in the 100 to 400 megacycle range, the chopper samples two incoming signal sources for a single load or distributes a low level signal to two loads in a periodic manner. Switching frequency is 100 cycles per second.

The voltage standing wave ratio (VSWR) is held below 1.2 by design of the cavity in which the switching contacts operate.

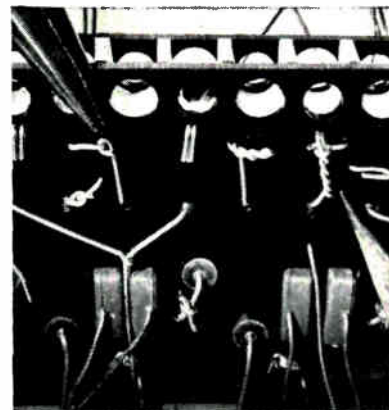
Type 199 has a phase angle of 30° and a dwell time of 160°. It operates effectively throughout a temperature range of -65 C to +125 C. Available from stock.



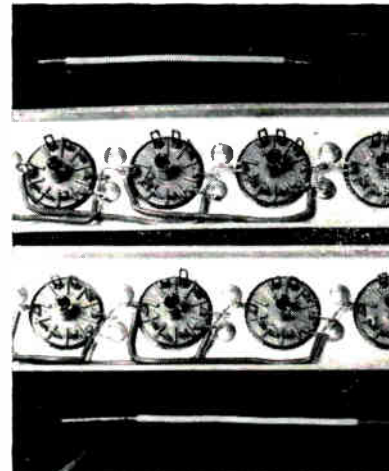
**AIRPAX ELECTRONICS**  
INCORPORATED  
JACKTOWN ROAD, CAMBRIDGE, MD.



Spring clip replaces tape, speeding welding



Pliers point to 1 twist which replaces 6 twists pointed out by pencil



One wire (bottom) replaces 2 (top) formerly used to make lug connections

secure wire leads on a counting unit reduced assembly time by 40 per cent. One twist, which hooks one wire around the other, is substituted for 6 twists previously given the wires before soldering. The unit pictured is a modular plastic mounting which holds neon lights, wiring and other components of a decimal counter. Annual labor savings come to \$800.

In another counter subassembly, 2 wires had been used to make 3 lug connections. An insulated wire

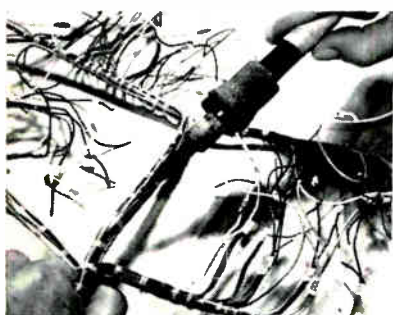


Recessed lid (right) eliminates plug slot

went to the first lug and a bare wire joined this to 2 others. Now, the stripped end of an insulated wire joins all 3 lugs. Total wire length is reduced from 5 to 4.5 inches, for a savings in time and material of \$1,500 a year on production of 42,000 units.

The fourth photo shows 2 lid styles. The lid at left required slotting of the base plug so the lid would close. By a \$65 modification in the lid blanking and forming die, recesses were provided in the lid. Estimated annual savings are \$1,500 and dust and hazard of sawing is ended.

### Hot Iron Unharnesses Teflon-Covered Wire



WIRING HARNESSES made up of Teflon-covered wire may be quickly opened by taking advantage of the heat resistance of the plastic. Originally, the harness is wrapped with a fabric or plastic with a melting temperature below 500 F. To open the harness for repair or replacement of a wire, the tip of a heated soldering iron is applied to the lacing. The lacing will burn off without affecting the sleeving, according to The Polymer Corp., Reading, Pa., a manufacturer of Teflon spaghetti tubing.

**SENSITIVE RESEARCH...**

# TRUE RMS RESPONDING .5% ACCURATE AC-DC RADIO FREQUENCY VOLTMETERS



**MODEL  
RFV**

**TRUE RMS RESPONDING  
RADIO FREQUENCY VOLTMETERS.** Direct-reading, thermocouple-type voltmeters particularly suitable for the accurate calibration of oscillators, signal generators, vacuum tube voltmeters and similar apparatus. The model RFV may also be used as an AC-DC transfer standard where maximum accuracy at high frequency is desired.

Multi-range instruments from 1 v. to 300 v. full scale. Accuracy .5% on DC and from 7 cps to 5 megacycles on 1 v. range and to 150 kilocycles on 300 v. range. Higher frequencies at reduced accuracy. Formica cases available.

**DIAMOND PIVOTS** and shock-mounted jewels of course!



**SENSITIVE RESEARCH  
INSTRUMENT CORPORATION**

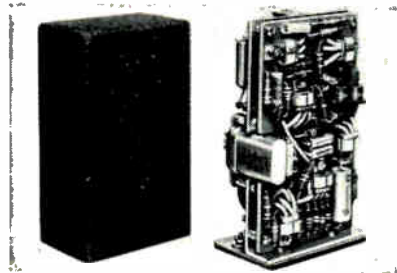
NEW ROCHELLE N. Y.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

# ON THE MARKET

## Voltage Comparator all-transistor

TRIO LABORATORIES, INC., Plainview, Long Island, N. Y. A new basic test module, capable of greatly simplifying test and control equipment design, the 200 series voltage comparator trips a dpdt relay out-

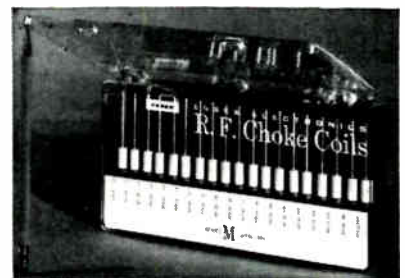


put when the unknown signal input exceeds the value of the known reference input. Its many applications include military ground support equipment, airborne instrumentation, modular test equipment, alarm/control systems and many data processing systems. Circle 200 on Reader Service Card.

## R-F Choke Kits for design engineers

ESSEX ELECTRONICS, 550 Springfield Ave., Berkeley Heights, N. J. A total of 63 chokes in the preferred series of inductance values are attractively packaged in 3 handy clear-plastic boxes to aid the de-

sign engineer in the immediate selection of choke parameters for any specific design condition. The series S kit contains 19 chokes in an inductance range of 0.1  $\mu$ h to 100  $\mu$ h; series M, 19 chokes from 1.0  $\mu$ h to 1,000  $\mu$ h; series L, 25 chokes from 1.0  $\mu$ h to 10,000  $\mu$ h. Circle 201 on Reader Service Card.



## Emitter Follower for airborne uses

COLUMBIA RESEARCH LABORATORIES, MacDade Blvd. and Bullens Lane, Woodlyn, Pa. Model 5000 subminiature emitter follower is designed for missile, satellite and airborne requirements. Unit is potted in an aluminum case and will operate in ambient temperatures between  $-65$  F and 185 F

under high noise and shock conditions. Seventy megohms of input impedance permits measurements from 5 cps to 100 kc with crystal type accelerometers, and the output noise characteristics are such that signals in the low millivolt region may be handled. Output is linear over a 20 v input range and the circuit draws about 660  $\mu$ a from a 28 v d-c supply. Circle 202 on Reader Service Card.

## Molded P-C Sockets eight types

WALDOM ELECTRONICS, INC., 4625 W. 53rd St., Chicago 32, Ill. A new line of molded printed circuit sockets is available in 8 types, in



various sizes from 7 to 9 pins with center shields. These sockets are precision molded for use by original equipment manufacturers, for replacement and servicing. Circle 203 on Reader Service Card.

## Amplitude Modulator transistorized

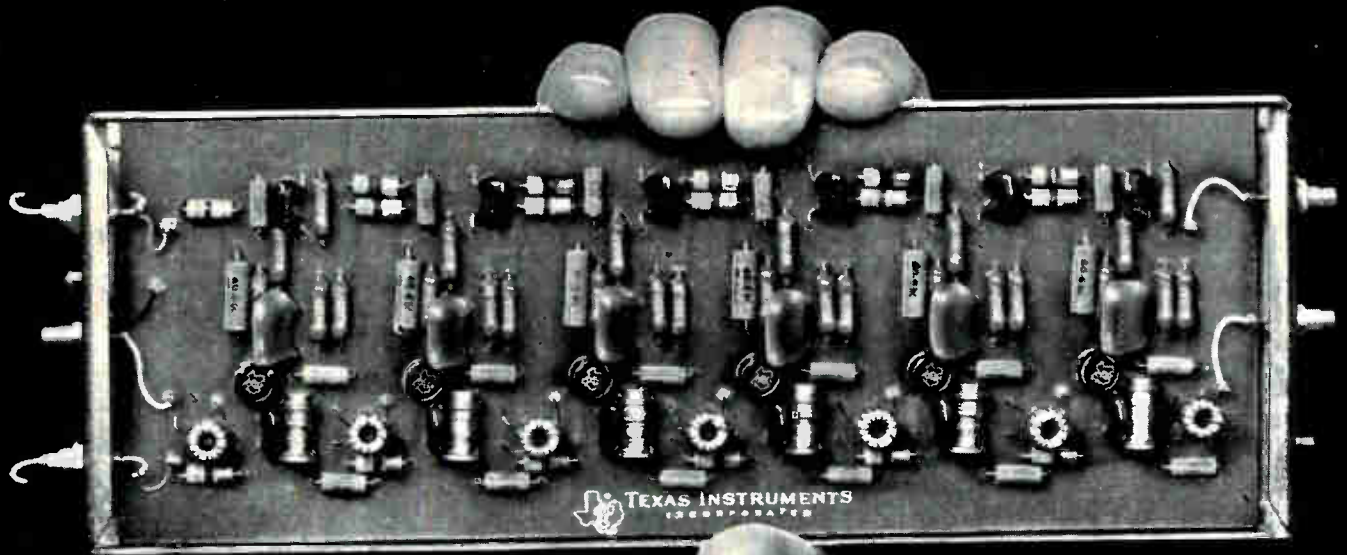
KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has introduced a new battery powered, transistorized instrument called the Megalator. It provides better than 100



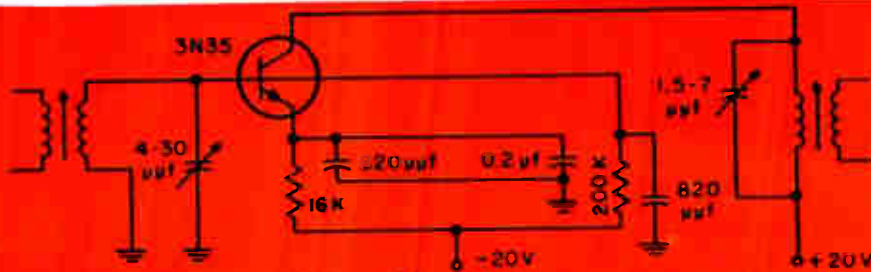
percent amplitude modulation over both c-w and f-m frequency ranges. Its internal oscillator is a continuously variable source of modulating frequencies from 15 cps to 15 kc. The Megalator also includes an accurate beat-frequency audio oscillator, making it



# 105 db gain in 60 mc I-F strip



Six-stage, 90 db gain, silicon i-f amplifier designed and built by TI's Apparatus division.



One stage of 105 db gain, eight stage, 60-mc i-f strip.



Write on your company letterhead for 105 db gain, eight stage, 60-mc i-f amplifier applications brochure.

## ...with TI 3N35 silicon transistors



### 105 db I-F STRIP CHARACTERISTICS

**Bandwidth: 20 mc at 3-db down**

**Center Frequency: 60 mc**

**No neutralization required**

The high gain of TI 3N35 transistors at high frequencies permits mismatch in the interstage coupling networks to eliminate complicated neutralizing circuitry. You save extra component costs, design with ease and gain added reliability . . . because the mismatch in this application sacrifices only 2.55 db gain per stage!

Designed for your high frequency oscillators, i-f, r-f, and video amplifier circuits, the TI 3N35 features . . . 20-db power gain at 70 mc . . . typical 150-mc alpha cutoff . . . operation to 150°C. These characteristics make transistorization feasible for radar, communications, missile, and other high reliability military applications.

*In commercial production at TI for two years, the 3N35 has a product-proved record of high performance and high reliability. These units are in stock now! For immediate delivery, contact your nearby TI distributor for 1-249 quantities at factory prices . . . or call on your nearest TI sales office for production quantities.*



from THE WORLD'S LARGEST SEMICONDUCTOR PLANT



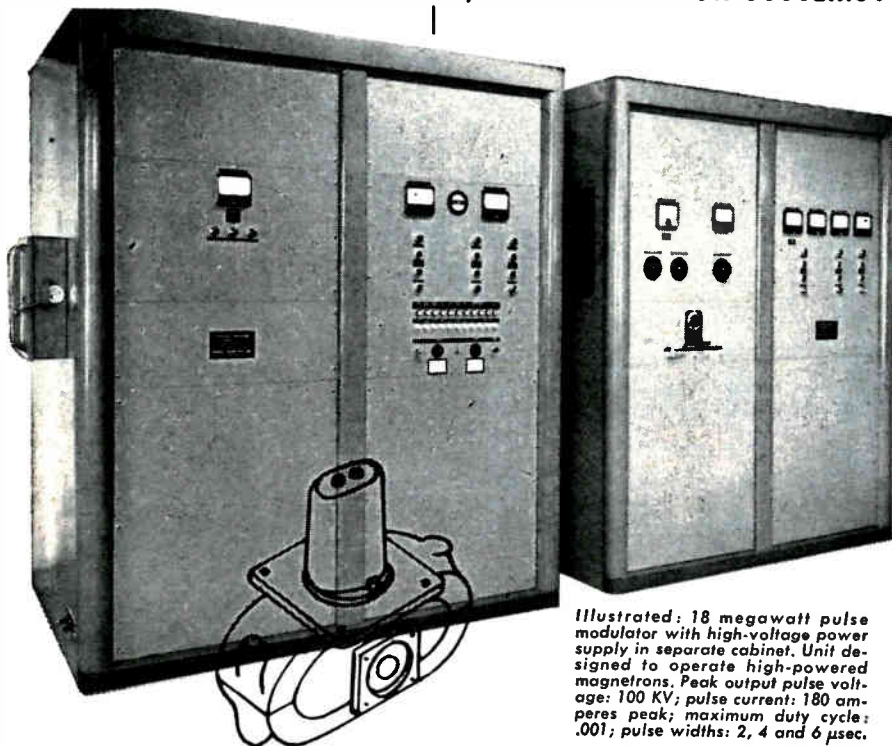
## TEXAS INSTRUMENTS INCORPORATED

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# Testing

## MAGNETRONS KLYSTRONS CARCINOTRONS

### ● OTHER MICROWAVE TUBES, COMPONENTS OR SYSTEMS?



Illustrated: 18 megawatt pulse modulator with high-voltage power supply in separate cabinet. Unit designed to operate high-powered magnetrons. Peak output pulse voltage: 100 KV; pulse current: 180 amperes peak; maximum duty cycle: .001; pulse widths: 2, 4 and 6  $\mu$ sec.

Come to Manson for the widest selection of standard *Pulse Modulators* and *High-Voltage Power Supplies* covering all useful power levels. From kilowatts to tens of megawatts, Manson has precision-engineered designs for operation and test of magnetrons, klystrons, traveling wave tubes, backward wave oscillators, lighthouse tubes, pulse transformers, waveguide components and related devices. The wide range of standard models is readily adaptable to meet individual specifications.

#### HIGH POWER PULSE MODULATORS:

Hard- and soft-tube types from 16 kw. to 30 megawatts peak power output, and higher. Average output powers as high as 60 kilowatts. Typical operating features include: continuously adjustable voltage control; discrete or variable pulse widths; internally- and externally-controllable repetition frequencies; auxiliary synchronized outputs; pulse-shape monitoring circuits; and interlocking and overload protection.

#### HIGH VOLTAGE POWER SUPPLIES:

High-voltage DC and AC types, single- or multiple-output, regulations and stabilities to 0.01%. Standard and custom designs to satisfy your specific tube testing or production problems: highly-regulated supplies uniquely suited for TWT test and operation; unregulated high-power supplies for systems testing; and complete power sources for controlling all aspects of tube production.

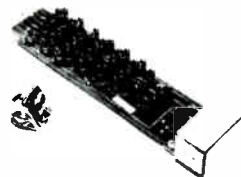
Available from stock! BASIC 1 AND 2 MEGAWATT MODULATORS



Manson offers to engineers and technicians a rewarding present and attractive future in Connecticut.

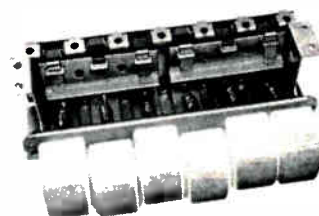
a versatile general purpose laboratory instrument which can be used with any signal generator or sweeping oscillator. Circle 204 on Reader Service Card.

1234567890



#### Digital Readout in-line in-plane

ELECTRONIC EQUIPMENT DIV., I.D.E.A., Inc., 7900 Pendleton Pike, Indianapolis 26, Ind., has developed a new low priced easily read in-line in-plane digital readout using selective group switching which is claimed to be a new principle in readout construction. Units consist solely of a resistor matrix and neon bulbs utilizing a p-c plug-in connector; other termination is available on order. Circle 205 on Reader Service Card.



#### Pushbutton Switches piano-type

INTERNATIONAL ELECTRO EXCHANGE, 2307 Foshay Tower, Minneapolis 2, Minn. Piano-type pushbutton switches manufactured by Rudolf Schadow of West Germany are now available. With any ganging arrangement desired, these miniature switches are available with up to 15 stations per switch, and with either 2, 4, 5 or 6 sets of spdt contacts per station. The contacts, which are easily removed for cleaning without severing soldered connections, have (Continued on p 84)

# WHEN YOU NEED THEM



JUNIOR DRAFTSMAN



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## ...WILL THEY BE READY?

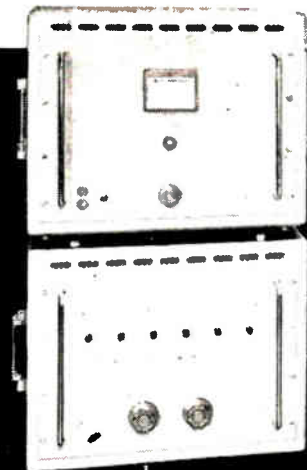
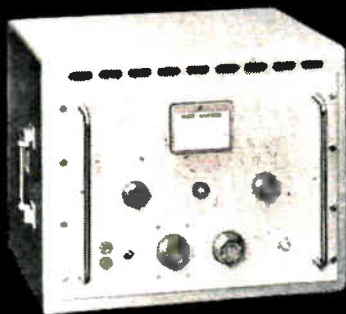
What kind of seniors will you hire this year from the high schools around you? Fast learners, steady workers, or...? Good schools are vital. And good schools *don't just happen*. If your company can help community groups to get better schools (population growth alone demands an extra 200,000 classrooms and 165,000 more teachers *right now*), the schools are sure to help your company. Think about it, won't you?



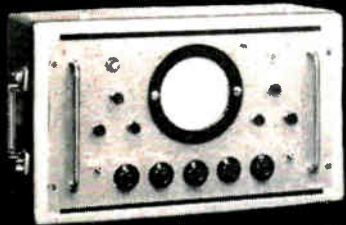
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# UNIQUE!

For the communications engineer, Marconi Instruments can supply an incomparable range of specialized instruments providing comprehensive testing facilities for VHF/UHF multi-channel telephone or television links.



0A 1249A



0A 1259



## WHITE NOISE TEST SET 0A 1249A

Measures baseband intermodulation and noise in multi-channel link equipment. Suitable for radio or coaxial systems operating 60, 120, 240, 600 or 960 channels. Measurement by noise-in-slot technique simulates busy traffic conditions.

## DERIVATIVE TEST SET 0A 1259

For fast and accurate linearity adjustments on multi-channel link modulators and demodulators. Generator sweeps 20 mc on i-f center frequencies from 65 to 75 mc. Oscilloscope unit displays 1st derivative—or slope—of response against instantaneous i-f.

# MARCONI INSTRUMENTS

*We will gladly mail you literature giving full details of Marconi multi-channel link test equipment—please ask for leaflets B144.*

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maximum ratings of: 500 ma; 500 v a-c or d-c; 50 w load. Contact pressure is 100 grams. Short or long levers are optional with easily exchangeable buttons, illuminated if desired. Circle 206 on Reader Service Card.



## Terminal Boards miniaturized

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. This new series MT terminal board is available with four or eight turret terminals which are molded directly into the body material. One-eighth in. diameter mounting holes can be supplied on either size. Voltage breakdown at sea level is 2,500 v rms. The standard molding compound is mineral filled Melamine (MIL-M-14E, type MME). Circle 207 on Reader Service Card.

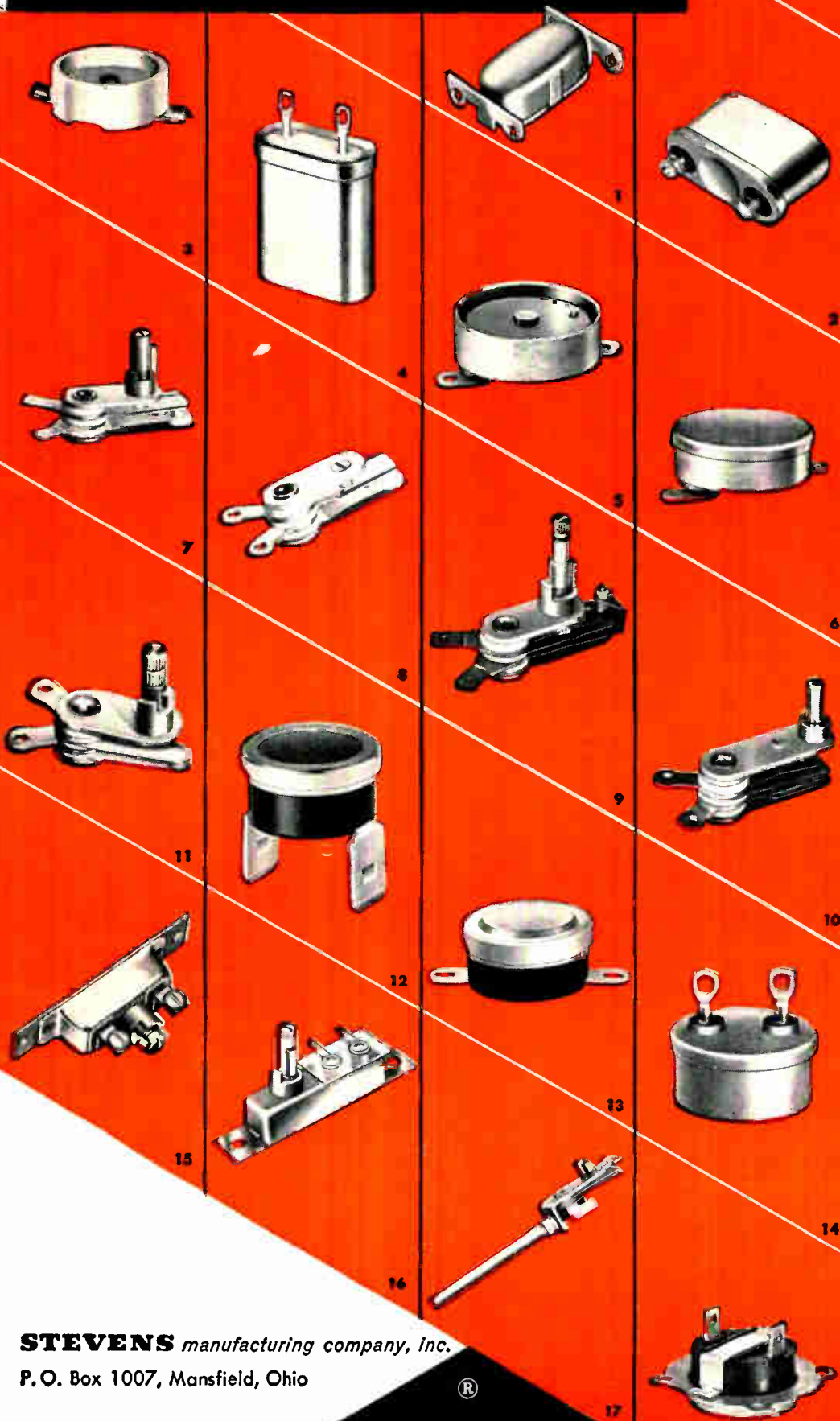


## Coil Winder multipurpose

ELECTROMATIC EQUIPMENT Co., 175 Fifth Ave., New York 10, N. Y. has available a new multipurpose precision coil winding machine, manufactured by Frieseke & Hoepfner GMBH of West Germany. The FH88K56 employs a stepless wire-feed control to handle a wide range of wire diameters—No. 52 to No. 17 Awg, instead of the usual assortment of

# STEMCO THERMOSTATS

for precise, sensitive temperature control



1, 2, TYPE C† semi-enclosed (1), hermetically sealed (2). Small positive acting with electrically independent bimetal strip for operation from -10° to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

3, 4, TYPE M\*† semi-enclosed (3), hermetically sealed (4). Snap acting bimetal disc type for appliance and electronic applications from -20° to 300°F. Rated: 3 to 10 amps at 115 VAC and 28 VAC/DC. Available with a variety of mounting brackets, type of terminals and/or wire leads. Bulletin 6000.

5, 6, TYPE MX† semi-enclosed (5), hermetically sealed (6). Snap acting miniature units to open on temperature rise for missile, avionic, electronic and similar uses. Temperature 10° to 260°F, 2° to 6°F differential. Depending on duty cycle, rated: 1 to 3 amps, 115 VAC and 28 VAC/DC. Also available in ceramic bases and hermetically sealed HC-6/U cans, with various mounting brackets. Bulletin 6100.

7, 8, TYPE S\*† adjustable (7), non-adjustable (8). Positive acting with single stud or nozzle mounting. Operation to 600°F. Rated at 15 amps at 115 VAC, 7 amps at 230 VAC. Spade, screw or formed terminals, various adjusting stems, etc. Bulletin 1000.

9, TYPE SA\*† adjustable (9), or non-adjustable. Snap acting with electrically independent bimetal. Also single-pole, double throw. Single stud or nozzle mounting. Rated at 1650 watts at 115-230 VAC only. Spade or screw terminals. Bulletin 2000.

10, TYPE SM\*† manual reset. Electrically same as Type SA (above) except for manual reset feature. Bulletin 2000.

11, TYPE B adjustable (11) or non-adjustable. For uses where heat generated by passage of current through bimetal strip is desirable. Various terminals, single stud or nozzle mounting. Operation to 400°F. Average rating 5½ amps, 115 VAC. Bulletin 9000.

12, 13, 14 TYPE A\*† semi-enclosed (12, 13), hermetically sealed (14). Insulated, electrically independent bimetal disc gives fast response and quick, snap action control for appliance and electronic applications from -20° to 300°F. Lower or higher temperatures special. Depending on duty, rated: 4 to 13.3 amperes, 115 VAC and 28 VAC/DC. Various terminals and mounting brackets available. Bulletin 3000.

15, TYPE R\*† sealed adjustable (15), sealed non-adjustable. Positive acting for operation to 600°F. Rated at 15 amps at 115 VAC, 4 amps at 230 VAC. Screw terminals. Bulletin 7000.

16, TYPE W\*† adjustable (16), or non-adjustable. Snap action bimetal strip type for operation to 300°F. Depending on duty, rated: 5 to 10 amps, 115 or 230 VAC. Screw or nozzle mountings; spade or screw terminals. Bulletin 4000.

17, TYPE H† adjustable. Positive acting for fry pans, skillets, sauce pans, etc. Fail-safe, open in low to 500°F in high. Rated at 1650 watts at 115 VAC. Bulletin 10,000.

18, TYPE D\* automatic (18), or manual reset. For laundry dryers or other surface and warm air applications. Snap acting disc type for operation to 350°F. Open or enclosed. Rated: 25 to 40 amps at 120-240 VAC. Screw or spade terminals. Bulletin 8000.

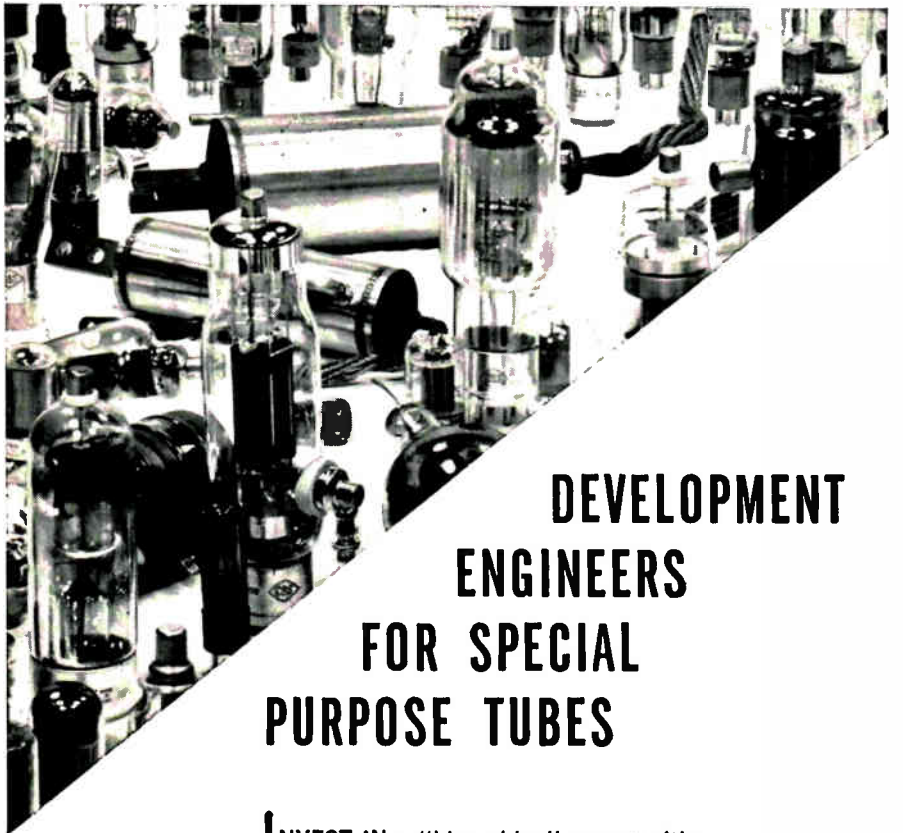
Illustrations, for general information only, do not necessarily show size comparisons. Fully dimensioned and certified prints on request. Manufacturer reserves right to alter specifications without notice.

\*Refer to Guide 400 ED for UL or CSA approved ratings.  
†These thermostats covered by patents issued or applied for.

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

**STEMCO**

**THERMOSTATS**



## DEVELOPMENT ENGINEERS FOR SPECIAL PURPOSE TUBES

**I**NVEST IN a "blue chips" career with CBS-Hytron. With CBS-Hytron, you not only join a well established company . . . you will also be joining an expanding, progressive organization that recognizes individual achievements and rewards all efforts.

**YOU WILL** be working for development and laboratory production of special purpose tubes. Your experience should be from 3 to 5 years, preferably on gas type tubes.

**IN ADDITION**, you'll be offered an attractive salary — a complete employee benefit program — and a company sponsored educational plan in an area boasting unsurpassed educational facilities.

▶ Send your resume, indicating salary desired, to Mr. Nicholas Bradley, Placement Administrator. It will be accorded absolute confidence and you will receive a prompt answer.

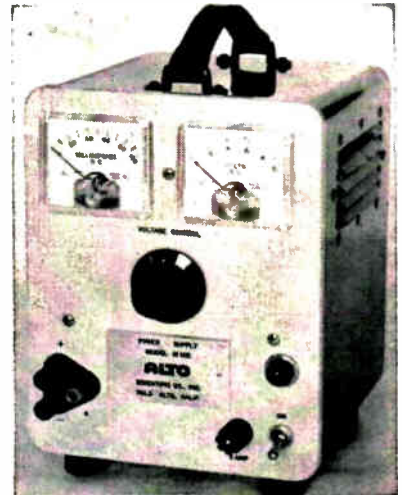
**ELECTRON TUBES**  
**CBS**  
**SEMICONDUCTORS**

## CBS-HYTRON

DANVERS PLANT  
A Division of  
Columbia Broadcasting System, Inc.  
100 Endicott Street  
DANVERS, MASSACHUSETTS  
Danvers is a suburb of Boston



gears and cams. Through the use of special-purpose easily-affixed attachments, a single machine can be used for a large variety of coils. Circle 208 on Reader Service Card.



## Power Supply transistorized

ALTO SCIENTIFIC Co., 855 Commercial St., Palo Alto, Calif. Model M102 transistorized power supply is a compact instrument with an output of 0.5 to 30 v, continuously variable. Its output current is 0 to 1 ampere maximum. Regulation from 0 to 1 ampere is 0.6 percent or 50 mv, whichever is greater; from 0 to 250 ma it is 0.4 percent or 30 mv, whichever is greater. Circle 209 on Reader Service Card.

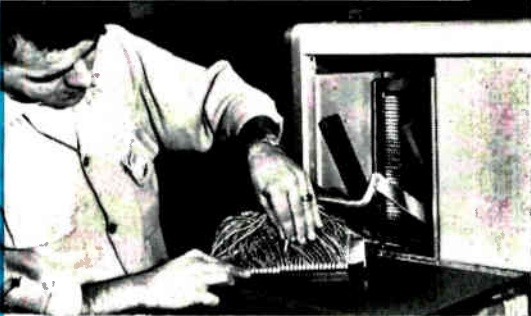
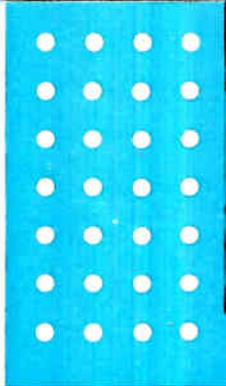
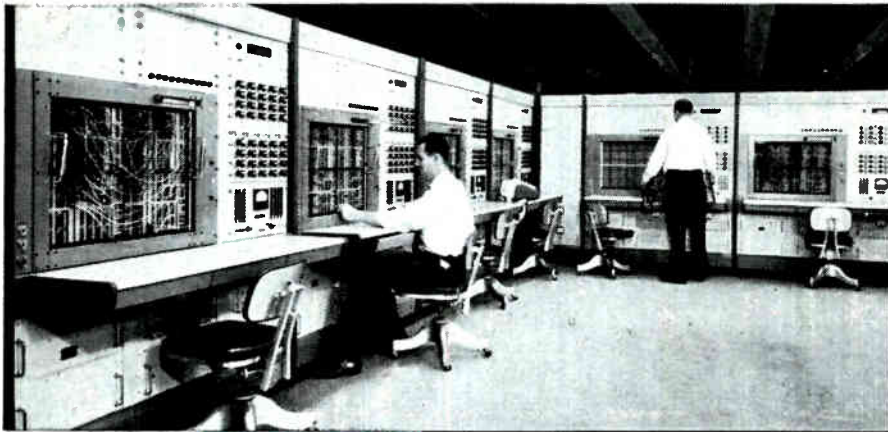
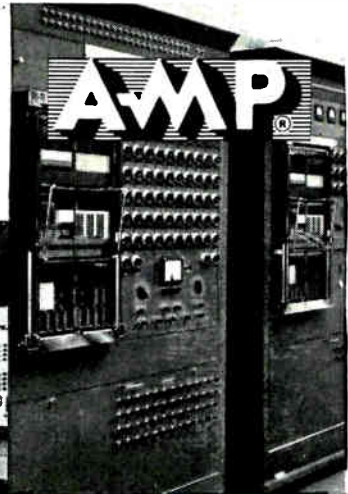


## Tantalum Capacitors rectangular case

SPRAGUE ELECTRIC Co., 35 Marshall St., North Adams, Mass., announces a new series of rectangular case tantalum electrolytic capacitors intended for applications which require large amounts of capacitance at low voltage under wide temperature extremes from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , as well as under conditions of severe vibra-

*for all the  
programming features  
you want...*

**Patchcord Systems by**



*In data processing and telemetering equipment, analog computers and other low signal level circuits, A-MP Patchcord Programming Systems and Panels offer the precise features you need, many of them exclusive. Here are a few:*

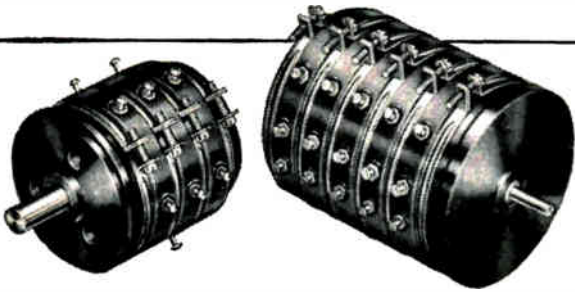
- full range of sizes in either universal or shielded types
- shielded systems feature patchcords constructed of coaxial cable and boards of unique cellular design which provide complete isolation for all signal circuits and positive grounding for all shields
- patented wiping action pre-cleans all contact surfaces whenever pre-programmed removable boards are placed in service
- frame mechanism assures positive contact when closed yet opens easily for quick board changes
- for complete data on patchcord system sizes, patchcords, and specifications on electrical characteristics (including voltage and current ratings—leakage resistance, capacitance and inductance) send for AMP's all new Programming Systems Catalog.

# AMP INCORPORATED

**GENERAL OFFICES: HARRISBURG, PENNSYLVANIA**

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

# Unlimited Phasing with Extreme Compactness



Linearity determined dynamically on each unit on NEW Gamewell \*LARTester  
(\*Linearity — Angle — Resolution — Tap location)

This special Gamewell Phasing Clamp design has two important extras: Extreme compactness and High Temperature compatibility. Check these features . . .

- Only 3/4" depth per section • Continuous service up to 150C available
- Stainless steel clamps give unlimited phasing • Large number of taps, limited only by physical spacing
- Exclusive Gamewell high unit pressure contacts give permanent, low resistance tap connection, no linearity distortion
- Will withstand High "G" and operation under severe vibration
- Three styles of mounting: Servo, Bushing and 3-hole
- Available in ball or sleeve bearings, shafts as specified
- Comes in models RL-270A-1 1 1/2"; RL-270A-2 and RL-270A-3.

More information, prices and delivery available from Gamewell representatives or write: **THE GAMEWELL COMPANY**, Newton Upper Falls 64, Mass.



**PRECISION  
POTENTIOMETERS**

CIRCLE 142 READERS SERVICE CARD

**RVG  
Precision  
Miniatures  
for superior  
performance**



RVG-10 3/4"



RVG-14 1/4"



RVG-17XS 1 1/16"  
Sine-Cos.

**SPECIAL!**

Send for New Gamewell Catalog on complete line.

tion and shock. Type 200D Tantapak capacitors, available in five case sizes, are provided with glass-to-metal positive solder seal terminals in order to avoid electrolyte leakage problems. Complete technical information is given in engineering bulletin 3705, available on letterhead request.



## Miniature Capacitors aluminum electrolytic

P. R. MALLORY & Co. INC., Indianapolis 6, Ind., has developed a new line of aluminum electrolytic capacitors, especially designed for miniaturized electronic equipment. The PET series uses a new low-resistance electrolyte which gives exceptionally long shelf life at temperatures up to 85 C. Capacitance variation from -30 deg to +85 deg is within the range of -15 percent to +10 percent. Leakage current, power factor and impedance are very low. Sizes of the units vary from 3/8 in. by 3/8 in. to 1 1/2 in. by 1 1/2 in. Circle 210 on Reader Service Card.



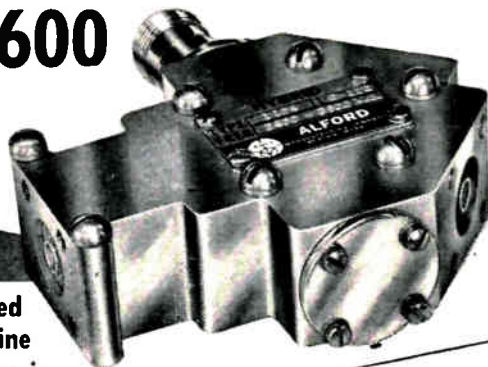
## Voltmeter Circuitry plug-in type

METRONIX, INC., Chesterland, Ohio, has developed plug-in electronic voltmeter circuitry, intended for applications where metering and range switching must be remote. Model SPD-21 is a d-c package that

**AMCI**

**TYPE 1104**

# NEW S BAND HYBRID 2400-3600 mc



An impedance-compensated coaxial-transmission-line hybrid whose balance is inherently independent of frequency.

- VSWR at parallel input is under 1.2; at series input, under 1.5
- Residual unbalance (the balance with equal loads on the outputs) is in excess of 35 db over the frequency range.
- Typical uses include measurement of impedances, production control of impedances, equal division of power, phase comparison, and balanced mixing.

Write for complete information on AMCI Transmission Line Hybrids

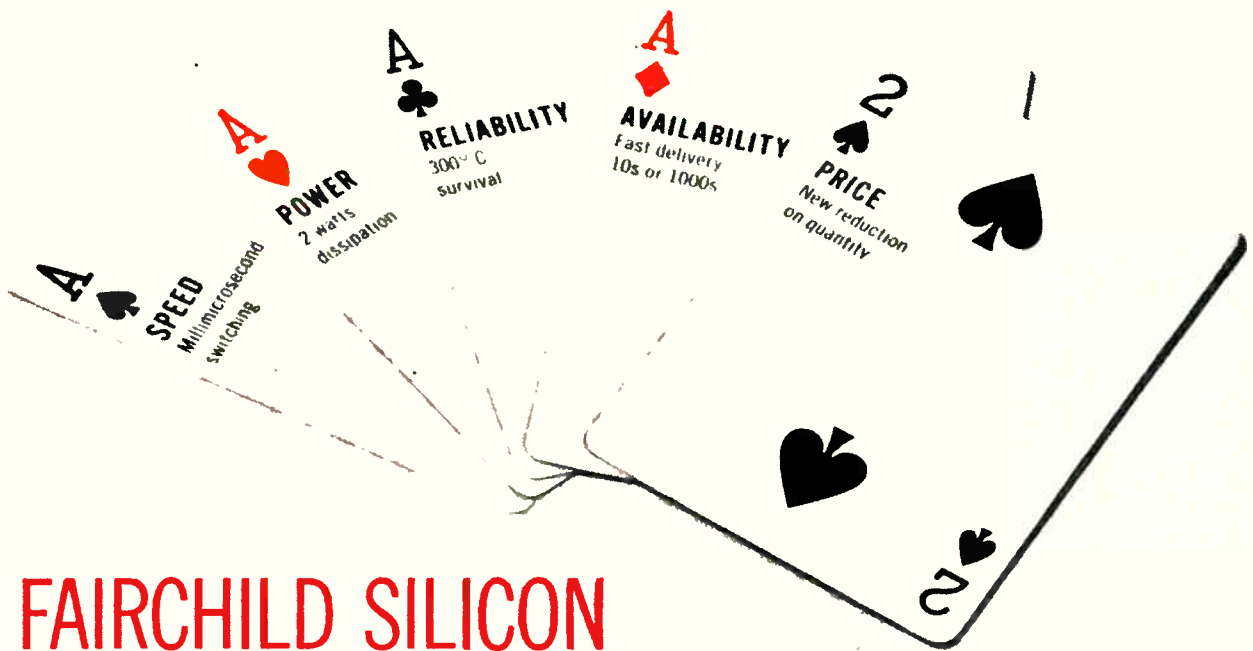


CIRCLE 56 READERS SERVICE CARD



# TRANSISTOR EXPERTS...

are betting that  
this is the  
winning combination:



## FAIRCHILD SILICON TRANSISTORS

come through, fulfilling the extraordinary promises you've heard rumored about the new solid-state diffusion devices.

**A ♠ SPEED** — 80 milli-micro-second rise time affords the fastest switching yet available with silicon.

**A ♥ POWER** — 2 watts dissipation at 25° C. leaves plenty of power handling capability at higher temperatures too.

**A ♣ RELIABILITY** — Storage at 300° C. for 350 hours caused no serious changes, assuring a large safety factor at operating temperatures. Mesa construction provides extraordinary ruggedness too.

**A ♦ AVAILABILITY** — Thousands of the 2N696 and 2N697 transistors have been delivered in the first months after announcement. Stock is available for immediate shipment.

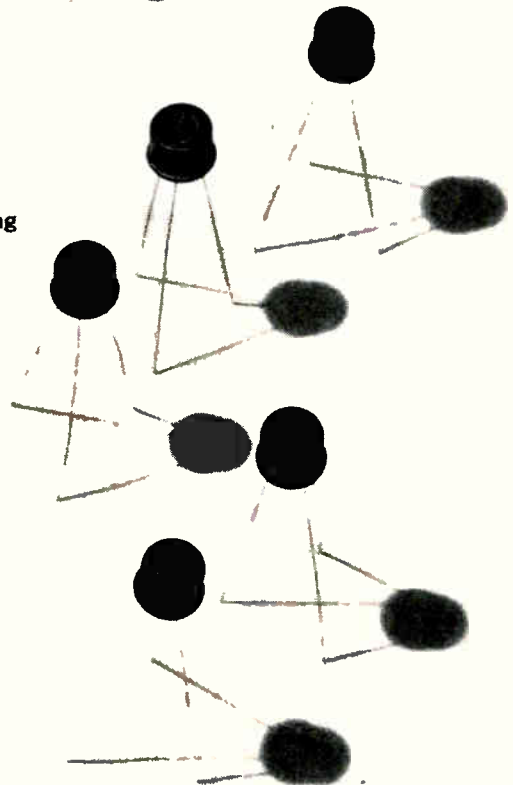
**2 ♠ LOWER PRICES** — Fairchild is gearing for quantity sales and bringing prices down within reach of more users. A second large plant expansion is being made in response to demand.

### Look to the future

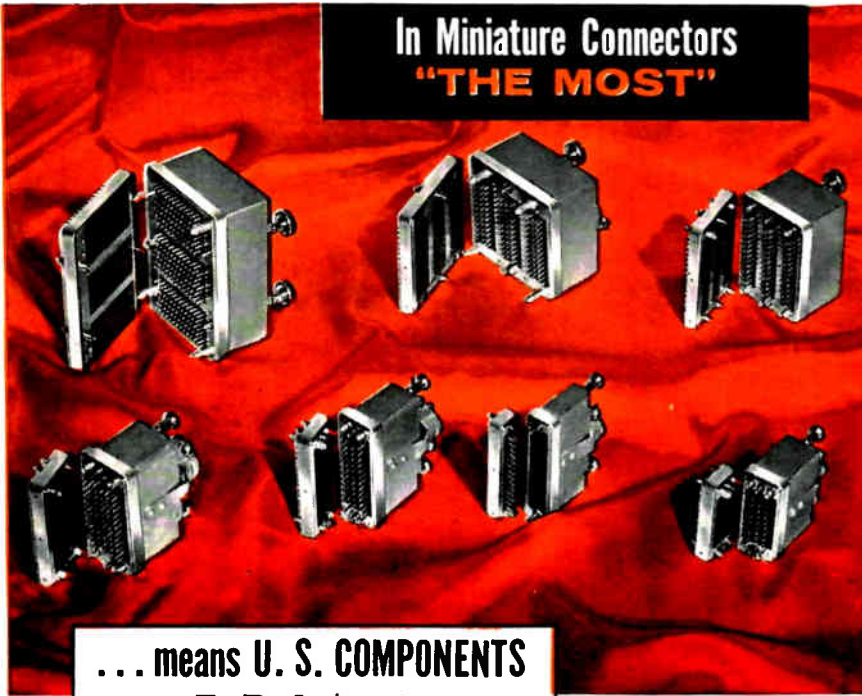
Existence of Fairchild's multiple-diffused transistors is already having a profound effect on the breadboard designs of today. It means competitive improvements in the quantity production of tomorrow — both in the race for military superiority and in various commercial bids for sales leadership. May we send you specifications?



844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695



## In Miniature Connectors "THE MOST"



... means U. S. COMPONENTS  
F. B. I. \* series

### "THE MOST" features

The most shock and vibration resistance—\*Patented Floating Body Isolation guarantees vibra-shock protection and operation by complete separation of electrical contact body from mechanical elements.

The most comprehensive line—Single units have 34-41-50-75 contacts. Modular multiple connectors have 123-150-225 contacts. Other configurations upon request.

The most flexibility in body molding compounds—Connector bodies can be supplied in asbestos-filled melamine; glass-filled alkyl and diallyl phthalates in various compositions and colors.

The most methods of attaching leads—wire solder, solderless or turret-type terminals.

The most in precision screw lock connectors.

The most in quality control—Inspection and testing applied on a 100% basis. Meet or surpass all applicable MIL specifications.

FBI SERIES	NUMBER OF CONTACTS			
MI-BSL Miniature Screw Lock	34	41	50	75
MI-BMSL Miniature Modular Screw Lock	123	150	225	

#### SPECIFICATIONS

Wire size ..... #20 AWG wire  
Voltage breakdown between contacts (with connector engaged—sea level—normal humidity)..... 2800 V. A.C. RMS  
Current rating ..... 7.5 amps.  
Hoods and brackets ..... aluminum anodized

Also available in Hoodless Knob Type

U.S. Pat. Nos. 2,761,108; 2,845,603; 2,845,604  
and additional Patents Pending.

*Your specific inquiry will receive immediate attention.*

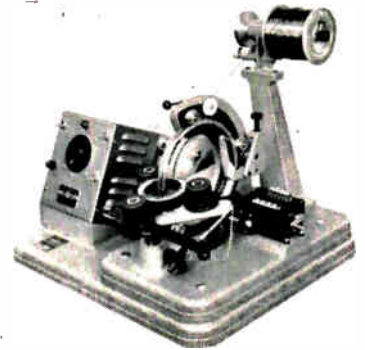


**U. S. COMPONENTS, INC.**

Associated with U.S. Tool & Mfg. Co., Inc.

454-462 East 148th St., New York 55, N. Y. CYPRESS 2-6525

may be used with other components to measure from 0 to 1,000 v. It contains complete vtvm circuitry but does not include the meter, calibration control, zero adjust, or the input voltage divider that selects the voltage range desired. Circle 211 on Reader Service Card.



### Coil Winder laboratory model

UNIVERSAL MFG. CO., INC., 1168 Grove St., Irvington, N. J. Model L-7 laboratory toroidal coil winding machine measures 20 in. by 18½ in. by 17 in. high. It is equipped with: Variac speed control for ½ h-p d-c motor, 0-575 rpm; self-releasing shuttle to magazine loading lock; wire guiding device for uniform wire distribution in magazine; high-speed geared pre-determining counter; and geared reset counter for magazine loading. Circle 212 on Reader Service Card.

### Preformed Epoxies extensive line

MANSOL CERAMICS Co., 140 Little St., Belleville, N. J., offers the electronic component and assembly manufacturer what is believed to be the most extensive line of preformed epoxies available for hermetic sealing and bonding. They are available in two basic materials. Filmex, series 800-D, is in sheet, or film form, and is die-cut to the customer's requirements. Filmex is employed for applications requiring a thickness of from 0.0015 in. to 0.020 in. Pressex, series 800-C, are forms made from pre-pressing of epoxies

# MODERN BUSINESS



# AND MODERN SCHOOLS



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Only one thing. Will the labor market keep pace?

That's where schools are important. If your company isn't helping community groups to get modern schools, it's not apt to get the skilled people it needs. Self interest, civic spirit, or both, you should make schools your business, too.



Want to find out how to help in *your* community?  
Get specific information by writing:  
Better Schools, 9 East 40th Street, New York, N. Y.

Because **HIGH RELIABILITY** Is A "Must" . . .

## Missile Engineers Specify *Vitramon* CAPACITORS

"Vitramon" Capacitors for high reliability applications are tested to meet the most stringent requirements for performance. Every capacitor ordered under the new High Reliability Specification S-1002 undergoes tests encompassing 300,000 UNIT HOURS OF LIFE AT 125° C to assure an A. Q. L. 12 times higher than Mil Specifications — and every shipment against an S-1002 order is accompanied by tabulated results to verify extreme reliability.

Inherent characteristics are built into "Vitramon" Capacitors through the fusing of quality porcelain enamel and fine silver to produce a dense, homogenous, truly monolithic unit that requires no case or hermetic seal. If you have capacitor applications requiring high reliability, write for High Reliability Specification S-1002, describing materials used, manufacturing process, as well as all tests and failure rates.



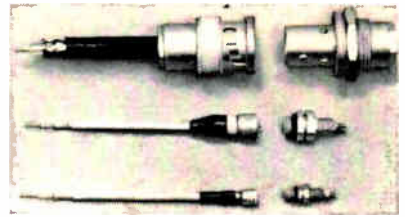
**"VITRAMON" CAPACITORS  
OF PROVEN QUALITY  
ARE USED IN  
THESE MISSILES:**

JUPITER	TALOS
LACROSSE	TARTAR
NIKE-ZEUS	ATLAS
BULLPUP	BOMARC
CORVUS	FALCON
POLARIS	MACE
REGULUS II	SNARK
SPARROW II	TITAN
SPARROW III	VANGUARD
	EXPLORER

*Vitramon*  
INCORPORATED

BOX 544E • BRIDGEPORT 1, CONNECTICUT

in powder form into the required shapes. Pressex is used in applications requiring a greater thickness than 0.020 in. Circle 213 on Reader Service Card.



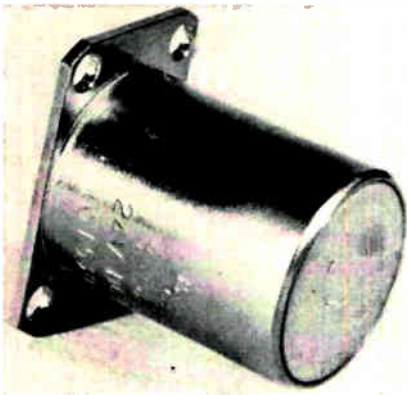
### Coaxial Connector sub-miniature

MICRODOT, INC., 220 Pasadena Ave., South Pasadena, Calif. The new "sub - microminiature" connector (at bottom in photo) is 1/25th the overall size of a standard BNC connector with 1/50th of the weight. It has recently completed extensive tests for vibration, vswr, and pull out and insertion ease. Samples and test data are available. Circle 214 on Reader Service Card.



### H-V Capacitors glass cased

ELECTRONIC FABRICATORS, INC., 682 Broadway, New York 12, N. Y. Type AG Glasscon glass cased high-voltage capacitors suitable for h-v d-c or l-v a-c are announced. They have a plastic film dielectric, glass or steatite tube construction, and are silicone impregnated. Units are available from 0.001 to 1  $\mu$ f capacitance for use at voltages ranging from 600 v to 60,000 v d-c. Circle 215 on Reader Service Card.



### Miniature Solenoid high-speed response

TELECOMPUTING CORP., 915 North Citrus Ave., Los Angeles 38, Calif. Ultra high-speed response is featured in a new miniature solenoid. Produced for maximum weight and space savings at optimum loads, the model R. S. 5178 will operate with a 10-lb load. The stroke is 0.015 in., with the start of the motion occurring at a maximum of 6 millisecc and the stroke completed at less than 13 millisecc from closing circuit. Circle 216 on Reader Service Card.

### H-V Transformers 1 kv to 15 kv

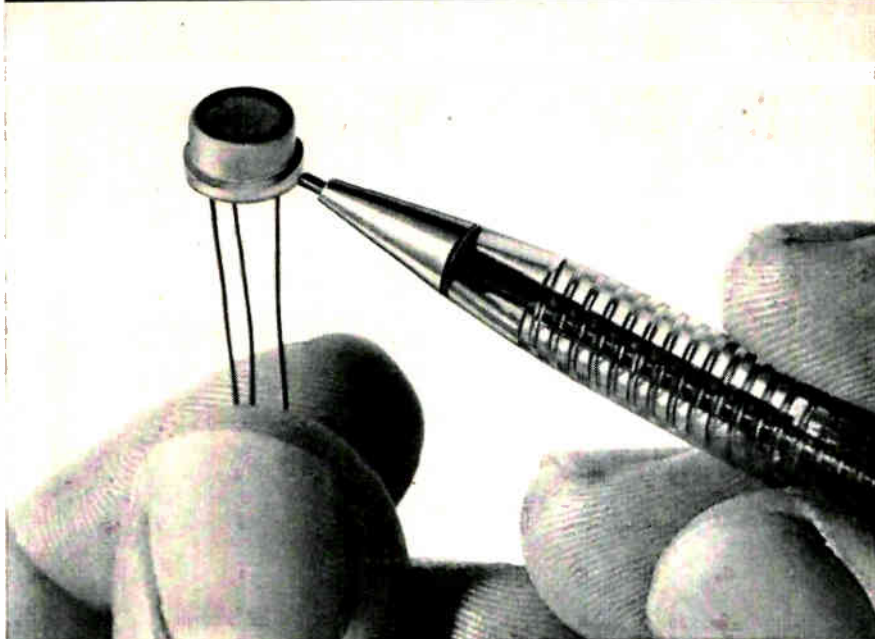
JAMES VIBRAPOWR Co., 4050 North Rockwell, Chicago, Ill., has announced a new series of high voltage transformers for custom installation in various types of instruments. Voltages available are from 1 kv to 15 kv with power ratings from 10 w to 250 w. Circle 217 on Reader Service Card.



### Tiny Resistor hermetically sealed

DALE PRODUCTS, INC., Box 136, Columbus, Neb. A new super-miniature 1/10 w hermetically sealed deposited carbon film resistor housed in a ceramic shell

# FREE ANALYSIS OF YOUR SMALL METAL PARTS JOINING PROBLEMS



## HERMETIC SEAL WELDED WITHOUT HEATING COMPONENT!

**PROBLEM:** weld transistor cap to base, make a hermetic seal without heating temperature-critical internal parts. **SOLUTION:** A Raytheon Welding Analyst recommended a DC "stored energy" welding system, using only 6.6 kva compared to the 75-100 kva required for an AC welder to do the same job. **RESULT:** 1500 perfectly uniform welds per hour; no damage from heat.

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Please have a Raytheon Welding Analyst contact me.

My problem is: (describe metals, thicknesses, type of part, etc.)

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COMPANY \_\_\_\_\_

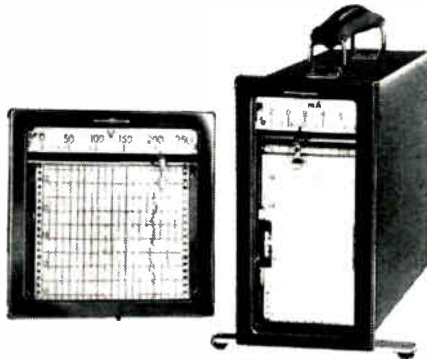
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## MINIATURE, STANDARD and DOUBLE SIZES!

### MINIATURE RECORDERS

Square Model 85, in flush mount, weighs 16 lbs. and is 5½" square x 12¼" deep. Slim models 86 (portable) and 87 (flush) save half the width of standard recorders . . . measure 3¾" x 7⅞" x 8¾" and weigh only 9 lbs.



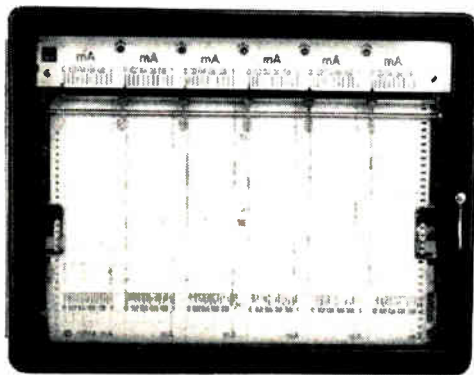
## CURTISS-WRIGHT

### STANDARD RECORDERS

Model 81 (portable) and 82 (flush) are also available for wall and projection mounting . . . take up to 3 channels. Weigh only 19 lbs. and measure 7½" x 9⅞" x 7⅞".



## PRECISION RECTILINEAR



### DOUBLE SIZE RECORDERS

Models 83 (portable) and 84 (flush) take up to 6 channels. Wall and projection mounting available. Chart width is 9½". Measure 12¾" x 9⅞" x 8¾" and weigh only 26 lbs.

## STRIP CHART RECORDERS

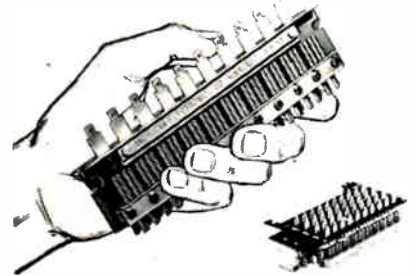
Made under licensing agreements with one of Germany's leading instrument manufacturers . . . combine accuracy with ruggedness.

Important features: *Rectilinear Recording* with patented linkage that translates angular meter motion into proportional straight line • *Inkless and Ink Recording in One Unit* • *Three-Speed Transmission plus 60:1 Speed Change* from hours to minutes; provides six interchangeable speeds in all • *1% Accuracy* for moving coil movement • *Shock-proof movement . . . splash and dustproof steel cases,*

AC, DC, power and combination movements; wide choice of ranges and chart drives. Write for full information.

ELECTRONICS DIVISION  
**CURTISS-WRIGHT**  
CORPORATION • CARLSTADT, N.J.

has been announced. It measures 7/64 by ¼ in. The DCH-1/10 has a resistance range from 100 ohms to 100 K ohms and has a standard tolerance of ± 1 percent. Operating temperature range is -55 C to 150 C. Rated at 1/10 w up to 70 C, it derates to 0 at 150 C, ambient temperature. Circle 218 on Reader Service Card.



### Push-button Switch reliable performance

AMERICAN-MONARCH CORP., 2801 37th Ave., Northeast, Minneapolis 18, Minn. Newly designed for applications requiring reliable performance, model 7711 push-button switch has a mean life of one million operations per station. Each station offers up to four type A contacts rated at 100 ma at 150 v d-c. The switch may be ganged, inter-bussed, cross-interlocked . . . and is available with lockout and automatic release solenoids. Circle 219 on Reader Service Card.

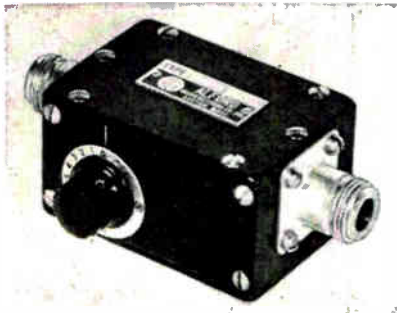


### Servo Amplifier transistorized

M. TEN BOSCH INC., 80 Wheeler Ave., Pleasantville, N. Y. Model 1800-3300 is a high temperature, miniaturized, hermetically sealed, plug-in transistor servo amplifier. It is primarily intended to receive signals from a synchro control transformer and to operate a size 11, 400 cycle, 3.5 w servo motor (Kearfott type R119-5 or equivalent). Circle 220 on Reader Service Card.

## Test Stations for leak detection

CONSOLIDATED ELECTRODYNAMICS CORP., 1775 Mt. Read Blvd., Rochester 3, N. Y. Designed to be used with mass-spectrometer-type leak detector, the PSM-102 (semiautomatic) and PSM-202 (automatic) are versatile test systems for handling the three most common types of leak detection (hooding, probing, and inside-out). Utilizing CEC's standard building block accessories, the basic system design is completely self-contained and operates independent of leak detector pumping system. Circle 221 on Reader Service Card.



## Matching Network adjustable

ALFORD MFG. CO., 299 Atlantic Ave., Boston 10, Mass. The Easymatch is an adjustable matching network, for vhf and uhf frequencies, used to change an approximate match into an accurate match. The input impedance varies slowly with frequency. Nominal impedance is 50 ohms. Four ranges of frequency are available: 45-85 mc; 85-150 mc, 150-300 mc and 300-700 mc. Units in each range will match any 1.1:1 mismatch regardless of phase. Circle 222 on Reader Service Card.

## Subtractor Converter digital unit

COMPUTER EQUIPMENT CORP., 1931 Pontius Ave., Los Angeles, Calif., announces a new digital subtractor converter unit. Model DS-12-A is an electronic instrument that compares two input signals which

# SHOCK

name  
your  
punish-  
ment...

and you'll find the Helipot Series T all-metal single-turn precision potentiometer can take it! Name your linearity, to  $\pm 0.20\%$ ...your resistance, from 650 to 100,000 ohms...up to 5 ganged sections and 9 taps per section...servo or bushing mount, with bearings front and rear for perfect alignment. Put them all together, in the T's new cup-type housing, and you'll have the best-value miniature you can design into your system! For the full T-Pot Story, whistle for data file A-12.

potentiometers : dials : delay lines : expanded scale meters : rotating components : breadboard parts

The T takes 50G's meeting MIL-R-19; exceeding NAS 710 proc. III



# VIBRATION

The T takes 500 cps at 30G's, meeting NAS 710 proc. III

# ACCELERATION

The T takes 100G's, exceeding MIL-R-19



The T takes  $-55^{\circ}$  to  $+125^{\circ}\text{C}$ , with 1.2 watts at  $40^{\circ}\text{C}$

# TEMPERATURE

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\_\_\_\_\_ degree.

I am not a graduate engineer but have \_\_\_\_\_ years experience.

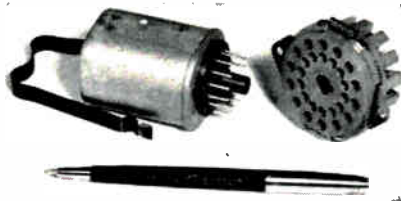
Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

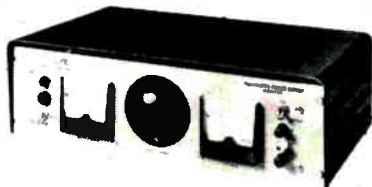
Zone \_\_\_\_\_ State \_\_\_\_\_

consist of digital pulses, subtracts one from the other digitally, and presents an analog output signal. The output signal may be recorded directly, or used to control automatic equipment. Circle 223 on Reader Service Card.



### Miniature Relay heavy-duty socket

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has available a miniature sealed, electromagnetic relay specifically designed for such industrial applications as machine tool controls, welding controls, instruments, and industrial electronic equipment. Key feature is the extremely rugged new 14-terminal header with keyed guide post which is mated with a heavy-duty, mica-filled phenolic socket. This new industrial-type design permits wire checking and speedy replacement which will greatly reduce maintenance and downtime. Circle 224 on Reader Service Card.



### Power Supplies transistorized

ARMOUR ELECTRONICS, INC., 4201 Redwood Ave., Los Angeles 66, Calif., has available the new T-200 series transistorized power supplies. Eight standard models provide output ranges suitable for both transistor and vacuum tube circuitry. The supplies provide 0.1 percent or 30 mv line or load regulation, 50  $\mu$ sec recovery time, 0.2 percent 24 hour stability and short

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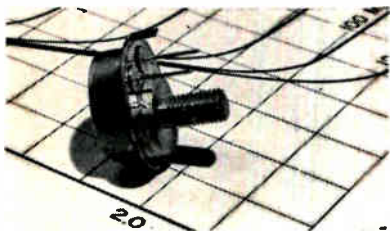
January 30, 1959 — ELECTRONICS



circuit proof design. Forced air cooling in all models provides excellent heat dissipation. Circle 225 on Reader Service Card.

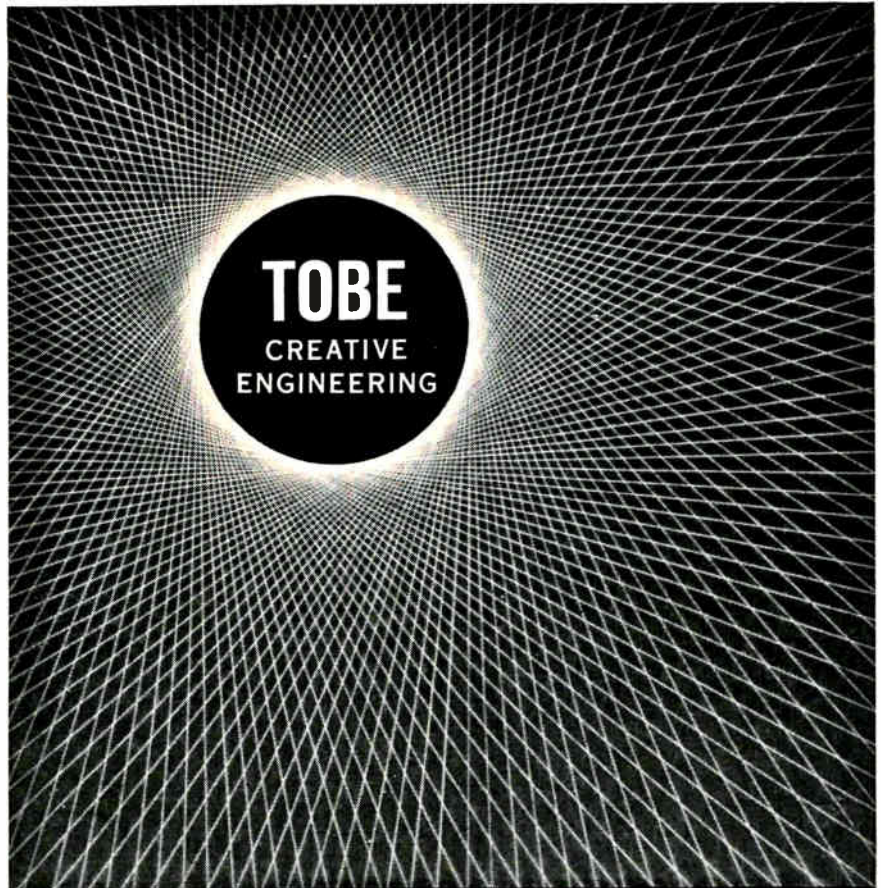
### Transistors switching type

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., announces a series of *pnp* switching transistors which incorporate maximum reliability and high-temperature stability. Designated types 2N404, 2N425, 2N426, 2N427 and 2N428, the series utilizes a hermetically sealed inverted base TO-5 package which offers heat dissipation up to 150 mw at 25 C. Type 2N404 has a collector to base voltage of -25 v, a junction temperature of -65 to +85 C with carefully controlled leakage current. The other four types have -30 v collector to base voltage, 150 mw power dissipation, and -65 to + 85 junction temperature. Circle 226 on Reader Service Card.



### Silicon Transistors high-power

WESTINGHOUSE ELECTRIC CORP., P. O. Box 2099, Pittsburgh 30, Pa., announces two new high-power silicon transistors, for switching and amplifier applications. Rated at 2 and 5 amperes, the new units (WX1015 and WX1016) each have a collector-to-emitter voltage range from 30 to 300 v and are capable of switching power up to 1 kw. The devices are of *npn* construction. The high voltage and current ratings of these transistors, together with low saturation resistances (maximum 0.7 and 0.5 ohm respectively, for the 2 and 5 ampere units) enable either to handle high switching power with minimum losses. Circle 227 on Reader Service Card.



## THE NRG-200 SERIES OF LOW-INDUCTANCE THERMONUCLEAR ENERGY-STORAGE CAPACITORS



NRG-200 SERIES SPECIFICATIONS				
Type No.	Watt Seconds	Rating		Self Inductance (Microhenries)
		Mfd.	D <sub>C</sub> Peak	
NRG-201	1000	5.0	20 KV	.04
NRG-202	1500	7.5	20 KV	.045
NRG-203	2000	10.0	20 KV	.055
NRG-204	3000	15.0	20 KV	.06

Tobe now announces the availability of a series of reliable, low-cost energy-storage capacitors for thermonuclear equipment and similar applications. The NRG-200 series capacitors have a minimum life expectancy of 1000 operations, and may be operated at ambient temperatures up to 40°C. Maximum permissible reversal voltage is 90%. They can be discharged into a very low-impedance load with complete safety.

For further technical information or engineering aid, write Tobe Deutschmann Corporation, Norwood, Mass.

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 NAME PLATES  
 PINS  
 PLATES  
 PLUGS  
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 SPACERS  
 SPOOLS  
 STANDS  
 STRIPS

SIZES: 1/8" to 2 1/2" LENGTHS: 1/16" to 9"

## Literature of the Week

### MATERIALS

**High-Purity Tantalum.** National Research Corp., 70 Memorial Drive, Cambridge, Mass. A new 4-page technical folder describes the application of NRC high-purity tantalum to the electronic, nuclear, chemical and missile industries. Circle 250 on Reader Service Card.

### COMPONENTS

**Transistor Sockets.** Elco Corp., M St. below Erie Ave., Philadelphia 24, Pa. Bulletin 12 contains an illustrated description and specifications for the series 3300-combination transistor sockets for 0.016 in. and 0.030 in. diameter pins. Circle 251 on Reader Service Card.

**Control Cable.** Chester Cable Corp., 101 Oakland Ave., Chester, N. Y., recently issued a six-page folder on plastic insulated and jacketed control cable (rated 600 v). Circle 252 on Reader Service Card.

**Special Charts.** The Bristol Co., Waterbury 20, Conn. Bulletin Y-1906 describes charts for special requirements (including pre-printed photo charts for oscillographic recording). Engineering information and chart samples are included. Circle 253 on Reader Service Card.

**Capacitors.** Electronic Fabricators, Inc., 682 Broadway, New York 12, N. Y., has published a four-page listing giving dimensions and prices of its Polystyrene and Mylar tubular and rectangular capacitors in  $\pm 5$  percent capacitance tolerances. Circle 254 on Reader Service Card.

**Engineer's Handbook Supplement.** CBS-Hytron, Danvers, Mass. (Continued on p 101)

Write, wire, phone for samples, prices and Bulletin F listing stock items. Send specifications or blue-prints for prompt quotations on specials.

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A 40-page supplement to the Engineer's Handbook offers new and revised data for 14 types as well as 8 pages of new and revised curve sheets. An up-to-date table of contents lists more than 500 types now included in the handbook. Handbook and supplement are available. Circle 255 on Reader Service Card.

**Precision Film Resistors.** Texas Instruments Inc., P.O. Box 312, Dallas, Texas, announces availability of the MIL-Bell decade table for determining standard resistance values of precision film resistors. Circle 256 on Reader Service Card.

## EQUIPMENT

**Multiple Transformer & Bobbin Winder.** Geo Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 46, Ill. A catalog page illustrates and completely describes a heavy duty (4 to 23 Awg wire) multiple transformer and bobbin winder which form winds coils without pounding. Circle 257 on Reader Service Card.

**Tubeless Counters.** Redford Corp., Lake Luzerne, N. Y. Bulletin EC-201 describes uses, design characteristics, maintenance and operating features of new totalizing and predetermined counters. Circle 258 on Reader Service Card.

**D-C to D-C Converter.** La Roe Instruments, Inc., 1709 B East Montgomery Ave., Rockville, Md. Type MA 28-2D transistorized d-c to d-c power converter is illustrated and described in recent engineering bulletins. Circle 259 on Reader Service Card.

## FACILITIES

**Microwave Standards Measurement.** Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. A 36-page application note describes the latest techniques and instrumentation for making various microwave standards measurements. Circle 260 on Reader Service Card.

# Accurate



\*These tolerances are from absolute frequency under any combination of the conditions within operating specifications. For specific operating conditions much closer frequency tolerances may be maintained.

## TRANSISTORIZED TUNING FORK FREQUENCY STANDARDS

### TYPE MAFC — Frequency Standard

- Frequency Range Available: 360 cps to 4 kc
- Tolerances %  $\pm$ : 0.2, 0.05, 0.02, 0.01, 0.005\*
- Temperature Ranges: —20 to +71°C  
—55 to +100°C  
—55 to +125°C
- Power Supply Voltage: 12 or 28 vdc  $\pm$  15%
- Size: 1 $\frac{3}{8}$ "x1 $\frac{1}{8}$ "x2 $\frac{1}{4}$ " • Weight: 8 oz.

### TYPE AFC — Frequency Standard

- Frequency Range Available: 360 cps to 4 kc
- Tolerances %  $\pm$ : 0.2, 0.05, 0.02, 0.01, 0.005\*
- Temperature Ranges: —20 to +71°C  
—55 to +100°C  
—55 to +125°C
- Power Supply Voltage: 12 or 28 vdc  $\pm$  15%
- Size: 2 $\frac{1}{8}$ "x2 $\frac{1}{8}$ "x3 $\frac{1}{4}$ " • Weight: 13 oz.

### TYPE MAFCD — Frequency Standard

- Frequency: 60 cps
- Tolerances %  $\pm$ : 0.2, 0.05, 0.02, 0.01, 0.005\*
- Temperature Range: —55 to +71°C
- Wave Shape: Sine w/less than 1% harmonic distortion
- Power Supply Voltage: 10 to 14 vdc
- Size: 4 $\frac{1}{16}$ "x4 $\frac{1}{16}$ "x4 $\frac{1}{16}$ " • Weight: 4 lbs.

### TYPE MFB — Frequency Divider

- Ratios Available: 2:1, 4:1, 5:1, 8:1, 10:1, 16:1
- Temperature Ranges: —20 to +71°C  
—55 to +100°C
- Power Supply Voltage: 12 or 28 vdc  $\pm$  15%
- Size: 1 $\frac{3}{8}$ "x1 $\frac{1}{8}$ "x2 $\frac{1}{4}$ " • Weight: 6 oz.

### TYPE MFS — Frequency Standard for Laboratory or Field

Type MFS is a small, lightweight frequency standard that can replace units many times its size without sacrificing frequency stability. Internal batteries and provisions for external power supply make the unit ideal for either laboratory or field applications.

- Frequency Ranges Available: 50 cps to 4 kc
- Frequency Stability: 2 parts in 10<sup>7</sup>/per month
- Temperature Range: —20 to +71°C
- Size: 3 $\frac{3}{8}$ "x5 $\frac{1}{16}$ "x5 $\frac{1}{16}$ " • Weight: 2 lbs.

### TYPE MLS — Laboratory — Frequency Standard

Type MLS is an extremely high stability laboratory frequency standard. The clock on the panel facilitates easy checking of stability.

- Frequency Ranges Available: 50 cps to 4 kc (Multiple Taps Optional)
- Frequency Stability Available: 5 parts in 10<sup>7</sup>
- Output: 10 watts at specified frequency
- Input: 115 v, 50 cycles to 400 cycles
- Size: 9"x10"x7" • Weight: 15 lbs.

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### NEW BOOKS

#### Electronics of Microwave Tubes

By W. J. KLEEN.

Academic Press, New York, 1958,  
349 p, \$9.00.

This new work of Prof. Kleen is a translation and revision of his two volume "Einfuehrung in die Mikrowellen-Elektronik". The revisions and inclusion of new material make it essentially a new and independent book. Of greatest interest is the first half of the work where the physical and mathematical foundations are laid for the interaction between electron streams and electromagnetic fields. This is done with mathematical rigor and elegance.

**Current Concepts**—After a chapter on electron motion in static electric and magnetic fields including space charge, the concept of the various currents is developed, carefully leading to the Llewellyn-Peterson equations. The exchange of power between electron streams and stationary and progressive fields is also treated. This chapter is followed by two on velocity modulation and a short chapter on extraction of power from a beam by a stationary field. The use of the Llewellyn-Petersen equation for velocity modulation analysis is particularly interesting.

Traveling-wave modulation, space-charge waves and crossed-field interaction are the subjects of three chapters. The analysis of electron streams as transmission lines is noteworthy.

**Microwave Tubes**—The second half of the book has two sketchy chapters on classification and practical applications of microwave tubes. Much better than these are the subsequent treatments of the tube as a circuit element and noise. The last three chapters are devoted to microwave resonators, delay lines and electron beams and guns. The chapter on delay lines treats the helix, the Karp circuit, interdigital lines and magnetron circuits. The chapter on electron beams includes a discussion on periodic magnetic focusing.

In all, the reader will find a valu-

able compendium of information on the theoretical foundations of microwave electronics. — MORRIS ETENBERG, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

## Principles of Electrical Measurements

By BUCKINGHAM and PRICE.

Philosophical Library, New York, 1957, 600 p, \$15.00.

THIS volume is an indispensable compendium of fundamentals underlying the very important field of electrical measurements. The major emphasis is on principles akin to the lower range of the frequency spectrum. Both students of electrical engineering and professionals will regard this text as a veritable storehouse of useful information.

The authors deserve high praise for their effort since they have succeeded in organizing a very large mass of material into an easily accessible unity. The topics are succinctly considered with stress on principles, classification of instruments, dimensional details, derivations of useful equations and inherent limitations. Errors in measurements are clearly discussed and evaluated.

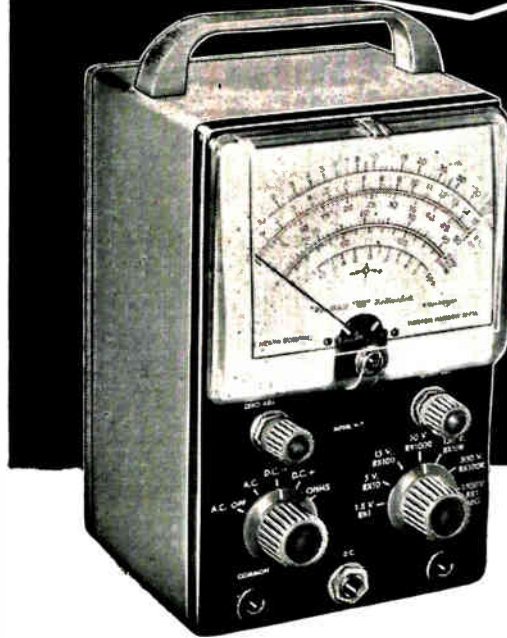
The authors have selected their topics rather carefully and the result is quite gratifying even though no mention is made of electromagnetic theory and circuit theory. The book is recommended as a valuable addition to the library of anyone interested in electrical measurements. — ANTHONY B. GORDANO, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

## THUMBNAIL REVIEW

1958 Registry of Radio Systems in the Transportation Services. Communication Engineering Book Co., Monterey, Mass., 1958, 84 p, \$4.00. Published by the authority of the FCC, this registry gives details of every mobile radio system in the U. S. operated by railroads, taxicabs, auto services, buses and trucks.

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## ITT Opens Raleigh Plant

RALEIGH, N. C., is the home of a recently-dedicated new electronics plant of Kellogg Switchboard and Supply Co., Chicago, communications division of International Telephone and Telegraph Corp.

Fred M. Farwell, executive vice president—ITT U. S. Group, who spoke at the special program, said the plant will be used to manufacture fully-transistorized carrier systems for telephone companies, microwave line-of-sight equipment, and over-the-horizon tv and telephone transmission systems.

The plant, Kellogg's fifth manufacturing facility in the U. S., has 30,000 sq ft of floor space and is located on a 25-acre tract. George T. Scharffenberger, Kellogg president, said William W. Simonds, an employee since 1943, would manage the new plant.

Kellogg, a supplier to the independent telephone industry for 62 years, also designs and manufactures special communications systems and equipment, and is engaged in work on the Atlas and other ballistic missiles.

Equipment manufactured at Raleigh will include two new carrier systems developed by ITT Laboratories. A carrier for rural exchanges makes private service possible on party lines, in addition to increasing eightfold the capacity of existing facilities.

The second carrier still in development will increase twelvefold the capacity of facilities between exchanges in metropolitan and large suburban areas without the necessity of tearing up streets to lay additional cable.

## NAB Award To Wilner

JOHN T. WILNER of Baltimore, vice president and director of engineering for radio and tv stations of the Hearst Corp., has been selected for the first engineering award given by the National Association of Broadcasters. He was cited for his work on the image orthicon saver, a device which greatly prolongs the life of expensive image orthicon tubes in tv cameras and prevents the image from sticking on the tube.



The award will be presented March 18 during a broadcast engineering conference in Chicago.

## Damon Joins Augat Bros.

NEW chief engineer at Augat Brothers, Inc., Attleboro, Mass., is Neil F. Damon. He was formerly chief mechanical component design engineer for Raytheon Manufacturing Company's commercial equipment operations.

Damon's technical background includes development work on radar mechanisms, preparation of component purchase specifications and design and development of electro-mechanical components, which included close association with various design and packaging engineers.

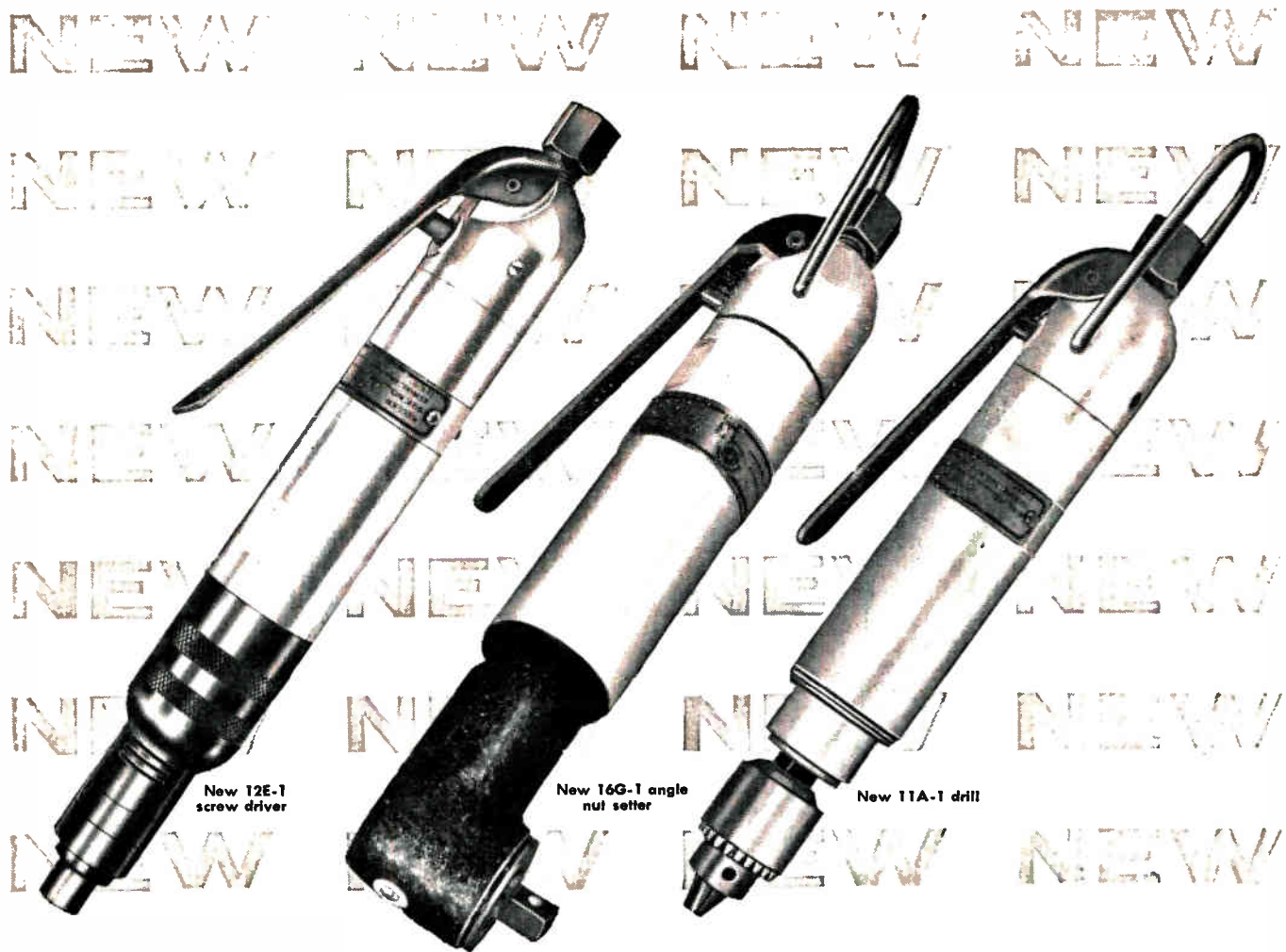


## Control Data Appoints V-P

HENRY S. FORREST has been promoted to the position of vice president of Control Data Corp., Minneapolis, Minn., computer and instrument firm. He has held the post of director of government service engineering and manager of the company's eastern office at Washington, D. C., since he joined Control Data Corp. in 1957.

## Elect Edwards V-P at Maxson

ALBERT E. EDWARDS has been elected a vice president of The W. L. Maxson Corp., New York City. Maxson specializes in research, development and manufac-



New 12E-1 screw driver

New 16G-1 angle nut setter

New 11A-1 drill

## Why you should know more about this new line of air tools

Now, more than ever before, you have to be cost-conscious. That's why Gardner-Denver has made the new No. 1 air tool motor—made it more powerful, yet more efficient.

Now, more than ever before, time saved is money in

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Noise reduction is always welcome. Gardner-Denver's muffled exhaust quiets motor whine . . . relieves fatigue.

### 2 NEW DRIVERS

#### 12E-1 In-Line Screw Drivers

- Sets machine screw sizes from 0 to 6
- Write for Bulletin 12E-1

#### 12G-1 Angle Screw Drivers

- Sets sizes 6 and 8 machine screws
- Write for Bulletin 12G-1

### 2 NEW SETTERS

#### 16E-1 In-Line Nut Setters

- Sets machine nut sizes from 0 to 6
- Write for Bulletin 16E-1

#### 16G-1 Angle Nut Setters

- Sets sizes 8 and 10 machine nuts
- Write for Bulletin 16G-1

### 2 NEW DRILLS

#### 11A-1 Straight Drills

- Drills holes to  $\frac{3}{32}$ "
- Write for Bulletin 11A-1

#### 11G-1 Angle Drills

- Drills holes to  $\frac{3}{32}$ "
- Write for Bulletin 11G-1

Like all air tools in Gardner-Denver's broad line, the new No. 1 tool line is available with dozens of interchangeable attachments for many fastening jobs.

Write for the bulletins mentioned above for complete information on the tools of your choice. Or call in your Gardner-Denver air tool specialist.



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For complete details request Bulletin 516.

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ture of precision electronic and electromechanical equipment for aircraft, missile and ordnance uses.

Since 1945, Edwards was vice president for manufacture at the Ford Instrument Co. division of the Sperry Rand Corp. in Long Island City, N. Y.



## Name V-P At Shure Bros.

HAROLD J. ADLER has been named vice president in charge of operations at Shure Bros., Inc., Evanston, Ill., manufacturer of microphones and electronic components.

For 17 years he was chief electrical engineer of the Sentinel Radio Co. and for five years he was director of engineering of the Hallcrafters Co.

Adler also was vice president of Edwin I. Guthman Co. For the last three years he has been a private consultant to industry on engineering, manufacturing and sales.

## Plant Briefs

Permag Corp., supplier and precision fabricator of permanent magnets, has moved to larger quarters in Jamaica, N. Y.

Radiatronics, Inc., Van Nuys, Calif., is a new firm engaged in engineering and manufacturing of radiation and electronics equipment for radar, communications,



telemetering microwave and other electronics applications.

**Bell Sound Systems, Inc.**, Columbus, Ohio, has become a full division of the newly combined companies now known as **Thompson Ramo Wooldridge, Inc.**

## News of Reps

**Cerruti-Hunter Associates** are appointed sales reps covering northern California and northern Nevada for **General Ceramics Corp.** and its subsidiary, **Advanced Vacuum Products**.

**Millard D. Shriver**, former vice president of **Panellit, Inc.**, Skokie, Ill., has formed **Millard D. Shriver Co., Inc.**, in Alhambra, Calif, as a sales and engineering firm specializing in instrumentation and control work. Territory served is the entire state of California. **Panellit** products being handled are annunciators, control panels, and information systems. Other firms' lines to be represented will be announced later.

**Robert W. Marshall** of Minneapolis, Minn., is the new sales rep in Eau Claire and LaCrosse counties, Wisconsin, and all of Minnesota for **Chicago Telephone Supply Corp.**, Elkhart, Ind.

**Hoffman Electronics Corp.**, Los Angeles, Calif., has appointed three additional reps to handle its electromechanical products. New reps are:

**Anderson Electronics Co.**, Roseville, Mich., covering Michigan.

**Electro - Mechanical Instruments, Inc.**, Pasadena, Calif., covering San Francisco and surrounding area.

**F. F. Sylvester Associates**, Springfield, N. J., covering New Jersey and metropolitan New York.

**Zak-Cowen and Associates, Inc.**, of St. Louis, Mo., are named manufacturer's reps for **Dage Electric Co., Inc.**, coaxial cable connectors, in Missouri, Kansas, Iowa and southern Illinois.



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## ELECTRONIC COMMUNICATION

**Just Published**—A wealth of practical electronics information for all major communication fields. Special emphasis placed on FCC license requirements. Covers such essentials as tubes, power supplies, amplifiers, transmitters, and receivers—including applications to radio, loran, radar, etc. Transistors, color TV, single-sideband transmission, and other developments are clearly treated. By R. L. Shrader, Oakland Jr. Coll. 937 pages, 771 illus., \$13.00

## ELECTRICAL MEASUREMENT ANALYSIS

**Just Published**—Guide to analytical solution of electrical measurement problems. Fully treats methods, concepts, and techniques of analysis, including theory and operation of electromechanical instruments. Null and deflection methods of measurement; errors; compensation theorem; square-wave response of galvanometers from steady-state and transient points of view; and other topics are covered. By E. Frank, The George Washington Univ. 443 pages, 245 illus., \$8.75

## GUIDED MISSILES

### Operation, Design and Theory

A full, authoritative survey of guided missiles and their components—how they work, what goes into them, their theoretical foundations, how they are checked, and how they are used. Gives you a background of fundamentals that aids in the design of missile components. Offers a vast storehouse of theory, facts, formulas—with drawings, charts, and diagrams illustrating every point. Sponsored by the Dept. of the Air Force. 546 pp., over 500 illus., \$8.00

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CIRCLE 74 READERS SERVICE CARD

## COMMENT

### Interchanging Ideas

Recently we came across a concise statement in a McGraw-Hill book which very aptly points a way for management and publicity to work together to mutual advantage in these days when scientific and research developments are snowballing at a bewildering rate. We feel that this sentiment could bear repeating.

Would you care to comment on it?

The paragraph is this:

"Any loss caused by lifting the veil from the modern American factory and revealing details of the art has been shown to be minimal, in view of the public relations gains that come with a reputation for being smart. The interchange of ideas through technical and trade magazines is an outstanding characteristic of our present-day production system. Its effect in multiplying production is no longer debatable. The contribution of the publicity man, a valued ally of the industrial editor in inducing management to let production methods be disclosed, is substantial."

We saw this in the 1953 McGraw-Hill book *Publicity for Prestige and Profit* by Stephenson and Pratzner.

ARTHUR F. JOY

RAYTHEON MFG. CO.  
 WALTHAM, MASS.

Wasn't it Boss Kettering who remarked, "when you lock the door to the research lab, you lock out more than you lock in"?

We can, with minimal effort, write reams on this subject, but since the interchange of ideas is the lifeblood of this magazine, it might seem a highly subjective outpouring. Suffice to say we subscribe heartily to the idea that the greater long-range profit for each and all results from the free interchange of ideas.

### Biggest and Tallest

In your story on the use of computers in department stores ("Stores a Ripe Market?" p 29.

work in the fields of the future at NAA



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THE LOS ANGELES DIVISION OF

**NORTH AMERICAN AVIATION, INC.**



Jan. 2) I think you did a grave injustice to Detroit by describing Macy's in New York as the world's largest department store.

Here in Detroit we recognize J. L. Hudson's as being the largest department store in the world. Its almost 2,000,000 sq ft of floor space moved it right up to the top many years ago. And in 1954, the store opened the largest suburban shopping center in the world in Northland.

The insular nature of New Yorkers has obviously had its effect on your normally careful and accurate reportage.

H. E. OSTERREICHER

DETROIT

Well, despite their insularity our editors remain both careful and reasonably accurate. Hudson's 25 stories make it the tallest department store in the world, but Macy's still has more floor space. Macy's made its claim when it first moved to its present location in 1902. The boast was successfully challenged by Wanamaker's Philadelphia, Marshall Field Chicago, and Hudson's; but additions to Macy's in 1924, 1928 and 1931 brought total floor space to 2,157,330 sq ft—somewhat more than Hudson's 1,960,000.

Macy's and Hudson's, incidentally, have the largest telephone switchboards outside of the telephone company and the Pentagon. Hudson's leads in trunklines 553 to 536; Macy's in extensions, 2,500 to 1,341.

#### Radar on Tv

We were very much interested in your article "Tv Radar Attracts Buyers" (p 17, Nov. 28'58).

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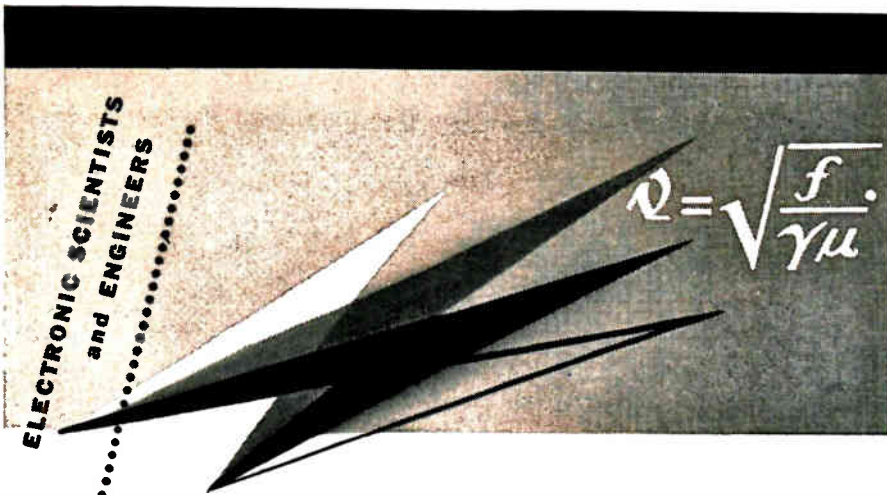
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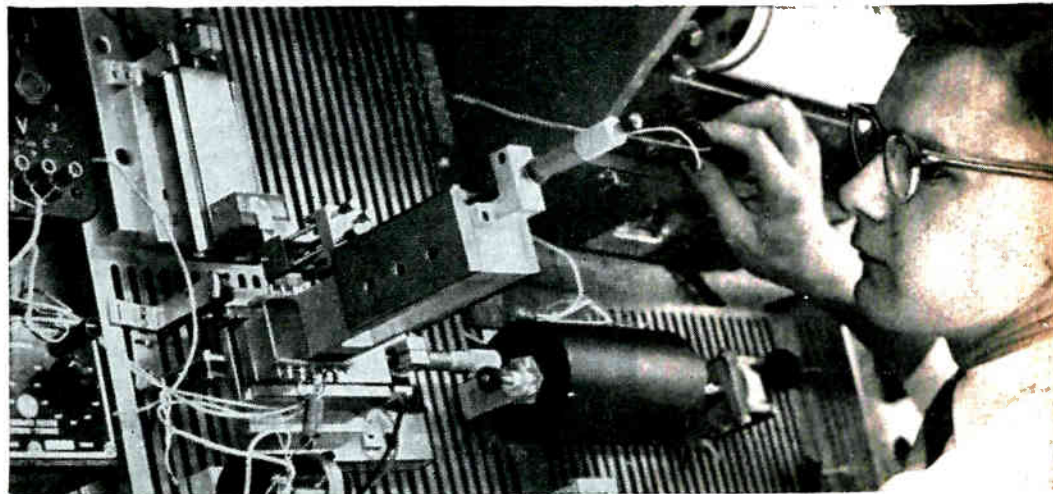
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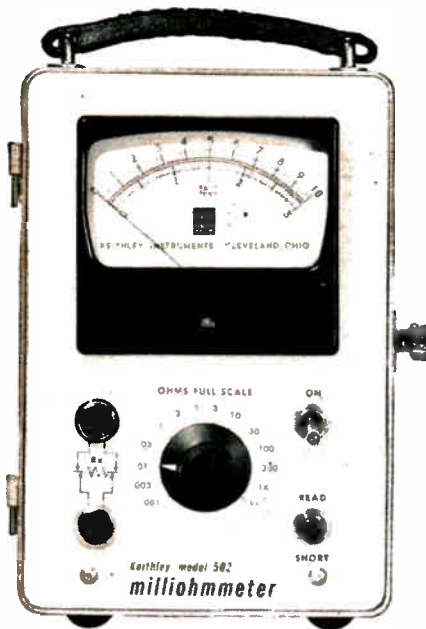
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- **accuracy within 3%** of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- **2 microwatts** maximum dissipation across sample.
- **no calibration** or zero adjustments.
- **instantaneous** indication of resistance without zero drift or errors due to thermal EMF's.
- **lightweight and portable.** Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

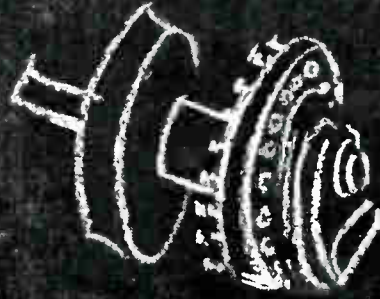
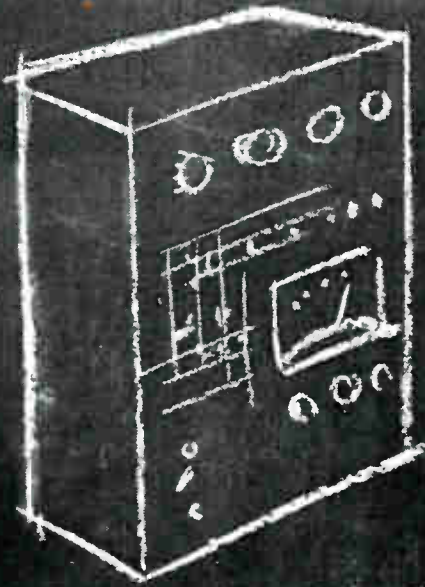


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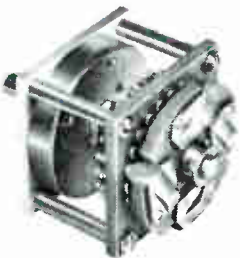
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