electronics

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Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 9

NEW RAYTHEON MAGNETRONS FOR A WIDE RANGE OF APPLICATIONS

Designed for C-band systems requiring tunability, the RK-7156 magnetron has a minimum peak power output rating of 250 kilowatts over a frequency range of 5,450 to 5,825 megacycles. Applications include a flight-tested, revolutionary airborne weather radar system. The RK-7156 is in quantity production.

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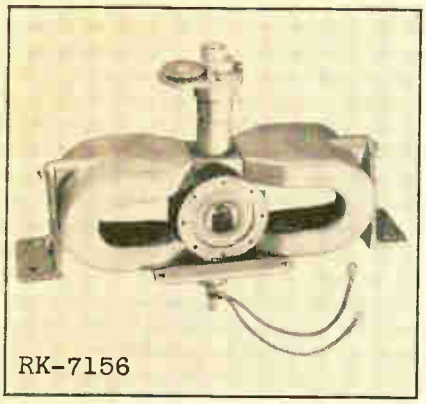
RK-7156

* * *

X-band magnetron for airborne search radar provides one megawatt minimum peak power and 875 watts average power within a frequency range of 9,340 to 9,440 Mc. Designated QK-624, this pulsed-type tube is liquid cooled and should give at least 1,000 hours of reliable service.

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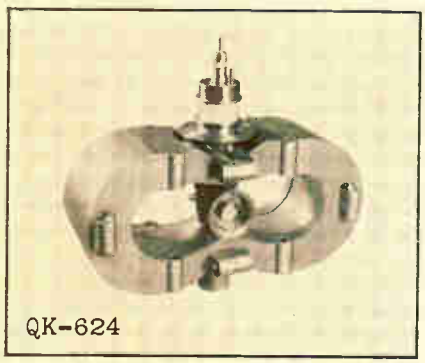
QK-624

* * *

For ground-based and airborne radar systems, the RK-7529 magnetron provides a 2.0 microsecond pulse of 3.5 megawatts minimum peak power over 2,700 to 2,850 Mc. This liquid-cooled tube is interchangeable with other fixed-frequency S-band tubes operating at similar power levels.

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RK-7529

* * *

A one kilowatt beacon magnetron, the RK-7578 weighs only 14 ozs., yet will withstand vibrations of 15 G's at 20 to 2,000 cycles and shock up to 100 G's. It is mechanically tunable and covers the 5,400 to 5,900 Mc range.


RK-7578

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* * *

Developed to withstand extreme environmental conditions, the RK-7449 magnetron is a lightweight, compact tube with a minimum peak power output of 45 kilowatts at the operating frequency of 24 kmc. The RK-7449 is required to withstand repeated shocks of 50G. Stable operation is guaranteed at vibration frequencies up to 2,000 c.p.s. with 30G applied.


RK-7449

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RAYTHEON

electronics

FEBRUARY 12, 1960

A McGRAW-HILL PUBLICATION
Vol. 33 No. 7

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Issue at a Glance

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FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

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

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007–6 (± .02% at —50° to +85°C)
R2007–6 (±.002% at +15° to +35°C)
W2007–6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

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

FREQUENCY STANDARD
TYPE 2001-2

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

FREQUENCY STANDARD
TYPE 2111C

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

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

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February 12, 1960 Vol. 33, No. 7

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SHOPTALK . . . editorial

RESEARCH. Electronics—as our special report in this issue suggests—is an industry which by its very nature is oriented toward research and engineering. All over the world, the industry is supported by laboratory experiment, by mathematical formulation—and, more and more, by pure thought.

Expensive as these "overhead" costs are to business, they are the means by which technology grows. As such, research effort is a direct measure of the health and vitality of an industry. And it eventually pays off, as our lead news story this week amply demonstrates.

The story discusses molecular electronics, one of the many names being applied to the new art of growing whole circuit complexes *en bloc* in solid crystalline form. There are a number of laboratories in this country and abroad working in this promising field. Their labors will ultimately lead to a higher level of circuit reliability under all sorts of environmental conditions, and to more value per dollar spent on electronic systems.

Even more important, molecular engineering—if we are to call it that—should ease many of today's production and maintenance problems. When the techniques are perfected, we may see nearly automatic production of electronic systems and plug-in-throw-away maintenance.

Coming In Our February 19 Issue . . .

SONAR. Antisubmarine warfare requires the ability to penetrate the modern submarine's underwater cloak of invisibility. Sometimes referred to as the fourth dimension at sea, the ocean depths are ideal hiding places for missile-carrying nuclear submarines, for they cannot be penetrated to any extent by visible light, radar or similar forms of radiation.

As a result, new and improved sonar systems are being emphasized as an effective method of determining range, bearing and depth of submerged objects.

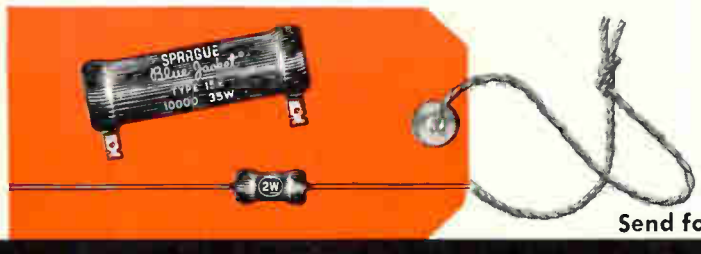
In our next issue, we will publish the first of two articles by G. Rand of Sperry Gyroscope Co. on sonar equipment. The article deals with the range capabilities of both passive and active systems. You'll find design charts for estimating the range of sonar gear and for determining the effect of the various parameters on the equipment range.

Rand has been concerned with underwater propagation studies, development of underwater sensing devices and sonar detection systems since he joined Sperry in 1957 as an engineering section head. Prior to that he spent 10 years as a chief project engineer on the design, development and production of sonar transducers and underwater detection devices. You will want to read his informative report on this vital topic.

SPOT WELDING. A welding control system that insures consistency and reliability of spot welds over long periods is described by G. R. Archer of The Budd Co. The new system, called voltage restraint, uses a feedback to compare the voltage across a spot weld with a previously determined command voltage indicative of the proper temperature for welding.

System is the result of a program to design and assemble a complete control system that would allow uniformly good welds over a wide range of in-process variation without the need for destructive testing.

Archer has been associated with the program in the capacity of chief engineer for the Electronic Controls Section.



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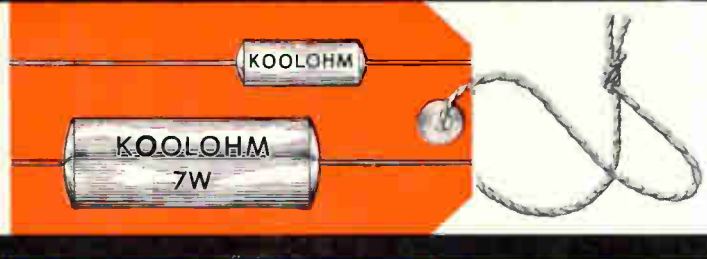

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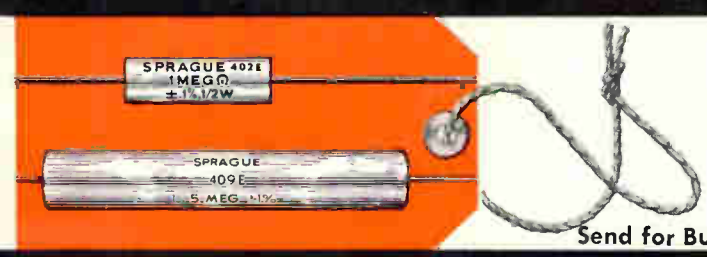

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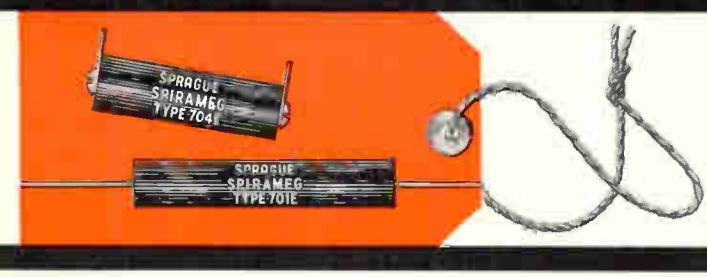

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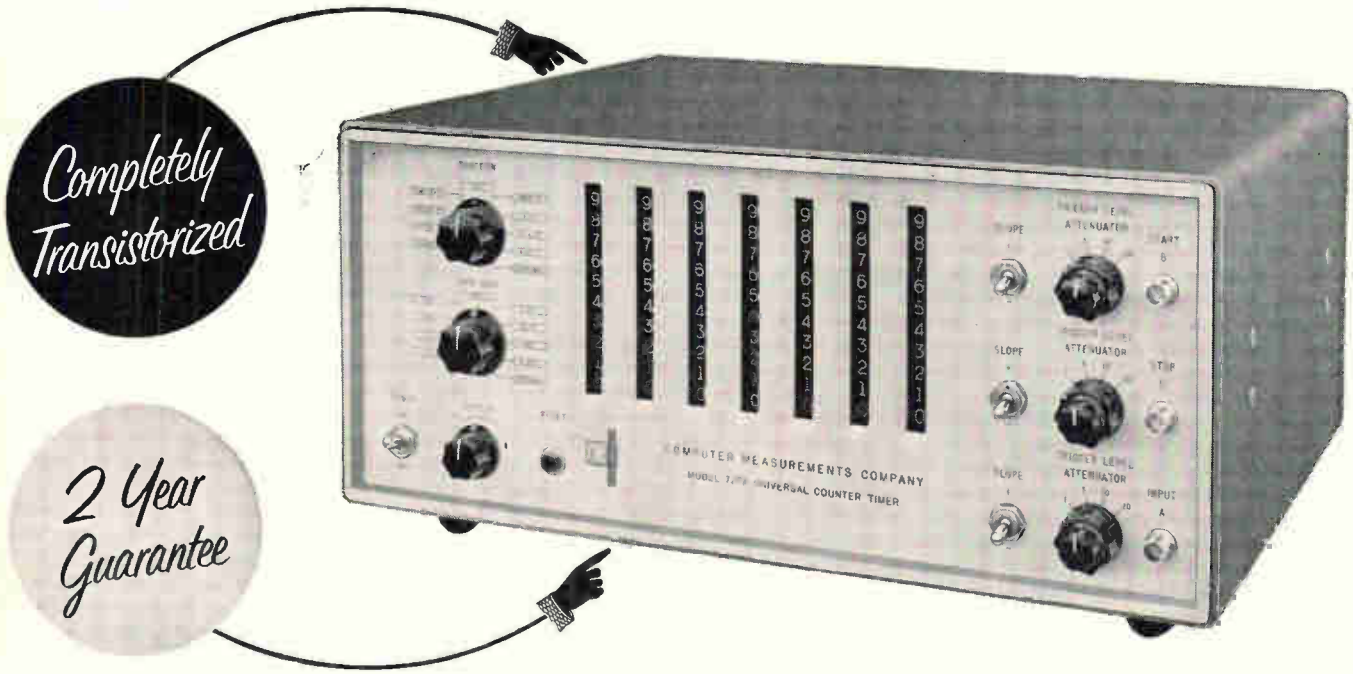

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DO ALL THESE JOBS

Measure frequency from dc to 10 mc, time interval from 0.1 μsec, ratio 1 cps to 1 mc and unlimited multiple period selection. Frequency converters available for higher frequencies. The counter also generates time interval marker pulses from 1 μsec to 1 second. Data can be presented on standard decades or inline Nixie tubes. The 700 series will operate digital recording equipment, punches, inline readouts, and other data handling gear.

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And The Price—Higher than vacuum tube models. But you can save the difference on down time in the first year. Model 727A Universal Counter-Timer, $3,500; Model 707A Frequency-Period Meter, $2,700; Model 757A Time Interval Meter, $2,500. Rack mount optional at no extra cost. All prices f.o.b. Sylmar, California.

More Information Available – Your nearby CMC engineering representative will be happy to arrange a demonstration and provide you with complete technical information. Or you may write Department 18.

CMC **Computer Measurements Co.**

A Division of Pacific Industries

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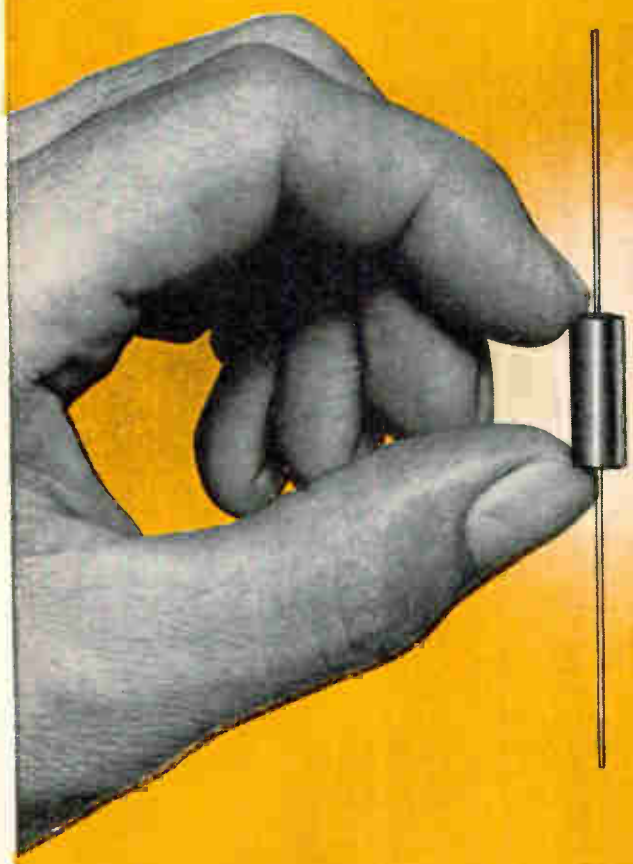
Phone: EMpire 7-2161



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New Electra Precision Metal Film Resistor

Here is an entirely new achievement in electronic components; one of the biggest steps forward in years. This precision metal film resistor offers you precision and stability that formerly was available only in a wire wound resistor, yet it is much smaller in size, much lower in cost, also has far superior high frequency characteristics. Available in five sizes from ⅛ to 2 watts, the new Electra Precision Metal Film Resistor meets or exceeds Mil-R-10509C, Characteristic C, and can be supplied in any of eight standard temperature coefficient tolerances. Why not let us supply you full details by return mail. Write today!

CHECK THESE OUTSTANDING TEST RESULTS

MIL-R-10509C (TYPICAL DATA) 237K MF1/2

TEMPERATURE CYCLE			MOISTURE			LOAD LIFE 125°C			SHORT TIME OVER-LOAD		
Initial	Final	% Change	Initial	% Change Wet	% Change Dry	Initial	Final	% Change	Initial	Final	% Change
236.9	236.9	0	236.9	−.21	−.04	237.4	237.5	.04			
237.5	237.5	0	237.4	0	0	237.5	238.0	.21			
238.1	238.1	0	238.1	0	0	238.0	238.8	.34			
237.1	237.1	0	237.1	0	0	237.0	237.0	0			
237.9	237.9	0	237.9	0	0	237.5	237.4	−.1			
236.6	236.5	−.04	236.5	−.04	−.04	237.1	237.6	.21			
236.9	236.9	0	236.5	−.04	−.08	237.0	236....	...			
237.4	237.4	0	237.4	−.04	−.04	236.9	236.4	−.21			
237.2	237.2	0	237.0	−.08	−.08	237.5	238.1	.13			
237.7	237.7	0	237.1	−.04	−.04	237.0	237.3	.13			

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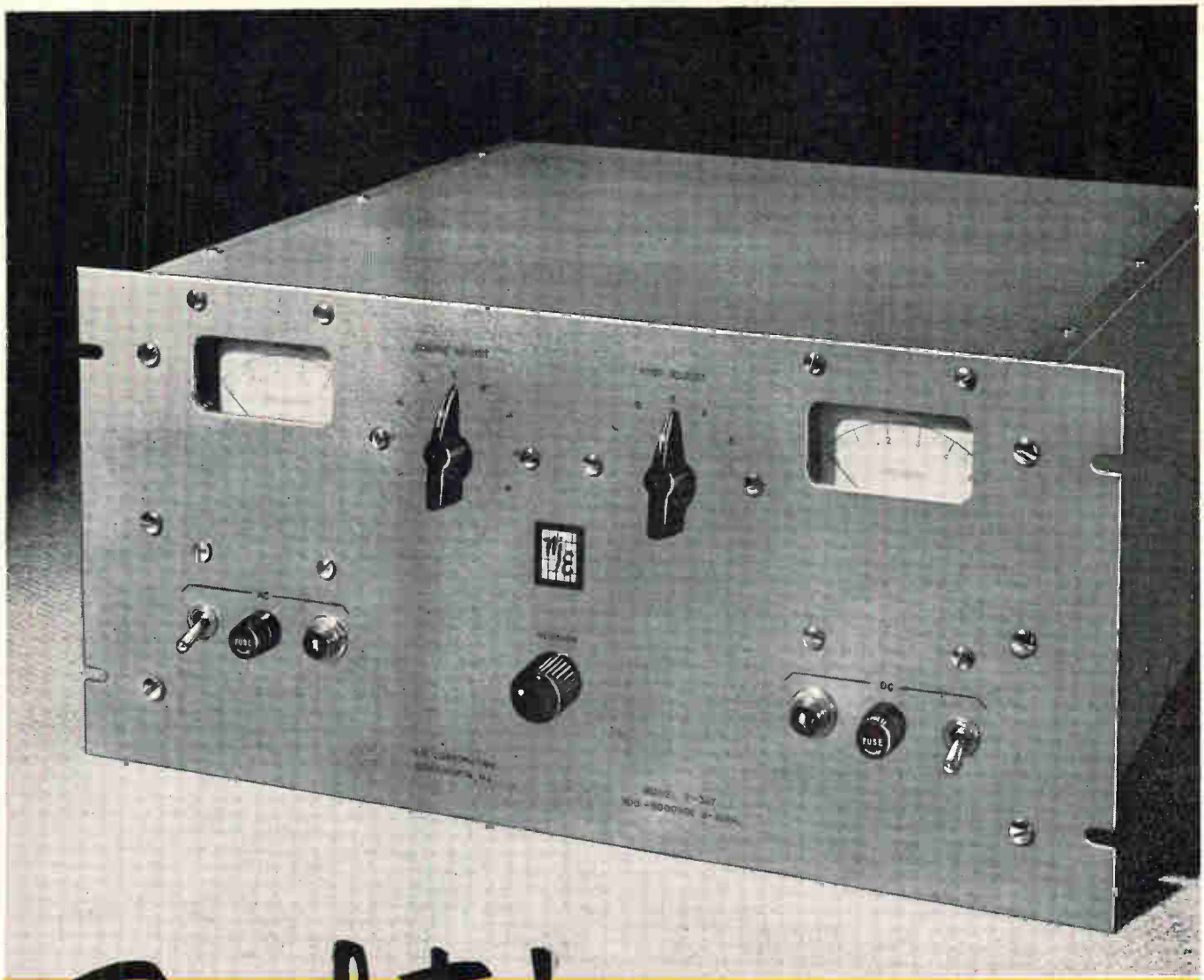
For more information write Department 120

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.



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S-324	800-2000	0-10 MA	25 MV	± 0.005%	60 MV	5¼"	$345.
S-325	500-2500	0-10 MA	5 MV	± 0.005%	60 MV	5¼"	$395.
S-326	500-2500	0-50 MA	5 MV	± 0.005%	0.005%	8¾"	$485.
S-327	500-5000	0-10 MA	5 MV	± 0.005%	0.005%	8¾"	$575.

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BUSINESS THIS WEEK

Tunnel Diode Factory Production Announced by U. S. and Japanese Firms

Tunnel diode production developments made news this week in Syracuse, N. Y., and in Tokyo, Japan.

H. B. Fancher, general manager of GE's semiconductor products department, disclosed that his company has started factory production of tunnel diodes in the face of increasing demand and has reduced prices on the devices. He announced that units priced at $60 and $75 have been reduced to $10 and $12.50.

Fancher reported that "several thousand" tunnel diodes have already been shipped by GE since samples were made available last September. He said advanced R&D was continuing but "production on a pilot manufacturing line is feasible."

In Tokyo, meanwhile, ELECTRONICS learned that Sony plans to make tunnel diode samples available next month. By then, the company expects to be producing the devices at a rate of "several thousand" a day. Kazuo Iwama, director of Sony's semiconductor division, expects the units to be priced at about $10, adds there are no plans set up to export any to the U. S.

New Telemetry Transmitter for ICBM's Can Operate During Missile Re-entry

Telemetry transmitter has been developed for the Air Force by ITT Laboratories to pierce the highly-conductive ionized plasma around a space vehicle re-entering the earth's atmosphere. **The company said the transmitter would be used on all ICBM's and in the Mercury man-in-space program.**

Extremely high frequencies—somewhere between 30,000 and 300,000 mc—are the key to the transmitter's operation during re-entry. (Absorption of r-f energy by the plasma sheath is inversely proportional to frequency.) Work was done in cooperation with Avco Corporation's R&D division.

Radar Signal Takes 17 Minutes To Bounce Off Sun's Outer Corona

Scientists at Stanford University's Radioscience Laboratory have just disclosed that they bounced a radar beam off the sun last April using a standard transmitter of 40,000 watts. **It took 17 minutes for the 25.6 mc signal to return to earth, and almost 10 months of magnetic tape analysis to verify that the echo received had actually come from the sun's outer corona.**

The scientists used a four-unit rhombic array for both sending and receiving. It consists of wires strung out on 22 power poles over 14 acres. The transmitter was turned on and off in 30-second pulses for 15 minutes, then kept silent while awaiting the echo. As a result of the 93-million-mile radar bounce, scientists expect to be able to explore the whole solar system with radar.

Dutch Market First Electronic Computer; Machine Uses Transistors and Ferrite Cores

First Netherlands commercial electronic computer, which uses transistors and ferrite cores supplied by Philips of Eindhoven, has been built by N. V. Electrologica of Amsterdam. **Estimated cost of the machine, one of which has been installed at First Netherlands Insurance Co. of The Hague, is $237,000.** Nine others have been sold. Computer has a 32,000-word memory, adds and subtracts at a rate of 15,000 characters per second and multiplies and divides at a 2,000-per-second rate. Punch-card input is 14,000 an hour, output 56,000 an hour.

ELECTRONICS NEWSLETTER

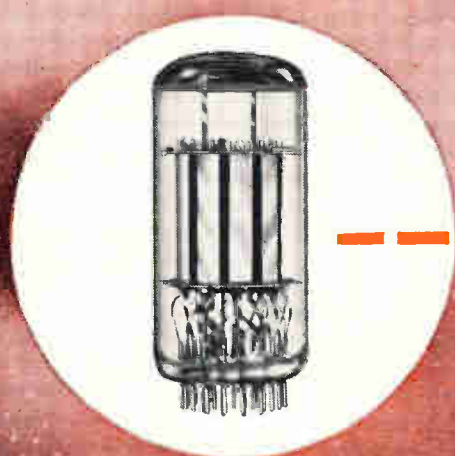
Rosy predictions for industry-wide semiconductor sales this year (ELECTRONICS, p 53, Jan. 1 and p 24, Jan. 29) are being bolstered by announcements of production expansion. Latest comes from Motorola's semiconductor products division, Phoenix, Ariz., which is preparing for an anticipated fivefold increase in sales of mesa transistors and other semiconductor products. The company will spend more than $3 million over 18 months in its second major expansion in two years, will add at least 100,000 sq ft.

Japanese electronics industry, which launched a five-year development plan in July 1958, will now revise it. New emphasis will include: cathode ray tubes for color tv, video tape recorders, aviation and medical electronics, microwave tubes.

New solid-state business data-processor recently announced by IBM and dubbed the 7080 has been ordered by Southern Railway to handle interline freight accounting, traffic statistics, passenger-use analysis and stockholder records. The 7080 is said to be 10 times faster than its predecessor, the 705. New computer has a high-speed front-end buffer memory for possible direct communications inputs. System is compatible with 705 programming.

Sophisticated electronic gear aboard merchant and other ships in requiring better voltage regulation of power-generating equipment and paving the way for more solid-state power supplies. At the winter general meeting of the American Institute of Electrical Engineers, experts on marine a-c systems last week discussed the stricter requirements of modern shipboard electronics. Some engineers recommended neutral grounding of electrical systems, claiming that floating ground sometimes results in overvoltages, accidental grounding to the hull, shock hazard and complicated troubleshooting of faults.

New "Beam-X"* switch outperforms all



solid state, vacuum & magnetic devices

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The *BEAM-X** eliminates

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and

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WRITE TODAY FOR TECHNICAL BROCHURE DESCRIBING THE OPERATION AND COMPLETE MECHANICAL AND ELECTRICAL APPLICATION DATA OF THIS NEW BURROUGHS *BEAM-X** SWITCH.

ANOTHER ELECTRONIC CONTRIBUTION BY

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ELECTRONIC TUBE DIVISION

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TIMING • SAMPLING • MEMORY • MATRIXING • PRESETTING • DECODING • DIVIDING

*TRADEMARK OF BURROUGHS CORPORATION

WASHINGTON OUTLOOK

CONGRESS moves in for a look at the increasing defense electronics buying programs. The General Accounting Office, congressional agency for review of administration spending, is making a study of present programs for defense electronics procurement.

GAO will focus most on spending for communications equipment. Missile systems and other weapons programs are less affected.

The organization will be looking for ways to save the government money in equipment purchases. GAO is particularly interested in finding out whether duplicate buying can be avoided by consolidating procurement of certain types of equipment in one military agency for distribution to the other services.

The initial review is expected to be completed by March or April. Results will be sent to the individual military services for comment before being presented to Congress.

GAO is taking an especially close look at procurement by the Army Signal Corps; Rome Air Materiel Area, Griffiss AFB, N. Y., which handles ground-based USAF electronic equipment; and the Navy's recently-set-up Bureau of Weapons.

- **GAO chief Joseph Campbell** has sketched some of the areas that will be covered in testimony before the congressional joint economic committee which is looking into general defense buying.

  Campbell indicated that the GAO is seeking to determine whether government orders for electronic equipment are being met with with respect to quantity and quality, and delivery times and places. Furthermore, investigators want to know the extent, if any, of duplication and overlapping of procurement, inventory, production, and distribution.

- **On another front,** electronics equipment manufacturers may benefit indirectly from the Pentagon's current review of procurement policies. The Defense Department aims to put more of its budgeted funds into weapon and spare parts buying while cutting down on purchases of nonessential goods. To this end, the Pentagon is studying a score of proposals for procurement savings.

  The underlying reason for the special attention to procurement policy is President Eisenhower's rigidly imposed ceiling of $41 billion on defense spending. Present indications point to maintenance of this spending level through June, 1962.

  The Defense Department is thus faced with a period in which the level of spending will remain constant while weapons costs are rising. This has already resulted in cutbacks and stretchouts in some weapons programs. Now Pentagon officials feel that one way to get more money for combat weapons and spare parts is to cut back on nonessential goods and tighten up on general buying practices.

- **The joint economic committee hearings** have produced attacks on the volume of defense orders going to the West Coast, and on the use of negotiation instead of competitive bidding in awarding defense contracts.

  Sen. Jacob Javits (R-N. Y.) contended that "to many of us in the east, the so-called missile gap has been translated into the defense order gap" because of the loss of contracts in New York and other eastern states. Javits recommended that the Defense Department be required to place more set-asides for small businesses in labor surplus areas of the East.

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The plus value tool for assembling small precision equipment; equipment with tight working areas; for continuous production operations.

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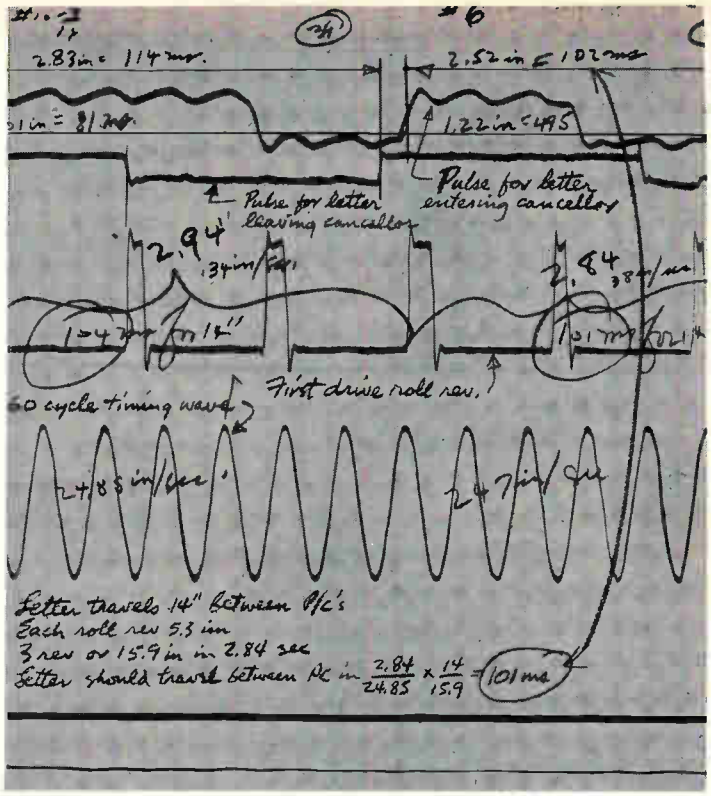
In development test...

This directly-recorded Visicorder chart shows a canceller test of a number of letters through a new mail-handling machine developed by Emerson Research Laboratories for the U.S. Post Office Department. The Visicorder test took only 3 hours to solve a 3-week problem: Why letters changed speed as they went through the machine. Constant speed is necessary to register cancellation on the stamp every time. Motor speed variations, belt slippage, and letter slippage in the drive rollers were responsible. A synchronous drive motor, a timing-belt drive, and a better grade of rubber in the drive rollers were added to solve the problem at a vast saving in engineering time. The Emerson machine is designed to cancel 30,000 non-uniform letters per hour. It is under evaluation tests in the Post Office Department Laboratory, Washington, D.C.

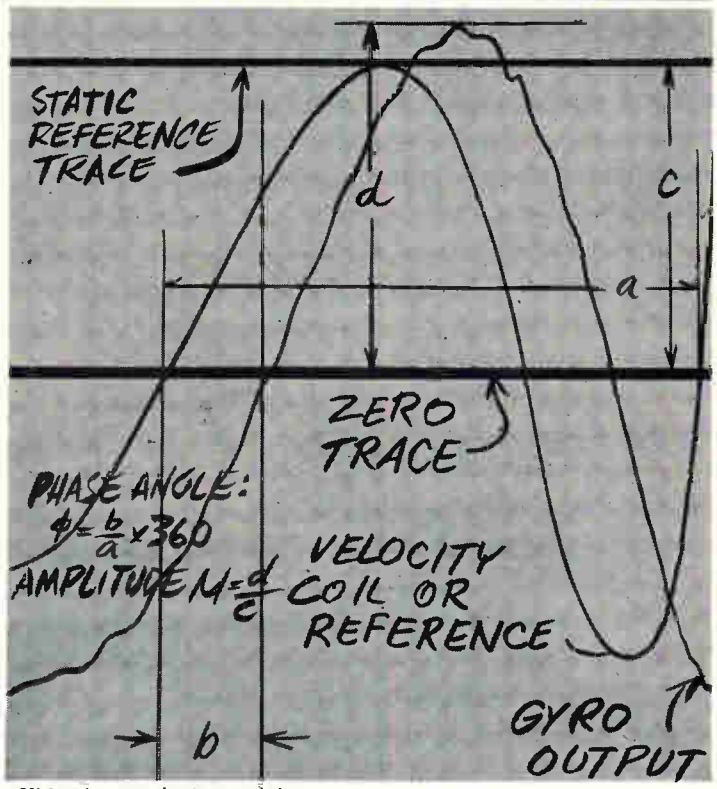


these are records of leadership

In production...

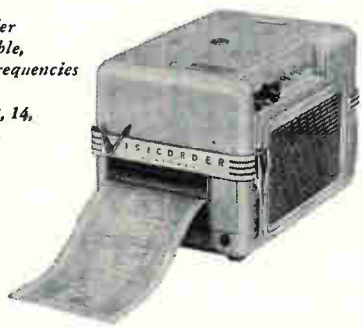
This comparison test of a production gyroscope was directly-recorded on a Model 906A Visicorder oscillograph by the test department of Whittaker Gyro, Van Nuys, Calif. Whittaker is a division of Telecomputing Corporation. The record shows how the Visicorder compares controlled angular velocities as a reference base to simultaneously-recorded variables, and how a dual static reference trace galvanometer simultaneously establishes a base line and a calibration line on the chart. In these and in hundreds of other scientific and industrial applications, Visicorders are bringing about new advances in product design, computing, control, rocketry, nucleonics and production.

For information on how to apply the unlimited usefulness of the Visicorder to your specific problems, phone your nearest Honeywell Industrial Sales Office.



Visicorder records 2/3 actual size.

The Honeywell Visicorder provides instantly-readable, high-sensitivity data at frequencies from DC to 5000 CPS. There are models with 8, 14, or 36-channel capacities.



Honeywell

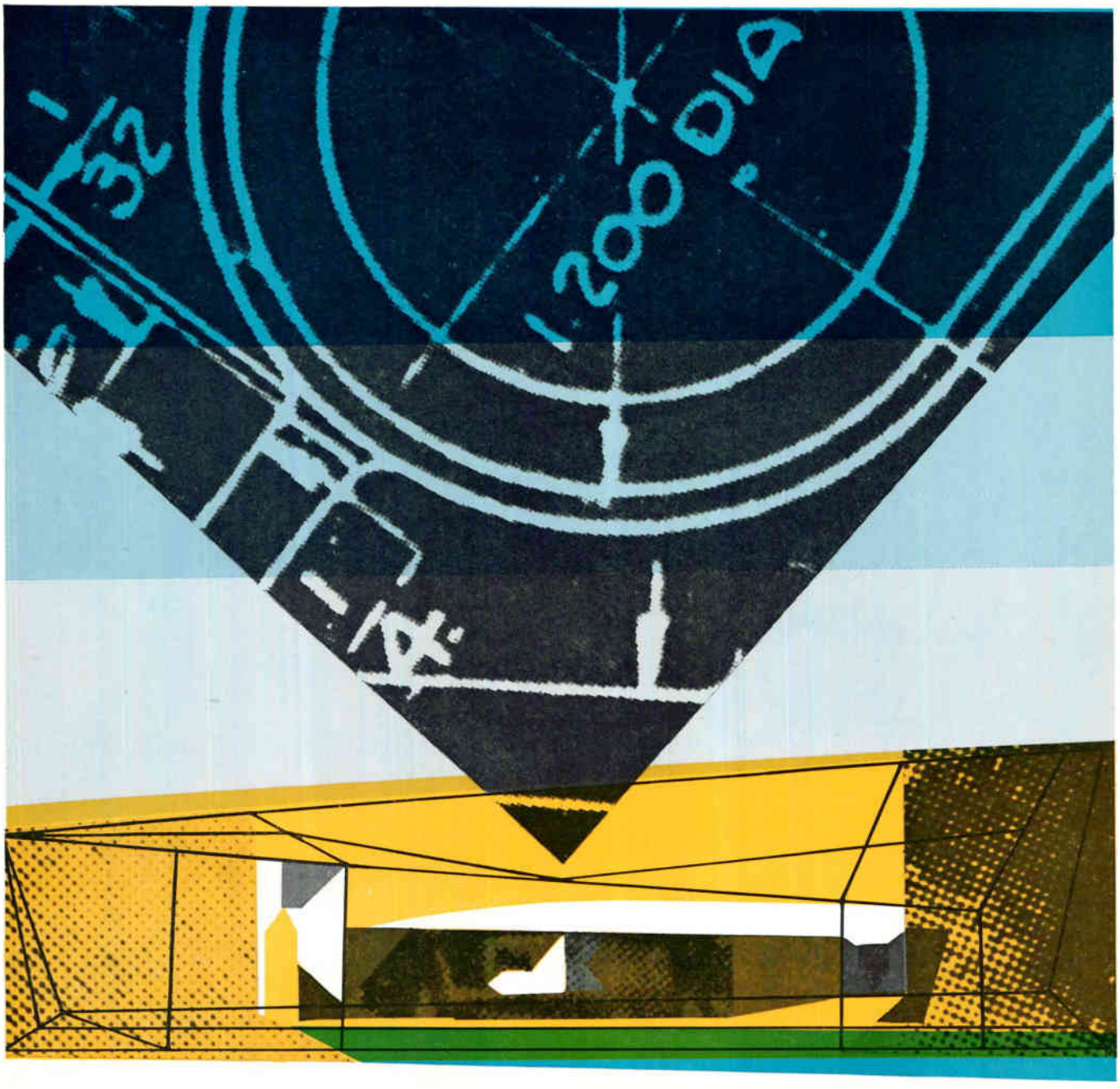
Industrial Products Group

Reference Data: Write for Visicorder Bulletins 906A and 1012.

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

General Motors pledges

AC QUESTMANSHIP



AC Seeks and Solves the Significant—Since GM has pledged its resources to this nation's defense, AC plans to forge to the forefront in the international race for technological superiority. The resolution of scientific problems even more complex than AChiever inertial guidance—that's what AC now has on its agenda / This is AC QUESTMANSHIP. It's an exciting creative quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control and detection / Questmanship is readily apparent in AC Manufacturing, headed by Mr. Roy McCullough, AC Works Manager. His group "offers an outstanding challenge to engineers capable of understanding the most advanced scientific concepts . . . and developing the techniques and tools to implement those concepts on a production basis" / There may be a position for you on our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," you should write AC's Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

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ACTUAL SIZE

The International Rectifier "Thyrode" Silicon Controlled Rectifier is a three-junction, hermetically sealed semi-conductor device that will block positive anode to cathode voltage as does a thyratron. When a signal is applied to its third (gate) lead, the device rapidly switches to a conducting state and provides the low forward voltage drop of a typical medium power silicon rectifier. Current flow may then be halted, by reversal or removal of the anode voltage. This simplicity of control makes the "Thyrode" applicable to a wide range of control and switching uses.

Absolute Max. Ratings (at 30°C; 50 to 100 cps, resistive or inductive load)

Int'l Type Number	Max. Rep. PIV, Volts	RMS Input (Sin.) Volts	Average Forward Current Amps	Surge Current (1 Cycle) Amps	Min. Forward Breakover Voltage, Volts	Max. Forward & Reverse Leakage, Ma		Gate Power, Watts		Gate Current Ma,		Forward Gate Voltage, Volts		Max. Forward Volt. Drop, 1 Cycle Volts
						Peak	Average	Peak	Average	Peak	Max. to fire	Peak	Max. to fire	
10 Ampere Rated Series, Operating Temperature Range: —30°C to +85°C														
X10RC2	20	14	10	125	20	45	22	5	0.5	2000	85	10	5	1.25
X10RC3	30	21	10	125	30	40	20	5	0.5	2000	85	10	5	1.25
X10RC5	50	35	10	125	50	35	18	5	0.5	2000	85	10	5	1.25
X10RC7	70	50	10	125	70	30	15	5	0.5	2000	85	10	5	1.25
X10RC10	100	70	10	125	100	25	12.5	5	0.5	2000	85	10	5	1.25
X10RC15	150	105	10	125	150	13	6	5	0.5	2000	85	10	5	1.25
X10RC20	200	140	10	125	200	12	6	5	0.5	2000	85	10	5	1.25
16 Ampere Rated Series, Operating Temperature Range: —30°C to +105°C														
X16RC2	20	14	16	125	20	45	6.5	5	0.5	2000	50	10	3	.90
X16RC3	30	21	16	125	30	40	6.5	5	0.5	2000	50	10	3	.90
X16RC5	50	35	16	125	50	35	6.5	5	0.5	2000	50	10	3	.90
X16RC7	70	50	16	125	70	30	6.5	5	0.5	2000	50	10	3	.90
X16RC10	100	70	16	125	100	25	6.5	5	0.5	2000	50	10	3	.90
X16RC15	150	105	16	125	150	13	6	5	0.5	2000	50	10	3	.90
X16RC20	200	140	16	125	200	12	6	5	0.5	2000	50	10	3	.90

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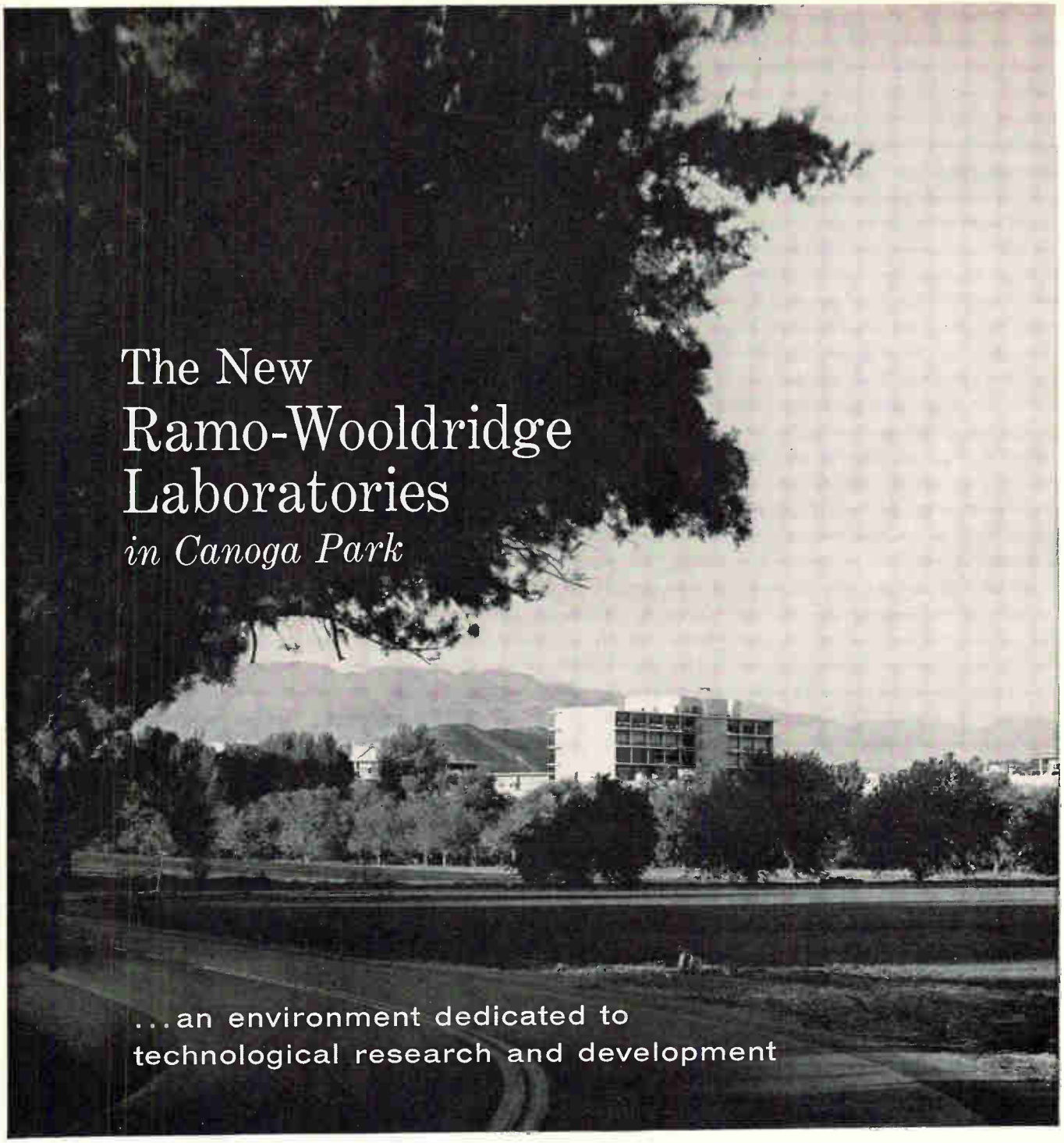

The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.

THE RAMO-WOOLDRIDGE LABORATORIES

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More Air Firms Go Electronic

Reports this week indicate increased activity by aviation companies in electronics firms.

• **Chance Vought Aircraft, Inc.,** Dallas, Tex., announces expansion and holdings in automation through a purchase agreement signed with **Information Systems, Inc.,** Skokie, Ill. The aircraft firm will acquire 80 percent of the Illinois company which manufactures readout systems. Information Systems, in an additional negotiation, is acquiring the assets of **Panellit** and of the **Genesys Corporation,** the latter being a Chance Vought subsidiary. The surviving company will be Information Systems which will operate as a subsidiary of Chance Vought.

• **Beech Aircraft,** Dallas, is reportedly studying the possibility of entering the electronics field, either through its own R&D efforts or through the acquisition of companies now in electronics. The firm is also studying the possibility of acquiring companies which will complement its present area of operation.

• **California Eastern Aviation** held a special directors meeting recently to discuss a 1960 program for operations in the fields of electronics, electromechanics, space research and other related fields. On the basis of contracts negotiated and in process, the company expects this year to exceed the $30 million gross sales reached in 1959. A five percent stock dividend was voted during January.

• **National Aeronautical Corp.,** Fort Washington, Pa., reports that recently completed expansions in manufacturing space and "vastly increased" engineering laboratories allow anticipation of a record year for 1960. For the fiscal year ended 1959, net sales were $6,100,000, an increase of 43 percent over fiscal 1958. Net earnings went from $370,000 in 1958 to $719,000 last year, a gain of 94 percent. Earnings were equal to 87 cents a share for 1959 compared with 45 cents a share in 1958.

• **Raytheon Co.,** Waltham, Mass. reports total profits after taxes in 1959 of $13,481,000, equal to $3.89 per share of common stock including a special gain equal to 88 cents a share. In making the announcement, the board of directors declared a five percent stock dividend payable March 18 to holders of record at close of business Feb. 24 this year. The special gain mentioned represents a reduction in the company's reserve for estimated liability for federal income taxes and for renegotiation with respect to government business in the past.

• Certificates for **Ampex** stock will be mailed to shareholders next week following approval of a three-for-one split of the Redwood City, Calif. company's stock.

25 MOST ACTIVE STOCKS

WEEK ENDING JANUARY 29

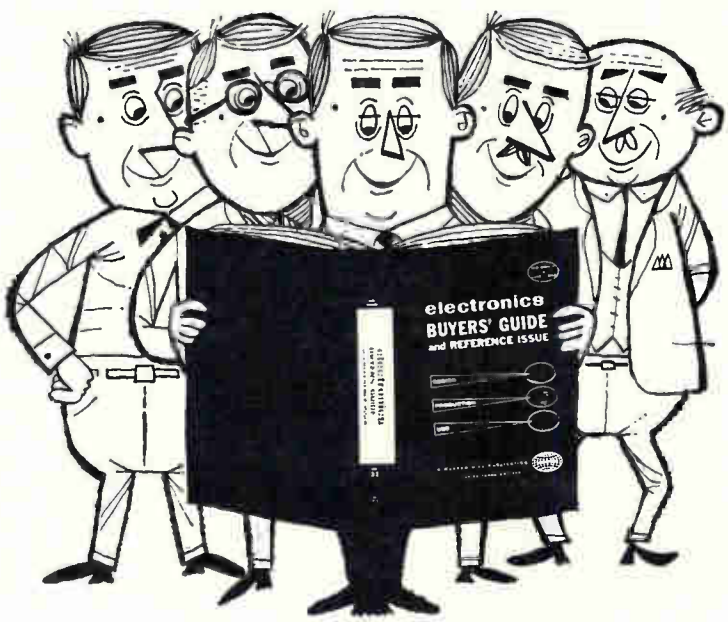
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Electric	825	90¼	84⅝	85½
Sperry Rand	759	23½	22⅝	22¾
Beckman Inst	714	72	66¼	67½
A. B. DuMont	698	9⅞	8⅝	8⅞
Elec & Mus Ind	606	7½	7	7
RCA	569	63⅛	59½	59½
Raytheon	548	50½	46⅜	47⅝
Varian Assoc	537	45½	40⅜	41¼
Philco Corp	522	32⅝	30⅛	31
Gen Tel & Elec	512	80⅞	75⅝	75¾
Avco Corp	499	14⅛	13	13
IT&T	456	37¼	34⅛	34¼
Reeves Sndcrft	436	11½	10	10⅜
El-Tronics	432	1¾	1½	1¾
Siegler Corp	389	34½	30⅞	33⅜
Collins Radio	382	62½	55¾	56½
Ampex	350	102¾	97⅝	99
Victoreen Inst	346	13¼	12	12
Dynamics Corp Amer	326	11¾	10⅜	10¾
Gen Dynamics	281	49⅞	46½	46⅞
Univ Controls	274	17⅜	16¼	16¼
Westinghouse	266	104¼	98¼	98¼
Lear Inc	258	18¾	17½	17⅝
Zenith	257	105½	97¼	98½
Int'l Resistance	248	23¾	20⅛	20½

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

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Amer Res & Dev Corp	$ .93	Feb. 23
AMP, Pamcor	.20	Mar. 1
Atomic Fund	.05	Feb. 23
Foxboro Co	.25	Mar. 1
IBM	.75	Mar. 10
Magnavox	.25	Mar. 15
National Co	.90	Apr. 1
Nucincs Chem & Elec	.50	Feb. 29

NEED PRODUCT INFO? LOOK IN THE NEW



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The CBS tubes described offer you many moves to greater reliability and improved circuit performance. They represent just a few types from the rapidly growing CBS industrial tube line.

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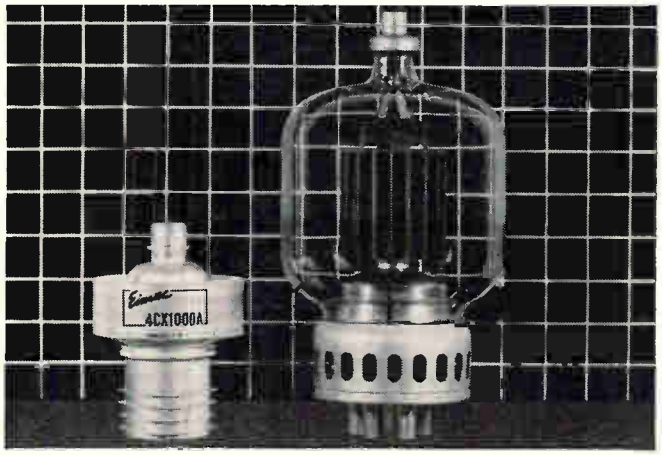
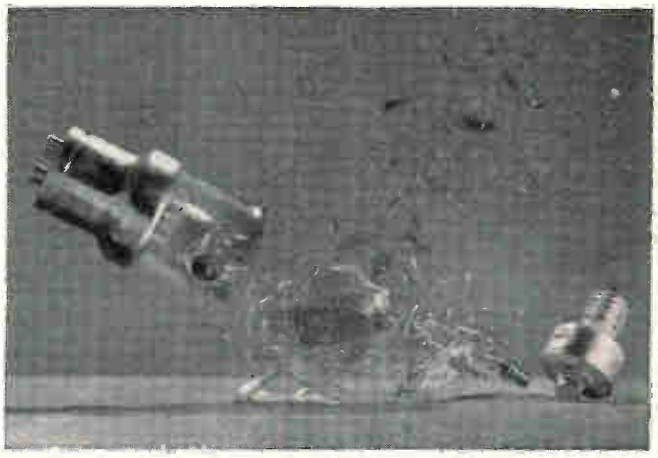
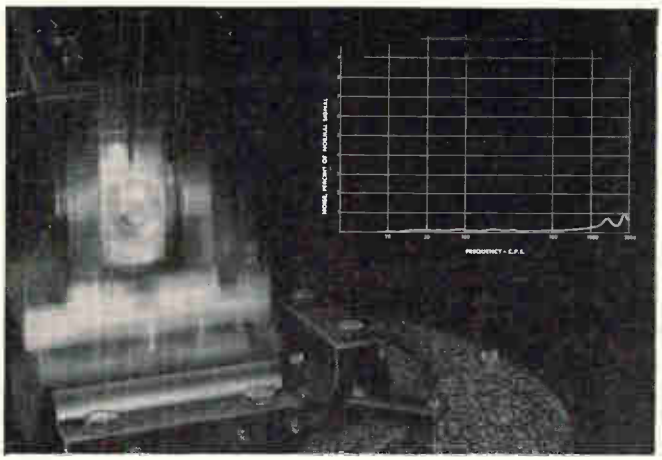


SMALLER SIZE

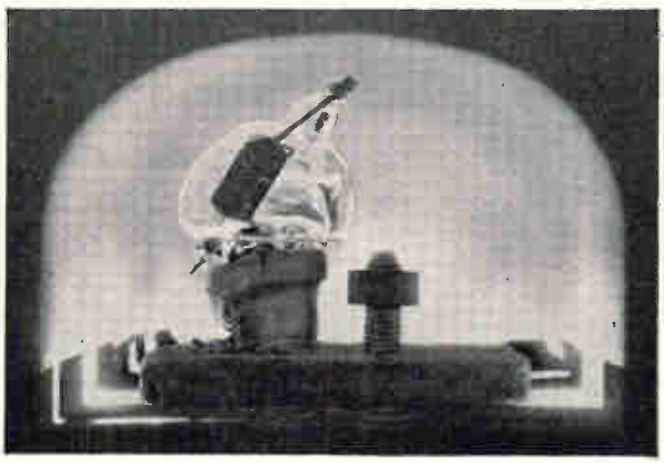


IMPACT SURVIVAL

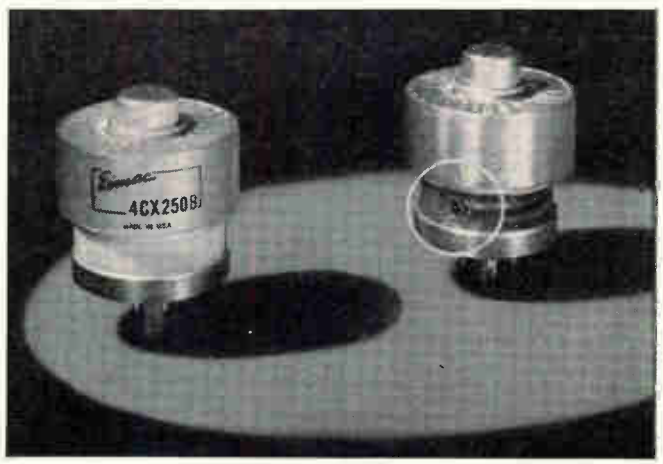


VIBRATION SURVIVAL

EXACT DIMENSIONAL UNIFORMITY



EXTREME HEAT SURVIVAL



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ABSOLUTE MAXIMUM RATINGS AT 25°C

Forward Current	I_f	50 mA
Minimum Breakover Voltage	V_{bo}	{ TSW-30 30V { TSW-60 60V
Reverse Breakdown Voltage	V_r	{ TSW-30 30V { TSW-60 60V
Storage Temperature		−65°C to 150°C
Ambient Temperature Range		−55°C to +125°C

SPECIFICATIONS AND TYPICAL CHARACTERISTICS

(At 25°C Unless Otherwise Stated)

		Typical	Max.	Test Conditions	
Saturation Voltage	V_S	1.0	1.5	Volts	$I_C = 50$ mA
Forward Leakage Current	I_F	0.1	10	μA	$V_C = 30V$
Reverse Leakage Current	I_R	0.1	10	μA	$V_C = -30V$
Forward Leakage Current	I_F	20.	50.	μA	at 125°C
Reverse Leakage Current	I_R	20.	50.	μA	at 125°C
Gate Voltage to Switch "ON"	V_g On	0.7	1.0	Volts	$R_L = 1K$
Gate Current to Switch "ON"	I_g On	0.1	1.0	mA	$R_L = 1K$
Gate Voltage to Switch "OFF"	V_g Off	1.2	4.0	Volts	$I_C = 50$ mA
Gate Current to Switch "OFF"	I_g Off	7.0	10.	mA	$I_C = 50$ mA
Holding Current	I_H	2.0	5.0	mA	$R_L = 1K$

SPECIALLY DESIGNED FOR:

- Miniaturized Memory Circuits
- Ring Counters
- Shift Registers
- Controlled Rectifier Driver
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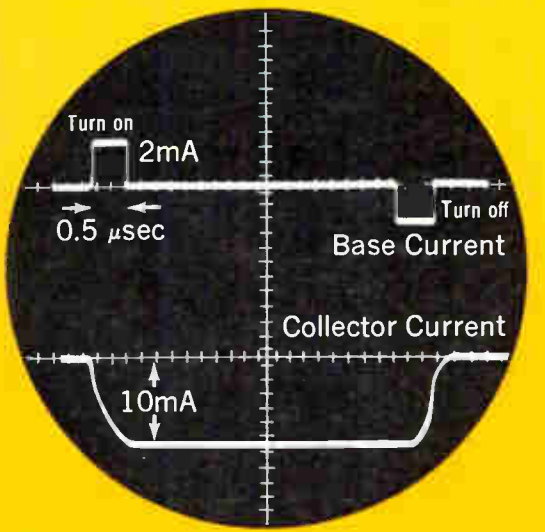
announces a NEW computer element for: Greater Reliability • Circuit Simplicity

THE TRANSWITCH



The TRANSWITCH is a new bistable silicon device that can be TURNED OFF with gate current.

This PNPN latching device "remembers" its last gate signal. High current gain, both turn-on and turn-off, leads to greater circuit simplicity and inherent reliability. Excellent linearity of electrical parameters over a wide current range fulfills both low logic level and medium power needs.

Here is a unique device that replaces TWO transistors plus resistors in most bistable circuits and permits increased component density.

Furthermore, the transwitch is FAST . . . requiring only 0.3 microseconds to turn ON or OFF!

The TRANSWITCH is now available from TRANSITRON in the popular JEDEC TO-5 package, ready to solve your switch-on-switch-off requirements.

For further information, write for Bulletin TE-1357A

Transitron

electronic corporation • wakefield, massachusetts

"Leaders in Semiconductors"

MARKET RESEARCH

F-M Radio Sales Look Up

F-M RADIO SET SALES in 1960 should show a gain of at least 50 percent over last year, predicts Edward Shafer, market research manager of Blonder-Tongue Labs.

He predicts factory sales of domestically produced f-m/a-m table sets will jump from 500,000 sets in 1959 to 750,000 sets this year. However, he also sees possibility that set sales will hit the million mark if foreign imports are included. They are currently running about 100,000 sets per year.

EIA recently reported 480,894 f-m/a-m sets were produced through November 1959, almost 60 percent more than the first eleven months of 1958.

Popularity of hi-fi gear and increasing interest in quality music are major factors supporting the rising sales curve.

• Magnetic recording industry association claims 750,000 entertainment tape recorders with a retail value of $170 million will be sold in 1960. It calculates that 650,000 recorders valued at $140 million were produced in 1959.

Four track tape, used for stereophonic recording, is the major influence behind the resurgence of magnetic tape recording business, says Herbert L. Brown, association president.

• Raytheon's president, Charles F. Adams adds his voice to the growing list of industry leaders who are calling attention to the expanding market for non-military electronic products. Sales of consumer and entertainment equipment, which he currently estimates at $4 billion, will reach $8 billion in 1970, he says. At that time electronics industry factory sales will total $20 billion, he says.

• Business and Defense Services Administration plans to issue in a few months its report on the proportion of shipments of electronic equipment and components originating in each of the 50 states and 20 large metropolitan areas.

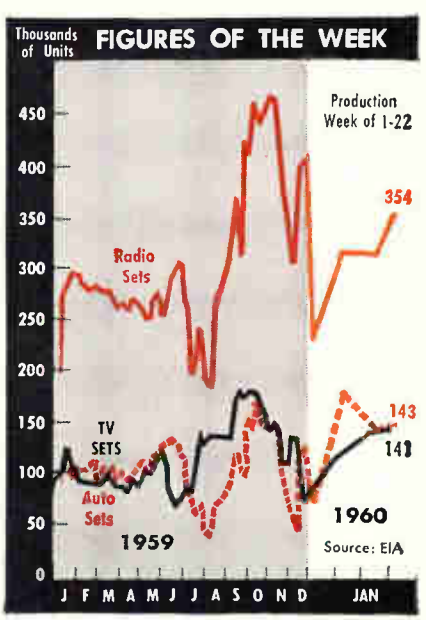
Study will show separate geographical breakdowns of shipments for total electronic industry products as well as for military, non-military equipment and major components.

BDSA findings are based on a government survey of where shipments from over 600 large electronics firms originate and a variety of other government data.

• This year, retail sales of tv sets may well reach 6.4 million, says Herbert Riegelman, general manager of General Electric's television receiver department. This estimate compares to sales of 5.8 million sets last year and 5.14 million sets in 1958.

Riegelman's forecast leans on expectations of prosperous national economic conditions and recent product refinements which manufacturers count on to spur consumer demand.

• Independent investigations by industry market analysts confirm our estimate that silicon controlled rectifier sales, which were $2 million to $3 million in 1959, will move up to the $4 million to $6 million level in 1960. (See ELECTRONICS, Jan. 1, 1960, p 22.) However, we are reminded that we slipped a digit in making our SCR unit estimate for 1959. It should have read 30,000 to 50,000 units instead of 300 to 500,000 units.



available from
inventory for
immediate delivery—
silicon transistors with

ONE WATT POWER DISSIPATION

@ 25° C in free air...five watts mounted in an infinite heat sink

These Hughes PNP fused junction silicon transistors are especially recommended for small signal current gain, DC amplifier and other applications. They utilize a rugged coaxial package which is unequalled for mechanical strength...thereby providing you with dependable performance under highly adverse environmental conditions. Furthermore, they offer you the following electrical advantages over competitive devices:

BV_{CBO}, BV_{EBO} and BV_{CEO} are symmetrical • Lower leakage current • Controlled gain band width • Lower saturation resistance • Higher operating frequency

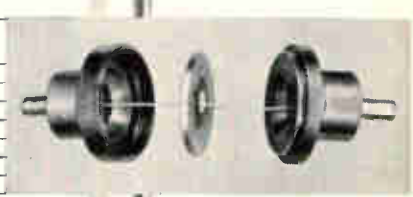
You receive still another benefit from these Hughes silicon transistors: proven reliability. Its reliability life tests at maximum operating temperature show a reliability factor of 10^{-4} or only one failure in 10,000 transistor hours of operating life.

Order today! These Hughes Transistors are available from inventory at both the factory and at all Hughes distributors. Just call or write your nearest Hughes Semiconductor sales office or distributor...or write Hughes, Semiconductor Division, Marketing Department, 500 Superior Avenue, Newport Beach, California.

Specifications

Type	BV_{EBO} BV_{CBO} BV_{CEO}	h_{FE} Min.	h_{FE} Max.	Max. V_{CE} @I_C=10ma @I_B=2ma	Maximum I_{CBO}* and I_{CEO}*	Typ.$f_{\alpha b}$ (MC)
2N1238	— 15V	14	32	—0.2	—0.1μa	1.2
2N1239	— 15V	28	65	—0.2	—0.1μa	1.2
2N1240	— 35V	14	32	—0.2	—0.1μa	1.2
2N1241	— 35V	28	65	—0.2	—0.1μa	1.2
2N1242	— 60V	14	32	—0.2	—0.1μa	1.0
2N1243	— 60V	28	65	—0.2	—0.1μa	1.0
2N1244	—110V	14	32	—0.2	—0.1μa	0.8

Transistors also available with same electrical characteristics in a JEDEC 30 (TO-5) package with a power dissipation of 400 mw!
*Measured at 80% of breakdown voltage



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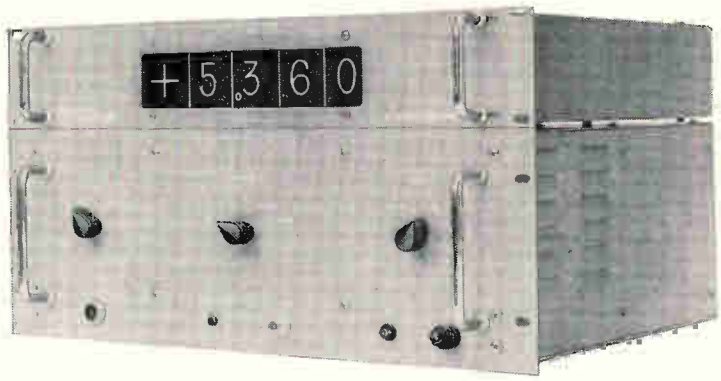

MODEL 7409 R4

NEW ELECTRO INSTRUMENTS HIGH-SPEED, ALL-ELECTRONIC, ANALOG-TO-DIGITAL CONVERTERS

1000 measurements per second!

Transistorized circuitry, one millisecond conversion rate, one megohm input impedance, automatic polarity, one digit sensitivity and resolution

These new 7000 Series High-Speed, Analog-To-Digital Converters and Digital Voltmeters accept both positive and negative input voltages and produce binary coded decimal descriptions of their magnitude and polarity. This determination is arrived at by the successive approximation method. Bits are sampled as a function of an internal clock and are successively tried and accepted or rejected. Encoding time is always a fixed millisecond.

Output can be applied directly to indicators for visual readout and also to auxiliary devices for controlling entry into recorders and computing systems. The constant encoding time and programmed ranging features make the 7000 Series ideal for systems applications.

Ask your EI Sales Engineer for complete specifications.

Electro Instruments, Inc.

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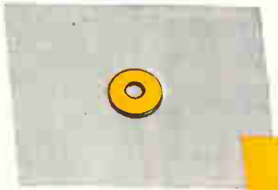
SAN DIEGO 11, CALIF.

Digital instruments for measuring AC/DC voltages, AC/DC ratios, resistances, capacitance, and frequency • X-Y Recorders • DC Amplifiers

CIRCLE 29 ON READER SERVICE CARD→

Superb Stampings



from the simplest, tiny washer

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—and everything in between!

We deliver superb stampings . . . anything from hub caps for baby carriages to vane locks for aircraft turbines—with tolerances well within the accepted standards of those industries.

Point is, we deliver *exactly* what you want. *That's* why we say our Stampings are "superb". You'll say it, too.

How do we do it? By applying the best of our own three Methods: the "ONE PLUS" METHOD avoids tooling charges . . . the SHORT RUN METHOD employs our own temporary tooling . . . the PRODUCTION RUN METHOD uses special dies at nominal cost.

Either way, you get exactly the Stampings you need—faster, better, and at surprisingly low cost. Our routine WATCH DOG SERVICE sees to *that.*

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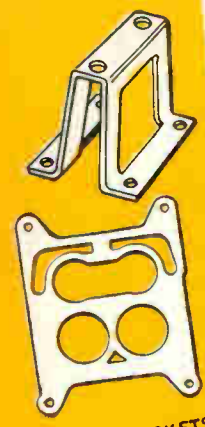
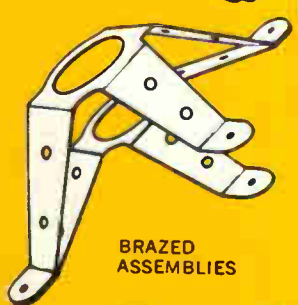
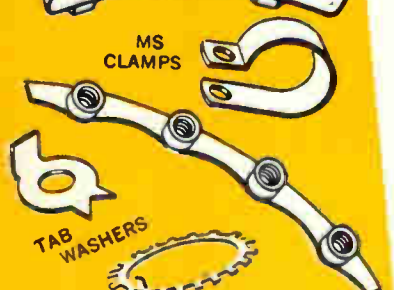
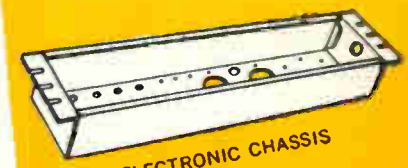
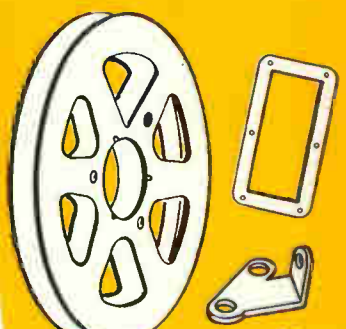
Interesting STAMPINGS FOLDER NO. 3 contains helpful information for ordering Stampings most economically. Send for your copy. No obligation.

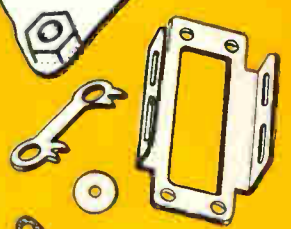


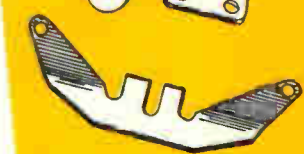


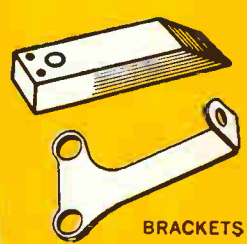


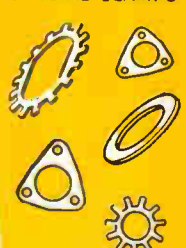












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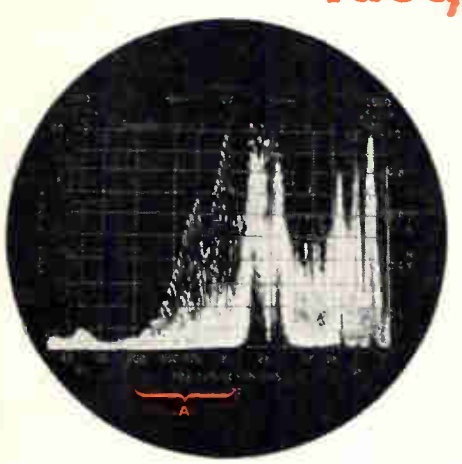

PANORAMIC LP-1a
SONIC SPECTRUM ANALYZER
20 cps-22.5 kc.

"Coast-down" analysis of Gyro Motor by Model LP-1a Spectrum Analyzer. Area A shows decreasing fundamental frequency, resonant rise and decay, and vibration components over 60 successive scans in one minute.

The Model LP-1a "quick-look" helps locate and evaluate discrete or random signals faster and easier by scanning the entire spectrum logarithmically from 40 cps to 20 kc. Once every second it automatically separates, measures and plots the frequency and voltage of waveform components on the calibrated X and Y axes, respectively, of a long persistence 5" CRT.

For very detailed analysis, linear segments 40 to 5000 cps wide, centerable between 0 and 20 kc, may be magnified on the screen.

Amplitude ratios of up to 40 db can be simultaneously measured.

High sampling rate and panoramic displays assure

1. Minimum risk of missing weak signals or spectrum holes.
2. Fast measurements by eliminating slow point by point plots.
3. Simultaneous measurement of signals with widely divergent amplitudes and/or frequencies.
4. Continuous analysis of rapid changes in spectral content or design parameters.

Proved in hundreds of research, design and production installations, the LP-1a is a valuable tool for Noise and Vibration analysis. Harmonic and IM measurements. General waveform studies. Spectral Power Density analysis. Response Curve Tracing.

SUMMARY OF SPECIFICATIONS:

Frequency Range: 20 cps—22.5 Kc.
(1) Preset linear frequency scans: any segment width of 200, 1000, 5000 cps centerable from 0-20 Kc : Variable from 40 cps to 5000 cps with Auxiliary Function Unit C.
(2) Preset Log Scan—40 cps to 20 Kc

Frequency Scales: Linear and Log

Center Frequency Control: Calibrated 0-20 Kc (used on lin scan)

Dynamic Range: 60 db

Amplitude Scales: Linear and 2 decade log (Expandable to 60 db)

Sensitivity: 500 μv to 500 v for full scale linear deflection

Voltage Accuracy: Lin Sweep (40 cps—22.5 Kc) : $\pm$5% or $\pm$0.5 db
Log Sweep (40 cps—20 KC) : $\pm$10% on lin ampl. scale, $\pm$1.5 db on log ampl. scale.

Scan Rate: 1/sec., internally generated; adjustable with accessory equipments

Resolution: For log scan, automatically optimized. For lin scan, preset 30, 75 and 170 cps at 200, 1000 and 5000 cps sweep-width, respectively. Variable from 10 cps to 1 kc with Auxiliary Function Unit C.

HIGHLIGHT FEATURES:

- 1-sec. "quick-look" at entire spectrum (40 cps—20 kc)
- Magnified analysis on reduced sweep widths
- Direct reading frequency—selective voltmeter
- Exceptionally stable circuitry: better than 5 cps/hr.
- Economical
- Simple Operation

dependable CERTIFIED SPECIFICATIONS for accurate data

Write, wire or phone NOW for detailed information and specifications on the Model LP-1a.

Ask for Vols. 1, 2 and 5 of the "Panoramic Analyzer" . . . featuring applications and techniques of Spectrum Analysis, and get on our regular mailing list for this helpful publication. NEW CATALOG DIGEST AVAILABLE

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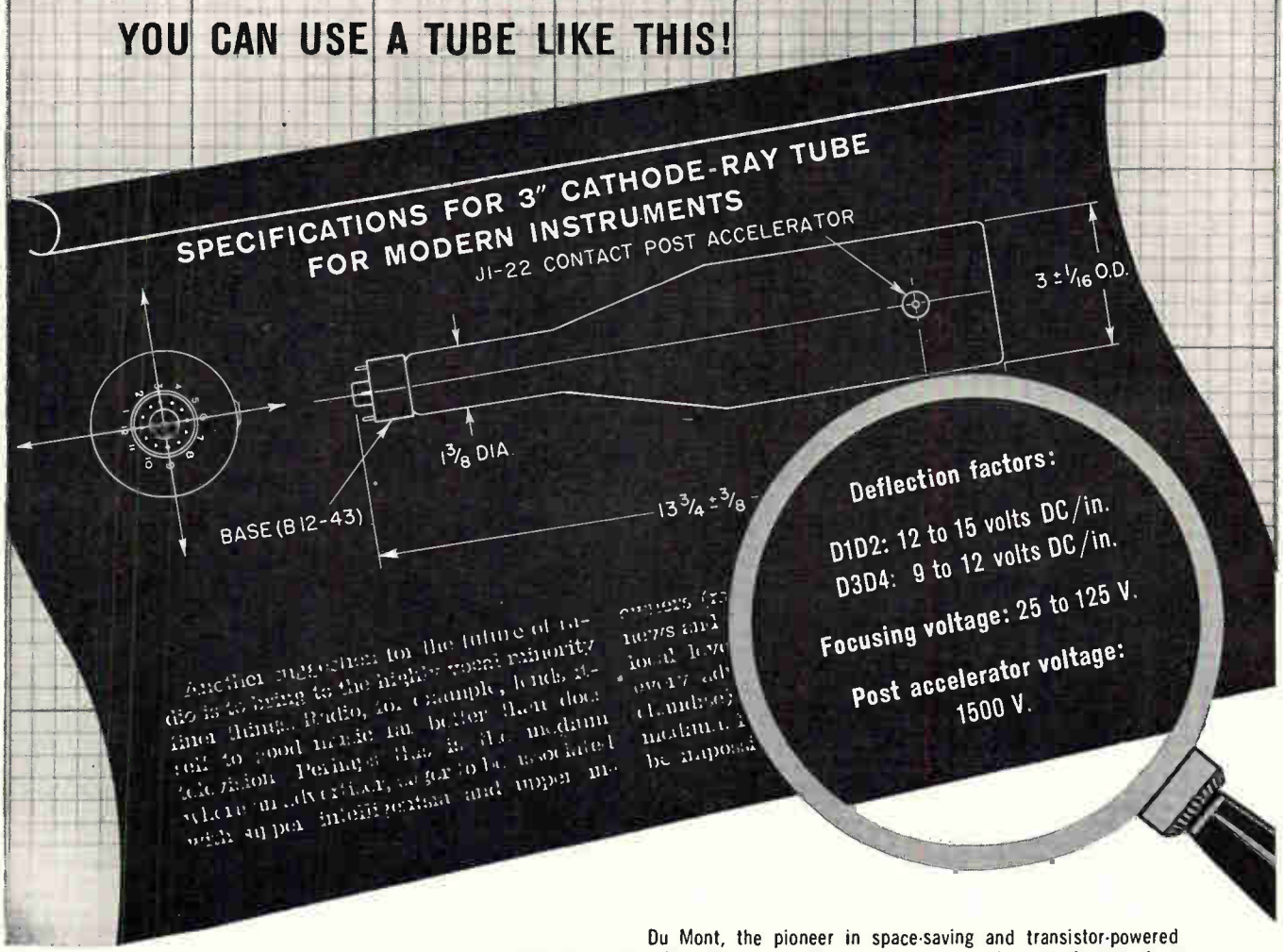
RADIO PRODUCTS, INC.

product of the pioneer

DESIGNING A NEW INSTRUMENT?

YOU CAN USE A TUBE LIKE THIS!



Du Mont, the pioneer in space-saving and transistor-powered cathode-ray tubes for radar, now makes possible the same inherent features in a fine instrument read-out tube. The Du Mont electrostatically deflected K1951 provides full scan with deflection voltages of 9-15 volts DC/in.

If your cathode-ray tube applications call for even greater compactness and power savings—consult the CRT Engineering Specialists at Du Mont. Daily advances in the state-of-the-art are being recorded for your benefit. A tube to fit your exacting requirements can be designed, developed and produced at Du Mont.

Whatever your CRT requirements, check with Du Mont first.

WRITE for complete details

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ELECTRONIC TUBES/INDUSTRIAL TV/MILITARY ELECTRONICS/MOBILE COMMUNICATIONS/SCIENTIFIC INSTRUMENTS/AUTOMOTIVE TEST EQUIPMENT

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Subminiature...
Proven Reliability

ACTUAL SIZE

TRIMPOT® MODEL 220

As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than 3/16" x 5/16" x 1". Power rating is 1 watt and maximum operating temperature is 175°C. This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld® fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. **Write for complete technical data and list of stocking distributors.** AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications.

BOURNS

Bourns, Inc., Trimpot Division
6135 Magnolia Ave., Riverside, Calif.
Plants: Riverside, California
and Ames, Iowa

Exclusive manufacturers of Trimpot®, Trimit®. Pioneers in potentiometer transducers for position, pressure and acceleration.

BASIC BUILDING BLOCKS FROM KEARFOTT

SIZE 11 SYNCHRONOUS MOTOR

Featuring pull out torque efficiency of 50% nominal with 3.4 watts input and 3 watts pull out power, this synchronous motor represents a major achievement in terms of performance for a unit of this extremely small size. Additional advantages made possible by Kearfott's unique design include resistance to environmental extremes, light weight construction and low unit cost. This motor and its variations are available in production quantities.

TYPICAL CHARACTERISTICS R172

Excitation:	Phase 1	Phase 2
Voltage	40V	40V
Frequency	400 CPS	400 CPS
Power	2.3 Watts	2.3 Watts
Current	0.157 Amps	0.157 Amps

Performance:

Synchronous Speed	8000 RPM
Stall Torque	0.2 In. Oz.
Pull Out Torque	0.35 In. Oz.
Pull In Torque	0.15 In. Oz.

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

FERRITES

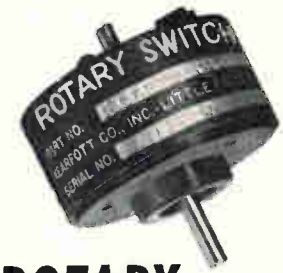
Kearfott's Solid State Physics Laboratory formulates, fires and machines permanent magnet ferrite materials of various compositions. Typical high-efficiency array utilizes Kearfott PM-3 ferrite material with specially designed pole pieces to produce a design both smaller and lighter than other arrays of equivalent magnetic field strength. Because magnets may be custom engineered to specific requirements, user is not restricted to stock magnet types, thereby providing greater latitude in parameters for focusing arrays. Pole pieces may also be provided according to specification, with the added assurance that, because of special Kearfott design techniques, B axial magnetic fields approximately 10% higher than those generally obtained in standard types may be produced.

TYPICAL CHARACTERISTICS

Peak Magnetic Field Strength	1200 gauss
Period	0.560 in.
Length	5.64 in.
Inside Diameter of Pole Pieces	0.400 in.
Outside Diameter	2.0 in.
Weight	3.2 pounds

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT



ROTARY SWITCH

Kearfott's rotary switching devices for missile and aircraft systems are used to sequence or switch circuitry as a function of time or shaft position. Used in conjunction with sensitive relays or solid state switching techniques, high current loads can be handled. These switches consist primarily of shaft assembly and bearing mounted cylinder divided into conducting and non-conducting segments with continuous track for common input. Multiple conductor "broom" type brushes ride on each cylinder track while number of tracks and segmentation of each is function of the number of circuits and type of "on-off" sequencing required.

TYPICAL CHARACTERISTICS P1280-11A

Number of switching tracks: 2

Angular Segmentation (both referenced to 0° start):
Track 1 — Non-conducting about 0° + 50°
Track 2—Conducting 0° -180°
Non-conducting 180° -0°

Mechanical Accuracy of Segmentation:
±1° (better as required)

Starting and Running Torque:
0.1 oz.-in.

Current Capacity:
50 ma at 28V/Brush (suitable for any sensitive relay or solid state switching circuits)

Write for complete data.

Free Gyro

Vertical Gyro

Directional Gyro

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

KEARFOTT DIVISION

GENERAL PRECISION INC.

LITTLE FALLS, NEW JERSEY

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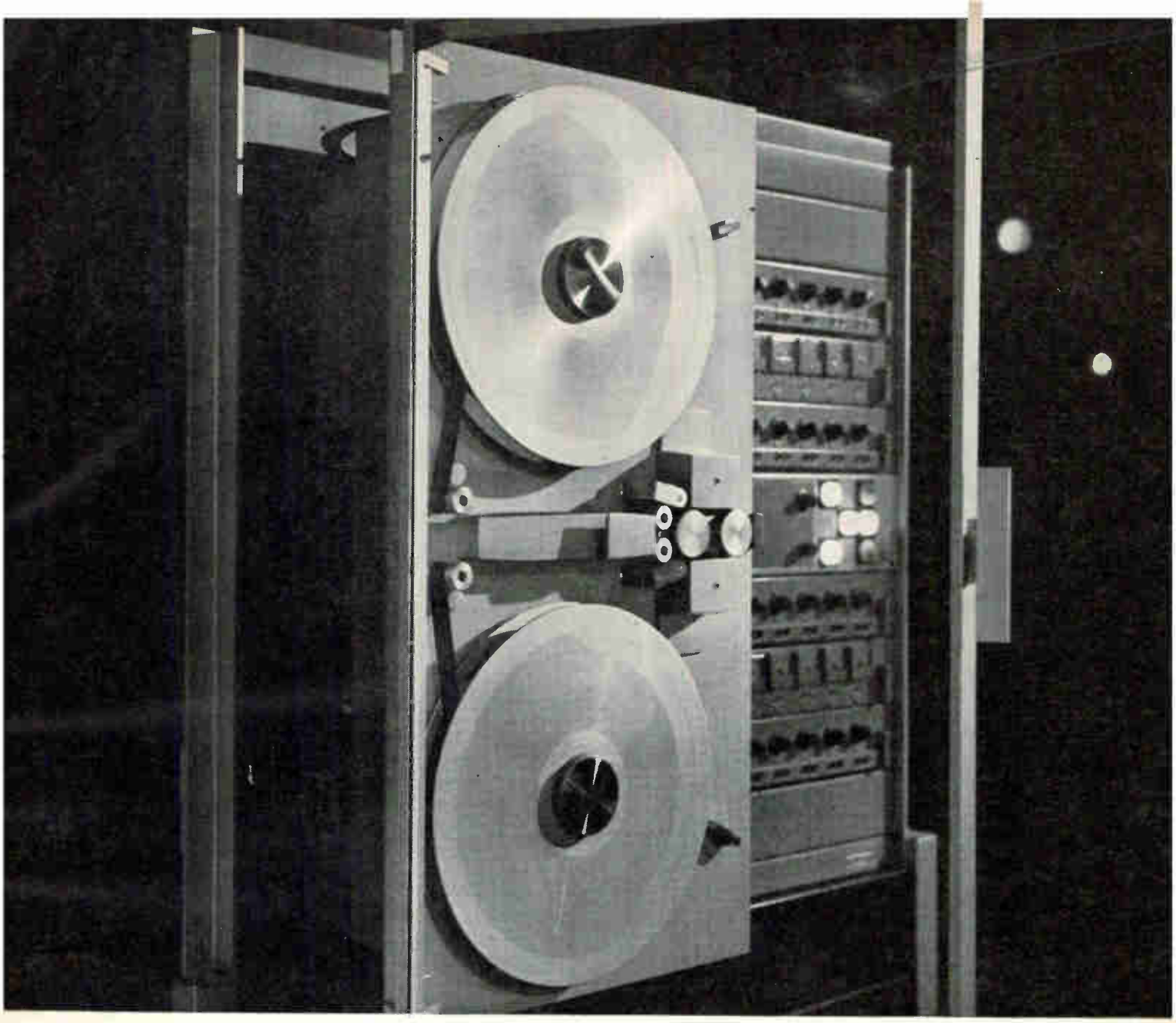


Two machines can do twice the work of one. *Sometimes*. With most analog recorders you can only record 24 minutes of 100 kc data on a 14-inch reel of 1-mil tape. The new Ampex FR-600 will record 48 minutes. Same data. Same reel. The reason: greater bandwidth at a given speed. 125 kc at 30 ips for instance. The benefits of this are worth considering. Most data runs these days average out at 30 minutes or more. With conventional equipment this means you need a stand-by recorder to pick up where the first leaves off. Or a dual transport set-up. Or a special machine with 19-inch reels. All expensive. Sometimes just for a few extra minutes of recording time. The FR-600 eliminates all this by doubling the recording time for any given bandwidth. It literally does the work of two conventional machines. You get the extra-wide bandwidth of 250 kc at 60 ips to boot. Nice for special applications. And every FR-600 tape is machine-to-machine compatible without lifting a tool. Good reasons why the FR-600 is the most versatile recorder you can use. A word from you will bring the full story. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This instrumentation recorder can do the work of two

FR 600 AMPEX

Microelectronics Moving Fast

Engineering on the molecular and single-crystal level promises to increase reliability, cut production costs

MICROELECTRONIC ENGINEERING is moving rapidly out of the research phase and into the realm of applications, paced by the space program's urgent need for smaller electronic systems.

The new field of engineering, which deals with electronic phenomena at the molecular and single-crystal level, was the hot topic of discussion at the International Solid-State Circuits Conference, held in Philadelphia this week. Applications of microelectronics could radically change both design and production techniques, and may have a profound effect on the business future of producers of small components.

Late last month Westinghouse Electric, one of many organizations working in the new field, revealed its new microelectronic techniques and disclosed some dramatic laboratory results achieved under USAF contracts.

Westinghouse scientists recently discovered how to grow multizoned semiconductor crystals in ribbon form (dendrites) and are rapidly following up on applications with Air Force support. Scientists believe the ability to grow multizoned crystal and to perform operations on the crystals as they grow in the furnace can be combined to achieve near-automatic production of electronic systems. The company says it eventually may be able to grow equipment as complex as present radio receivers and amplifiers.

Production Is Contract Aim

Following the company's disclosure of its work with multizoned semiconductor crystals, the Air Materiel Command's Aeronautical Systems Center at Wright-Patterson AFB, Ohio, announced the award of a contract to Westinghouse to develop production processes for dendritically grown silicon and gallium arsenide crystals.

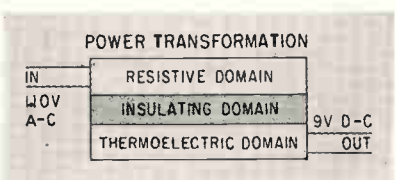
Westinghouse's "molecular electronics" concept has already successfully grown a multivibrator directly from a pool of molten semiconductor material (ELECTRONICS, p 11, Jan. 29). Air Force and company spokesmen predict that:

- By 1962 it will be possible to grow in similar fashion a pea-sized molecular radio receiver as a single block of material.
- Within three or four years the same dendritic crystal-growing techniques will produce infrared detectors, telemetering equipment to transmit information on radiation and light intensity from outer space, and guidance and communications equipment for missiles or satellites. The spokesmen would not say whether or not the guidance and communications gear would be produced in the form of a single block of material, but did not deny that it might be.

Molecular Electronics

In the dendrite process, crystals in the form of a ribbon about an eighth of an inch wide and a few thousandths of an inch thick are drawn directly from a molten mass of semiconductor material. The process is essentially a continuous one in which the ribbon grows at a rate of 6 to 12 inches a minute.

Crystals 180 ft long have been produced, ELECTRONICS learns. The surfaces of the ribbon are always correctly oriented, optically flat, and thus immediately usable without lapping or other finishing, say scientists.

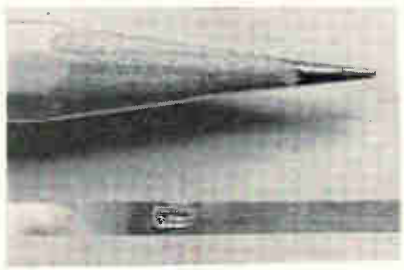


Solid-state power supply uses resistive domain to transform a-c into heat, Seebeck effect to convert heat to d-c. Output has no ripple

A number of solid-state phenomena are employed in the molecular approach, including Seebeck generation, Peltier cooling, Hall-effect multiplication and the growing of *p-n* junctions. Interfaces and junctions for the various effects can be grown into the dendrite as it is drawn from the furnace. The final result is a single function-block composed entirely of semiconductor material and doing the work of a circuit or subsystem.

System Design

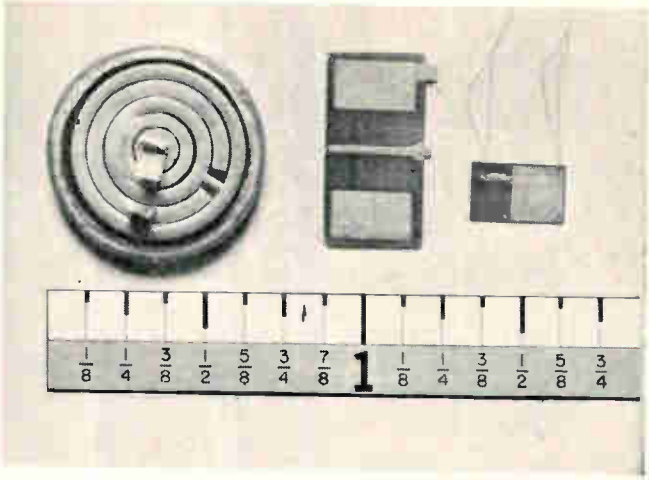
Analysis of the system requirements establishes the functions to be performed by the block. After this analysis, a topologist determines the arrangement of the domains and interfaces that will most efficiently control the energy flow in the block.



Ribbon of semiconductor crystal produced by dendrite process with multiple-junction circuit

Production of a block starts with a basic semiconductor wafer. Necessary domains and interfaces are produced by using techniques employed in the production of conventional semiconductor devices: diffusion, plating, electron-beam machining, etching, irradiation, alloying, cutting and photographic processing. The finished block is encapsulated for protection against shock, vibration, temperature changes and ionizing radiation.

One of the simpler function blocks described by the firm uses domains and interfaces to obtain a



Three of eight molecular circuits developed by Westinghouse are shown above: left to right, audio amplifier, free-running multivibrator and 2-stage video amplifier. At left, audio amplifier and large power amplifier replace standard parts of conventional phonograph amplifier

d-c power supply from line-power input (see cut). It employs the Seebeck effect for the thermoelectric generation of electricity, first converting 110 volts a-c into heat in a resistive domain. The thermoelectric domain is electrically but not thermally isolated from the resistive domain by an insulating layer. Heat produced in the resistive domain is converted into 9 volts d-c in the thermoelectric layer.

A conventional power supply requires five components—a transformer and diode, plus the inductor and two capacitors of a pi-section filter—to do the same job. Voltage output from the molecular rectifier has no ripple.

Function Blocks

Westinghouse received a $2-million contract from Air Research and Development Command last spring to develop *en bloc* circuits. Eight classes of function blocks resulted from the contract: a 5-w audio amplifier, a two-stage video amplifier, a tuned amplifier, various multivibrator circuits, multiposition switches, a variable potentiometer, a two-stage cooler employing the Peltier effect, and an analog-to-digital converter.

In a status report to the Department of Defense in late January, the firm demonstrated over twenty working subsystems. Important among these was a tuned amplifier which uses a semiconductor notch filter and requires no inductance coils. The amplifier is highly selective to frequency. Changing the potential applied to the amplifier permits tuning it over a range far wider than the broadcast band.

May Solve Problems

Colonel W. S. Heavner, chief of Wright Air Development Center's electronic technology laboratory at Wright-Patterson AFB, remarks in the report: "It appears that the majority of present-day military electronic equipment requirements can be satisfied with molecular electronics." Other defense agencies are also known to be keenly interested in microelectronic engineering as a potential solution to problems of reliability, space limitation, heating, and production cost.

Many companies and research establishments are actively engaged in pursuing solid-state approaches to microminiaturization. During the 1960 International Solid-State Circuits Conference this week, scientists from Bell Telephone Laboratories, Westinghouse, Fairchild Semiconductor, General Electric, Motorola, Texas Instruments, Stanford Research Institute and Massachusetts Institute of Technology have been discussing their work in this field. It is expected that at least one other firm will demonstrate its progress in microelectronics within the next few months.

Observers say that the success of any approach to microminiaturization will depend on the cost, reliability and repeatability of the technique as compared to conventional processes. Westinghouse figures its dendrite crystal-growing offers a jump-off to lower production costs and higher reliability, and claims an acceptably high level of repeatability for the process. Other manufacturers, without giving details, indicate that their approaches to microelectronics will give the same results.

One factor common to all methods of reducing size and weight is the elimination of conventional component parts. Low-power conventional resistors, capacitors, diodes and transistors of today appear to have no place in these new circuit design techniques. Military experts feel that conventional components will not be supplanted completely, but that need for components as we now know them will diminish as more manufacturers begin to produce circuits directly from raw materials.

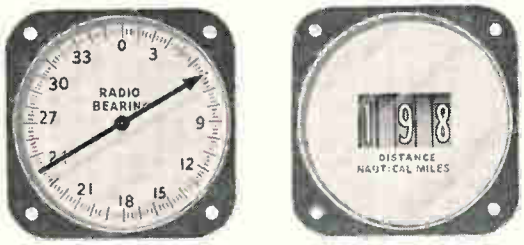
Although hailed as revolutionary by some, solid-state approaches to microelectronics are actually evolutionary. Some of the new techniques are adaptations of techniques used in thin-film work, and others are adapted from conventional transistor technology. Increased knowledge of materials and better production methods are also contributing to microelectronic engineering.

Miniaturization means only active components G-E subminiatures use to give miniaturization

HOFFMAN TACAN: MEETS 780% - HIGHER AGREE* SPEC!

*Advisory Group on Reliability of Electronic Equipment, which has set a new standard of 150 hours mean-time-to-failure for TACAN.

General Electric subminiature tubes with heat-resistant glass have played a key role in advancing the reliability of Hoffman Electronics Corporation's new ARN-21C to nine times that of older TACAN equipment.



Compactness is a feature... transmitter, receiver, and electronic computer functions all are grouped in one "black box" that measures only 8 by 11 by 17 inches. Heat build-up necessarily is substantial.

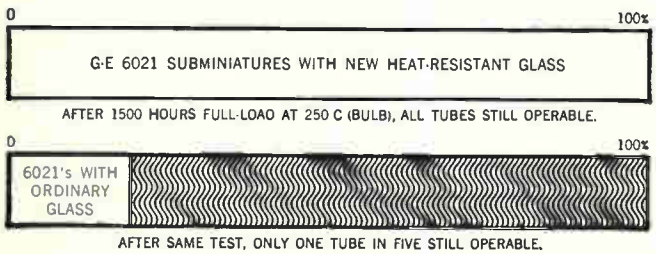
In General Electric subminiature tubes, Hoffman found the answers to their pressing need for tubes that would stand up to heat *with no sacrifice in reliability.* 28 G-E subminiatures are used in the ARN-21C.

heat. Tubes  are the that can withstand heat. new heat-resistant glass with reliability.

ACTUAL SIZE

WHAT TESTS SHOW

Life tests of G-E subminiatures with new heat-resistant glass prove that high-temperature operation has no adverse effect on reliability. Check the total absence of failures with G-E type 6021 after 1500 hours at 250 C, against the high failure rate of ordinary 6021's under the same conditions!



Type 6021 is a key tube in Hoffman's TACAN circuit. Glass electrolysis—cause of 90% of tube failures at high temperatures—has virtually been eliminated by General Electric in the 6021 and other subminiature receiving tubes.

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General Electric subminiature tubes are proved performers at high temperatures. And their small dimensions give you the extra compactness you need to meet tight equipment size limitations. Telephone your nearest General Electric Receiving Tube Department office below!

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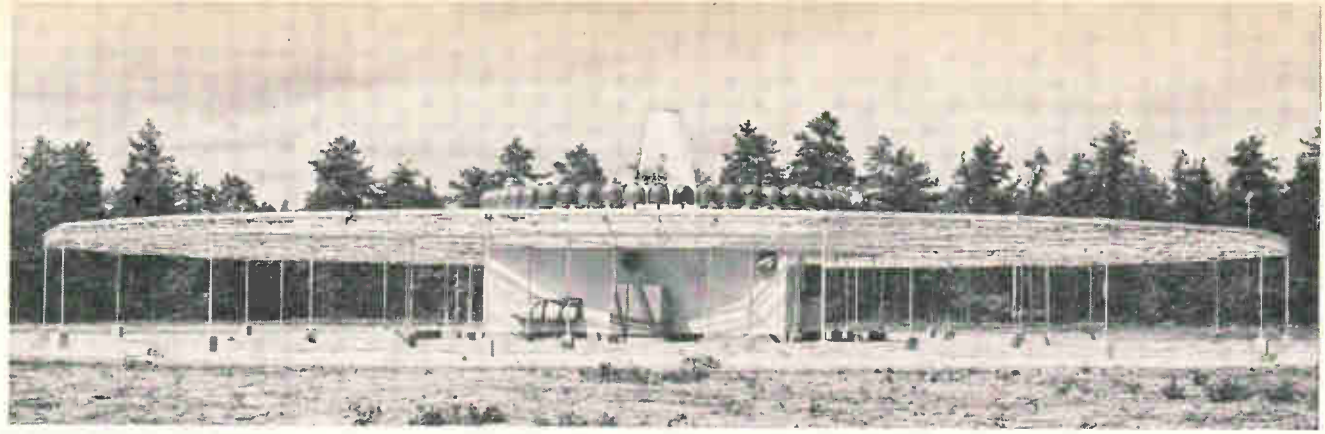

At FAA's Atlantic City proving grounds, doppler VOR undergoes test. Fifty loop antennas in 44-ft circle on roof are excited in sequence, creating rotating-beam effect

Air Agency Plans for '60

YEAR-OLD Federal Aviation Agency, despite a lot of time spent putting out brushfire emergencies, has managed to build a firm framework under the nation's airways control system, and has a raft of big and little plans for 1960.

FAA's fiscal 1960 program was based on an appropriation of $118.2-million for establishment of facilities and $48.7 million for R&D. Of this amount, approximately 75 percent of purchases and undoubtedly more of the R&D money is going for electronics.

For the coming fiscal year, the administration has requested $65 million for research and development projects and $195 million for acquisition of new facilities or improvement of old ones. Of the $260 million total, approximately the same percentages will go for electronics.

The Agency's program concentrates heavily on air navigation facilities, traffic-control systems, and special-purpose buildings, with special attention to radar.

Radar and Controls

The program for the current fiscal year calls for eight long-range radars at an average cost of over $2.4 million. Three Air Defense Command radars will also be made available for joint use by FAA controllers; in these joint-use situations, FAA pays only for remoting the ADC radar data to FAA control facilities.

Sixteen long-range radars will be fitted with scan-conversion equipment, costing $375,900 each; and 24 will be equipped with radar beacons at $106,400 each.

Twenty airports will get new traffic-control towers. New instrument-landing systems costing $195,-900 will go into 15 airports, four of which will use them for training purposes. Sequenced flashing approach lights will be installed at 54 airports at a cost of $36,200 per system.

Terminal-type vhf omnirange (TVOR) equipment will be installed at 18 locations; this special type of VOR is used as an approach aid, where standard VOR is used for en-route navigation. TVOR systems cost $100,600 on an average. Another specialized type of vhf omnirange—Doppler VOR—which minimizes interference from terrain obstacles and buildings, will be installed at 20 locations for $54,900 apiece.

A total of 32 direct air-ground communications channels will be established at 19 locations; average cost per channel is $108,700. The Agency will spend $5.6 million to improve teletypewriter service (used for weather and traffic-control data) at 500 locations. An additional $3-million-plus will go toward improving communications in the Caribbean, the Pacific and Alaska.

New instrumentation for use in flight-checking the accuracy of nav-aids and traffic controls will be installed in 14 flight-inspection aircraft. Average cost will be $345,475 per aircraft.

In actions during the calendar year 1959, besides taking over from Civil Aeronautics Administration, FAA commissioned 365 new navigation aids or traffic-management facilities, an average of one a day. The Agency installed medium-scale computers with large-volume memories at six of the busier traffic-control centers and hooked up four of these to communicate with each other.

To keep pace with jet operations, FAA set up a total of 25,455 miles of high-altitude jet routes. With the help of 38 air defense radars which supplemented FAA's own long-range radars, almost the entire jet route structure was placed under radar advisory. At the present time, FAA can track all jet flights from takeoff to touchdown except for a small area in the Rockies.

First major action this year was the announcement that almost all transport-category aircraft used by commercial airlines to carry passengers must be equipped with airborne weather radar. The rule excludes the Curtiss C-46 and two non-transport craft, the Douglas DC-3 and Lockheed L-18.

1961 Programs

FAA's request of $195 million for new facilities and $65 million for R&D represents less than half the total $654 million in new obligation authority requested for the Agency in the President's 1961 budget. The rest of it is eaten up by expenses, and by construction, operation and maintenance costs for the Washington airports.

Included under expenses is a request for 4,547 new employes—primarily technicians, and specifically including more traffic controllers, engineers and electronics mainte-

nance personnel.

ELECTRONICS learns that FAA will continue to stress electronics in purchases and establishment of facilities during fiscal 1961. New facilities will be mostly—in order of importance—air traffic-control towers, short-range nav-aids like Vortac (VOR with Tacan-compatible distance-measuring equipment), instrument-landing systems, runway-approach lights, including sequenced flashing lights, long-range radars, radar beacons, terminal-area radar equipment like ASDE (airport surface detection equipment) and PAR (precision approach radar).

NAFEC Projects

Most of the $65 million in research and development authority will go to or through the National Aviation Facilities Experimental Center for its development and evaluation programs. More than 70 projects are on the center's agenda for the coming year.

The first components of a fully automated air-traffic control system are already installed at the Atlantic City, N. J., test facility. General Precision Laboratory's air-traffic computer, the heart of the system, is now undergoing test.

The engineers and scientists at the center will also be looking at automatic landing systems, including Bell Aircraft's AN/GSN-5 (beginning this month) and REGAL later this year.

Among radar systems undergoing test will be an experimental quad radar, so called because it combines in one system the four functions of surveillance, precision approach (PAR), airport surface detection (ASDE) and height-finding.

The year at NAFEC will also be marked by extension of the space-position range, the precision measurement facility for determining the position of aircraft over the range. Two phototheodolites are currently installed on temporary earth mounts; these will be moved to steel towers and additional units will be installed. The center is putting in a MOPTAR system (multiple-object precision tracking and ranging), a radio complex that can simultaneously track five aircraft with extreme precision up to 200 miles out and derive precision data.

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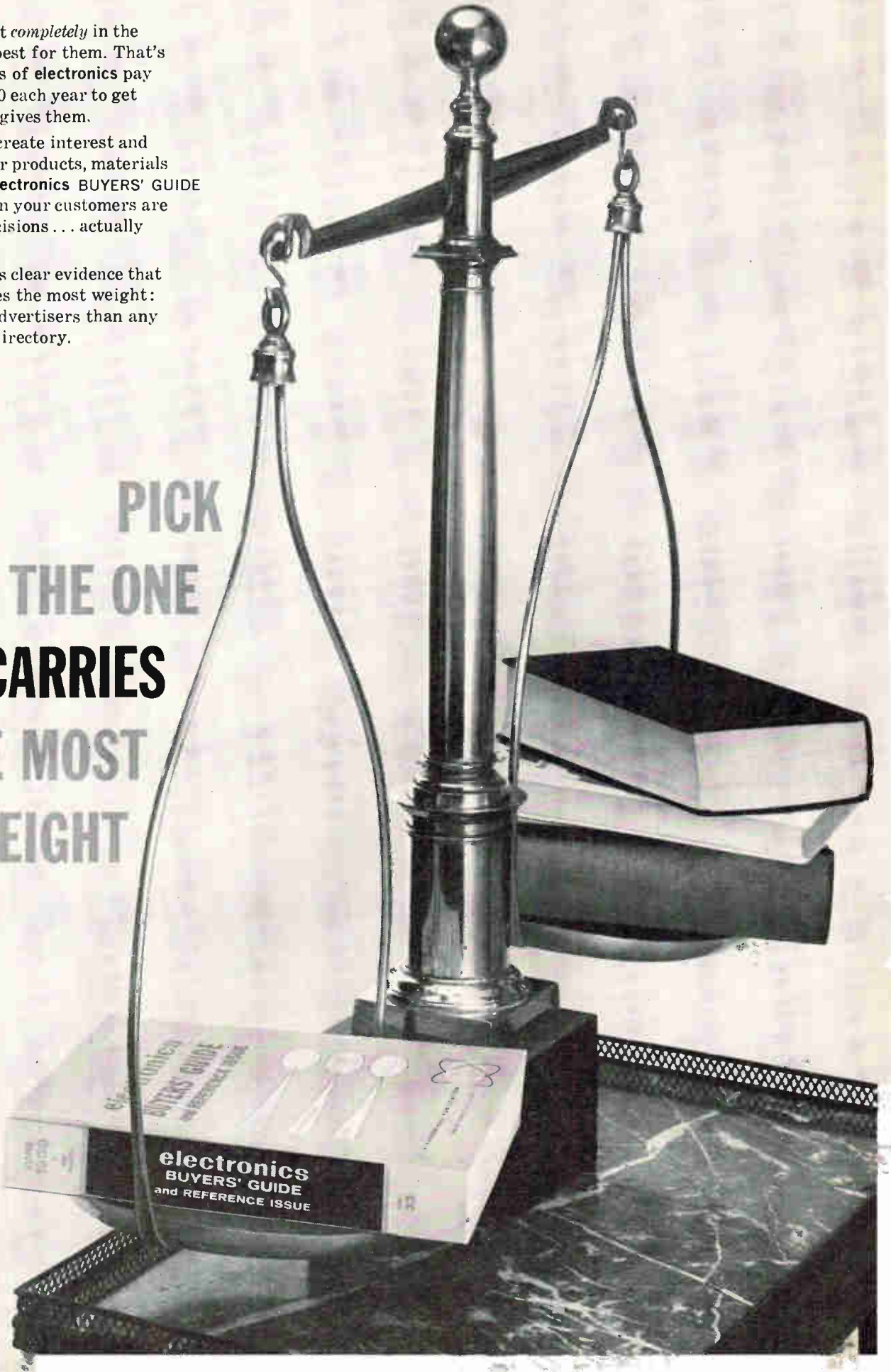

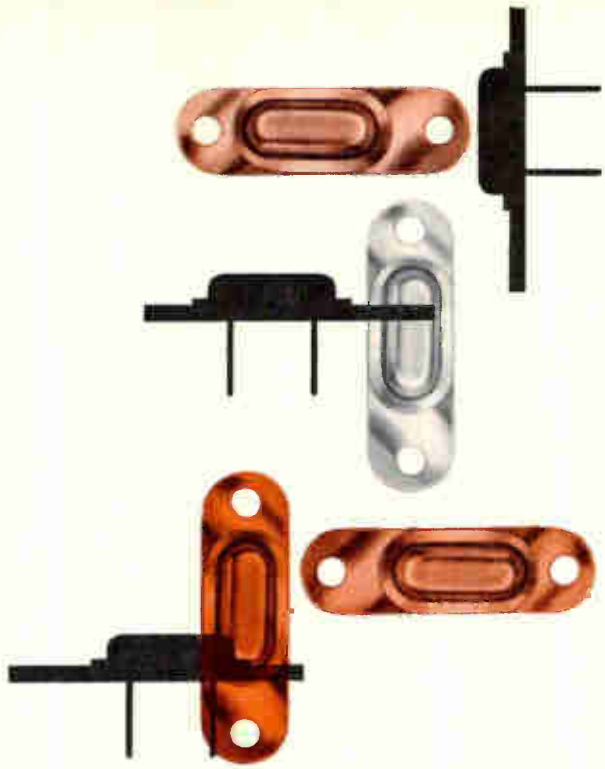

CLEVITE'S NEW

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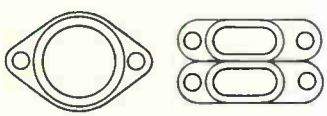
TRANSISTOR



½ *actual size*

THREE AMPERE SWITCHING TYPES

TEST	CTP 1728	CTP 1735	CTP 1729	CTP 1730	CTP 1731	CTP 1736	CTP 1737	CTP 1733
Min BVcbo @ 2 ma (volts)	40	60	80	100	40	60	80	100
Min BVceo @ 500 ma (volts)	25	40	55	65	25	40	55	65
Min BVces @ 300 ma (volts)	35	50	65	75	35	50	65	75
Max Icbo @ 90°C @ Max Vcb (ma)	10	10	10	10	10	10	10	10
Max Icbo @ 2 V (μa)	50	50	50	50	50	50	50	50
D. C. Current Gain @ 0.5A	30-75	30-75	30-75	30-75	60-150	60-150	60-150	60-150
Max Veb @ 3.0 A (volts)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Max Vce (sat) @ 3.0A, 300 ma (volts)	1.0	1.0	1.0	1.0	0.8	0.8	0.8	0.8
Min fae @ 3.0 A (kc)	20	20	20	20	15	15	15	15
Max Thermal Resistance (°c/w)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Compared with present power transistors of similar ratings, the new Clevite *Spacesaver* gives you important new advantages.

Better Switching — Its low base resistance gives lower input impedance for the same power gain and lower saturation resistance, resulting in lower "switched on" voltage drop. Its lower cut off current means better temperature stability in direct coupled circuits (such as regulated power supplies) and a higher "switched off" impedance.

Better Amplifying — Improved frequency response leads to higher audio fidelity, faster switching and improved performance in regulated power supply applications.

Better Mounting — The *Spacesaver's* simple rectangular configuration and low silhouette make it adaptable to a wide variety of mounting requirements where space is at a premium. In aircraft and missile applications, its low mass (half present type) improves shock and vibration resistance of lightweight assemblies.

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AMP taper technique points the way to greater reliability

Magnetic Amplifiers, Inc. of New York carefully manufactures its Static Inverters with a step-by-step quality control and testing program to build in the reliability required for aircraft and missile applications.

It found that AMP Taper Technique simplified this procedure. A high speed AMP Automachine pre-terminates circuit leads with crimp-type, pre-insulated solid Taper Pins. Components are then easily tested in the modular stage before final assembly. Crimping eliminates difficult soldering operations and the danger of burning wound components while Taper Technique permits checking and trouble shooting without destroying the main cable. After final assembly, when the Pins are inserted into the Blocks, this Technique provides rugged vibration resistance and operational reliability.

AMP solderless Taper Pins are made in formed and solid types, with or without pre-insulation and mate with a wide range of one or two piece stackable Taper Blocks. You'll find that AMP Taper Technique is ideal for *your* quality control or circuit density problems too.

Magnetic Amplifiers' 250VA Static Inverter Model SIS-425041

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X-rays for Communications?

Air Force has just let a contract for a feasibility study of X-rays as a possible means of space communication. It's part of a look at the whole spectrum for transmission possibilities

TAKING several giant steps across the electromagnetic spectrum, the Air Force is investigating X-rays as a possible means of space communication.

The feasibility study by Tracerlab-Keleket of Waltham, Mass., is part of an overall investigation by the Air Research and Development Command of the entire spectrum from a communications standpoint. Rome ADC has let a $75,000 contract for the study, part of its inquiry into the possibility of using radiation in the transvisual frequencies as supplemental media for conveying information.

X-rays are only mildly scattered, can be made highly directional, and so potentially offer the advantage of privacy for space communications. The power needed to swamp them would be prohibitive, so they also offer antijamming advantages.

At the present time, power requirements for X-ray transmissions are felt to be about the same as for radio transmission—or a bit higher, according to Joris M. Brinkerhoff, head of the physics department, and Charles A. Ziegler, staff scientist, at Tracerlab.

Low-energy X-rays—probably below 10 kv—will be used, requiring no more shielding than would otherwise be needed in a manned space vehicle.

Lower altitude limit for effective use of this type of communication is believed to be about 30,000 feet. As the most practical experimental altitude, researchers will concentrate on communications in space at 100 kilometers and above.

Pulsing May Be Key

At the frequencies involved, the quantum nature of electromagnetic radiation becomes important. Since counting of quanta is the basic method of detection, there may be an advantage in pulsing the power source. Unlike radio waves, the quanta can be detected instantaneously, and this gives X-ray pulsing an edge over pulsing of radio waves. In fact, there are indications that pulsing may be the key to practical X-ray communication.

Conventional nuclear radiation detectors like ionization chambers and scintillation counters will be modified for receivers. New electronic circuits will be required for demodulation in the context of pulses, no sine waves being involved in the transmission technique.

In addition to cosmic background, another kind of noise is involved in X-ray transmission. This is an uncertainty, arising from quantum statistics, as to whether or not a bit of information has been received. In fact, researchers anticipate that the predominant noise in X-ray transmission could arise from the uncertainty in the arrival rate of quanta.

As in radio transmission, a compromise will be necessary between noise level and rate of message-sending. In radio, recourse to a wide band lets in more noise.

Prospective modes of conveying intelligence are analogous to radio transmission. Intensity modulation, by which there is produced a variation in the rate of arrival of quanta at the detector, is comparable to a-m. Energy modulation, accomplished by changing the energy of the X-rays or electrons, may be considered analagous to f-m. In this technique, if an electron beam is used, it will strike one element and that element's characteristic line of radiation will be detected; then another target will emit a different line of radiation.

Scrambling Techniques

A combination of intensity and energy modulation will be considered; also scrambling techniques, such as sending a special pattern of quanta.

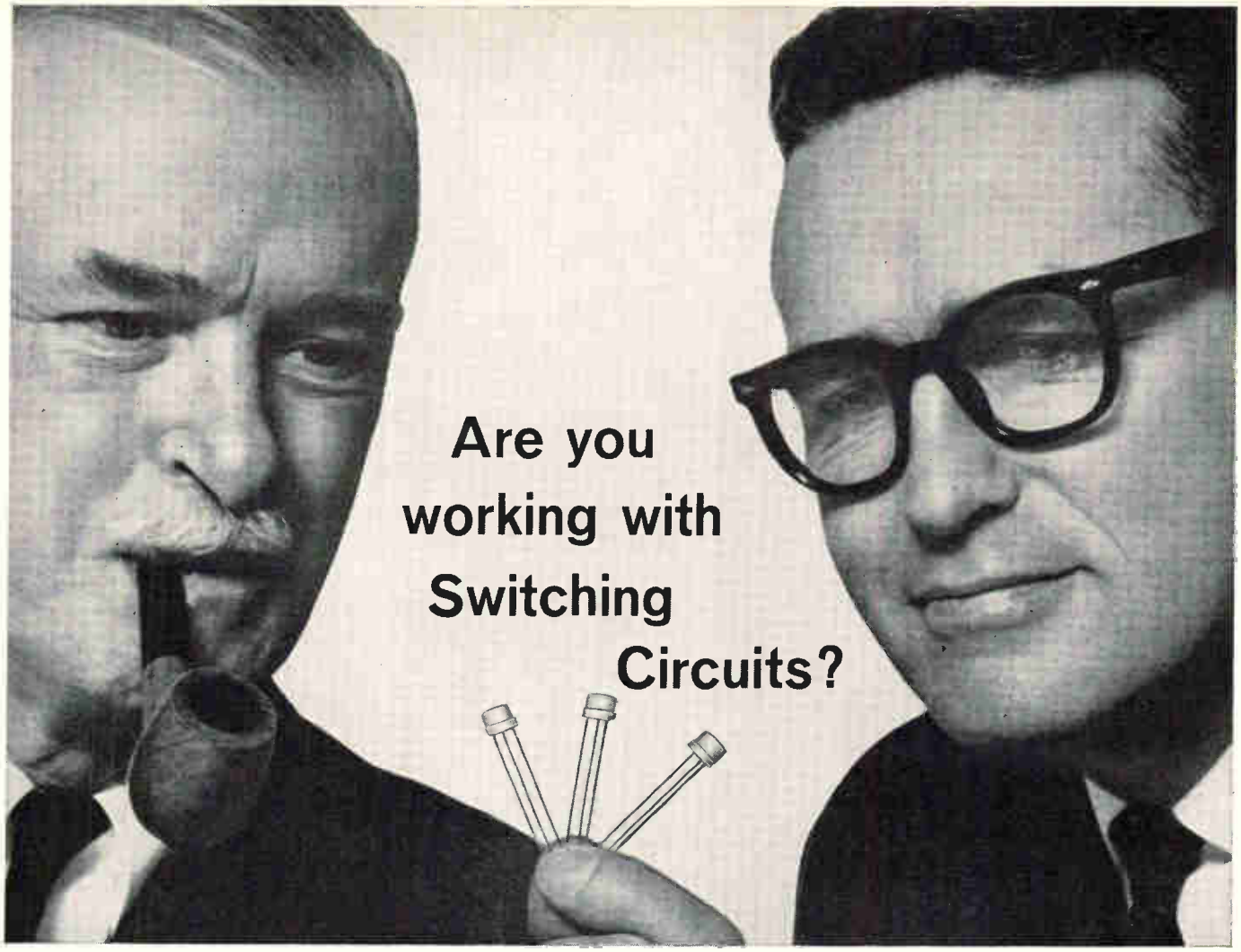
The study will also embrace conditions in outer space, particularly with reference to possible interference by natural phenomena. X-rays are subject to interference only by gross objects which absorb them, while electrons are bent by magnetic fields. On the other hand, the certainty of X-ray reception may be adversely affected by large fluctuations in ambient level, such as that caused by solar flares.

Efficiency of transmission—bit-per-second-per-watt—will be investigated along with other factors.

After the study, Tracerlab may select one or two possible systems of instrumentation and build a local short-distance demonstration model to evaluate various modulation and demodulation techniques.

PENETRATION OF X-RAYS AND ELECTRONS AT VARIOUS ALTITUDES (ARDC MODEL ATMOSPHERE)

ALTITUDE	X-RAY HALF-VALUE LAYER (km)		ELECTRON RANGE (km)	
	20 Kev	2 Mev	20 Kev	2 Mev
0	.047			
10	.110	30	10^{-5}	.025
50	40			
95	350,000		100	100,000
220	5×10^9		10^6	
Beyond Atmosphere	$\sim 10^{14}$		$\sim 10^{11}$	



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Unique switching networks automatically divide scales into any number of equal parts regardless of range. It's no longer necessary to calibrate each checkpoint or set up extra equipment to obtain required outputs. Operation is reduced to four or five simple steps.

These consoles typify Weston leadership in long-term reliability and stability. All are supplied in blue-gray cabinets or ready for mounting in standard 19" rack panels. Also available: an oil bath which accommodates up to 12 Weston Normal Standard Cells . . . maintains temperatures within .01C. Removable racks also fit baths at U.S. Bureau of Standards.

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CIRCLE 47 ON READER SERVICE CARD 47

Hams Seek Facsimile

Military Affiliate Radio System hams and makers of communications equipment see new products coming from need for sending visual data

FACSIMILE and slow-scan television are now being considered as possible supplements to the regular civilian ham broadcast activities of the Military Affiliate Radio System (MARS).

MARS, now 12 years old and counting a record 5,000 radio amateurs as members, is designed to function as an emergency network for military communications. The system has an active training and education program, which is carried out through various Army headquarters.

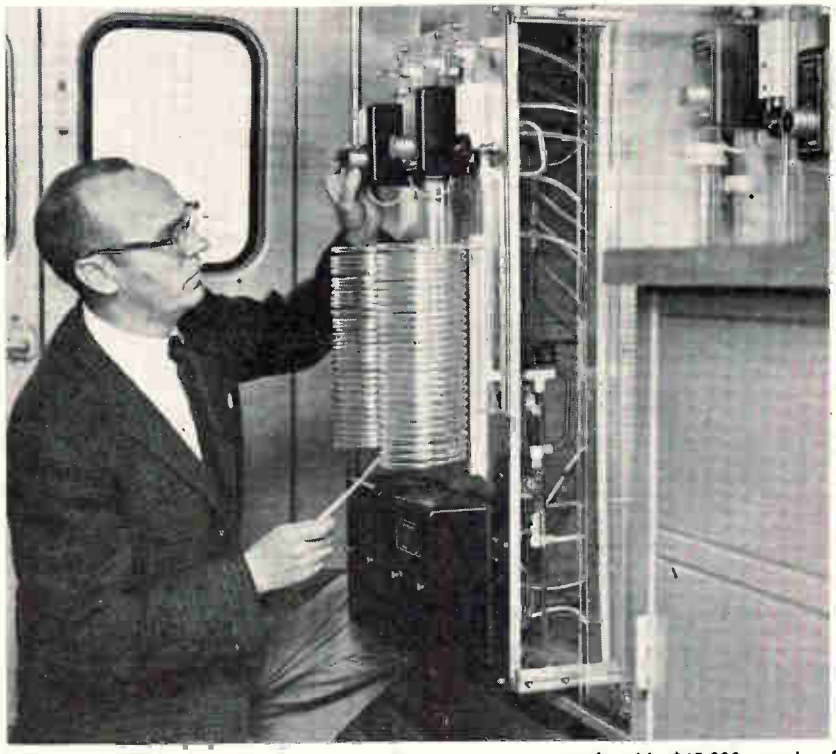
Right now, interest is focusing on equipment to transmit visual information in the amateur frequencies. E. S. Piller, director of the First Army's MARS technical education program, told ELECTRONICS that new developments in facsimile and slow-scan television would be valuable to the system. He said there was a definite need for transmission of visual material.

Cost of visual transmission equipment is the stumbling block. Facsimile gear to transmit photos and drawings would cost the amateur operator about $1,800. Receiving equipment can be bought for about half this amount.

Some hope that lower equipment costs can be achieved is expressed by manufacturers. John Long, president of Long Laboratories, Emerson, N. J., for example, says that the cost of facsimile equipment could be brought down if stepped-up market demand brings about increased production.

Most of today's facsimile equipment is used by government agen-

Inspecting Smog Detector



Orange County, Calif., officials have outfitted a step-van truck with $45,000 worth of instruments for measuring air pollution. Monitors, developed by Beckman Instruments, include four air-pollution analyzers (picture) which measure low concentration of nitric oxide, nitrogen dioxide, oxidant and sulphur dioxide; and two infrared analyzers to measure carbon monoxide and hydrocarbons. All monitors can be used for independent or simultaneous analysis

Gear

cies, common carriers and police departments. There are indications, however, that more manufacturers are requiring rapid means of transmitting visual information such as drawings, schematics and photos.

One observer, citing the more than 200,000 hams now licensed in the U. S., expressed the feeling that interest by large numbers of amateurs could be a force in lowering prices. Help in bringing this about may come from the MARS practice of making surplus equipment available to members, he adds. A number of facsimile transmissions made by technical education directors may serve as the spur to purchase of additional units.

Work being done now in single-sideband transmission points to the possibility of using one sideband for voice and the other for transmission of the visual information.

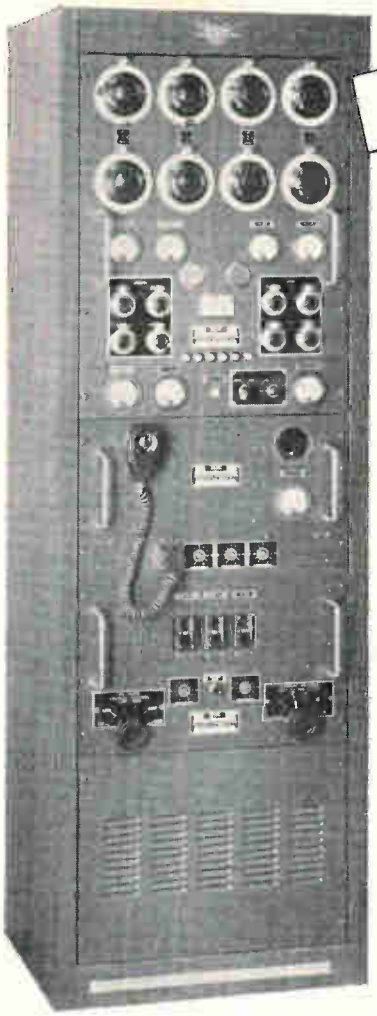
MARS members are said to be interested in these possibilities. Some amateurs have been in the MARS system since it was first authorized by the Secretaries of the Army and the Air Force in 1948. Originally membership was limited to military personnel on active duty. Today, less than seven percent of the members are in uniform.

Open to Amateurs

Membership in MARS is open to any licensed radio amateur who is at least 16 years old. Rules require a minimum participation of six hours for each three-month period of the year. In addition, reports on participation must be filed.

MARS officials say the highest percentage of participation in system work is now taking place in the Fifth Army region. This area, which comprises the upper section of the Midwest, has about 600 members with 95 percent active participation in transmitting messages and taking part in training and educational programs.

Members of the First Army technical net (New York, New Jersey and New England), who number close to 500, attend talks by manufacturers, users of communications gear and military specialists in this field.



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The Aerocom 1046 Transmitter is designed to give superior performance for all point-to-point and ground-to-air communications. It is now in use throughout the world in climates ranging from frigid to tropical (operates efficiently at −35° to +55° Centigrade).

As a general purpose High Frequency transmitter, the 1046 supplies 1000 watts of carrier power with high stability (above −10° Centigrade: ±.003% for telegraph and telephone. Temperature controlled oven for FSK). Multichannel operation is provided on telegraph A1, telephone A3 and FSK (Radio Teletype). It can be remotely controlled using one pair of telephone lines plus ground return with Aerocom Remote Control Equipment. Front panel switches and microphone are included for local control.

Four crystal-controlled frequencies (plus 2 closely-spaced frequencies) in the 2.0 - 24.0 megacycle range can be used one at a time, with channeling time only two seconds. Operates into either balanced or unbalanced loads. The power supply required is nominal 230 volts, 50 - 60 cycles, single phase.

The housing is a fully enclosed rack cabinet of welded steel, force-ventilated through electrostatic filter on rear door.

Telegraph keying (A1): Up to 100 words per minute. Model 1000 M Modulator (mounts in transmitter cabinet) is used for telephone transmission; a compression circuit permits the use of high average modulation without overmodulation. Model 400 4 Channel exciter is used for FSK.

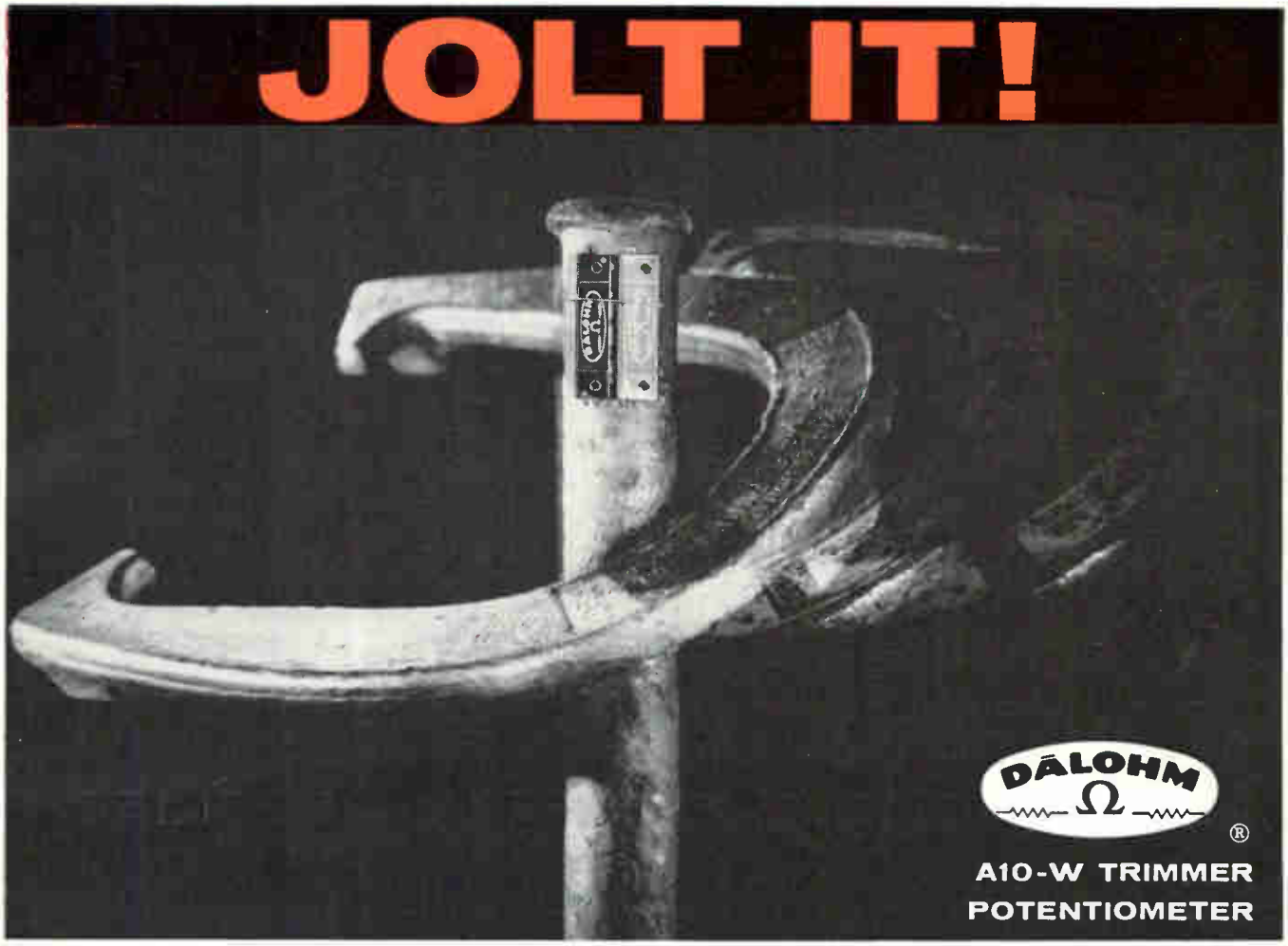
Output connections consist of 4 insulated terminals (for Marconi antenna) and 4 coaxial fittings Type SO-239, which can be used separately or in parallel in any combination. For 600 ohm balanced load, Model TLM matching network is used, one for each transmitter channel.

As in all Aerocom products, the quality and workmanship of Model 1046 are of the highest. All components are conservatively rated. Replacement parts are always available for all Aerocom equipment.

Complete technical data on Aerocom Model 1046 available on request.

AER-O-COM

3090 S. W. 37th AVENUE MIAMI 33, FLORIDA



A DALOHM Trimmer Potentiometer Retains its INHERENT STABILITY

Even the smashing shock of steel on steel has no effect on the inherent stability that is standard in DALOHM trimmer potentiometers.

DALOHM T-Pots not only offer rugged construction to withstand high shock and vibration, but also maintain exceptional stability under load, and operate reliably under extremes of temperature — all in sizes to meet the tightest space requirements.

For all applications that demand trimmer potentiometers that meet or surpass MIL specs, you can depend on DALOHM.

WIRE WOUND • PRECISION • MINIATURE
DALOHM A10-W TRIMMER POTENTIOMETER

A miniature T-Pot that surpasses most military requirements.

- Rated at 1 watt up to 70° C. ambient temperature, derating to 0 at 150° C.
- Resistance range from 10 ohms to 50K ohms
- Standard tolerance ± 5%; closer tolerances available
- Resolution 0.1% to 1%, depending on resistance
- Operating temperature range from —55° C. to 150° C.
- Insulation resistance: 1000 megohms minimum at 500 VDC at room temperature
- End resistance not greater than 4%
- Temperature coefficient of trimmer unit within 100 PPM
- Miniature size, .220 x .312 x 1.250 inches
- Screw fully adjustable throughout 25 turn range
- Shaft torque 7 inch/ounce maximum
- Safety clutch arrangement on movable wiper contact prevents breakage due to over-excursion
- Self locking adjustment; wiper will not shift under vibration or shock

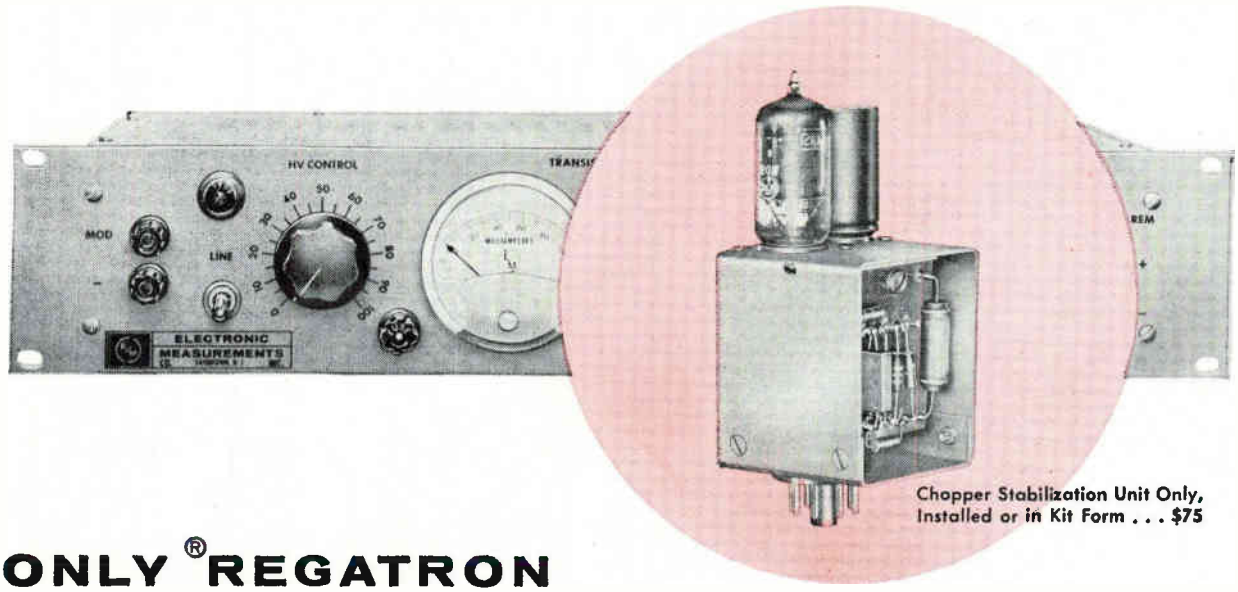
Write for Bulletin R-32, along with handy cross-reference file card.

SPECIAL PROBLEMS?

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

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

Optional Chopper Stabilization



Chopper Stabilization Unit Only, Installed or in Kit Form . . . $75

ONLY ®REGATRON PROGRAMMABLE POWER SUPPLIES HAVE IT!

0.01% or 0.003 V from no load to full load . . . this is the conservative regulation specification for Regatron Programmable Power Supplies equipped with chopper stabilization. And just as important, chopper stabilization assures a higher order of regulation and stability at every output voltage, even at fractions of one volt.

There are other advantages too: Chopper stabilization provides for exceptionally high repeatability of voltage control settings . . . enhances remote control operation.

And chopper stabilization can be specified at any time. The compact plug-in unit can be installed at the factory as an original accessory, or it can be installed in the field. A complete kit is available for field installations. Instructions and all hardware are included.

Ask your local E/M representative for more information, or write . . .

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ELECTRONIC MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

Radiation Used in Brain Study

ACADEMIC RESEARCH in electronics continues to probe for new ways to expand the horizons of man's knowledge. Here are some examples:

• **University of California** researchers at the university's medical school are conducting experiments to determine the extent to which electromagnetic stimulation can produce mental, emotional and hormonal responses. Studies are also aimed at determining ways of stimulating nerves, muscles and other body tissues electromagnetically. Locating brain areas which control different types of behavior has been largely accomplished by direct application of electrodes when the skull is surgically opened. Use of electromagnetically induced eddy currents could be accomplished without surgery in a conscious patient.

• **Rutgers University,** New Brunswick, N. J., reports encouraging progress in work being done at its year-old microwave research lab. Research programs currently under way include: development of ceramic radomes for Office of Naval Research; studies for the Air Force on the aging of lead calcium titanate and other ferroelectric ceramics, and studies on the crystalline structure and other properties of these compounds; research on harmonic generation at millimeter wavelength for the Air Force; investigation of slow-wave structure for the Signal Corps and studies on the electrical conductivity of titanium oxide.

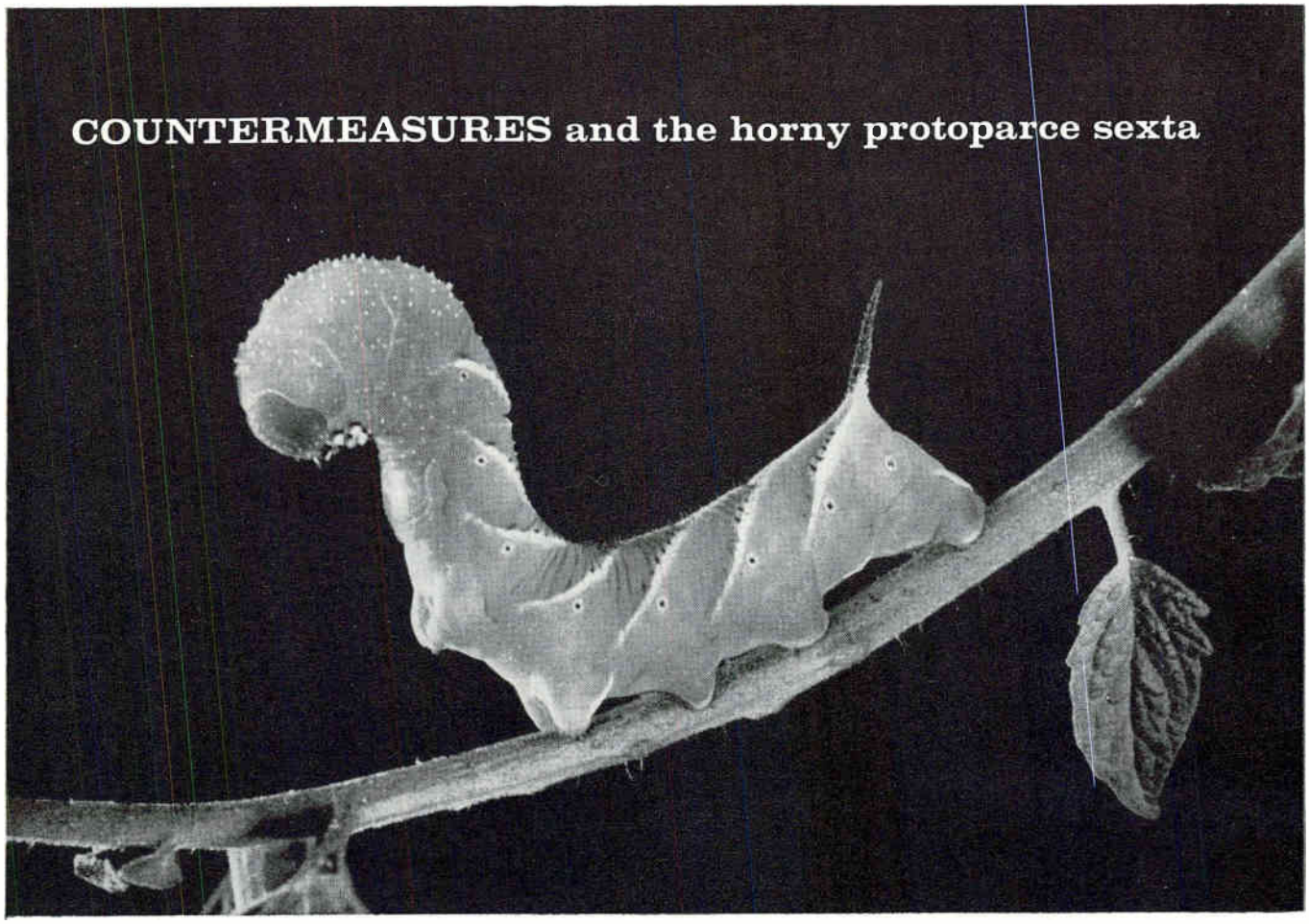
• **Georgia Institute of Technology,** Atlanta, reports creation of a new research division. Called the Electronics division, the new organization will consist primarily of the research staffs of the former Radar and Communications branches of the Physical Sciences division. The head of the Radar branch, M. W. Long, has been named chief of the new group. Institute officials say the Electronics division was necessitated by the rapid growth of the Physical Sciences division in recent years. It included many research activities in physics, systems analysis and electrical engineering in addition to radar and communications. Communications studies now in process are devoted to advanced techniques of modulating and detecting radio signals, ionospheric effects on radio signals and mutual interference problems. In radar, research is being pursued to develop greater range and angular resolution.

• **Syracuse University** researchers are at work under a $10,200 grant from the Atomic Energy Commission used for purchase of radiation biology equipment. The gear will be used for student training which will focus attention on radioisotopes from the viewpoint of detection and application to biology.

• **Arizona State University** reports a pledge of $150,000 from Motorola for development of a doctoral program in engineering and physical sciences. To date, $30,000 has already been advanced. The contribution is in memory of Paul V. Galvin, late president of the company.

• **Polytechnic Institute of Brooklyn** has been awarded a grant of $60,000 by National Science Foundation to set up a high-speed computer facility. An IBM 650 will be used in the many science programs being worked on as well as an educational program in computer work.

• **Case Institute of Technology** researchers are exploring the value of thin magnetic metal films in computer memory systems. R. W. Hoffman has described films as little as 50 atoms thick made by evaporating iron, nickel and their alloys in vacuum. The resulting magnetic coatings may become spontaneously magnetized below 600 F and changed fast.



"RAVEN" SPELLS TROUBLE FOR THIS FELLOW

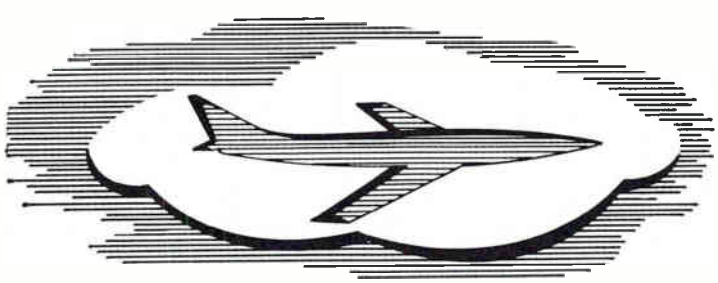
but it once spelled security for our military

The protoparce (Tomato worm) faced with the serious problem of existing from day to day, does so by the logical method of vanishing before the eyes of his enemies. To a Raven, he seems only another part of whatever bush or tree he sits upon. This is an application of basic countermeasures.

On the other hand "Raven", the World War II code name for countermeasures, meant security for us and trouble for our enemies.

INSTRUMENTS FOR INDUSTRY, a leader in the field of countermeasures, has long been active in successors to project "Raven."

Recently under development is a device which effectively intimidates counter-interception equipment aboard attacking enemy aircraft, resulting in our planes literally disappearing before the eyes of the enemy.



You can't shoot down a shadow...but that's all that can be found. Another countermeasure by I.F.I.

MILITARY INSTRUMENTS ifi INC. FOR INDUSTRY ELECTRONICS

See us at the IRE Show Booth 1424

INSTRUMENTS FOR INDUSTRY, Inc.
101 New South Road, Hicksville, L. I., N.Y.

Graduate engineers with two or more years of circuit application in the fields of electronics or physics are invited to meet with Mr. John Hicks in an informal interview or send complete resume to: Dir. Personnel, IFI, 101 New South Road, Hicksville, New York.

MEETINGS AHEAD

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

Feb. 10-12: Cleveland Electronics Conf., ISA, IRE, AIEE, CPS, CIT and WRU, Cleveland Eng. & Scientific Center, Cleveland.

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

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

Feb. 19-23: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Feb. 25-26: Scintillation Counter Symposium, AIEE, AEC, IRE, NBS, Hotel Shoreham, Wash., D. C.

Mar. 17-18: Synchro Design and Testing Symposium, Bureau of Naval Weapons, Dept. of Navy, Dept. of Commerce Auditorium, Wash., D. C.

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

Mar. 24-25: Human Factors in Electronics, PGHF of IRE, Bell Labs Auditorium, N. Y. C.

Apr. 3-7: National Assoc. of Broadcasters, Engineering Conf. Committee, NAB, Conrad Hilton Hotel, Chicago.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

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

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

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 134.

EXTRA QUALITY AT NO EXTRA COST WITH BENDIX TRANSISTORS

Bendix Bulletin

Up-to-the-minute news about transistors

NEW DRIVER TRANSISTORS SWEEPING THE FIELD

Extra-versatile Bendix units beat high costs, design limitations over wide front

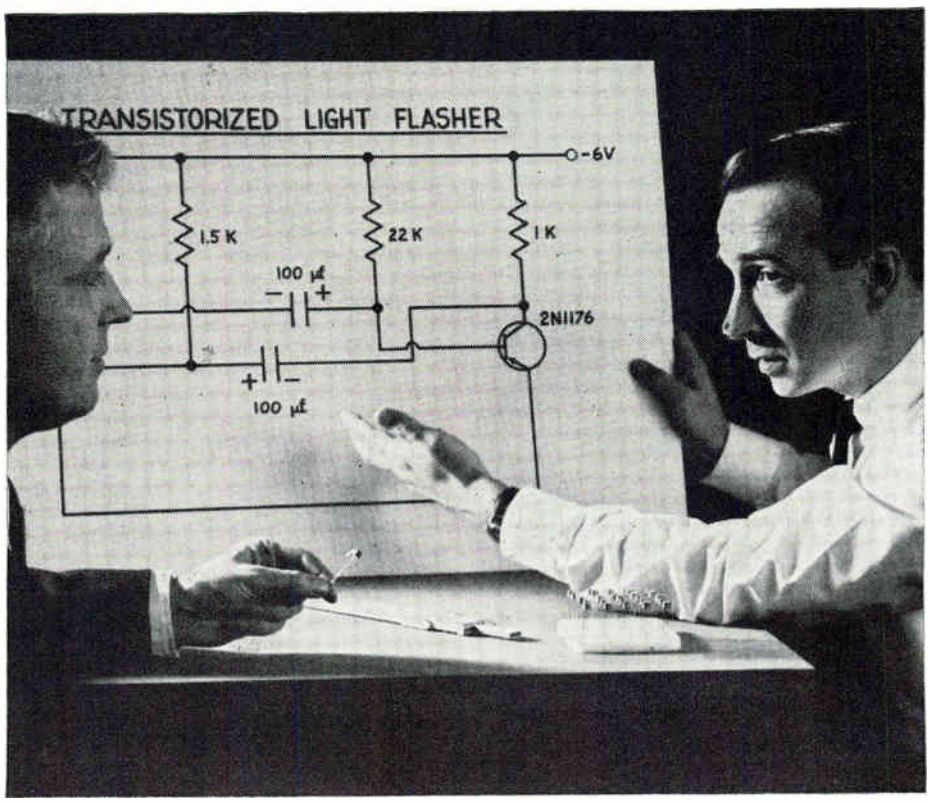
Called the "workhorse of the transistor industry," the new Bendix* Driver Transistor series is winning the nod from more and more engineers daily. These men find it the answer to audio frequency and switching applications requiring extra performance without extra cost.

Here is a special device for use where reliability, versatility, and low cost are primary requirements. The Bendix units combine higher voltage rating and high current gain with more linear current gain characteristics for low distortion and more efficient switching.

They're now in high production for rapid delivery in JEDEC TO-9 packages.

NEW BENDIX SEMICONDUCTOR CATALOG on our complete line of power transistors, power rectifiers, and driver transistors available on request. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, N. J. For information about employment opportunities write personnel manager.

*TRADEMARK



ENGINEERS KNOW the new Bendix Driver Transistor line-up meets an unusually wide range of circuitry applications. Bendix Applications Engineering Department suggestions on circuitry problems are helpful, too.

APPLICATION, PERFORMANCE DATA INDICATE BROAD USAGE

TYPE NUMBERS	MAXIMUM RATINGS					TYPICAL OPERATION		
	Vce	Ic	Pc	Tj	T storage	hfe	fαb	Vce(Sat)
	Vdc	mAdc	mW	°C	°C	Ic = 10 mAdc		Ic = 100 mAdc Ib = 10 mAdc
2N1008	−20	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1008A	−40	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1008B	−60	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1176	−15	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc
2N1176A	−40	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc
2N1176B	−60	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc

Ideal for such applications as:

TRANSISTOR DRIVER • AUDIO AMPLIFIER (CLASS A OR B)
POWER SUPPLY • SERVO CONTROL • AUDIO OSCILLATOR
MOTOR CONTROL • RELAY DRIVER • POWER SWITCH

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LONG BRANCH, N. J.

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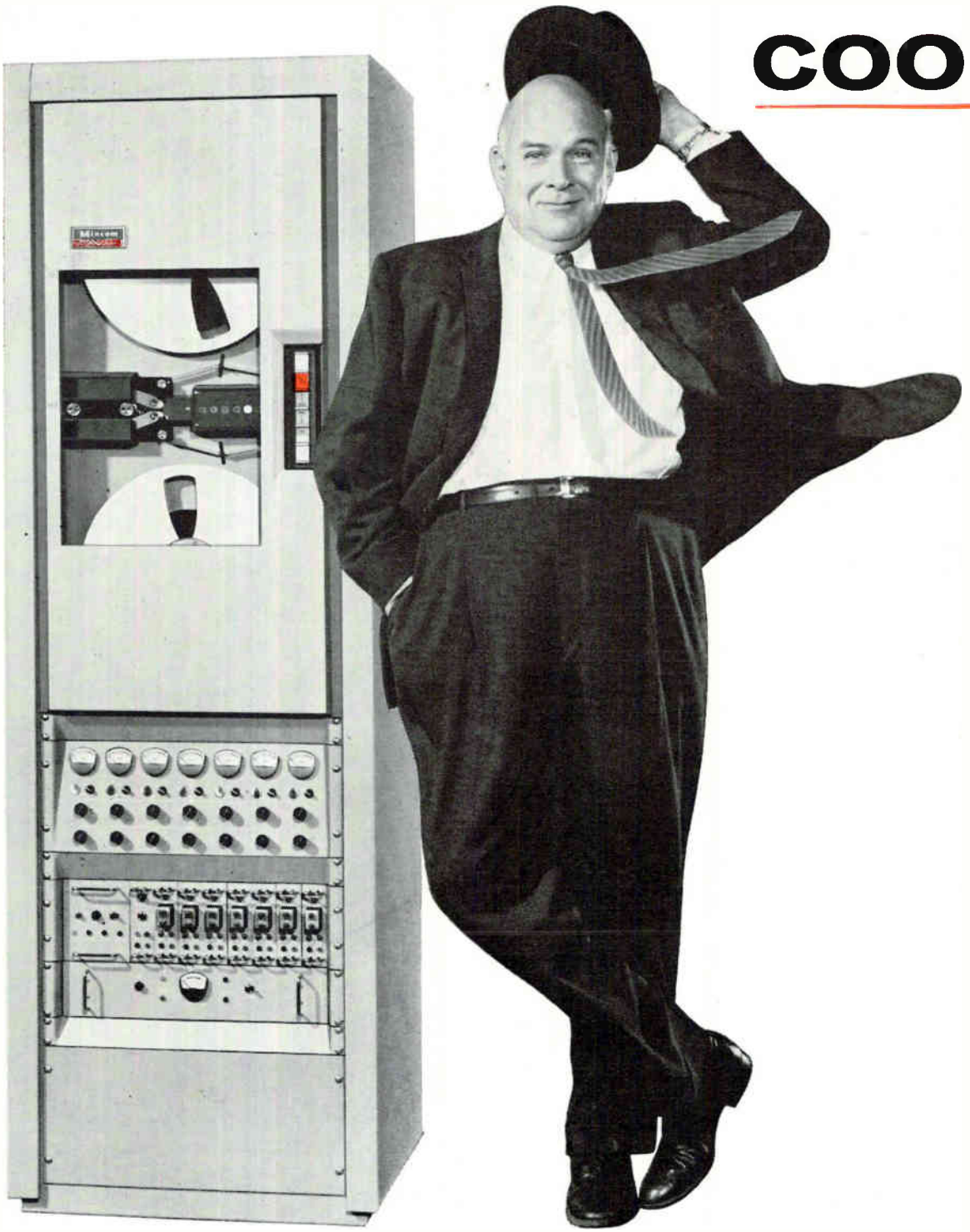
Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario, Canada

Visit us at the New York I. R. E. Show—Booth #2228

COOL



Standby time is no problem with the new, cool (all-transistorized) Mincom C-100. No blowers necessary — and the new Mincom Model C-100 Instrumentation Recorder/Reproducer is particularly new in its simplicity and reliability. Six speeds record frequencies from 50 cps to 100 kc. Only 500 watts input for 14-track system. No mechanical brakes. Only 0.1% flutter and wow. Instant push-button speed control, no belt changes. Interested? Write Mincom for specifications today.

3M ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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CIRCLE 57 ON READER SERVICE CARD

ECONOTAPE crossbar contacts are most efficient for electrical relays

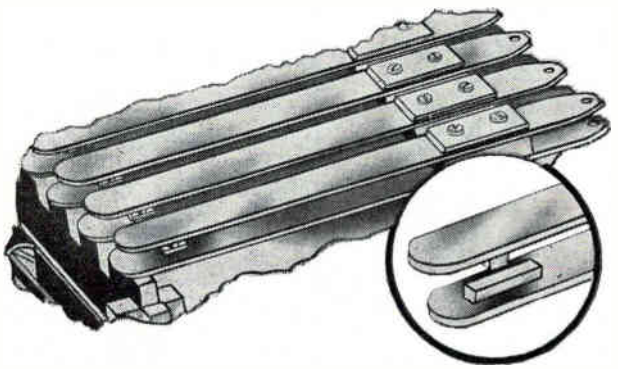
D. E. MAKEPEACE DIVISION

You can now get ideally efficient crossbar contacts for your electrical relays—with as many contacts as you need, where you need them—with positive assurance of full, contact surface. This has been made possible through the development of Makepeace's new ECONOTAPE, a precision-drawn shaped or rectangular contact wire in either solid precious metal or in laminated metal—in your choice of gold, platinum, palladium, silver and their various alloys.

Econotape crossbar contacts are supplied complete, attached to Makepeace blades... attached to blades supplied by you... or Econotape for your own attaching.

Econotape is cut off and welded to the blade in one operation. It is no longer necessary to handle and attach individual button type contacts. Positioning of Econotape on the blade is done automatically as the tape is cut off and welded. Permanent attachment is assured by a homogenous metallurgical bond that is undisturbed by expansion and contraction caused by temperature changes.

If you are designing a new relay or trying to cut the cost of your present mechanism, send for Econotape literature.



D. E. MAKEPEACE DIVISION • PINE & DUNHAM STREET
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fine wire, thin foils, ribbon and tubing in noble metals and their alloys, for all applications.

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The unique combination of properties of the noble metals continually recommend them for industrial applications. Our modern melting, wire drawing, rolling and heat treating equipment coupled with long experience in the field is at your service for production of standard and special items.

WIRES: Bare drawn wire of ductile materials down to .004" —High temperature thermocouple wires—High temperature furnace windings — Potentiometer and Resistance wires — Platinum clad tungsten wire.

FOILS: In platinum, palladium and gold down to .0001"— In iridium and rhodium as thin as .001".

TUBING: Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with .042" wall.

For complete information write for our leaflets, "Fine Wire, Foils, Ribbons" and "Noble Metal Thermocouple Wire".

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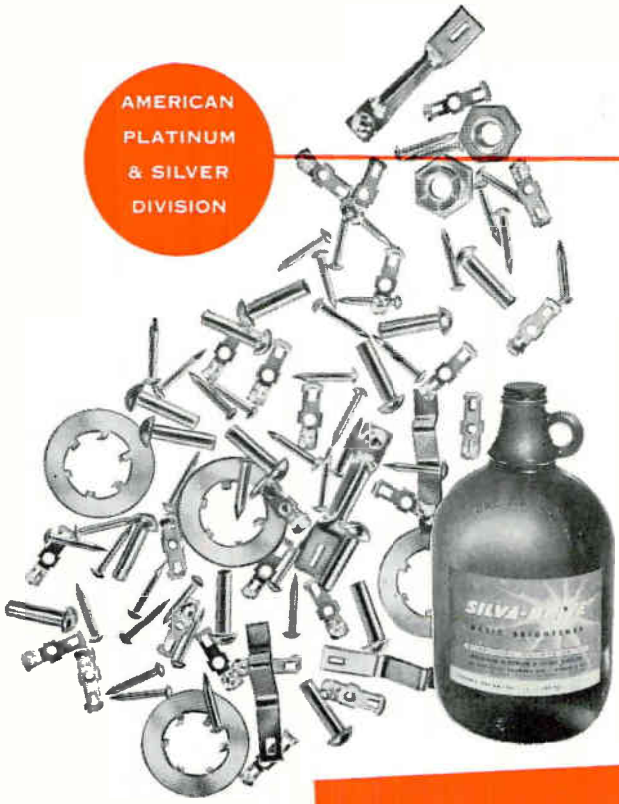
PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER

AMERICAN PLATINUM & SILVER DIVISION



a simplified mirror-bright silver plating process for electrical and electronic components

Here is the most efficient, simple procedure to protect electrical electronic and lamp components with a mirror-bright silver finish—through a complete range from flash to heavy deposit. The procedure is easy, economical and non-critical —with little or no polishing required. Silva-Brite is a clear, water-white solution, enabling the operator to observe work as it is being plated. Uniformly good results are attained with current densities ranging from 10 to 40 amperes per square foot. Normal room temperature operation minimizes fumes and tendency toward bath decomposition. Send for descriptive data together with detailed plating procedures.

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CHEMICAL DIVISION

for low cost purification and drying of hydrogen and other gases

The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million — dried to a dew point of —100°F. *No inert gas purging is needed.* The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

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100% OF ASSAYED PRECIOUS METAL CONTENT • IRVINGTON-BAKER REFINING DIVISION

KAY *Ligna-Sweep®* SKV

Cat. No. 935-A

AUDIO—VIDEO—VHF . . . IN ONE INSTRUMENT!
SWEEPING OSCILLATOR

- FREQUENCY RANGE—200 CPS TO 230 MC.
- SWEEP REPETITION RATES FROM 0.2 TO 60 CPS.
- LINEAR AND LOGARITHMIC SWEEPS.
- AUDIO SWEEP—200 CPS TO 20,000 CPS.

- 3 Highly Stable Video Bands—1 kc to 12 mc., Variable or in Single Sweep.
- RF Output of 1 Volt RMS at 70 Ohms±.5 db Over Widest Sweep Width.
- 8 Narrow Customer Selected Fixed Frequency Bands—20 kc to 12 mc.
- 9 Fundamental Frequency, Wide VHF Bands—10 mc 220 mc.

SPECIFICATIONS

VARIABLE FREQUENCY RANGES: .5-12 mc, .1-12 mc, 10 kc-12 mc, 10-220 mc (9 bands)

FIXED FREQUENCIES: Up to max. of 8 center frequencies (20 kc to 12 mc—Customer selected)

AUDIO RANGE: 200 cps to 20 kc.

SWEEP WIDTHS: Selected for maximum stability 1-10 mc on .5-12 mc band; .2-2 mc on .1-12 mc band; 20-200 kc on 10 kc-12 mc band; 6% to 60% of center freq. to 50 mc and 3 mc to 30 mc above 50 mc on 10-220 mc bands. 2-20 kc on fixed frequencies and audio range.

OUTPUT LEVEL: Continuously variable from 1 volt rms down to 65 db below 1 volt, ±5% over widest sweep. AGC. Audio range: variable .5-1 volt rms.

IMPEDANCE: 70 ohms nominal (50 ohms on request). Audio range: 600 ohms.

SWEEP OUTPUT and REPETITION RATES: Sawtooth for horizontal deflection of oscilloscope. Approx. 7 volts peak to peak—Output Impedance 1000 ohms nom.; fixed 60 cps, line locked; fixed 30 cps, logarithmic (for audio and video application) 3 cont. var. ranges—.2-1 cps, 1-5 cps, 5-30 cps.

MARKERS: Swept signal available for operation of *Vari-Marker SKV* Generator.
Optional Internal Markers. Limited number of sharp, crystal-controlled pulse-type markers at customer specified frequencies can be provided. Please inquire before ordering.

POWER SUPPLY: Input approx. 220 Watts, 117v (±10%), 50-60 cps. B+ electronic regulation.

PRICE: $995.00 f.o.b. factory. Fixed freq. bands add $17.00 per band.

The wide range of frequency and repetition rate in the *Ligna-Sweep* Model SKV make it ideally suited for alignment and testing of a wide variety of electronic instruments—audio amplifiers, filters, communication receivers, radar IF channels, TV receivers and transmitters.

The unit is stable and carefully shielded and filtered to prevent spurious signals on beat frequency video bands. A wide range of sweep repetition rates makes viewing easy on conventional oscilloscopes. Low repetition rates used with long persistence screens permit study of high Q circuitry, LF limits of band circuits and observation of the "ring" characteristics of tuned circuits.

Ligna-Sweep® MODEL CP

SWEEPING OSCILLATORS

Cat. No. 932-A: Variable bands between 100 kc and 215 mc. Price: $750.00 f.o.b. factory. 18 pulse-type markers avail. at customer specified freq., $17.00 each.

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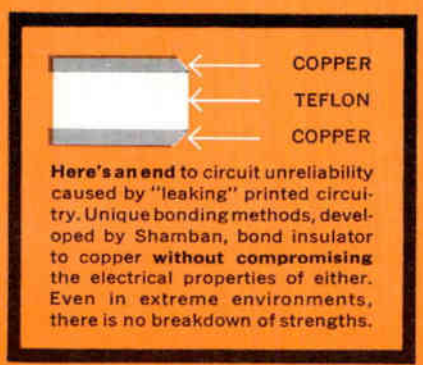
SEE US AT THE IRE SHOW
BOOTHS #3512, 14, 16, 18

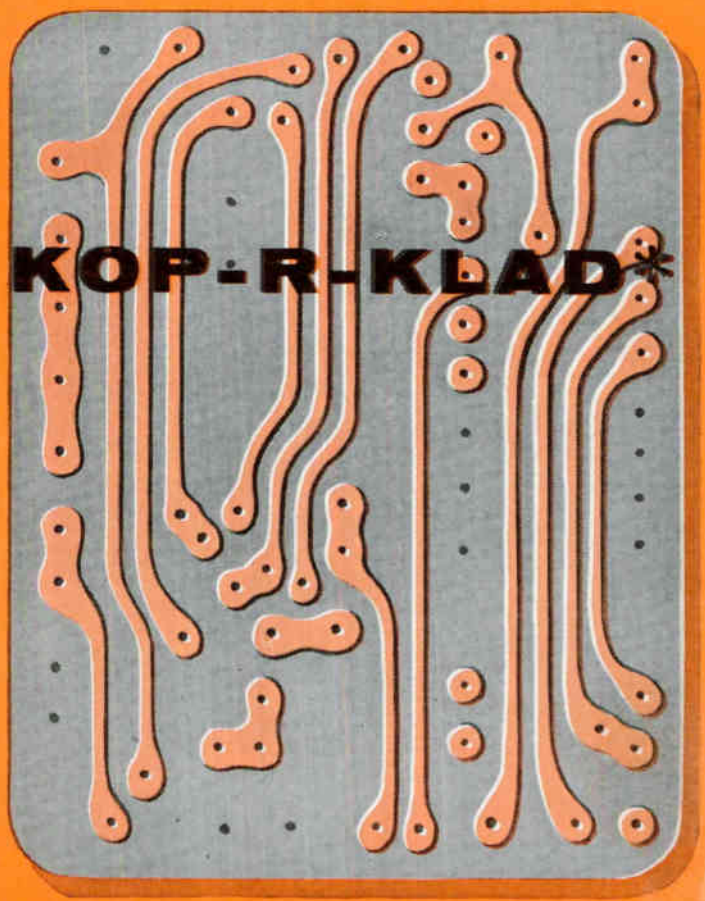
WRITE FOR NEW KAY CATALOG

KAY ELECTRIC COMPANY
DEPT. E-2, MAPLE AVENUE, PINE BROOK, N. J, CApitol 6-4000

NOW SHAMBAN KOP-R-KLAD* printed circuit laminate



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



*Tradename of W. S. Shamban & Co.

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

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

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

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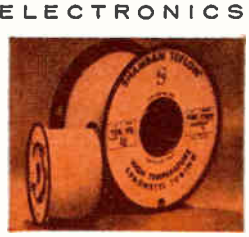
SHAMCO

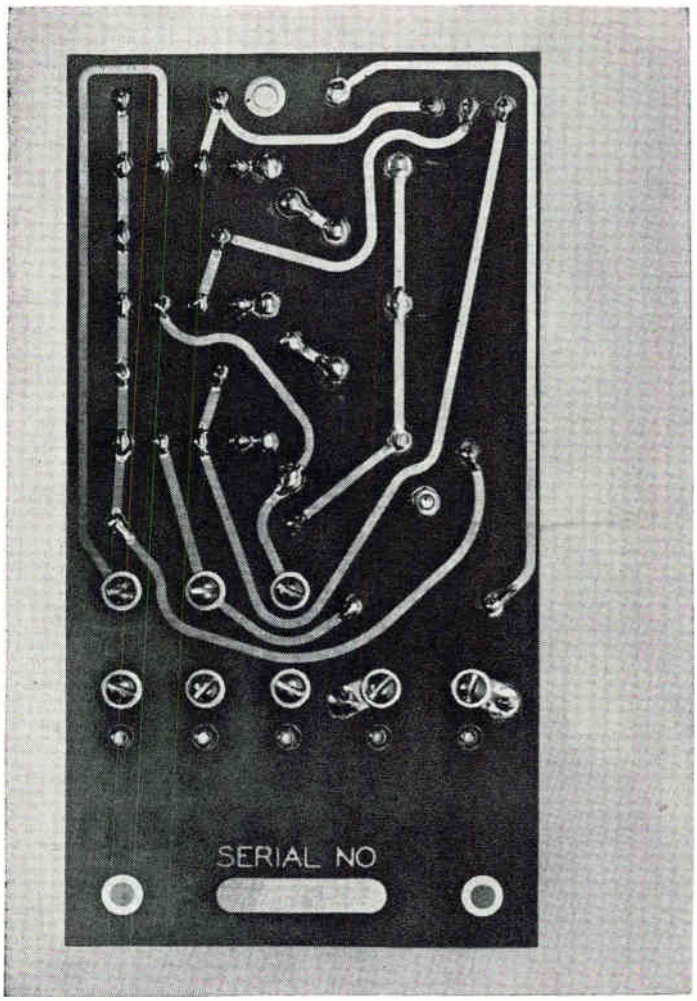
SHAMBAN PRODUCTS FOR ELECTRONICS

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

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



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



High strength-to-weight ratio. This printed wiring board for a phase failure relay (manufactured by Phase-Guard Co., Carnegie, Pa., and distributed by Stradley Engineering Co., Pittsburgh) was designed with CDF Di-Clad 28E (epoxy resin laminated with medium weave glass cloth) for high mechanical strength, very low moisture-absorption, and good insulation resistance. Details upon request.

How CDF Di-Clad® can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DEL.

In Canada: 46 Hollinger Road, Toronto 16, Ont.

TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

NOW $825

A Full Four-Digit Voltmeter at a Pointer Meter Price!

FOR THE FIRST TIME you can have the accuracy, speed and reliability of an NLS digital voltmeter with full four-digit resolution . . . for the price of a quality pointer meter. That's the dramatic story of the new NLS V64! Only NLS high-volume production techniques make it possible. Use the low-cost, versatile V64 for a wide range of measuring jobs. See the V64 in action . . . contact NLS today!

BRIEF SPECIFICATIONS: Accuracy ± (.02% of reading plus 1 digit) . . . full 4-digit resolution . . . measures DC voltages from one millivolt to 500 volts in steps of ±9.999/99.99/500.0 . . . one package design (5¼" high, 15¼" deep for 19" rack) . . . plug-in accessories permit measuring AC or low-level DC voltages . . . available from stock for immediate delivery.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

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

PROJECT CR 4-8884

It takes less than a minute. But it could be the biggest project of your life when you dial CRestview 4-8884. Your *future* is literally at your fingertips, and it's an opportunity-filled future with the Bedford Laboratory of Raytheon Company in Bedford, Massachusetts. In this key laboratory of Raytheon Company's Missile Systems Division a man can literally "pick his spot". Ability is quickly recognized . . . achievement rewarded. And, working and living conditions are the finest available . . . in the heart of New England. If YOU can qualify for one of the following positions, act NOW!

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

Packaging Engineers . . . with a knowledge of packaging and production techniques in sheet metal and electronic equipment. Will design electronic portions of guided missiles, radars, computers, test equipment. Should have thorough knowledge of circuitry.

Electromechanical Designers . . . will design electromechanical equipment and electronic portions of guided missiles, including coordination of effort through the shop. Will work closely with Design Engineers in developing electronic packaging philosophies. Knowledge of electronics, electronic components, and ability to read schematics required. Should have experience in sheet metal equipment design and knowledge of current "state of the art" in electronic equipment.

Call collect CRestview 4-8884 and ask for Mr. Jerry Morris. He will arrange an appointment for you with key personnel at the Bedford Laboratory. If you prefer, send your postcard or letter to Mr. Morris, Raytheon Company, Missile Systems Division, Bedford, Mass.

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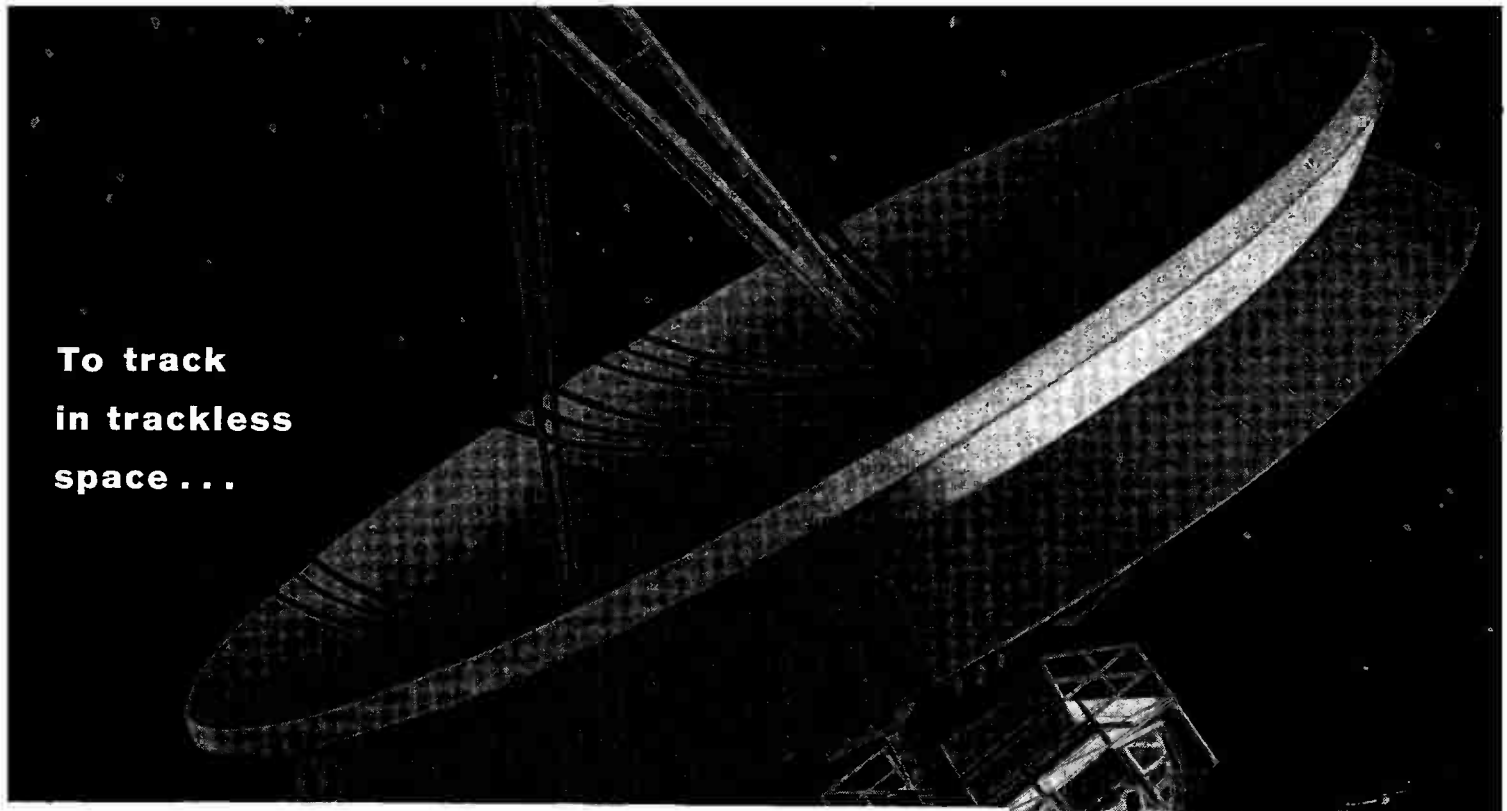

To track in trackless space . . .

Philco has designed and built the world's largest 3-axis tracking antenna

The world's largest 3-axis tracking antenna was recently completed at the Philco Western Development Laboratories in Palo Alto. It will be used at one of the world-wide satellite tracking stations to receive vast amounts of scientific information from outer space. By employing the unique design feature of tri-axial mounting, this extremely accurate and complex instrument, designed and built by Philco, has complete flexibility of movement and can provide continuous coverage of telemetered information and data from satellites and missiles during any phase of flight.

At Philco you will find the skills that come from close association with the involved problems of planning, developing and implementing advanced space communications programs . . . experience that includes the design and construction of antennas of many types. Each fully meets the stringent specifications of the military and various scientific research organizations. Philco stands ready to fill your specific needs.

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Communications and Weapons Systems Division
Computer Division • Sierra Electronic Division
Western Development Laboratories

PHILCO®

Famous for Quality the World Over

This Philco 3-axis antenna stands 80 feet high and weighs over 130 tons. One of its most unique features is the 60-foot reflector—a solid aluminum skin paraboloidal structure manufactured to a tolerance of 65/1000 of an inch over its entire surface to provide maximum reception under the most severe environmental conditions. The antenna maintains its accuracy in winds up to 60 miles per hour and its mechanical efficiency in winds up to 140 miles per hour.

SIZE 8

SYNCHROS • SERVO MOTORS • MOTOR TACH GENERATORS

400 Cycle: Many for 125°C operation . . . Higher for special applications

Many Immediately Available From Stock in Small Quantities

SIZE 8  SYNCHROS

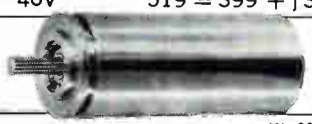
Highly Stable. Minimum Error Variation from −55°C to +125°C

OSTER TYPE	CLASS	INPUT VOLTAGE	INPUT CURRENT AMPS	INPUT WATTS	OUTPUT VOLTAGE	PHASE SHIFT (° LEAD)	ROTOR RESISTANCE (OHM)	STATOR RESISTANCE OHMS	Z_{ro} OHMS	Z_{so} OHMS	Z_{rss} OHMS	NULL VOLTAGE (MV)	MAX. ERROR FROM E.Z. (MIN.)
4253-01*	LZ-CT	11.8	.087	.21	23.5	9.0	157.0	24.0	212+j722	28+j119	263+j69	30	±7
4269-01*	Diff	11.8	.087	.21	11.8	9.0	35.0	24.0	37+j139	28+j124	47+j13	30	±7
4273-01**	XMTR	26.0	.100	.54	11.8	8.5	34.0	12.0	48+j255	12+j45	82+j31	30	±7
4277-01*	HZ-CT	11.8	.030	.073	22.5	8.5	316.0	67.0	500+j1937	79+j350	594+j182	30	±7
4261-01**	Resolver	26.0	.043	.39	11.8	15.0	162.0	22.0	208+j612	34+j159	243+j77	30	±7

*Stator as Primary **Rotor as Primary

SIZE 8  SERVO MOTORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC²
5004-01	26V 26V	288 = 226 + j 176 294 = 238 + j 174	.15	6200	2.0	.47	0.863	1.2	22,500
5004-02	26V 36V	288 = 226 + j 176 526 = 409 + j 332	.15	6200	2.0	.47	0.863	1.2	22,500
5004-03	26V 40V	288 = 226 + j 176 715 = 582 + j 415	.15	6200	2.0	.47	0.863	1.2	22,500
5004-09	26V 40V	230 = 190 + j 131 519 = 399 + j 332	.20	6200	2.5	.47	0.863	1.2	30,000

SIZE 8  MOTOR TACH-GENERATORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC²	GENERATOR VOLTAGE	INPUT WATTS	OUTPUT VOLTS PER 1000/RPM
6204-01	26V 40V	230 = 190 + j 131 519 = 399 + j 332	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25
6204-03	26V 26V	230 = 190 + j 131 230 = 190 + j 131	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25

Oster®

The Size 8 400 Cycle Servo Motor Tach Generators listed above have 150° max. cont. frame temperature, 110 MA input current, ±5° phase shift and Null Voltage (Total R. M. S.) of 15 millivolts.

OTHER PRODUCTS INCLUDE:

Resolvers
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Contact Mr. Robert Burns, Personnel Manager, in confidence.

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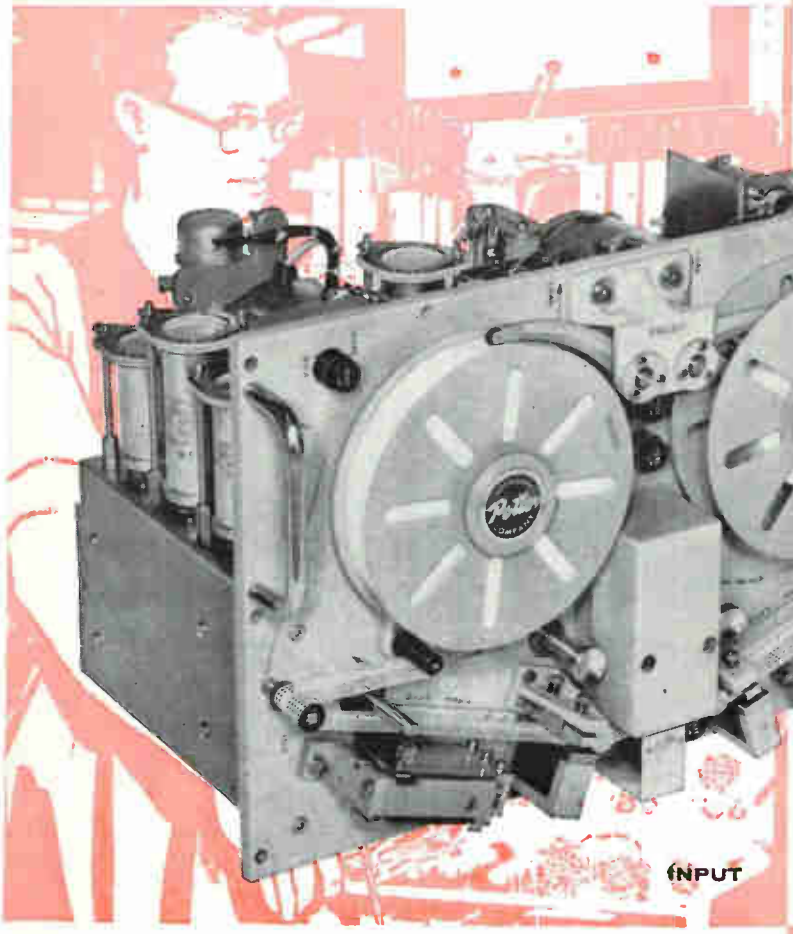
Giving ultimate reliability and superb construction for Military use, MIL Spec., of course



MODEL 3277 PUNCHED TAPE READER

SOLID STATE, MILITARIZED DESIGN

SPEED
Up to 350 characters per second (200 is standard)

CAPACITY
550 feet, 2.5 mil, 1" wide Mylar tape

CHANNELS
Up to 8 information, plus sprocket

RUN-STOP INPUT
10 volts, negative pulse

BI-DIRECTIONAL
External SPDT contact control

START TIME
15 milliseconds to next character at 200 char/sec.

STOP DISTANCE
On stop character

REWIND TIME
1 minute

OUTPUT
—10 volts for logic "0", 0 volts for logic "1"; 40 ma. maximum

DIMENSIONS
17" wide x 11" high x 11" deep

POWER INPUT
28 V D.C., 3 amps; 115V 400 cps, 1 phase, 1 amp.

MODEL 3303 HIGH SPEED PRINTER

SOLID STATE, MILITARIZED DESIGN

SPEED
Up to 10 lines/sec.

CAPACITY
Up to 17 columns in 20 column format

DATA INPUT
(Nominal)—10 volts for logic "1"
(Nominal) 0 volts for logic "0"
Maximum loading 5 ma.

DATA LOADING
Parallel or serial at 30 kc max.

DATA CODING
4 level; all electronics self-contained to store, compare, and print

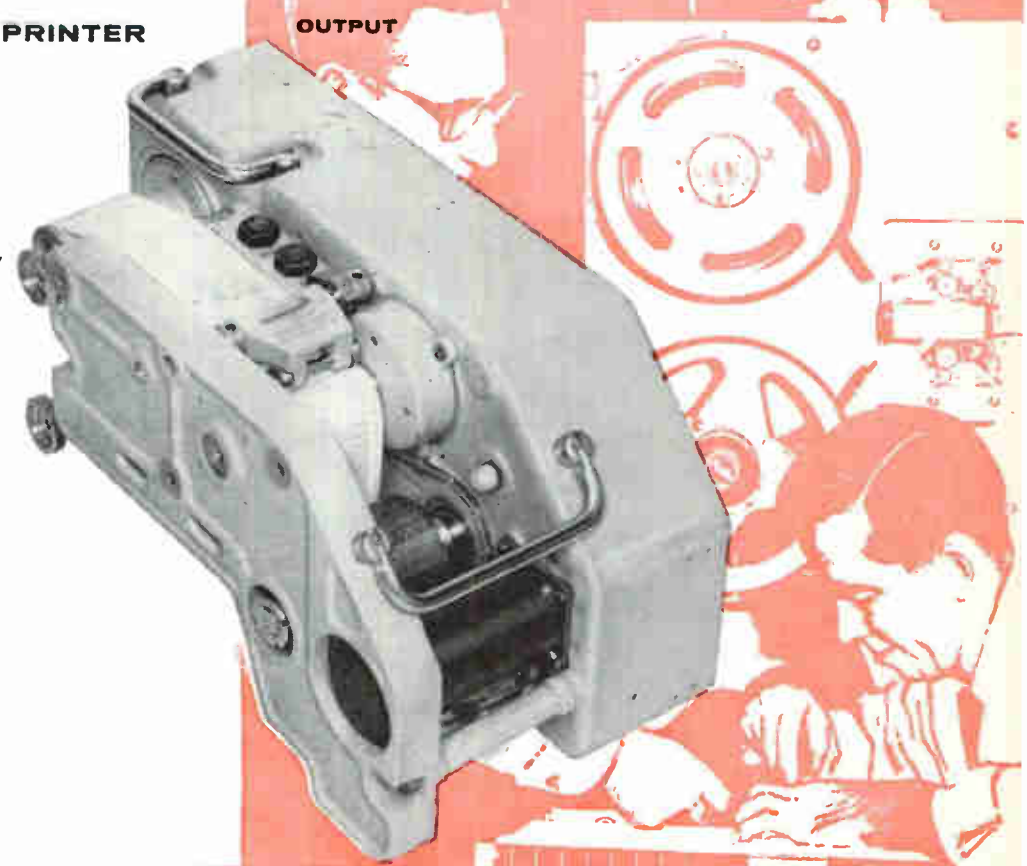
CONTROL FLEXIBILITY
Input/Output signals permit closed loop operation with data source

PAPER STOCK
Pressure sensitive (no ribbon required) with self-contained supply and takeup

DIMENSIONS (Mechanism Only)
8" wide x 8" high x 15" deep

ASSEMBLY
RETMA panel or separate mechanical and remote electronics

POWER INPUT
115 volt, 60 cps, 1 or 3 phase
115 volt, 400 cps, single phase



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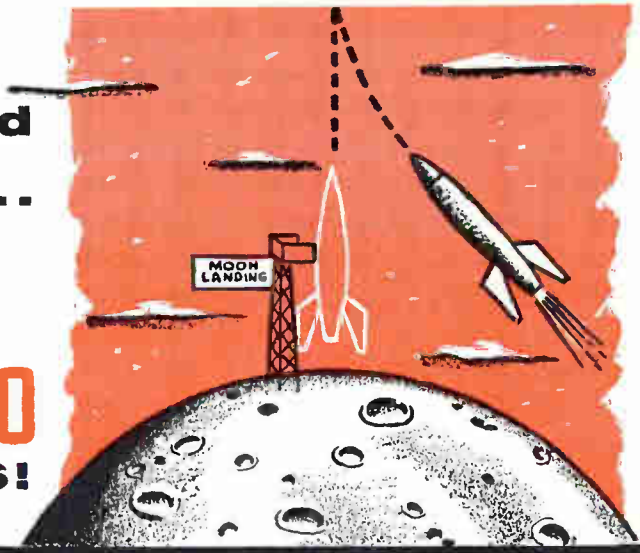
It could happen... with

El-Menco CAPACITORS!



NEW *Mylar-Paper Dipped CAPACITORS TYPE MPD

INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure in 7,168,000 Unit-Hours for 0.1 MFD Capacitors*

Setting a new standard of reliability!

*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 716,800 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.

SUPERIOR FEATURES!

- *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MMF
1600 WVDC —	.001 to .05 MFD

SPECIFICATIONS

- **TOLERANCES:** ±10% and ±20%. Closer tolerances available on request.
- **INSULATION:** Durez phenolic resin impregnated.
- **LEADS:** No. 20 B & S (.032") annealed copper-weld crimped leads for printed circuit application.
- **DIELECTRIC STRENGTH:** 2 or 2½ times rated voltage, depending upon working voltage.
- **INSULATION RESISTANCE AT 25°C:** For .05MFD or less, 100,000 megohms minimum. Greater than .05 MFD, 5000 megohm-microfarads.
- **INSULATION RESISTANCE AT 100°C:** For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- **POWER FACTOR AT 25°C:** 1.0% maximum at 1 KC.

Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS #MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE . . . COUNT ON EL-MENCO MYLAR-PAPER DIPPED CAPACITORS . . . FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

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El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors

● molded mica ● dipped mica ● mica trimmer ● dipped paper ● tubular paper ● ceramic ● silvered mica films ● ceramic discs

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Optically as far as the first obstruction. For some, the same applies to mental vision. By seeing beyond the apparent obstacles, established theories or accepted principles, Fairchild Semiconductor Corporation has been able to achieve spectacular product innovations in transistors. Because of this faculty, the company has grown from an original nucleus of eight scientists to a complement of more than fourteen hundred in little more than two years.

From continuing research and development work through engineering, tooling, manufacturing and testing of products on the line, the success of Fairchild is built on the abilities of its men to see around the obstacles and move beyond. It has resulted in products more advanced than any others of their type and in a solid reputation for quality workmanship.

In a rapidly growing company with many challenging programs (e.g. current work on Esaki diodes and micro-logic circuits), there is a constant need for men who can see beyond the first obstacles. If yours is a relevant background and you find our approach attractive, we would like very much to hear from you.

FAIRCHILD
SEMICONDUCTOR CORPORATION

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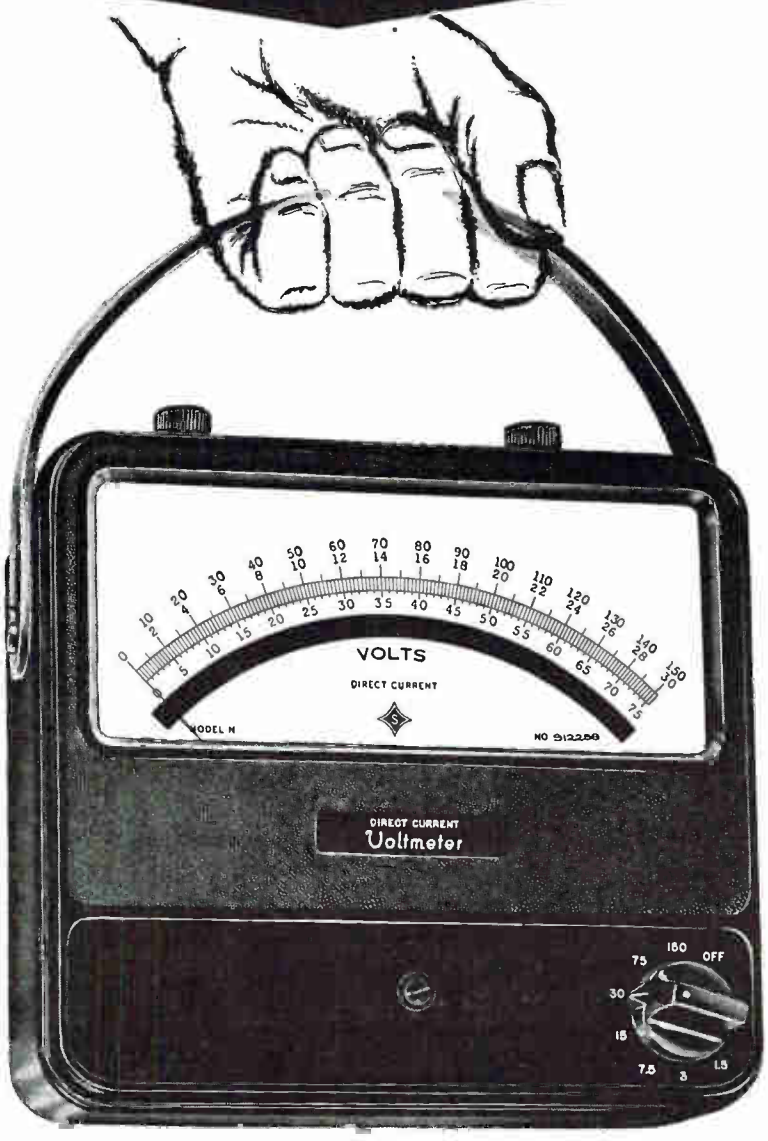
SENSITIVE RESEARCH

THE *New* MODEL "N"

A new series of AC and DC portable electrical indicating instruments — *that can also be panel mounted.*

A *New* HIGH in accuracy, resolution, and stability.

A *New* LOW in cost.



Model "N"

In short, the SRIC Model "N" series probably has just the instrument for which you've been looking **HIGH** and **LOW.** The Model "N" is a true "secondary standard" because it is engineered and manufactured by "standards people."

GENERAL SPECIFICATIONS:

Accuracy: .5% of full scale.

Scale: Hand-drawn and mirrored.

Scale length: 6".

Resolution: 100 to 150 division.

Ranges: DC from 50 ua. to 50 A. and 20 mv. to 1000 v. full scale. AC from 10 ma. to 10 A. and 7.5 v. to 750 v. full scale.

Availability: 1 to 8 ranges completely switch-controlled and self contained.

Construction: DC — double pivoted permanent magnet type. AC — moving iron vane for RMS measurements and germanium rectifier type for average reading measurements.

Shielding: Magnetic and electrostatic.

Pivots and Jewels: High carbon steel pivots and shock mounted sapphire jewels. (Diamond pivots available on special order).

Case: Black moulded bakelite with leather carrying handle. Size 7½" x 6¾" x 3½".

The *New* Model "N" is a stable, rugged, versatile field or laboratory instrument that is *spectacular* because in every way it offers a little bit "more" than any other instrument in its class. It is available in standard range combinations or in quantities with special ranges and/or special scale markings.

***The New* Model "N"** *conforms to ASA specs. C 39.1-1951 for .5% class instruments. All SRIC instruments are calibrated against primary standards that have National Bureau of Standards Certificates of Accuracy and are unconditionally guaranteed for a period of one year.*

The movement construction shown features a large size U-shaped magnet with an inherently high torque-to-weight ratio, stability and sensitivity — and not the common center core magnet usually found in instruments in its price range.

SENSITIVE RESEARCH INSTRUMENT CORPORATION

Symbol of Quality

NEW ROCHELLE, N. Y.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

ALLIED'S New CRYSTAL CAN 5 amp Relay

GENERAL FEATURES

Contact Arrangement:
Two pole double throw.

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

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

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

Initial Contact Resistance:
.05 ohms maximum.

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

Ambient Temperature:
−65°C to +125°C.

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

Insulating Resistance:
10,000 megohms minimum.

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

Shock: 50 g operational. 100 g mechanical.

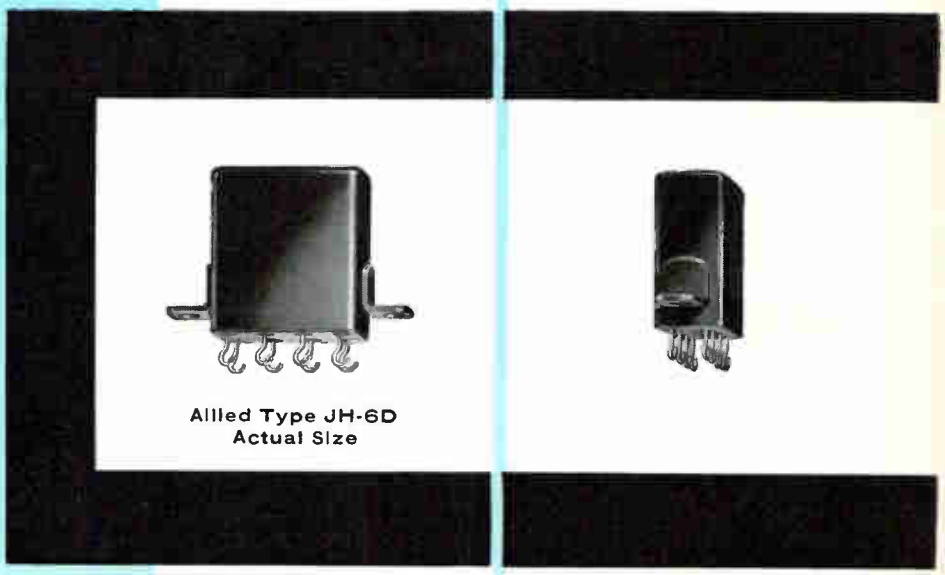
Operate Time:
10 milliseconds or less at rated voltage at 25°C.

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

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

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

Weight: 0.8 ounces maximum.



Allied Type JH-6D
Actual Size

Write
for
Bulletin
JH-6D

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N.Y.

CIRCLE 71 ON READER SERVICE CARD

CDE *Consistently Dependable Capacitors*

TEFLON
−55°C to +250°C

MYLAR
−55°C to +160°C

POLYSTYRENE
−55°C to +85°C

Cornell-Dubilier film dielectric capacitors... reliable for temperatures up to 250° C (under proper operating conditions)

Turn up the thermostat! Cornell-Dubilier's Teflon* film dielectric capacitors can take the heat...up to operating temperatures of 250°C without a moment's discomfort. For that matter, C-D's Mylar* and polystyrene are almost equally immune to any environmental, life or performance ordeal to which you may want to put them. C-D film dielectrics also offer the widest selection of electrical ratings, case styles, materials and configurations to satisfy space, weight and cost limitations. And they are immediately available in production quantities.

Ask now for C-D engineering assistance and bulletins on all the film dielectrics shown here. Write to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. *Manufacturers of consistently dependable capacitors, filters and networks for electronics, thermonucleonics, broadcasting and utility use for 50 years.*

*DuPont Reg. T.M.

CDE **CORNELL-DUBILIER ELECTRIC CORPORATION**

AFFILIATED WITH FEDERAL PACIFIC ELECTRIC COMPANY

CIRCLE 73 ON READER SERVICE CARD 73

ELECTRONICALLY speaking.....

CUBIC DIGITAL SYSTEMS

speak for themselves:

DC VOLTAGE MEASUREMENT: Models V41, V51, with Control Unit C-1

AC VOLTAGE MEASUREMENT: Models AC-1 (manual ranging), AC-2 (Automatic) AC Converters

RESISTANCE MEASUREMENT: Models 0-41, 0-51 4 and 5-digit Ohmmeters, with Control Unit C-2

VOLTAGE RATIO MEASUREMENT: Models R-41, R-51 Ratiometers, Models VR-41, VR-51 Volt-Ratiometers

INPUT SAMPLING: Model MS-2 100-point Scanners, Models MS-1, AS-1 Master-Auxiliary 1000-point Scanning Systems

DATA RECORDING: Model PC-Series Printer Controls for use with any quality printer on the market

Cubic Corporation manufactures *the superior* digital instrumentation, including the Voltmeter with these unparalleled electronic features:

.003% repeatability, precise accuracy again and again

.003% attenuator accuracy for wide-range precision

.003% bridge linearity with carefully matched quality components

PLUS maximum noise rejection with the finest input filter known ... and unmatched stability through superior noise rejection.

The Cubic 4 and 5-digit Voltmeters are only two of the superior instruments in a line of digital instrumentation available on an off-the-shelf basis for simple bench use or for easy development of sophisticated systems for measurement and recording.

NEW FROM CUBIC . . .

The Talking Meter, instrumentation that really does speak for itself, instrumentation that provides a new dimension in "readout," measurements or other parameters reported to the ear by a clear human voice.

Years-ahead engineering, factory production techniques inspired by pride in the end result, careful quality control and reliability testing . . . all these factors make Cubic's the truly fine instrumentation . . . Digital Systems that speak for themselves.

CUBIC CORPORATION
INDUSTRIAL DIVISION
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Electronic Engineering With a Dimension for the Future

Electronics

RESEARCH & DEVELOPMENT

Around the World

SCIENCE IS UNIVERSAL and knows no borders. This is particularly true of electronics, which heavily influences all other sciences.

Any complacency that might have existed in the United States regarding the scientific abilities of other countries was largely dispelled by Sputnik, has been further dissipated by the recent success of other countries in export markets and, indeed, within the United States itself. Many countries in a disadvantageous economic position immediately following the war are now making up for lost time.

Research and development in the field of electronics is rapidly advancing in the countries covered within this special report by men recognized as expert. They were approached personally in ELECTRONICS' behalf by McGraw-Hill's unique World News Bureau, and we are particularly indebted to representatives in London, Paris, Milan, Stockholm, Zurich, Tel Aviv, Tokyo and Melbourne for the result.

Not all scientifically important countries are covered, nor are all the important research and development activities within these countries. Security requires some omission abroad as it does at home and commercial reticence is not unheard of. We have carried many stories about specific Russian engineering and will again. But to our request for a roundup the Soviet officially said "Nyet." A West German author promised a report right up to deadline and then cabled that company executives had turned thumbs down. A Netherlands author led us to believe he would cover the Dutch waterfront and then delivered a description of one project preoccupying one company which we will publish conventionally later.

We found the reports that follow informative, instructive and fascinating to read in detail. We hope this will be your reaction.

W W MacDonald

EDITOR

EASTWOOD

ENGLAND

Silicon parametric diode may lead to breakthrough, thin-film magnetic storage approaches ability of brain, waveguide point-to-point system attracts attention and c-w radar returns to the news

By ERIC EASTWOOD

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AT NO PREVIOUS TIME in the history of telecommunications has the rate of progress been greater than at present; neither has there been greater opportunity for new ideas and inventions. This is true whether we consider the basic devices, materials and circuit elements of electronics on the one hand, or, on the other, the association of these components to form the systems necessary to order the fundamental processes of sensing or information collection, information transmission and, finally, data utilization and control.

SEMICONDUCTORS AND TRANSISTORS—If the period 1948-1958 were termed the "Decade of Promise" for the transistor, then the period 1958-1968 must surely be the "Decade of Fulfilment". No longer does the research engineer merely assess the contribution that transistors might make; he is too busy seeking new devices the development engineer is demanding for his next circuit design.

The British transistor industry is growing rapidly to meet the needs of the new era of electronics. It is not allowing its preoccupation with production and testing techniques to obscure the need for devices capable of operating at higher frequencies and at higher power levels. Structures of all kinds are being investigated. For example, interest in transistor geometrics has brought a germanium mesa structure of the 500-mc class to the production stage. (Ed. Note: Illustrated in pictorial section of this Report.) This type of work depends greatly upon the availability of primary material of the requisite purity.

Silicon devices, with their promise of better temperature performance, are making steady progress. Progress is likely to be speeded with the wider use of the vapor deposition—floating zone purification technique. In this connection, recent work on the silicon parametric diode may lead to a semiconductor break in the kilomegacycle circuit engineering field.

THIN-FILM STORAGE—A transistor capable of operating effectively at frequencies in the order of hundreds of megacycles is required urgently, not only to permit complete transistorization of the tv, vhf and uhf bands, but also to accommodate high speed switching characteristics of thin-film magnetic storage elements which are likely to emerge in the near future.

Intense research effort is being devoted to the magnetic properties of thin films, and it is clear that turnover times measured in millimicroseconds will be achieved. It is an impressive thought that storage elements of this type, in association with the new transistors that will be developed to match them, can lead to such a high degree of miniaturization that information storage capacity not incomparable with that of the brain itself may be feasible. The problem of access to these active storage elements still remains formidable, for we have as yet nothing comparable to the elegant electrochemical linkages achieved by the brain and the central nervous system.

RADAR—Developments in military radar during the early postwar years were still directed towards the wartime operational objective of countrywide defense against airborne attack. The aim was to achieve comprehensive radar cover and, to this end, transmitter powers were substantially increasing. Low noise-figure receivers and highly directive antennas were also developed, with other components.

Many of these developments have now become available for civil use, but their adaptation is a highly selective one since the civil need can depart widely from the original military objective. A military radar seeks for good range performance in spite of electronic countermeasures by an enemy; it is thus not possible for transmitter power to be traded for receiver noise figure. In the civil case, no jamming exists and economics demands that receiver noise figure be improved in order to reduce the need for transmitter power. For this reason, civil interest in parametric amplifiers is great.

The threat of jamming influences the military choice of radar frequencies, but civil authorities are free to choose the frequency best adapted to their purpose. This freedom has recently been exercised by the Ministry of Transport and Civil Aviation, who has stated its intention to use the 50-cm band as the wavelength of one of the components of its new Airways Surveillance System. This choice is dictated by the desire to reduce rain and ground clutter effects to a minimum, and so to secure continuous tracking of all traffic in the airways. The new approach to the civil radar problem is illustrated by the 500-kw output stage of a transmitter that has recently appeared. This radar is based on a new 50-cm klystron which permits maximum advantage to be taken of a fully coherent system, achieving both good cover performance and reliable MTI.

DIRECTIVE ANTENNAS—Large-aperture antennas which provide very narrow beams in the horizontal plane are as attractive to civil authority as to the military, but in both cases it is necessary that sidelobes be reduced to a minimum. A great deal of effort is, therefore, being applied to the sidelobe problem and in this work simulation studies by electronic computers of required phase and amplitude patterns are making a great contribution. No longer can 20 db be accepted as an adequate first sidelobe.

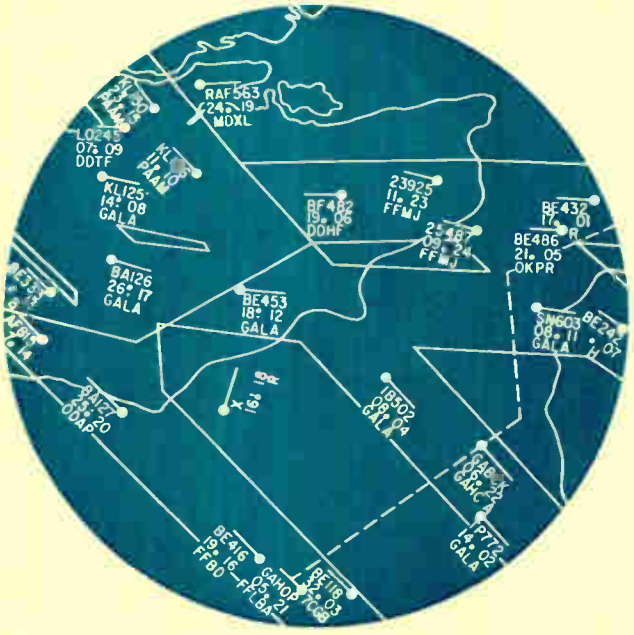

FIG. 1—Symbolic, or synthetic, ground-radar display for civil air controller

The large antenna also poses many difficult mechanical problems such as the accurate figuring of a large double curvature reflector, techniques of stressed skin fabrication and profile distortion in wind. These problems are being studied not only in radar laboratories but also in communication laboratories because of their interest in tropospheric scatter systems. Airframe manufacturers are interested since it has been found that techniques developed for the accurate fabrication of wings can be of great assistance to the antenna designer.

The combination of greatly increased transmitter power and very large antennas for both radar and communications has produced a recognition of how little is known of the effects of microwave radiation upon the human body. Study of the physiological effects of intense fluxes of radio-frequency power has been commenced and considerable thought devoted to the development of foolproof alarm devices to indicate when the flux at any selected location exceeds the 10 mw per square centimeter which is at present regarded as a reasonably safe limit for continuous exposure.

CIVIL AIR TRAFFIC CONTROL—The growing volume of air traffic is likely to saturate the present system of procedural control in the not too distant future. At present the safety of aircraft is insured by imposing physical separations which are excessively wide, and this leads to rapid saturation of the airways' capacity. The introduction of ground radar will permit the authority to monitor the content of the airways more accurately.

The introduction of this system will demand not only a comprehensive radar data handling system, but also the integration and utilization of both radar data and the present procedural information derived from flight plans and aircraft reports. The problem of utilization of radar data is consequently being studied as a matter of urgency in many radar laboratories, industrial as well as governmental, and much effort is being applied to the development of components that will probably be required. One such component is the symbolic or synthetic display illustrated in Fig. 1; such a display permits the controller to present edited information and position about classes of aircraft selected from the storage device and is more adapted to his task than is a raw radar display. The alphanumeric characters shown upon the screen are derived from a transistorized character generator, and are located about the point on the plan display which is the extrapolated position to be taken up by the aircraft at any selected time.

COMMUNICATIONS—Progress towards more information-carrying capacity in the Hartley sense goes on continuously, and methods of improving the signal-to-noise ratio on any circuit are still as earnestly sought after. Improvements in antenna performance are as vital to the communication engineer as to the radar engineer. It is now considered essential, for example, to achieve sidelobe levels in the tropospheric case of not worse than 36 db.

Improvements of signal-to-noise ratio by reduction

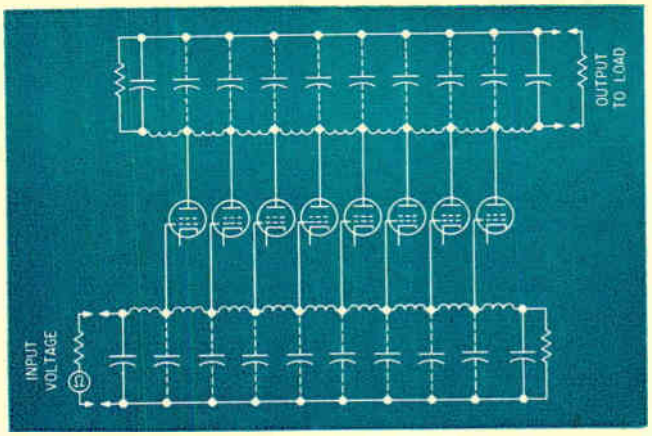

FIG. 2—Broadband distributed amplifier in simple form

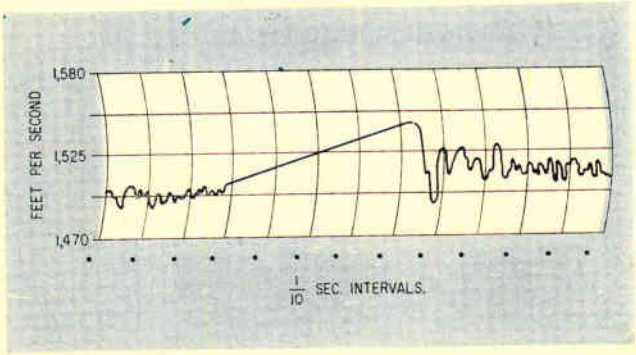

FIG. 3—Cw-radar trace of shell leaving muzzle of gun

of receiver noise figure is always attractive to the communications engineer and explains the great interest which is being taken in parametric amplifiers. Applications of the Adler-tube type of amplifier must await the successful conclusion of development work by the tube engineers; the semiconducting-diode type of unit is receiving attention in most system laboratories and is proving a somewhat difficult device to stabilize and hold to acceptable tolerance.

Broad-band operation characterizes the greater part of telecommunication development today, including the hf band. Optimum information transmission demands the ability to change frequency rapidly, so that the correct propagation path permitted by the state of the ionosphere may be established. This change of frequency has normally been produced by adjustment of the tuning capacitor, but the requirements for remote control and the need to achieve reliability in the electromechanical elements involved have presented the transmitter designer with a problem. The Marconi solution to this problem is to use a distributed amplifier. Such amplifiers have long been in use at low power levels.

A simple form of distributed amplifier is shown in Fig. 2. The input signal is applied to an artificial line in which the shunt capacitance is provided by the tube input capacitance. Each tube is driven in succession, the time delay depending on the properties of the artificial line. The anodes feed a transmission line having identical delay characteristics. Half the anode current of each tube will travel to the right and will add in phase in the output load R_o. The transmitter elaborates this basic circuit and also employs a two stage amplifier. The input is 10 to 20 mw at the radiated frequency and the output from the high power stage is 1 kw.

Research effort is being applied to other modes of communication, particularly point-to-point. The H_{01} mode of waveguide transmission is generating a surprising amount of interest for a subject which many engineers might have thought to be wholly academic. This is not the case, however, as the rapid growth of television and the need for large channel capacity to accommodate digital transfer of business data suggests that short-haul H_{01} linkages into busy city centers may not be too far distant. To meet this need in the future, study is being made of modulation techniques, the virtues of fm and pcm are under scrutiny and special thought is being given to the characteristics of the waveguide and the methods for its fabrication and installation. A recent demonstration by S. T. & Co. of such a circuit transmitting a color-tv signal was most impressive.

SATELLITE WORK—The initiation of a modest satellite research program by the government has stimulated interest in satellite communications. Telemetry circuits, or data links that might be used in such work, are being actively considered and the design problems associated with packaged transmitters and power supplies in a satellite environment are in the early laboratory stage.

Communication circuits depending upon reflection from families of satellites in the role of passive repeaters are also being examined for feasibility and from the point of view of economics. In this connection the recent successful experiments on moon communication conducted by Jodrell Bank with the aid of a Pye 201-mc transmitter are extremely suggestive.

CW DOPPLER STUDIES—Although the effectiveness of cw radar as a research tool was demonstrated by Appleton as long ago as 1923, when he commenced his investigations on the structure of the ionosphere, the technique of radiolocation by use of continuous waves received scant attention during the wartime years compared with its pulsed counterpart. It is, therefore, all the more remarkable that there should have been a great upsurge of interest in cw radar methods during the last year or two.

In the first place, developments in high-power pulsed radars for military deployment were rapidly approaching the point where major limitation on performance was produced by the earth's curvature. Or, rather, this would have been the case had not the emergence of high-power microwave jamming devices profoundly changed the whole situation. A sure method of improving the performance of a radar in the presence of electronic jamming is to increase the transmitter power, but this is economically expensive. To increase the mean power of a pulsed radar required that many difficult problems associated with the generation and handling of high-power pulses should be overcome, and so it was attractive to consider the cw approach to the problem of increasing the level of the average power radiated. Again, in certain military situations accurate range

information on a target is unnecessary, but initial detection and angular coordinates are essential. In such a case the cw radar, with extraction of the doppler signal, is ideal.

Civil interest in cw radar techniques has also grown during this period because of a number of requirements that demand the use of a radar capable of operating over very short ranges, probably in the presence of heavy ground clutter and with the need for accurate velocity extraction. Examples of civil applications are traffic control on both road and rail and velocity-measuring radars applied to the study of automobile performance and braking.

Growth of interest was fortunately matched by intensive research work in a number of tube laboratories, aimed at producing the necessary generators of microwave power. This work has resulted in spectacular reduction in am and fm tube noise produced in cw klystrons, accompanied by great increase in power output. The klystron work is also being influenced by the needs of tropospheric-scatter communications, and the net result is that klystron generators are now available having a wide range of power outputs well above one kilowatt, at frequencies which span the whole microwave band from 500 mc to 10,000 mc.

The power of the cw approach, also the trend in design of small velocity measuring radars, is illustrated by a new electronic velocity analyser. This unit provides a means of obtaining a continuous and highly accurate record of the velocity-time characteristic of a whole class of moving targets such as aircraft at takeoff or touchdown, road vehicles, projectiles from guns, rockets and guided missiles. The equipment operates at X-band and provides an accuracy in velocity measurement of ± 1 ft per sec within any velocity bracket of 115 ft per sec up to 5,000 ft per sec. To facilitate velocity bracket selection, the local oscillator is of switched RC type which can be phase locked to suitable harmonics of a crystal-controlled oscillator. The performance of this type of velocity measuring radar is illustrated in Fig. 3, which shows the velocity-time record yielded by a shell leaving the muzzle of a gun.

IMPROVED COMPONENTS—The various subjects discussed above represent some of the more exciting prospects in telecommunications, but it would be inappropriate to close without some reference to the less exciting but equally vital work that is directed towards improvement of the basic elements of the whole technology, the electronic components themselves.

Reliability in military electronic equipment is essential, and so it is not unnatural that government establishments should have provided leadership in this field. The military electronic environment is also somewhat exotic, but the component designer in meeting the needs of guided missiles and supersonic fighter aircraft is also helping to provide higher reliability in civil electronic equipment. The industrial laboratories are profiting from this work and they may always be relied upon to temper military desirability with commercial expediency.

FRANCE

Nuclear fuel leaks detected by "sweating", tubes cooled by static water, micro electron-probe analyzes alloys, new ferrites promised, masers measure earth's field and help spectroscopy

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GOUDET

GRIVET

FRANCE participates actively in the world's technical evolution, thanks to increasing research and advanced development. This work is shared among the universities, schools of engineering, the Centre National de la Recherche Scientifique, several large state organizations such as the Centre National d'Etudes des Telecommunications and many private industrial laboratories.

Scientific development faces an acute shortage of manpower, and various remedies are being put into action. The universities have introduced a short cycle leading to a simplified Ph.D. thesis in two years;

French HIEROGLYPHICS

CAMECA	Compagnie d'Applications Mecaniques a l'Electronique au Cinema et a l'Atomistique	Paris
CEA	Commissariat a l'Energie Atomique	Gif-Sur-Yvette
CENG	Centre d'Etudes Nucliaires de Grenoble	
CFTH	Compagnie Francaise Thomson-Houston	Paris
CGE	Compagnie Generale d'Electricite	Paris
CIT	Compagnie Industrielle des Telephones	Paris
CNET	Centre National d'Etudes des Telecommunications	Issy-les-Moulineaux
CNRS	Centre National de la Recherche Scientifique	
CSF	Compagnie Generale de TSF	Paris
INSA	Institute National de Science Applique	
LCT	Laboratoire Central de Telecommunications	Paris
LEP	Laboratoire d'Electronique et de Physique Appliques	Paris
LMT	Le Materiel Telephonique	Boulogne-Billancourt
LTT	Lignes Telegraphiques et Telephoniques	Paris
OPL	Optique et Precision de Levallois	Levallois-Perret
PTT	Poste de Telegraphe et Telephone	
SAT	S.A. de Telecommunications	Paris
SEA	Societe Technique d'Application et de Recherche Electronique	Nogent-Sur-Marne
SILEC	Societe Industrielle de Liaisons Electriques	Paris
STAREC	Societe Technique d'Application et de Recherche Electronique	Nogent-Sur-Marne
TRT	Telecommunications Radioelectriques et Telephoniques	Paris

many are building new specialized institutions.

WIRELESS COMMUNICATION—The network of 4000-mc radio links for telephone and tv is being extended. For example, a network extends through Corsica and Sardinia to Algeria, and has been interconnected with Switzerland, Germany and Belgium. More recently, a connection between Lille and Folkestone, England, has been established by LMT.

Among interesting new developments is a cigar or "sausage" radiator, and a new transmission method combining tropospheric scattering and diversity by variation of frequency. Another is that of STAREC, which has developed a slot antenna for jet airplanes covering 225 to 400-mc and multicouplers for vhf and uhf to be used in Paris airports.

WIRE COMMUNICATION—The Marseilles-Algiers submarine cable now handles 60 channels, uses 28 flexible bidirectional repeaters developed by CIT.

The use of H_{01} (or TE_{01}) mode in waveguides for long distance links is being studied.

Another recent achievement is a 240-line fully electronic telephone switchboard developed by LCT. Conventional electromechanical switches have been replaced by cold-cathode tubes controlled by a central computer using semiconductor devices and ferrite memories.

TELEVISION—Several companies have produced lightweight sets for industrial purposes or for submarine prospecting based on vidicons. There is also color tv designed for surgical operations.

RADAR AND NAVIGATION—Laboratories Derveaux has developed a 10,000-mc radar and a range finder for aircraft, 3,000 and 10,000-mc navigation radars for ships, radars for harbor surveillance and associated beacons.

CSF is producing the radar used in the Mirage III fighter and has also developed a system of diversity reception for long-range protection; it is used by NATO in various areas of Europe.

COMPUTERS, INDUSTRIAL CONTROL—The OMEL2 is a versatile and popular analog computer. It uses 12 d-c amplifiers, 30 potentiometers for the insertion of coefficients or initial conditions, and may be used with a rack of nonlinear elements working as function synthesizers or multipliers or with a short-cut system for inverting matrices. One analog computer uses only passive components and operates with hf currents.

Companies des Machines Bull has constructed digital computers utilizing delay lines for memories (capacity 12 bits) in models suitable for accounting. For scientific calculations, these can use a magnetic drum which multiplies capacity by a factor of 1,000.

In the domain of industrial control, one good example of progress is CIT equipment for control of the first nuclear power plant of Electricite de France, at Chinon. During a scanning cycle of one minute, it registers temperature of 1,250 rods. Another example is the monitoring and control equipment of the EL3 reactor installed by the National Atomic Agency in Saclay. It performs neutron flux measurements, manual or automatic driving of the reactor, control of the safety rods, measurements of radiation and collects physical data such as temperature, pressure.

In the domain of components, SEA is producing an efficient type of d-c servomotor with printed flat windings.

REACTORS, ACCELERATORS—Saturne has built a three-gev proton synchrotron. Among the main electronic problems involved was automatic control of frequency, which must continuously vary between 650 kc and 8.5 mc. This was solved by using a Ni-Zn ferrite, the "Fernilite" of LTT. This material is used in the master oscillator as well as in the main accelerating cavity; it has made it possible to reduce the necessary hf power to 1 kw, which is one-tenth

that of earlier types. The frequency-control equipment itself, made by SEA, comprises an analog computer, an integrator and a power amplifier. It maintains the instantaneous frequency to an accuracy 10^{-3} at the beginning of a cycle and 5.10^{-3} at the end.

A linear electron accelerator has been built for the new Paris University by CSF. This design provides presently 50-ma peak current, with a repetition rate of 300 per second and a pulse length of 2.5 μsec at a final output of 250 mev; conversion to higher energies (1 gev) seems impeded only by choice of site, in the center of the Orsay campus.

Another achievement is the equipment of CFTH for checking the tightness of nuclear fuel cans. The envelope to be tested is evacuated and placed under high helium pressure. If helium has penetrated during the first phase it "sweats" out during the second and is then detected by a mass spectrometer. A leakage of 10^{-10} cm^3 at atomospheric pressure is detectable.

Many firms are engaged in the field of radiation measurement apparatus. A typical case is that of an equipment made by Intertechnique, in collaboration with the Oil Refining Co. Shell-Berre. It measures the sulphur in oil by absorption of soft x-rays by a Geiger-Muller counter tube. A quantitative measurement is carried out in five minutes instead of the 30 minutes or more required by previous methods.

TUBES—The tube field has many new developments. An example of particular interest is the series of Vapotrons by CFTH. These are transmitting power tubes (from 10 to 300 kw) cooled by evaporation of water in a purely static arrangement. There is also a triode capable of delivering three megawatts peak power at 200 mc for long pulses up to 200 μsec. It is used in the 50-mev injector of the 25-gev strong-focusing proton-synchrotron which reached full energy in November at the CERN in Geneva. It will also be used at Brookhaven in the U. S. for the new 35-gev project.

There is a klystron which delivers peak power of 30 mw at 3000 mc. The average power is 20 kw, the bandwidth 60 mc. In the big linear accelerator at Orsay 16 CSF tubes of 20 mw each are supplying power at 3000 mc. A recent model traveling-wave tube uses electrostatic focusing, with two helices at different d-c voltages. A peak power of 1 kw is obtained from 1000 to 2000 mc. There are magnetrons for radar, including one giving 2.5 mw at 3000-mc. There is also a family of carcinotrons, with or without magnetic fields. A recent oscillator covers a continuous range from 1000 mc to 37.5 kmc.

In a very different domain, there are two new image converters. The first transforms a radar image into a much brighter television image. Observation can be made at a distance in normally lighted rooms. Furthermore, it is provided with an adjustable memory. The second is made for medical purposes. It transforms an x-ray pattern into a 3,000-times brighter tv image. This high intensification allows an important decrease of the x-ray dose. Input field diameter is 6 inches, while the viewing screen has a diameter of 9 inches.

The photomultiplier has taken on increasing importance for the detection of nuclear radiation. A variety have been built by LEP and others, with diameters reaching 8 inches and current gains of the order of 10^6. Special care has been taken to obtain transit time constant for all possible trajectories of the electrons. La Radiotechnique announces a constancy of 10^{-9}.

In the laboratory of the Paris Observatory, low-noise photomultipliers and infrared photocells for threshold applications are being studied and developed for military as well as for astronomical purposes by Dr. Lallemend. At the Toulouse University the group led by Prof. Dupouy is devoted to electron optics, and their work culminated in the recent development of a very flexible magnetic electron microscope which is currently produced by OPL. In Paris, a joint effort of Prof. Guinier's x-ray laboratory and of the ONERA enabled Dr. Castaing to develop fully his original micro electron-probe, which is now industrially produced by CAMECA. This apparatus is excellent in speed and accuracy for the quantitative microanalysis of alloys. There is also a CFTH simplified mass spectrograph for leak detection, and a high-resolution device for the quantitative determination of heavy elements and especially uranium compounds by CSF.

SOLID STATE—In the field of semiconductors, French production is still relatively low. However, valuable performances have been obtained. An example is a Silec silicon power rectifier, rated at 650 peak inverse volts.

In the Ecole Normale Superieure, Prof. Aigrain is studying semiconductors; the old PEM effect of Kikoin and Naskov was rediscovered and shaped to form an accurate tool of control and research.

The study of magnetism is conducted at the University of Grenoble, where Prof. Neel founded the present theory of ferrites and where new garnets were recently developed. And at CNRS laboratory at Bellevue Prof. Guillaud initiated the development of MnBi magnets and of numerous compositions for ferrites; those are now produced by LTT.

An early but fundamental contribution to the art of masers was made in the Ecole Normale by Prof. Kastler, who coined the term "pumping between quantum levels" when discovering with Dr. Brossel the technique of optical pumping. A new contribution was recently added by Abragam's group at CEA Saclay, which synthesized an original medium for a three-level maser in an aqueous solution of paramagnetic salt. It is used for convenient and accurate measurement of the earth's magnetic field. Still another low-frequency maser using two levels and nuclear resonance in a stream of water was developed at the University of Paris and may prove useful in nuclear spectroscopy. Even more recently, an effect similar to Overhauser's was noted by Prof. Ubersfeld of Ecole de Physique & Chimie and explained by Abragam; it is hoped that greater understanding of this phenomenon will help solve problems of nuclear orientation and nuclear spectroscopy.

MARSILI

QUAZZA

ITALY

Off to a late start, the electronics industry has nevertheless achieved some component miniaturization, improved magnetic industrial controls, designed and modestly produced high-quality instruments

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THE ECONOMIC and political situation in Italy following the war conditioned development of its electronics industry. In many other countries the striving for perfection was dictated by exasperating technical requirements of military problems. In Italy, there were severe limitations in the defense budget.

COMPONENT PARTS—The qualifications of manufacturers of components required in military radars and servomechanisms has now made available paper, oil, ceramic and tantalum capacitors of minimum size and maximum stability at high temperatures, as well as reactors, rectifiers, impulse transformers, relays, connectors, synchros and two-phase motors for small servomechanisms.

The home market does not yet seem to justify production of high-quality resistors, special iron for magnetic amplifiers or memories.

The same situation exists with respect to potentiometers for analog computers as well as to high-quality oscilloscopes and other laboratory electronic instruments. On the other hand, the demand for commercial equipment has led two firms to start manufacturing germanium diodes and transistors. Others are achieving noteworthy production of vacuum, gas and cold-cathode electronic tubes, tv picture tubes, magnetrons, klystrons and x-ray tubes.

AUTOMATIC CONTROLS—Automatic controls make up a large part of the activity in electronics. This is noted chiefly in collaboration between manufacturers of machines, or of manufacturing plants, and electronic control-equipment designers. In all sectors of industry, electronic firms contribute in varying measure to solve speed, voltage, current, frequency, power, positioning, axes synchronizing, gage coordination, sequential programming, counting, and data processing problems.

A firm has been formed with the exclusive aim of electronics research and development. It is engaged in development of controls for large rolling mills and paper mills, computer servomechanisms, power-plant combustion controls and operational amplifiers, data-processing computers and static-power converters, large alternator voltage-regulators and machine-tool positioning, telecommunications for utility networks and many other things.

MAGNETICS AND SERVOMECHANISMS—There is great vitality among small manufacturers of magnetic-amplifier motor controls who base their business more on low-cost production of a few types of widely used equipment than on versatility of applications. One firm lives on the construction of special-application, high-quality electronic servomechanisms

and the building of highly specialized metadynes.

Iron and steel plants requiring perfected speed, drawing and thickness controls often use mercury-vapor rectifiers. Printing and paper mills, where analogous problems of synchronization, of continuous regulated-speed operations, constant-draw rolling and unrolling, controlled quick stops and starts have for several years favored electronic solutions (initially thyratrons) today mainly use magnetic amplifiers with transistor pilot stages. There are new longitudinal register controls for rotogravure, with extremely accurate electronic synchronization of the sections, operations and programmers for magnetic-drum paper cutting machines that memorize variable programs and control the automatic cutting cycle. These are also useful in operation of speed boxing machines, box counters, plastic-bag cutting controls, and in cable and rubber production where power, drawing and speed-control problems still exist, especially in rolling and unrolling.

Frequent use of variable-speed magnetic amplifiers or program controls is in the textile industry, especially in ring spinners and in hosiery looms and warping machines. These are low cost solutions, except for large man-made fiber production plants, where, next to warp or yarn-regularity electronic controls, there are interdependent operation sequence devices.

In the chemical, cement, and glass industry automatic controls have been added to electronic speed regulators in the control of electrolytic bath currents, heat-exchanger power, electric furnace temperatures, glass-mixture composition, plate thicknesses. In electric-energy production and distribution, next to alternator-voltage control, the electronics industry has helped solve auxiliary problems such as stabilized-frequency generators, telecommunications and telemetry. On ships there are many magnetic-amplifier voltage controls. In port there is the magnetic control of lifting equipment.

INSTRUMENTS—The production of electronic instruments not strictly connected with automatic control has many voids, but does offer high-quality instruments. For example, still non-existent are professional cathode-ray oscilloscopes, variable-frequency oscillators, electronic voltmeters, while of noteworthy quality, are nucleonic measuring instruments such as radioactivity meters, impulse analyzers, meters for very short time intervals. There are also limited examples of pioneer production of microwave measuring instruments.

There is good local production of pH meters, conductivity meters, temperature recorders, electric-field meters, strain-gage elastic stress recorders, electroacoustic meters, stress meters, zero amplifiers for dimension recorders of grinder parts, photoelectric devices for various uses. Italian companies also make medical x-ray equipment and heavy industrial gear such as resistance welders and induction heating equipment.

COMMUNICATIONS—That part of the electronics industry that designs and builds telephone exchanges, carrier-frequency equipment, radio links, telemeters and remote controls is fairly mature and self-sufficient. Technically, it appears to be about at the same level as other advanced countries, but there is less basic research. There is conspicuous national production of specific telephone-equipment components such as relays and selectors.

Very active is the production of radio and tv, including transmitting equipment manufactured by at least three large firms for the Italian Radio and Television State Network, for the Navy and other military uses, and for industrial applications. The production of picture tubes has been very active.

There is also the beginning of production of sound-reproduction equipment including high fidelity.

COMPUTERS—A few years ago, a university designed and built an electronic computer with an extremely large memory capacity. Now the digital technique has just left the laboratories and gone into industrial production.

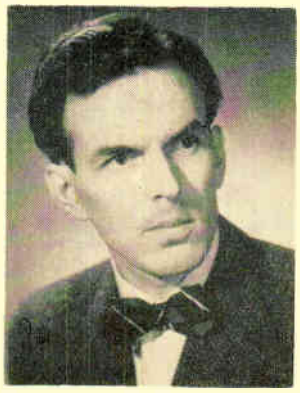
The presentation of a numerical electronic computer for use in banking, mathematical and logical operations by a large manufacturer of office machinery is of this year. Input is on punched tape, card or magnetic tape; output is on punched tape, card, magnetic tape or teletype. The computer has a ferrite-core memory in units from 1 to 8 capable of 120,000 bits each, with 10/μsec access time, 10/μsec time for elementary logical operation. The computer also has up to 20 tape memories with total capacity of 180,000,000 characters, reading and recording speed of 35,000 character/sec and magnetic drums each with 120,000 characters and 10/μsec access time.

MILITARY—Fire-control-room analog computers, which today at least five firms manufacture in various forms, are technically up to date. Also quite modern is firing radar, missile telemetry equipment, countermeasures, two-way aircraft transmitters, ultrasonic equipment.

TEACHING AND RESEARCH—Credit must be given to state institutions for their considerable contribution to the foundation of research centers, especially in nuclear electronics. There are today electronics and servomechanism sections in at least four nuclear research centers as well as in many universities, in electrotechnical and telecommunication institutes and microwave research centers. Moreover, the polytechnics and universities, despite relatively unelastic academic programs, are giving courses in electronics, computers, automatic controls, and microwaves.

Different but equally important is the operation of the electronic centers of a few large private companies striving to improve their production with the introduction of electronic control equipment and of numerical computers for bookkeeping operations, and studying at times independently their most complex technical problems with the aid of analog computers.

In general, the Italian electronics industry today appears to be technically very much alive.



AGDUR

SWEDEN

Free magnetic rings in plasma may solve thermonuclear-energy problem, computers announce subway-train destinations, transistorized telephones talk loud and a traveling-wave maser is under construction

By BERTIL AGDUR
Professor, Royal Institute of Technology, Stockholm

INVESTIGATIONS of gas discharge plasmas, with the aim of generating thermonuclear energy, are being carried out at the Royal Institute of Technology and at the University in Uppsala.

One experiment is intended to produce free plasma rings. A 200 μf, 5-8 kv capacitor bank is discharged in 0.03-3 dry hydrogen between coaxial electrodes, forming a plasma gun. A ring of plasma is formed, and accelerated by electrodynamic force towards the muzzle of the gun. There it encounters a static magnetic field directed radially between the electrodes. A circulating current is induced in the plasma and it leaves the gun as a free magnetized ring. The ring moves in a drift tube of glass, where it is studied by means of Kerr-cell photography and by magnetic measurements.

The circuit current represents a rapidly damped oscillation, passing through zero 13 μs after ignition of the discharge. The magnetic flux connected with the ring increases to a maximum, which often appears when the circuit current passes zero, and then decays approximately exponentially. When circuit current passes zero the flux curve is smooth and the direction of the flux does not change. This indicates that a current continues to circulate in the plasma independent of the circuit current for about 40 μs.

Recent developments in the field of high-voltage dc transmission at ASEA, representing the electric power industry, include design and construction of mercury-arc valves for 160 mw cross-channel transmission between England and France by cable. Conductors are at $\pm$100 kv with respect to ground. Inauguration of the service is scheduled for 1961. Six tubes handle 800 amp at 100 kv on the dc side. Compared with those in the high-voltage dc transmission system comissioned in 1954 between the Swedish mainland and the island of Gotland, these new tubes provide an eightfold increase in power-handling capacity.

ASEA is also studying ac arc discharges at currents of the order of 200,000 amp. Such arc dischargers are used in high-voltage switches. Investigations are made of conditions for rapid deionization of the arc and of fast build-up of dielectric strength in the discharge region after the arc is extinguished.

COMPUTERS AND DATA-PROCESSING—Typical companies working in the computer and data-processing field include AB Atvidaberg, SAAB Aircraft, Bo Nyman, Philips Teleindustri, Standard Radio and Telephone and LKB-Produkter. There are also many smaller companies working on data-processing systems for civil and military applications.

One interesting example of development work in this area is a type of random-access memory system, the so-called "Carousel". Data are recorded on short pieces of magnetic tape which are wound around 64 separate spools. These spools are arranged in two concentric rows on a large wheel rotating on a horizontal axis. Each spool can also rotate around its own axis. Both the spools and the carousel can easily be removed, which means that data can quickly be exchanged by changing the information-carrying medium as in a conventional magnetic tape unit.

Selection is performed in three steps. First a particular carousel is selected; each carousel unit has a storage capacity of about three million alpha numeric characters. Then a particular spool is selected by turning the carousel until the desired spool is directly below the center of the carousel, which is then stopped. The carousel can rotate left or right in order to achieve the shortest possible access time. The free end of each tape is equipped with a small weight, which guides the tape to a magnetic head and a drive capstan located below the carousel. A roller presses the tape against the capstan and the tape unreels downwards and is accumulated in a tank. The third step in the selection process is per-

formed during the read-write operation, while the tape is passing the magnetic head, and at this time specified blocks of information can be selected.

Average access time is 1.9 seconds. Rewind starts automatically after each read or write operation. Each spool houses about 8.5 meters of tape. The speed of the tape is five meters per second. There are eight channels, one of which is used for checking. The magnetic head uses ferrite cores and there is a constant air gap between the head and the surface of the tape. "Drop outs," one of the most serious problems encountered in connection with digital magnetic-tape recording, have been virtually eliminated.

Bo Nyman is manufacturing a data machine, Wegematic 1000, which is a development of the earlier Alvac III E. This is a binary-series machine with magnetic-drum memory.

Commercial developments are under way at SAAB on digital computers, analog computers and numerically controlled machine tools. One example is the BT9 toss-bomb sight. The American M2 bombing system is derived from the BT9 system.

LKB has designed an automatic system to record the positions and movements of railway cars. On an axlebox of each car there is a soft iron plate with a shape that corresponds to the number of the car in a binary system. Along the railway line are placed coil systems which can read the number plates when the train passes by, and feed the information to a memory. In one of the systems the movement of 7,000 cars can be recorded. A similar system is being developed for automatic destination-announcements in the subway in Stockholm.

Standard Radio and Telephone has developed a system for the Swedish Air Force. Data from radar stations are distributed to remote ppi equipment. Presentation is performed with symbols, symbol numbers and vector lines introduced by the interscan method. Data handling and storing is performed in digital equipment using transistors and diode logic, with ferrite-core storage. The output from the digital equipment is in binary-decimal form for in-line direct-view presentation and binary-analog for ppi presentation. Ppi circuits for video, sync, waveform generation and antenna rotation modulation are centralized and distributed to the number of ppi's required.

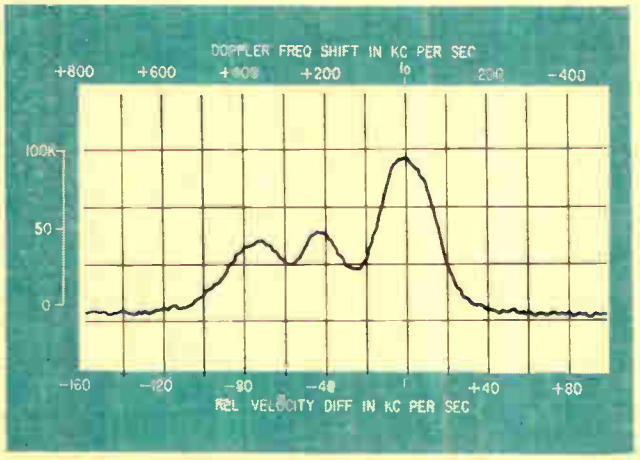


FIG. 4—Hydrogen-line emission from a portion of our galaxy, obtained by a radio telescope operating on 21 cm

TELECOMMUNICATION AND SPEECH RESEARCH—Like most other companies in the telecommunications field, Telefonaktiebolaget L. M. Ericsson is conducting development work aimed at utilizing electronics in telephone exchangers, telephone instruments and transmission circuits as well as for military purposes. One line of development is an all-electronic telephone system working on the time-multiplex principle. This work is being pursued in collaboration with the Swedish Board of Telecommunications.

Electronics is gaining ground in the field of telephone instruments as well. A transistorized telephone, with amplified reception, has recently been marketed.

Fundamental studies of the acoustic nature of speech and of speech production and speech perception, and new methods of speech transmission, are being carried out at the Speech Transmission Laboratory. This Laboratory is attached to the Division of Telegraphy-Telephony of RIT. The electronic instrumentation used for the research includes unique designs of spectrographs for continuous short-time frequency analysis. New methods of oscillographic data-recording and instrumentation for production of synthetic speech have been developed. Analysis and synthesis techniques have applications for reducing the bandwidth in speech-transmission links and in speech storage and retrieval systems. Techniques for machine recognition of spoken units and of synthetic speech production have applications in man-machine and machine-man communication systems.

SEMICONDUCTOR ELECTRONICS—Fundamental research connected with the semiconductor field is carried out at several university laboratories.

At the Institute of Semiconductor Research problems concerning crystallization and treatment of semiconductor materials such as silicon, germanium, III-V-alloys and silicon carbide are being studied. They also develop devices for industry, such as rectifying systems made by diffusion processes, controlled rectifiers and *pnpn*-switches.

Ericsson is developing transistors to satisfy demand for low failure rate and long life, 15 to 50 years. They have, with some success, used intensive temperature cycling before testing.

Work at RIT is partly devoted to studies of temperature, stability and noise properties of semiconductor circuits. There has been some progress in development of methods for analyzing and synthesizing *pn*-transitions.

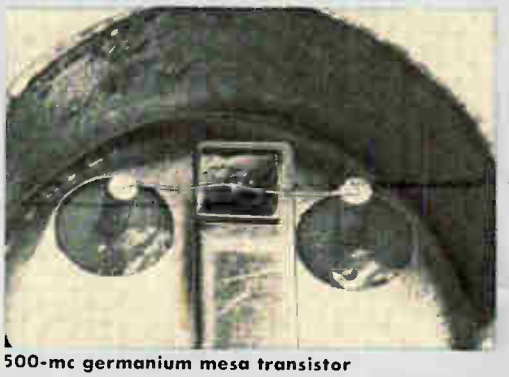
COMPONENTS AND INSTRUMENTS—To meet the demand for extended life on electron tubes,

IDEAS and EQUIPMENT

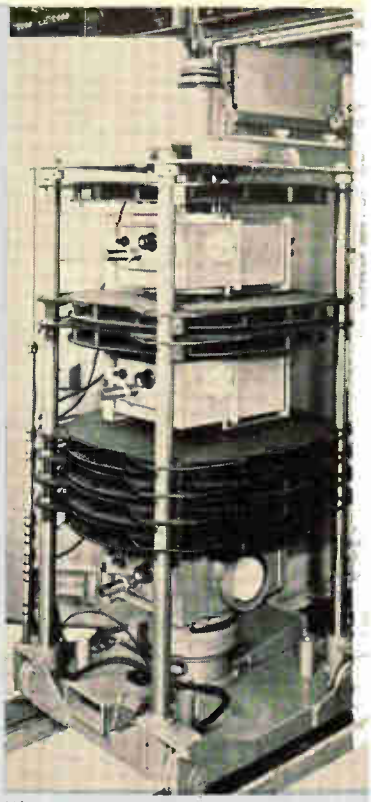
ENGLAND

High-power distributed amplifier, showing anode lines (Marconi)

Electronic velocity analyzer used to measure shell velocities



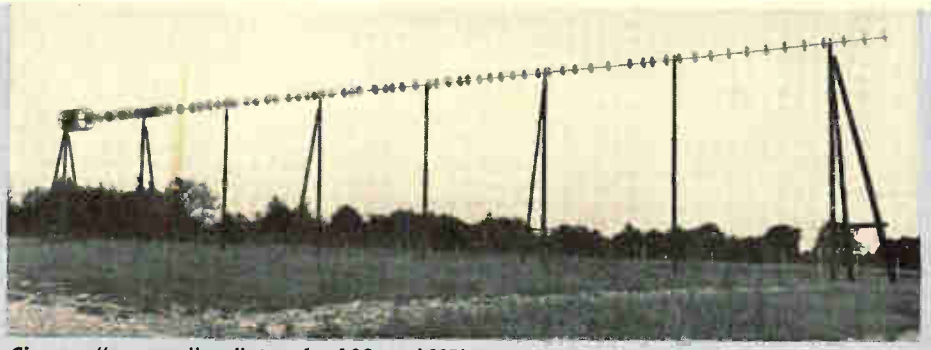
500-mc germanium mesa transistor (Associated Transistors)



Klystron output stage of 50-cm radar (English Electric Valve)

FRANCE

Mode filter for TE_{01} mode (CNET)



Cigar or "sausage" radiators for 180 mc (CSF)

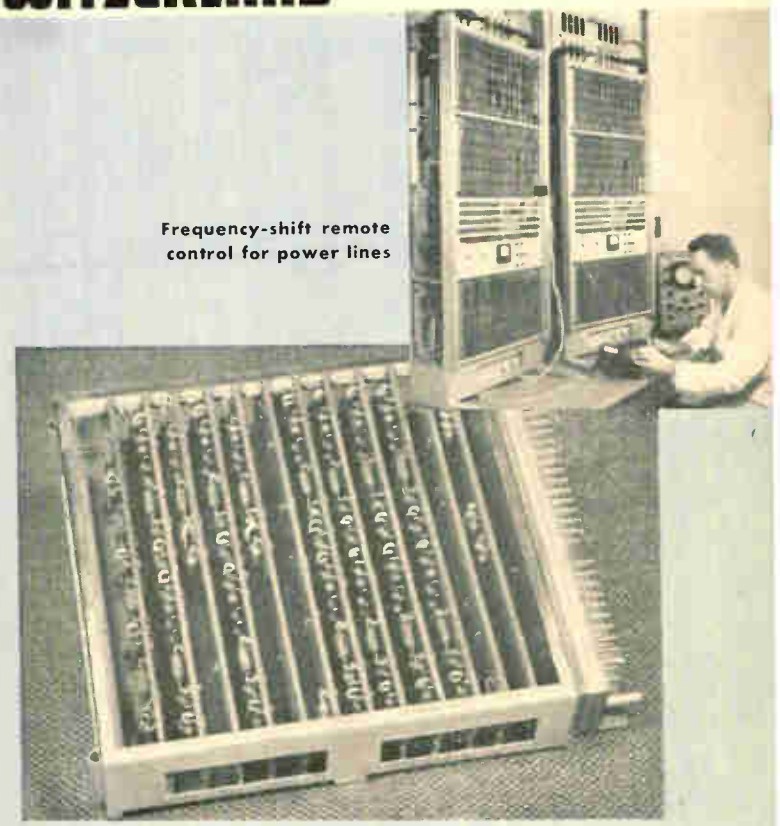
Operating desk of the EL3 atomic-reactor's monitoring and control equipment (CFTH)

from abroad

SWEDEN

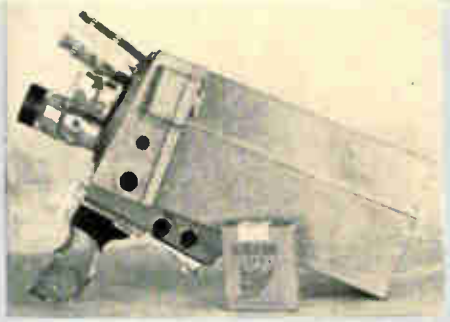
"Carousel" random-access memory
(AB Atvidaberg)

SWITZERLAND

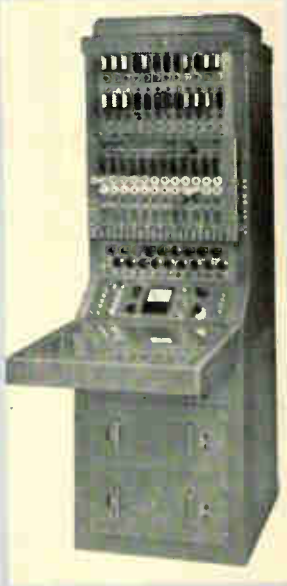


Frequency-shift remote control for power lines

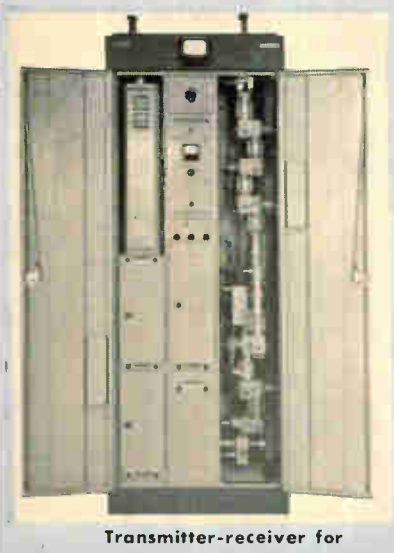
Plug-in unit containing 48 switching circuits



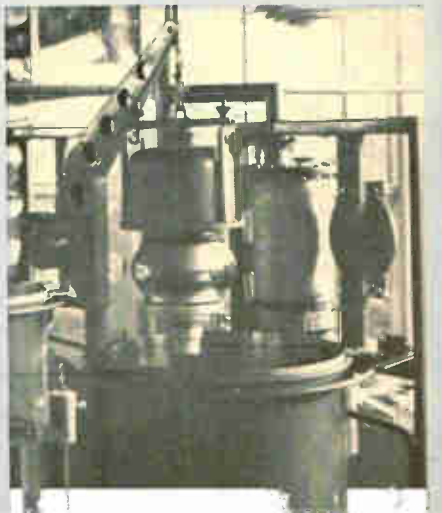
Transistorized vidicon television camera (LEP)



Electronic analog computer (SEA)



Transmitter-receiver for
4,000-mc relay station (TRT)



Three-megawatt,
200-mc triode with
resonant cavity (CFTH)

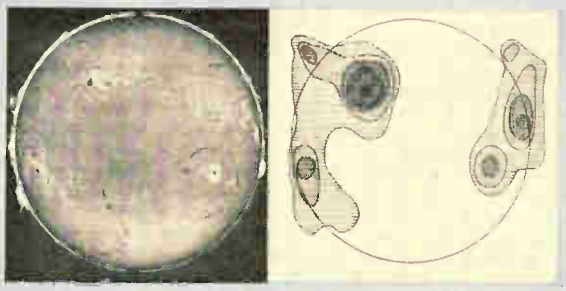
IDEAS and EQUIPMENT from abroad

CONTINUED

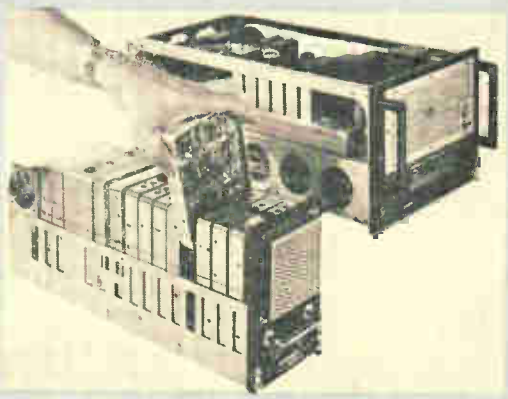
Newly developed coneless woofer and tweeter loudspeakers

ISRAEL

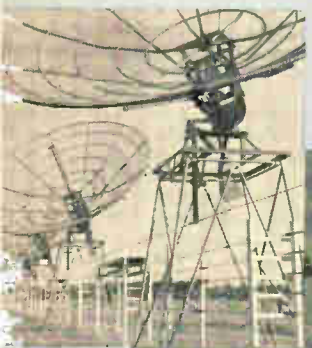
AUSTRALIA



Radio heliogram of sun (right) compared with conventional spectroheliogram

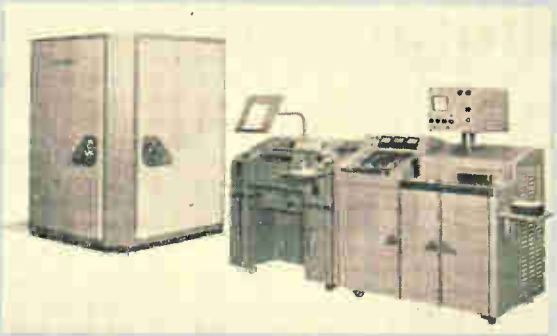


Transistorized DME receiver (foreground) compared with tube type



64 paraboloids each 19 feet in diameter are used in crossed interferometer having 1500-foot arms

JAPAN



NEAC 2201 provides series-parallel decimal presentation (Nippon Electric)

64-character printer handles 300 lines of 120 characters per minute (Oki)

HIPAC 101 has parallel-binary presentation (Hitachi)

Ericsson uses passive nickel cathodes. At a silicon content under 0.01-0.02 percent it seems that the interface problem can be almost completely solved even for high-transconductance tubes. Low-noise application of electron tubes might be mastered by means of a refined-grid technique including use of 0.005-mm wire. In experimental tubes grid wires of 0.003 mm diameter have been used.

At Chalmers University of Technology low-noise amplifiers, especially for radio astronomy applications, are being developed. A three-level solid-state maser is in operation and a traveling-wave maser is under construction.

At the Research Institute of the National Defence in Sweden O-type carcinotrons with bifilar helices giving wide electronic tuning ranges, and parametric traveling-wave amplifiers are being developed. They are also working on ferrite components and have developed one-way attenuators covering the whole bandwidth of a conventional waveguide.

Sivers Laboratories have precision swr meters with a residual standing-wave ratio of less than 1.005; they may be driven by a motor for automatic recording. The meters allow direct reading of frequency on a counter and have an accuracy better than 0.1 percent.

WAVE PROPAGATION—Studies in the field of wave propagation are being carried out at a number of places. Chalmers University of Technology's wave propagation observatory is equipped with five radio telescopes, average diameter 25 ft, a meteor, solar and satellite-tracking interferometer. Fig. 4 shows a Doppler-shifted 21-cm emission from three spiral arms of our galaxy.

At RIND intensive studies are being made of the mechanism of tropospheric scattering. Another program includes continuous measurements of ionospheric conditions. The Institute has developed an aurora all-sky camera. Also being studied is the effect that electrical properties and topography of the ground have on wave propagation in the vhf and uhf regions.

Studies of microwave propagation in electron beams are carried out both at CUT and at RIT. The latter is considering the possibility of amplifying microwaves by sending electron beams through a plasma, and some experimental amplifiers have been built on that principle.

MEDICAL ELECTRONICS—Work done at Karolinska Institute is one interesting example of developments for medical applications. Several types of "radio pills" for telemetering physiological data from body cavities in animals and humans have been developed. These miniature radiosondes are used to telemeter gastrointestinal pressure waves, pH, temperature, enzyme activity and oxygen-tension values.

The lifetime of batteries powering the transmitters varies between a few days and five months. The smallest sonde for telemetering pressure has a volume of 0.9 cm^3 and a lifetime of four days. The pills are usually unnoticeable to the patient, and thus permit investigations under almost normal conditions.

SWITZERLAND

U. S. cooperation important, but local institutions are carrying out important research in masers, short-time effects in stimulable phosphors. Teleprinter systems being transistorized, pulse-code modulation popular for communications

BAUER

By **JAKOB BAUER**
Vice Director for Electronics, Hasler, Ltd., Bern

SWITZERLAND has had a highly developed electric power industry for many years. Its electronic industry got started really during World War II, when several Swiss companies became interested and invested in development and research.

US CONTRIBUTION—Three U.S. organizations have established laboratories for carrying out research in the field of electronics. They retain local

professors as consultants, and some of their members teach at the universities.

Battelle Memorial Institute started work in Geneva in 1952. Initially, the program was limited to investigation of basic properties of semiconductors. The scope was then expanded to include semiconductor devices and circuits. The present program includes logic and memory circuits with transistors and magnetic cores, digital control circuits and fundamental studies of electric motor design and control.

Laboratories RCA, Zurich, was established in 1955. Here, an international group of scientists is working in the solid-state field, studying synthesis and properties of insulators and semiconductors. In addition, an Industry Service Laboratory is maintained to provide engineering assistance to European manufacturers, particularly in the field of tv and radio receivers.

IBM Research, Zurich, is focussed on exploration of speed obtainable through solid-state materials. The objective is to increase the capabilities of data-processing machines. Thin magnetic films are also the subject of investigation; a physics group is studying the basic physical properties underlying ferromagnetism. Very high speed measuring techniques have been developed, such as a sampling oscilloscope with submillimicrosecond rise time, and an apparatus to measure magnetic-film switching in this range. The same techniques are being used for investigating short-time effects in stimulable phosphors.

EDUCATIONAL INSTITUTIONS—Swiss Federal Institute of Technology has six institutes whose research program includes electronics. A. P. Speiser of IBM teaches here. The Institute of Physics, under G. Busch, is carrying out fundamental research on semiconductors, and the Institute of Technical Physics, under E. Baumann, is doing significant work on semiconductor materials, electronic circuitry and television. Eidophor large-screen tv is the result of fundamental research carried out by the former head of the institute, Professor Fischer.

The Institute of General Electrical Engineering has focussed its research on automatic-control systems. Eduard Gerecke, head of the institute, is treasurer of the International Federation for Automatic Control. Under M. J. O. Strutt of the Institute for Advanced Electrical Engineering, work is being carried out on instrumentation. Hall-effect wattmeters and flux-density meters are examples. There is also study of such things as stabilization and operating life of transistors. A particularly interesting application is the Hall-effect mixer for broadcast receivers shown in Fig. 5.

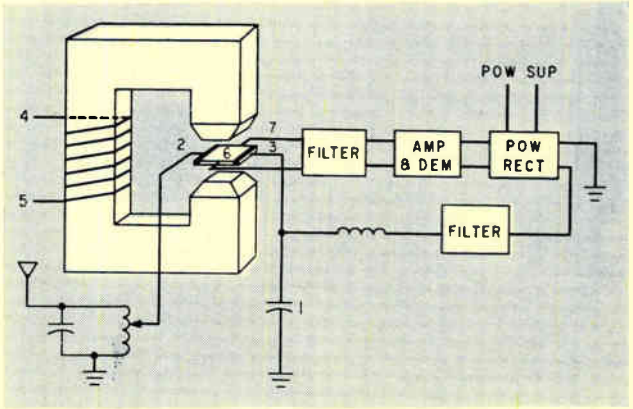


FIG. 5—Hall-effect mixer circuit. Antenna signal fed via tank and capacitor 1 to probe through contacts 2 and 3. Local oscillator signal fed to 4 and 5. Output taken from contacts 6 and 7, filtered and amplified and demodulated. Power rectifier supplies d-c energizing probe through filter and choke

The Institute of High-Frequency Engineering, under Franz Tank, a former vice-president of the Institute of Radio Engineers, is concentrating on microwaves. The major part of this program is devoted to instrumentation and radar applications. The Institute of Telecommunications has a varied research program, in keeping with the broad interests of its head, Heinrich Weber. Several projects have instrumentation applications; there is analyzing equipment for investigating speech defects, equipment for analyzing teleprinter signals and a transistorized quartz clock with time recording and calibration facilities for field use in goedesy.

At the University of Basle, E. Baldinger's Institute of Applied Physics is carrying out work on fast-pulse transistor circuitry and applications to nuclear instrumentation.

At the University of Neuchatel and the Swiss Research Laboratory for Time-keeping Devices much significant work is being carried out under the supervision of J. Rossel on electronic instrumentation and masers for time-keeping purposes. These laboratories developed the first maser to operate over a long period of time.

At the Institute of Technology of the University of Lausanne work is being carried out on electronic circuitry under R. Dessoulavy.

COMPONENTS—Two large firms are engaged in the manufacture of electron tubes, Brown Boveri and Hasler. Manufacturing and research programs are concentrated on transmitting tubes and special devices for microwave and control purposes.

Much development work is going on on capacitors, particularly of mica and polystyrol type, by Leclanche, Condensateurs Fribourg, Standard Telephone and Radio.

Fundamental research work on new insulating materials is being carried out by CIBA, the chemical industry group in Basle, and by Micafil and Oerlikon and associated wire and cable-insulation companies such as Isola-Werke Breitenbach.

Several plants and pilot plants have been set up for manufacturing semiconductor devices, including Ebauches in Neuchatel and Philips in Zurich. As germanium and silicon are already well known, present research is concentrated on semiconducting intermetallic compounds. From theoretical investigations it seems that the most interesting of these materials will be Ag Se and Cu_2-Se.

RADIO AND TELEVISION—Work is being done

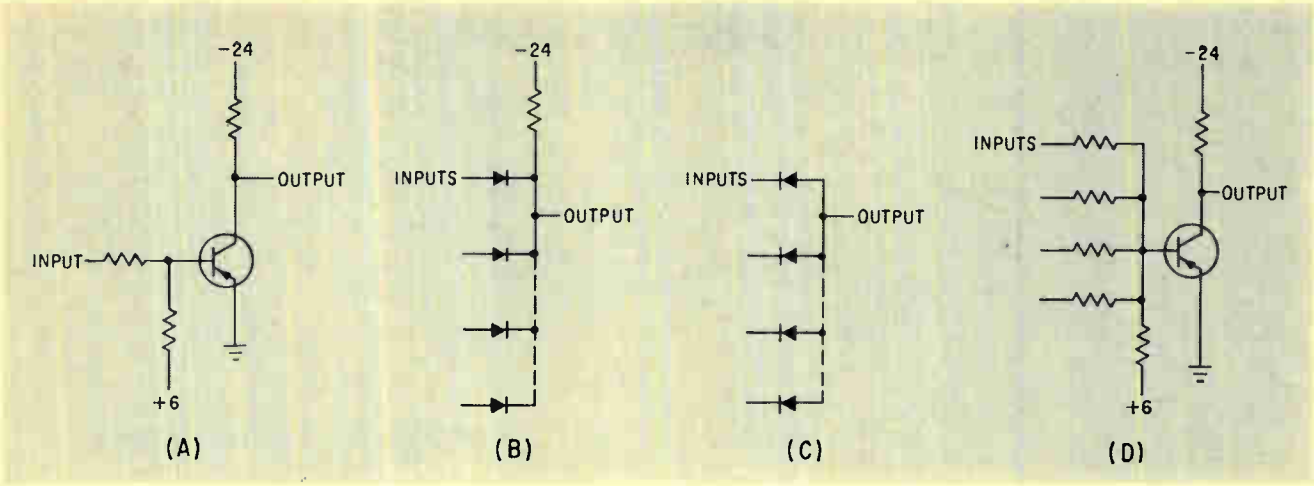


FIG. 6—Logic switching of transistor and diode system. (a) Inverter "not" circuit. (b) "and." (c) "or." (d) "or" and "not"

on uhf variometers by Sondyna AG of Zurich and Autophon AG of Solothurn.

SWITCHING TELEPRINTERS—A major application of transistor circuitry is in switching systems. Fig. 6 shows transistorized logical circuits applied to a fully transistorized ARQ system for teleprinter service on radio links. In addition to these circuits using direct-coupled transistor and diode units, the parametron is being studied.

New electronic switching circuits enable size of equipment to be reduced one half, power consumption one fourth. One system uses the Van Duuren error-detection principle with a 3-out-of-7 code, error correction being achieved by a 4 or 8-character repetition cycle. Error detection is performed by the code converter itself. Called the Electronic TOR, this system provides four channels by means of time multiplexing. It contains about 1,300 transistors, 3,000 diodes, 11,000 resistors and 160 capacitors and is designed for extreme operating conditions. Reliable operation is maintained even when supply voltages vary by ±50 percent, transistor alphas decrease to 50 percent of nominal value, and cut-off collector-currents increase by a factor of three.

Further work is being carried out to eliminate all mechanical elements in the whole teleprinter system.

TELEPHONE—Advanced work is in progress in the domain of electronic switching techniques for the development of an all-electronic automatic telephone exchange. In the meantime, semi-electronic systems are being investigated. These are mechanical switching systems combined with electronic central control circuits. The central control circuit consists of two main parts, a memory and a decision-making unit. In the memory, information describing the characteristics of the calling and the called subscriber are stored. In addition, it contains all programs needed to control the decision-making unit. Changes or additional specifications can be easily effected by writing a new program into the memory. Several million bits have to be stored and access time has to be a fraction of a microsecond. Memories using ferrite or permalloy cores are well suited for this purpose.

An obvious result of the continuously increasing demand for high-quality long-distance telephone channels at reasonable cost is the use of higher and higher frequencies. This applies not only to radio links but also to cable circuits. The next step in coaxial-cable carrier technique will be the extension of the present 6-mc bandwidth to 12 mc. This future system will provide 2,700 telephone channels, or 1 tv channel plus 1,200 telephone channels, as compared to the present 1,260 telephone channels or one 625-line tv channel. Semiconductor elements are being increasingly employed in channel, group and line equipment.

In radio links, work has been started on microwave systems in the 4 to 8,000-mc range. Pulse-code-modulated transmission systems are being particularly studied. It seems that such systems could be competitive with ordinary frequency-sharing systems for short distances.

Several firms have recently developed paging systems; Hasler, Autophon, Albiswerk. One system uses pulse-code modulation for selecting the required receiver and the spacing between the pulses is varied, another uses a two-frequency code.

OTHER APPLICATIONS—Research work is being carried out on transistorized control and remote-control systems for power plants, railways, pipelines. A laboratory model of one such system uses frequency shift. Frequency shift and bandwidth of the transmitting channel are adjusted to the control speed.

A report on electronic research would not be complete without mentioning the development of electronic wristwatches and clocks. Significant work is being carried out by several laboratories.

Earlier work enabled the replacement of the watch spring by a miniature battery. The problem now is to design an electronic device to replace the watch escapement. This has not been solved for the wrist watch but much promising work is being done on quartz-controlled clocks, which might lead to a small model for office and home use. Advantage: the clock would run accurately to the minute for over a year.

GAMZON

ISRAEL

Low and high-temperature research receiving much attention, epileptic brain waves remotely studied. New ferrites may lead to higher-fidelity loudspeakers and industry is on the threshold of television and industrial applications

By R. GAMZON
Acting Head, Department of Electronics,
The Weizmann Institute of Science, Rehovot

RESEARCH may be broken into two categories, basic and applied. However, it is difficult to say if some of what we call basic electronics research is not in reality research in solid-state physics.

SEMICONDUCTORS—In the Department of Experimental Physics of Hebrew University, basic research is carried out on the electrical properties of semiconductor surfaces under the direction of A. Many. The study is concerned mainly with the investigation of the parameters describing the fast states present in semiconductor surfaces and is of fundamental importance in transistor problems. This research has been extended to cover the range of low temperatures. In addition, measurements have been made on the recusation of carrier mobility due to surface scattering. The properties of cadmium sulfide are also being investigated at high temperatures.

FERROMAGNETISM—A team has been working on ferromagnetism at Weizmann under the direction of E. H. Frei. Materials are known to be divided into homogeneously magnetized domains. However, in 1945 W. F. Brown, Jr., of the University of Minnesota proved that once a perfect ferromagnetic ellipsoid is magnetized to saturation the energy barrier to change this state of saturation is so high that no domains should be observed under normal laboratory conditions. One of the main results of this discrepancy between theory and experiment, known as Brown's paradox, is that the experimental coercive force is usually two or three orders of magnitude lower than the theoretical one.

In 1958 DeBlois measured a coercive force approaching the theoretical value in quite perfect iron whiskers under idealized conditions. This suggests that the paradox can be resolved if materials are made as perfect as required by this theory or if the theory can be modified to include practical materials with their crystal imperfections and non-ellipsoidal shapes. The group in Rehovot is working to resolve the paradox. The experimental part of this work consists of growing single crystals of magnetic materials. In the theoretical work some local lowering of magnetocrystalline anisotropy has been observed in simple models.

A team has been working on a new type of ferrite obtained by anion substitution in the known barium ferrite. Theoretically, such ferrites should have a better BH_{max} product.

The properties of Neodynium-Yttrium garnets are also being investigated.

NUCLEAR ELECTRONICS—Within the next few years most instruments used in nuclear physics will be transistorized. This will include scalers, linear pulse amplifiers and pulse-height analyzers. Some transistor circuits, such as linear gates and coincidence circuits, have already been constructed and used and have proved very satisfactory.

COMPUTERS—Off-line printers, and magnetic tape-to-tape amplifiers, have been built using transistors. Transistors are used in input-output equipment.

MEDICAL ELECTRONICS—A team is working on subminiature transistorized electroencephalograph preamplifier and transmitter which could be mounted on the head of a living animal and would transmit normal and epileptic brain waves to a receiver placed at some distance from the animal. The fact that wires are not necessary is important in cases of convulsive epileptic attack and a small transistorized instrument would permit simultaneous transmission from different areas of the brain.

ELECTROACOUSTICS—Transistorized amplifiers

will soon be constructed to work with a new electroacoustic transducer. This transducer is electrodynamic but has many of the qualities of an electrostatic type and may constitute a turning point in the development of electroacoustical devices.

The transducer was the direct result of research in ferrites. The high coercive force of this magnetic material, and its low permeability, gave rise to the possibility of imprinting a magnetic pattern on a ferrite plate to obtain various forms of relatively strong fields outside this plate. This has been done to get multipole flat magnets. It has also resulted in construction of a coneless electrodynamic loudspeaker. This speaker uses a very thin, supple, flat membrane as a radiator. A ribbon of thin aluminum which has a zig-zag form and covers nearly the entire area of the membrane is placed on the membrane by the printed circuit method. At the beginning of research this membrane was stretched above a perforate ferrite plate, where a magnetic pattern was printed according to the geometrical dimensions of the zig-zag in such a way that the vector product of the field by the current had the same direction perpendicular to the membrane over the entire area of this membrane. It was found afterwards to be more efficient to use thin strips of oriented ferrites on a perforate plate, thus constituting a magnetode. The high coercive force of ferrites permitted use of two magnetodes in opposition to each other, and provided a much stronger and more homogenous field.

Transducers produced in the laboratory have many interesting qualities and the distortion in the working range of either woofer or tweeter is lower than in the normal cone speaker. The transducers have the qualities of both electrodynamic and electrostatic speakers and may be a step towards higher fidelity. There may be applications of the principle in microphones and stethoscopes and in high-power sound projectors.

FUTURE DEVELOPMENT—Industry is concentrated heavily on production of home radio sets. Component manufacture is growing steadily and all except tubes, transistors and resistors are made here.

There is some export. The trends for the next few years will include development of printed circuits, high-fidelity chains, stereophony and, with a green light from the government, television; several firms are already training their staffs.

Several firms in partnership with foreign companies are beginning to expand in the production of electronic devices.

JAPAN

Emphasis is on semiconductors, including tunnel diodes, barrier and "hole" capacitors, but parametrons are coming as computer switching elements and there is considerable interest in electronic language translation

By HIROSHI WADA
Chief of Electronics Division, Electrotechnical Laboratory, Ministry of International Trade and Industry, Tokyo

WADA

A TECHNICAL COMMITTEE was organized to extract germanium from copper sludges or exhausted gasses from coal combustion. Neither process came into industrial use because of high costs, but refining facilities for germanium were a result. Silicon is produced by several chemical plants. Specific resistivity is some hundreds of ohms-per-centimeter.

The debut of the transistor radio from Sony stimulated several enterprises to establish transistor manufacturing facilities. At present, progress is directed not only to get cheaper and greater production, but also to develop high-frequency, high-power and switching elements. High-frequency transistors include alloy, drift, grown-diffusion, and diffused-melt-back types, each having 100-150 mc alpha cutoff. In

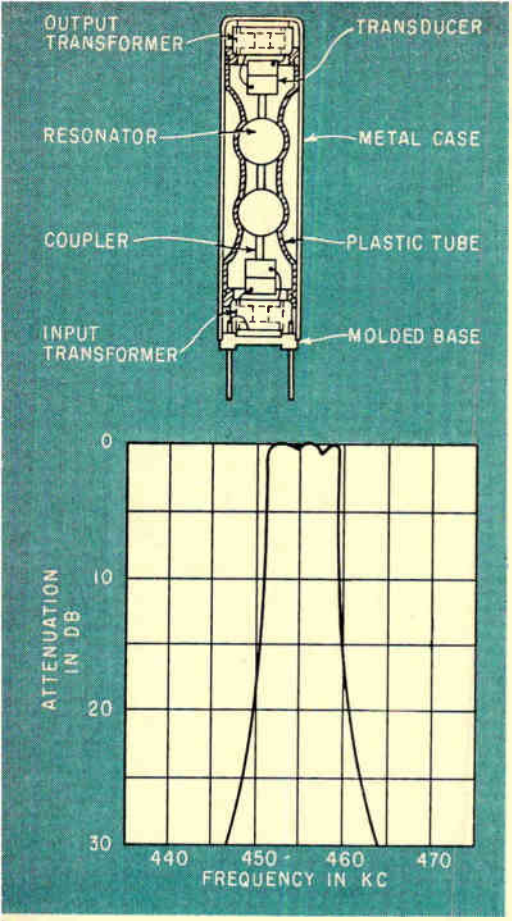


FIG. 7—Steel-ball i-f filter and bandwidth

Table I — Characteristics of Parametrons

	High Speed	Standard	Low Power
Exciting freq., 2f	6 mc	2 mc	200 ke
Maximum clock freq.	140 kc	25 kc	2 kc
Power for continuous excitation	120 mw	30 mw	5 mw
Dc bias	0.6 amp	0.6 amp	0.6 amp
Maximum number of inputs	3 or 5	3 or 5	3 or 5
Maximum number of output branches	12	15	15

Table II — Characteristics of Ne-ferrite

Initial Permeability μ_0	Core Loss at 100 kc $\tan/\mu_0 x10^6$	Jordan Coefficients of Core Losses			Induction at 10 oer B (gauss)	Curie Point Tc (C)
		$h/\mu^2 x10^6$	$Fn/\mu x10^6$	$t/\mu x10^3$		
2000 ± 200	2	250	50	4	4800	230

1960, mesa-types are expected to be incorporated in new tv receivers.

In power-handling applications, further development of silicon transistors and rectifiers is the interest. A power rectifier by Toshiba of Tokyo is fabricated by the solid-diffusion technique, and has the rating of 750-v inverse voltage, 400-amp forward current. Solar batteries are under field trial.

SEMICONDUCTOR SWITCHING—Recent developments for switching elements are considered very important. There are several activities on silicon *pnpn* switches and controlled rectifiers. L. Esaki has delineated tunnel-diode operation. He noted the anomalous effect in highly-doped *pn* junctions, based on the quantum-mechanical penetration of degenerated electrons. In addition to the usual diffusion current by minority carriers, this tunnelling current manifests negative resistance in current-voltage characteristics of the *pn* junction.

The tunnel diode is believed to have no frequency limit, since the mechanism of operation takes practically no time whereas the usual diffusion mechanism takes appreciable time for rearrangement of minority carriers.

NEW COMPONENTS—Development of transistor radios and computers has pushed miniaturization of electronic components. Research in capacitors and magnetic ferrites has been great. With the advent of the barium-titanate capacitor in quantity production, Murata of Kyoto has produced i-f filters by using steel balls as mechanical resonators. Figure 7 shows a cross-section of the assembly and bandwidth characteristics. Center frequency is determined by diameter of the balls and bandwidth by the length of the coupling nickel rods. The price is low.

Semiconductive properties of barium titanate are also under investigation. The approach visualizes controlling the material with a cerium or niobium-group additive. A barrier capacitor is expected to be developed in the near future.

The "hole" capacitor, a name given to the foil-type

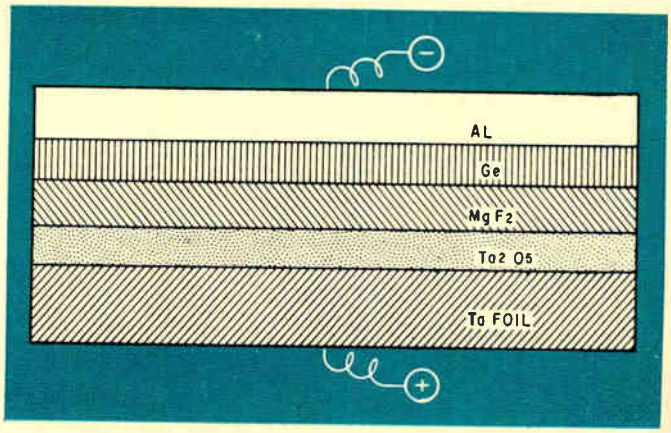


FIG. 8—Semiconductor and tantalum "hole" capacitor, and

solid-electrolytic tantulum capacitor developed by Nippon has nearly the same specific capacity as the electrolytic tantulum capacitor. Its schematic cross section is shown in Fig. 8. A thin layer of MgF_2 or CaF_2 is evaporated upon the oxide film of tantulum. Then layers of germanium and of aluminum are evaporated successively. The origin of the capacitor came from Y. Sasaki's idea that the anodic oxide film had a structure similar to a *pn* junction which one finds in a semiconductor. As the capacitor contains no electrolyte, it can be used over a wide temperature range from −200 to 200 C. The value of leakage current at room temperature is about 0.2 $\mu a/\mu f/v$. Since the invention of the parametron, Tokyo Denki Kagaku has been supplying components. The parametron requires a non-linear reactance. The performance of three hundred kinds of ferrites has been tested to find one that fits best this requirement. Several commercial units, which contain 25 such elements, are shown in Table 1. These can be used as basic elements for computers, automatic-control devices and telephone dialing systems. Products using thin magnetic film are expected to be used in the near future.

Ne-ferrite, a Mn-Zn ferrite, has characteristics shown in Table 2. It is mainly used for the filters and coils of telecommunications.

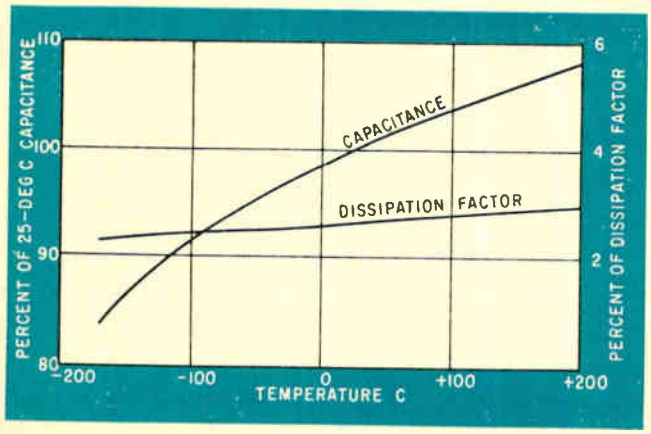
COMPUTERS—Research on digital computers was started with a relay computer at the Electrotechnical Laboratory. Then electronic computers using tubes were developed by two groups, and research for transistorized computers followed. E. Goto of Tokyo University later suggested the parametron. If, in the circuit shown in Fig. 9, a direct current and a high-frequency current of $2f$ are supplied to the primary winding, then an oscillation of frequency f, determined by L and C, will be imposed in the secondary circuit by parametric excitation. In the oscillation thus generated, the phase of the oscillation has either one of the two stable phases which differ by π-radians from each other. This difference can represent and memorize one binary digit 0 or 1. The phase of oscillation can be controlled by the phase of the initial current in the secondary circuit. The parametron can also be used to transmit information by a three-phased clock, and to perform various logical operations based on a majority-decision principle by the sum of voltages of odd numbers.

The parametron computer PD-1516 and transistor-computer ETL-3 were prototypes. Following these machines, computers ETL-4, M-1 and PC-1 were completed. They are equipped with magnetic drums operating at 18,000 rpm or ferrite-core matrices. Work on them was done by the staffs of university and governmental laboratories. Some manufacturers for telecommunication devices designed their products in accordance with them. Products of Hitachi and Nippon using magnetic drums, together with a high-speed line-printer of Oki, have been exhibited. The first has a word length of 10 decimal digits, 63 instructions, handles 1,040 words. The second has word length of 48 bits, 48 instructions, handles 1,024 words.

INDUSTRIAL APPLICATIONS—Mechanization in offices lags in Japan. No products for punched-card systems are available. Under these circumstances, magnetic-tape devices and tape-sorting techniques are under intensive development. Quite recently E. Goto proposed basic circuitry for the realization of an extremely fast computer. His idea is to utilize tunnel diodes as switching elements and to apply the majority-decision principle for logical operations as in the case of parametron circuits.

Equipment for automatic control of process industries are actively adopting electronic systems. A system recently revealed by Yokogawa Electric has a unified specification for signal translation. The system, including compensation and stabilization circuits, is well designed. Solid-state devices are used. The transducer for displacement, for example, uses a Hall-effect generator. Low-speed analog computers have been developed by several manufacturers.

Research on process control by digital technique is under development. Hokushin Electric has a digital computer intended for use as an on-line machine to calculate operational guides for chemical processes. ETL has developed a high-speed digital computer for on-line control of rotating machinery. It can



performance characteristics

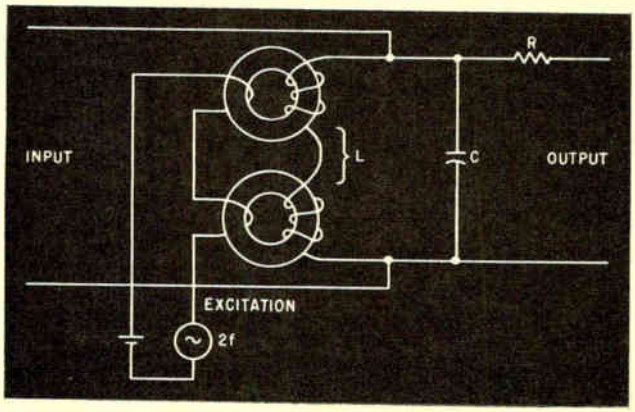


FIG. 9—Circuits of parametron

also be used to investigate computer control by connecting it to an analog computer through analog-digital and digital-analog converters.

Digital control of machine tools is under development at Fuji Telecommunication and in other places.

OTHER R&D—Other research activities include S. Takahashi's English-Japanese machine translator. Research aims first at the rearrangement of word order in a sentence. A letter-reading machine under study by the author can read both capital and small letters of the alphabet together with other symbols. A voice typewriter for speech and a device designed for character recognition of phonetic letters are under development.

Our electronics industry is still too young to have borne much fruit from our own basic research. However, we are optimistic about new research programs.

BOWEN

AUSTRALIA

Radio astronomy is high on the list of developments, embracing electronic telescopes and heliographs. Interest in aviation aids and weather forecasting runs a close second

By E. G. BOWEN
Chief, Division of Radiophysics,
Commonwealth Scientific & Industrial Research Organization, Sydney

THE GREAT MAJORITY of radio and electronics firms in Australia are associated with or are subsidiaries of British and Amercian firms. They are closely in touch with new technical developments as these occur overseas.

One company has, to its considerable advantage, maintained a vigorous local research and development facility for many years. Other manufacturers are starting to open research laboratories to adapt overseas techniques to our environment.

The lines along which developments are likely to take place will be broadly similar to those elsewhere, in television services, scatter propagation, solid-state devices, electronic control both for the older and for the newly developing industries, computers for business and scientific purposes. Banks are already keenly aware of special problems they face which are different from those in the Northern hemisphere; in country regions their transactions are spread over a comparatively large number of small branch offices extending over huge areas.

AVIATION ELECTRONICS—Aviation has seen rapid growth and aircraft now carry a substantial proportion of the passenger traffic within the country and on its overseas links. The services are operated to very high standards and they have achieved excellent regularity and safety records. A share of the credit must go to excellent communications and navigation systems, some of purely Australian origin. Perhaps the best example is Distance Measuring Equipment, a radar-beacon system giving the pilot direct measurement of distance in miles to his terminal point or to any beacon enroute. See Fig. 10.

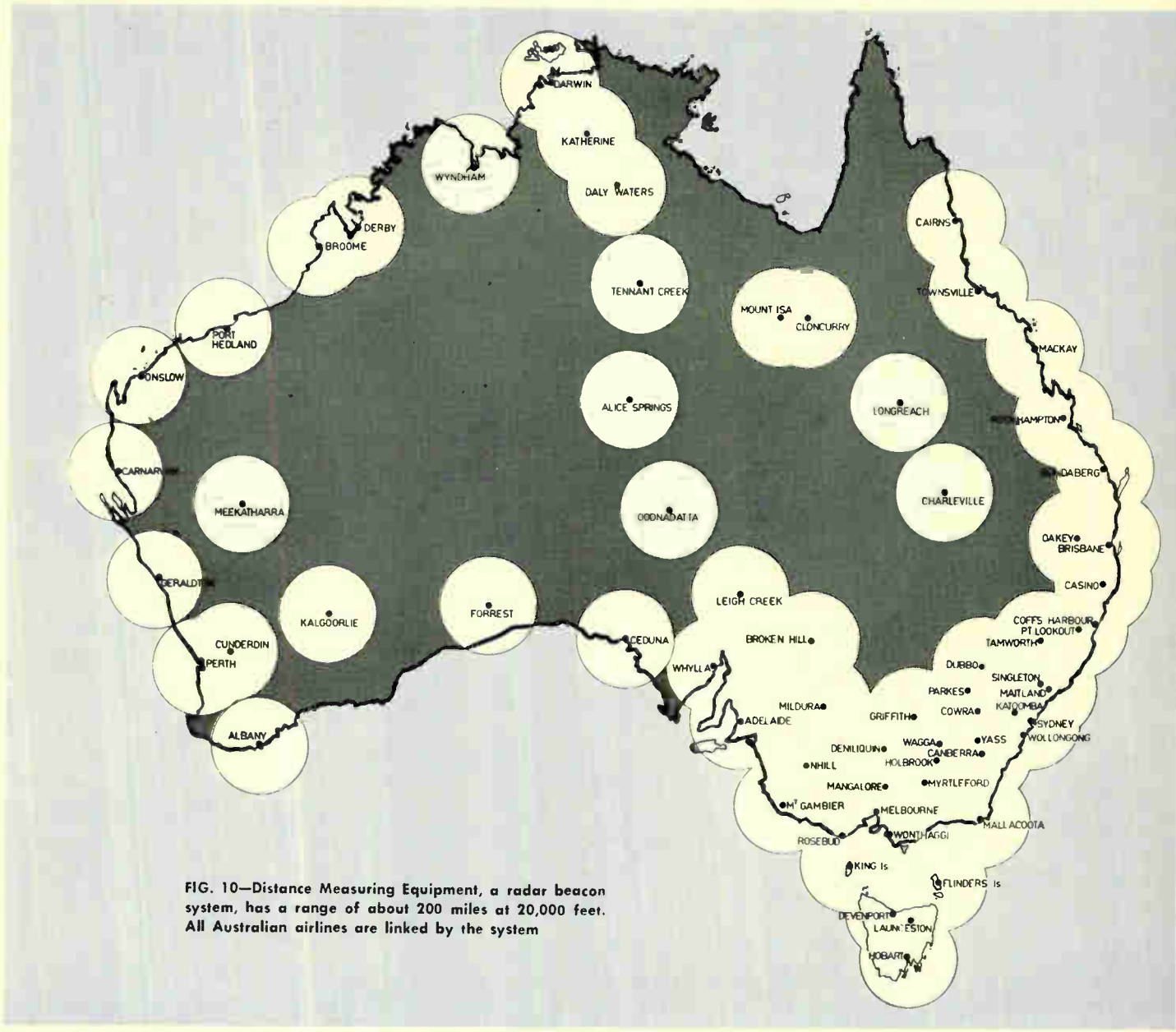


FIG. 10—Distance Measuring Equipment, a radar beacon system, has a range of about 200 miles at 20,000 feet. All Australian airlines are linked by the system

Maximum range is about 200 miles at 20,000 feet, with an accuracy of one or two miles. Within 10 miles of the landing field the accuracy is $\pm\frac{1}{4}$ mile. All air routes are covered by the system and the equipment is mandatory on all passenger-carrying aircraft. A transistorized version of DME exists in the laboratory and will shortly be introduced into service. It is half the size, quarter the weight and requires one-tenth the input power; these characteristics might well mean that its use will be extended to smaller private aircraft.

In a related field, the application of ground radar to assist the flow of traffic, and of airborne radar for weather avoidance, are well understood and the scene is ripe for developments along these lines.

WEATHER AIDS—The Weather Service has suffered from a dearth of information imposed by the vast size of the continent and the comparatively small population. Much of our weather has its origin in the surrounding oceans, and there is almost a complete lack of precise information on the movement of weather systems from these regions.

The situation is wide open for the application of radar and other aids. These must be supplemented by observations of events in the high atmosphere which undoubtedly contribute to the vagaries of weather experienced on the surface. Information along these lines is already obtained from Doppler observations of the drift of meteor trails at Adelaide University and from rocket observations at the Woomera Range.

SATELLITE OBSERVATIONS—In common with

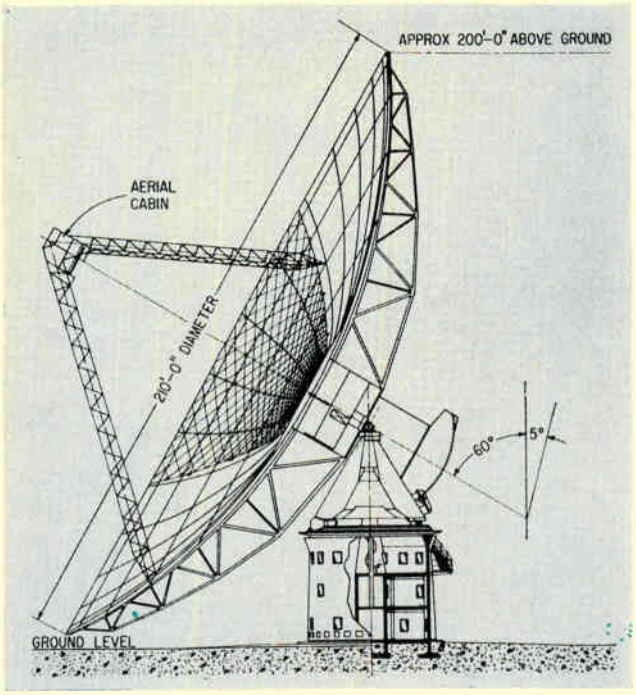


FIG. 11—Steerable radio telescope scheduled for completion in 1961

other countries in the Southern Hemisphere, we have made an important contribution to observations of satellites at times when they cannot be seen from the Northern Hemisphere. Among these countries, Australia is unique in its ability to participate in a space-research program. It has a highly developed rocket range and is one of the few small powers to be so endowed. It has access to powerful rockets and facilities to fire them and is preparing to embark on its own high-altitude research program.

RADIO ASTRONOMY—In radio astronomy the country is responsible for pioneer efforts. In this sphere we are known for a host of researches on solar and galactic problems. Among the earliest of these were radio-spectrograph observations of noise bursts and outbursts coming from the sun on meter wavelengths. These are known to be associated with vast explosions in the solar atmosphere which in turn are connected with sunspots, flares and other visual features on the surface.

Radio observations show that when these phenomena occur, streams of particles are ejected from the sun, some at the comparatively modest speed of 500 to 1,000 kilometers per second, others up to a third or half the velocity of light. These particles travel vast distances through the solar system and those which hit the earth produce auroras, magnetic storms and severe disturbances in the upper atmosphere. They have a profound effect on long-distance radio communication and could conceivably influence our weather.

In parallel are radio heliograph observations on decimeter wavelengths giving, in effect, still pictures of radio disturbances in the sun's atmosphere. These match the well-known optical observations of flares and the magnetic observations of the Mount Wilson Observatory. They show that the radio disturbances originate in the sun's atmosphere rather than at the surface and give data from which the density and temperature structure of the sun's atmosphere can be obtained out to distances which were inaccessible to the astronomer prior to the advent of radio measurements.

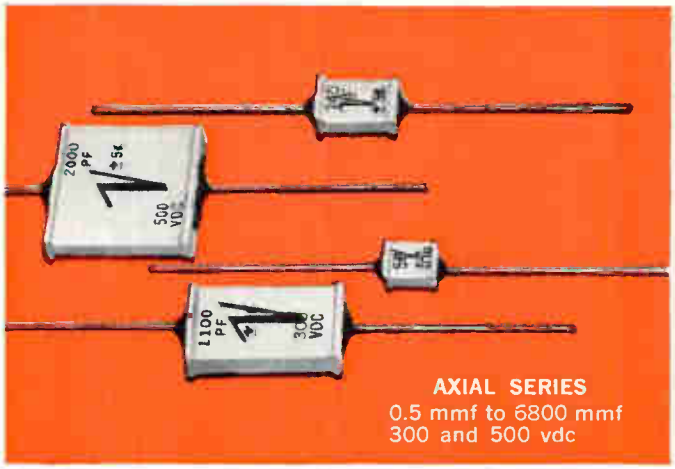
Results in the galactic field are no less exciting. In collaboration with Leiden observers, a complete map of the spiral arms of our own galaxy has now been obtained. This is only the beginning and the stage is set for a further attack on the detailed structure of the system. At still greater distances, it appears that signals come mostly from abnormal external galaxies emitting vast amounts of energy in the radio spectrum. Some are known to be on the very edge of the observable universe and many are beyond the reach of the most powerful optical telescopes.

Researches began with simple but elegant adaptations of existing radio techniques. Then came the invention of various ingenious devices, of which perhaps the Mills Cross is the most famous. This was followed by the crossed-grating interferometer of Christiansen, the so-called "Chris-Cross". Both instruments are now being duplicated in other parts of the world and in the future still larger and more refined versions will be constructed.

Among the plans in hand is one to extend solar observations using a rapid-scan radio heliograph on meter wavelengths. This should provide pictures of the movement of disturbances on the sun and will give us further information on the physical processes involved.

For galactic and extra-galactic researches, a new development is the construction of a giant radio telescope, shown in Fig. 11, due for completion in 1961. This instrument is of the alt-azimuth type and incorporates a steerable parabolic reflector 210 feet in diameter. An accuracy of $\pm\frac{1}{2}$ inch will be maintained over the whole of this surface and the telescope should have first-class performance at the 21-centimeter design wavelength. It is to be controlled by a unique master equatorial system and there is every expectation that a tracking accuracy of one minute of arc will be achieved.

A contract for construction was placed in July 1959 and fabrication has started. Research observations should commence towards the middle of 1961. The telescope will be erected on a quiet valley site at Parkes, approximately 200 miles west of Sydney. The electrical noise level in this region is exceptionally low and likely to remain so for the next twenty to thirty years. When complete, the instrument will be unique in the Southern Hemisphere and among the most refined of its kind in the world. It will be used principally for researches into the structure of our own galaxy and of the galactic systems in the universe beyond. It will also provide one of the most important links with planetary and space probes others are now planning and, in association with similar instruments in the Northern Hemisphere, a complete cover of the celestial sphere.



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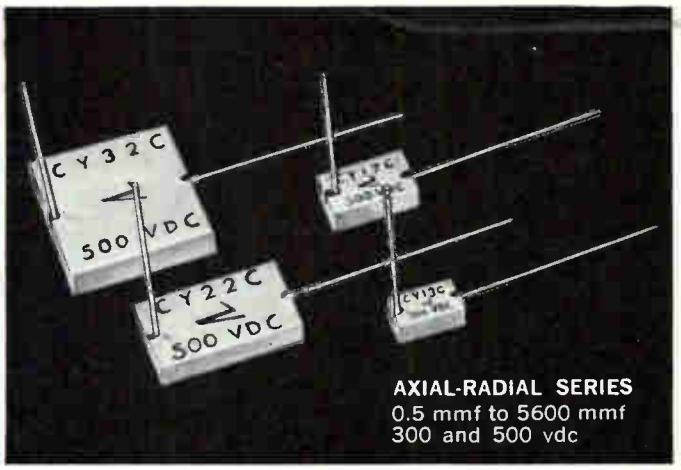

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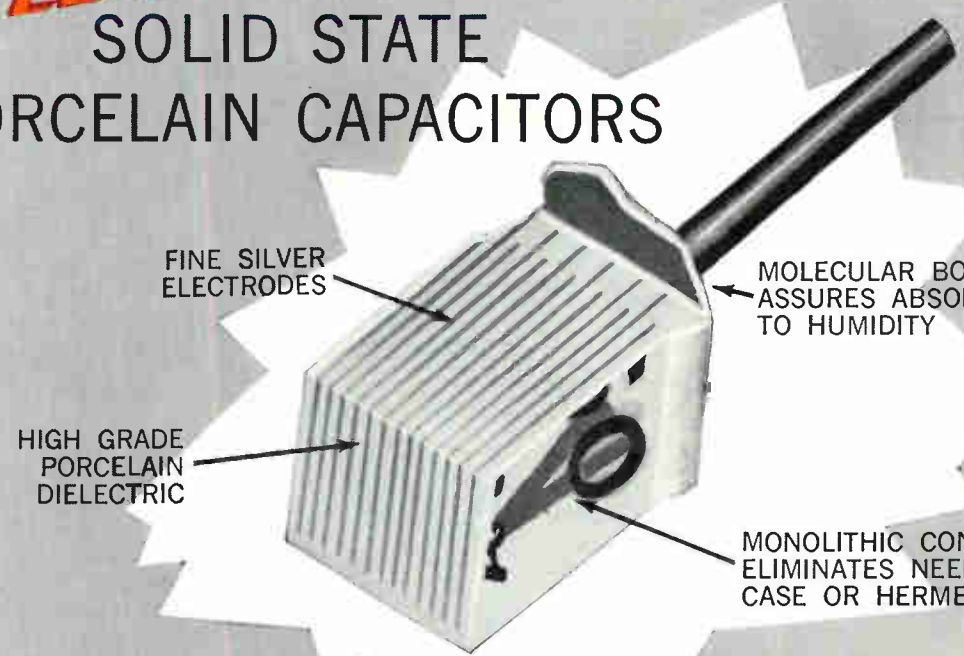

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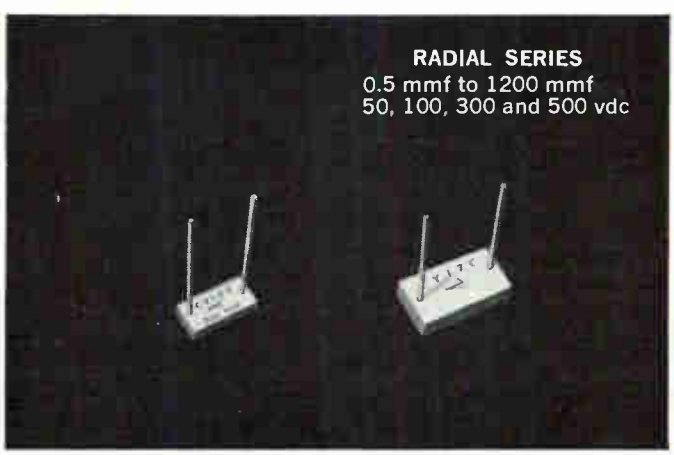

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0.3 mw full scale	−15 to −5dbm
1.0 mw full scale	−10 to 0dbm
3.0 mw full scale	−5 to +5dbm
10 mw full scale	0 to +10dbm

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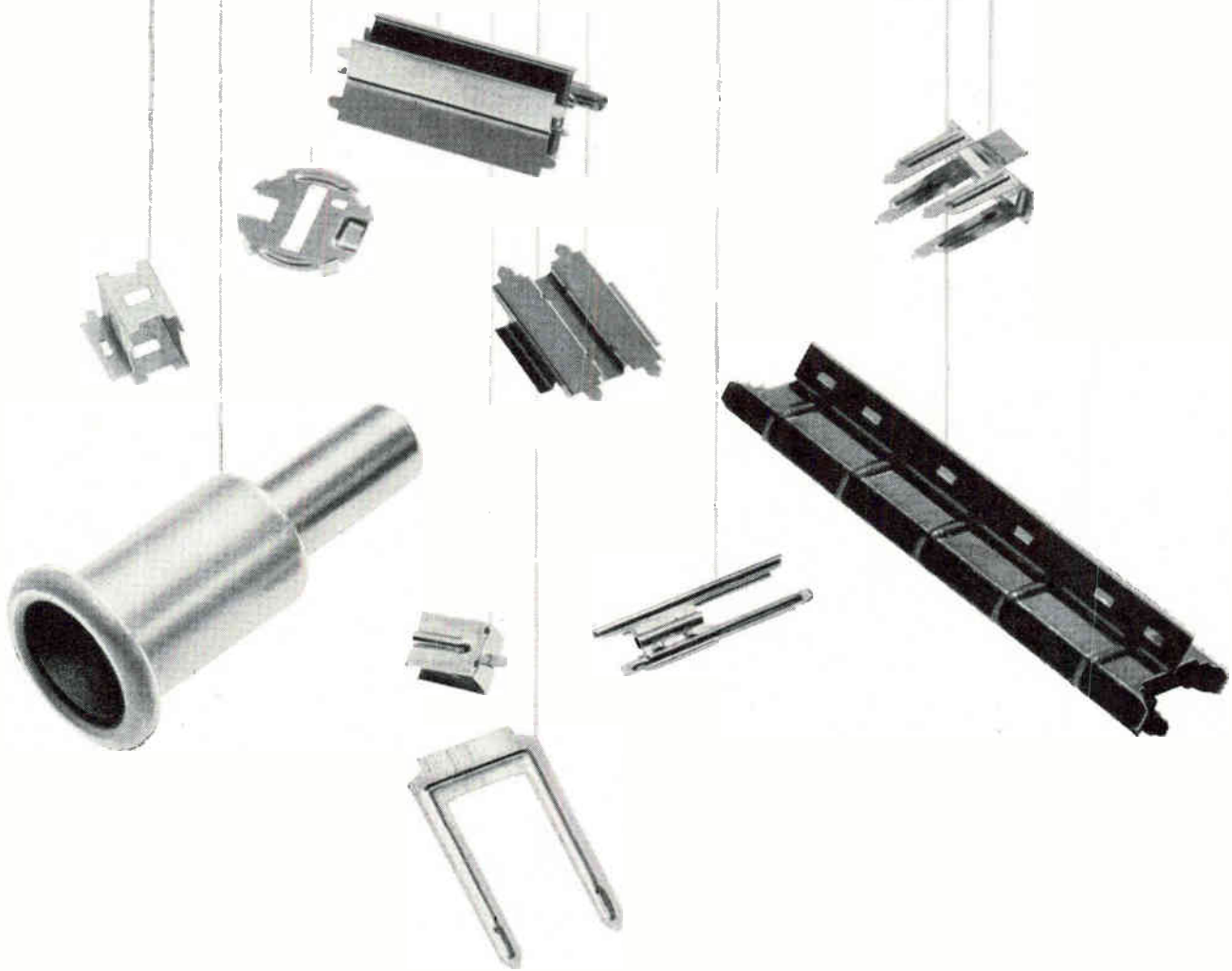

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FEBRUARY 12, 1960

Three-Element Semiconductor Materials

List of possibilities is nearly endless. But the search isn't a blind one. Certain rules make it possible to predict new compounds

By J. H. WERNICK and R. WOLFE, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

Photomicrograph of polished and etched surface of $AgSbTe_2$ (light areas) containing small amount of silver telluride (dark areas)

EXCITING NEW electronic devices, based on the varied properties of semiconductors, are invented each month in research laboratories around the world. Some of these—tunnel diodes, thermoelectric power generators and refrigerators, solar batteries, Hall-effect gyrators and circulators, parametric amplifier diodes, photoelectromagnetic infrared detectors—may soon be as important to the electronics industry as transistors and rectifier diodes are today. All of these devices are the fruits of the ever-increasing research effort on fundamental semiconductor properties (ELECTRONICS, July 19, 1959).

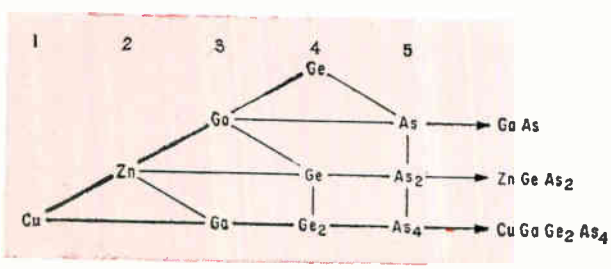

FIG. 1—Semiconductors related to germanium by substitution

One basic attribute of semiconductors makes this great variety of devices possible—the electrical properties of a semiconductor can be controlled over wide limits. This control is achieved by variation of the density of free electrons or holes in the material by adding to the pure material minute quantities of foreign atoms or molecules, either uniformly throughout a specimen, or locally within a single crystal. The behavior of the electrons or holes can then be controlled by electric, magnetic or electromagnetic fields; by heat; or by mechanical force. For example, in the photoelectromagnetic infrared detector, when a uniform bar of semiconductor is illuminated with infrared light in the presence of a magnetic field, an electric field is produced.

For each device, a particular material is chosen which has the best combination of properties. For transistors, high electron mobility and large energy

Table I—Ternary Compounds

	Melting Point °C	Energy Gap (eV)	Room Temp Mobilities (cm^2/volt-sec) Electrons μ_n	Holes μ_p		Melting Point °C	Energy Gap (eV)
$CuFeS_2$	875	0.53		>30	Cu_3AsS_4	655	
$CuFeSe_2$	574	0.16		<20	Cu_3SbS_4	555	
$CuFeTe_2$	740	0.16		<50	Cu_3SbSe_4	425	
$AgFeS_2$					Cu_3SbS_3	555	
$AgFeSe_2$	736	0.23	>250		Cu_3AsS_3	640	
$AgFeTe_2$	680		>2,000		$CuSbS_2$	535	
$CuAlS_2$					$CuSbSe_2$	460	
$CuAlSe_2$					$CuAsS_2$	625	
$CuAlTe_2$					$CuAsSe_2$	415	
$AgAlS_2$					$AgSbS_2$	514	
$AgAlSe_2$					$AgSbSe_2$	636.5	
$AgAlTe_2$					$AgSbTe_2$	576[b]	
$CuGaS_2$					$AgBiS_2$	810	
$CuGaSe_2$	1,040	1.63			$AgBiSe_2$	765	
$CuGaTe_2$	870	1.0	60		$TlSbS_2$		
$AgGaS_2$					$TlBiSe_2$		
$AgGaSe_2$	850	1.66			Ag_3SbS_3	486	
$AgGaTe_2$	720	1.1			Ag_3AsS_3	480	
$CuInS_2$		1.2[a]			Ag_3AsSe_3	385	
$CuInSe_2$	990	0.92[a]	1,150	50	$PbSb_2S_4$	597	
$CuInTe_2$	780	0.95[a]		100	$PbAs_2S_4$	424	
$AgInS_2$		1.9[a]			$AgAsSe_2$	390	
$AgInSe_2$	773	1.18[a]			$AgAsTe_2$	325	
$ZnSiAs_2$		2.1[a]			$AgInTe_2$	680	0.96[a]
$ZnGeP_2$		2.2[a]			$CuTlS_2$		
$CdGeP_2$		1.8[a]			$CuTlSe_2$	405	
$ZnGeAs_2$		>0.6, <1.1[a]			$CuTlTe_2$	375	
$ZnSnAs_2$					$AgTlSe_2$	328	0.72
$CdSnAs_2$			>5,600		$AgTlTe_2$	290	

[a] Optical energy gaps [b] Lattice thermal conductivity 0.006 watts/cm—°C

gap are desirable. For thermoelectric materials, low thermal conductivity is of primary importance, but high mobility, effective mass and energy gap are also useful. However, for each device, a compromise must be reached, because no known semiconductor is superior in all of the required parameters. Better devices of every type could be made if a material could be found which combined the best properties of the various known semiconductors. For example, if a new semiconductor were discovered which had the electron mobility of indium antimonide, the electron effective mass of bismuth telluride, the thermal conductivity of silver antimony telluride, and the energy gap of silicon carbide, thermoelectric generators could be made with an efficiency of 50 percent as compared with conventional power units like diesel engines which have efficiencies up to 40 percent.

It is the search for the best combination of properties for the various devices which prompts the continuing research on new compound semiconductors. This research may also lead to the discovery of new phenomena which may suggest still further additions to the list of devices and which will certainly contribute to the basic understanding of the nature of semiconductors.

Many physicists are still engaged in fundamental studies of elemental semiconductors, particularly germanium and silicon. It might be expected that nothing remains to be learned about these materials, but deeper understanding and new devices continue to come from this research. The tunnel diode is a notable example of a recent device based on an effect observed in germanium. New semiconductors continue to be discovered among the many possible binary compounds, such as InSb or Bi_2Te_3. The unique properties of some of these compounds have been utilized in such applications as infrared detectors and thermoelectric devices.

Recently the search has been extended to include ternary (three different parts) compounds and more complex materials. The list of possibilities is nearly endless. However, the search is not a blind one; there are rules which enable new semiconducting compounds to be predicted.

PREDICTING NEW SEMICONDUCTORS—The nature of the bonding in solids, and therefore the properties of the solids, are determined mainly by the interactions of the valence electrons of the constituent atoms. In the simplest semiconductors, Si and Ge, the bonding is purely covalent. Each atom has 4 valence electrons (Group 4b of the periodic table). In the solid, each Si or Ge atom is surrounded by four other atoms in a tetrahedral configuration, each electron being shared by two atoms to form a covalent bond. There are therefore four covalent bonds per atom, and the electron to atom ratio is 4:1. We can make use of these two facts, valence electron to atom ratio of 4:1 and tetrahedral coordination, for the prediction of semiconducting compounds. For example, if instead of 2 Ge atoms (8 valence electrons) we take a gallium atom (Ga—Group 3) and

an arsenic atom (As—Group 5), we form the semiconducting compound GaAs. All of the 3-5 binary compounds can be formed in this manner. Similarly, by combining Group 2 and Group 6 elements, one can form the semiconducting compounds ZnS, CdSe, and CdTe. This procedure can be extended in a manner shown in Fig. 1.

All of these compositions have electron to atom ratios of 4:1. The composition GaAs and $ZnGeAs_2$ are known to be single-phase semiconductors with a tetrahedral atomic configuration. By proceeding in this manner, one can fabricate hundreds of compositions which may yield single-phase semiconducting compounds.

The crystal structures of known compounds can be examined and those with tetrahedral atomic configurations can be chosen as possible semiconductors. For example, the minerals Enargite (Cu_3AsS_4), Tetrahedrite (Cu_3SbS_3), and Tennantite (Cu_3AsS_3) have tetrahedral coordination and are semiconductors.

As discussed above, elements Si and Ge are covalently bonded. Bonding in the Groups 5b and 6b elements is also essentially covalent. This fact, together with the results of the above discussion, suggests another approach in predicting new semiconductors; that is, compounds containing elements from Groups 4b, 5b, and 6b may have a large covalent component to the bonding, an apparent necessary feature for intrinsic semiconductivity, and such compounds should therefore be semiconductors. In addition, by the substitution of chemically similar elements, for example Se and Te for S, one may make new semiconductors. An example of this approach is the substitution of the heavier Se atom for S in the mineral Matildite, $AgBiS_2$. One obtains the new semiconductor $AgBiSe_2$ having the identical crystal structure.

The properties of the new semiconductors will be different from those of the compound on which they are based. In general, as the molecular weight of the compound increases, the melting point, thermal conductivity and energy gap decrease while the carrier mobility increases. There are exceptions to this generalization, but it is widely used, particularly in the search for new thermoelectric materials. Solid solutions of two or more semiconductors will exhibit properties which will be different from those of the end members.

Regardless of the procedure one follows in predicting that a given combination of elements should yield a single-phase semiconductor, there is no assurance that this combination will lead to a new compound. It is necessary to do much research to establish that this material after preparation is single phase and an intrinsic semiconductor.

Because of the volatility of one or more of the constituents, the compounds are usually prepared in sealed systems made of quartz. Occasionally, the partial pressure of the volatile constituent must be kept constant by maintaining one portion of the sealed system at a constant lower temperature. The single-phase nature of the material can be established by metallographic, x-ray and thermal-analysis techniques. A single-phase semiconductor is one in which the chemical composition and crystal structure

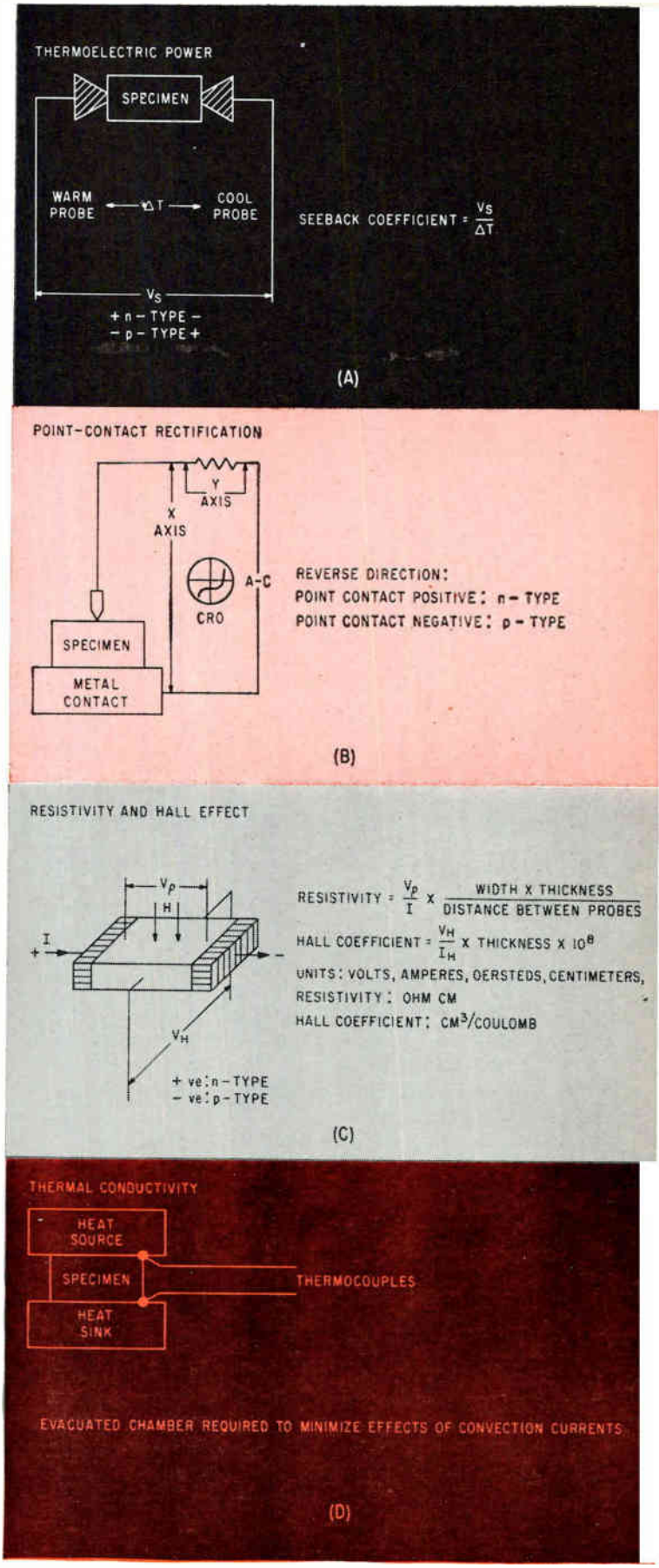

FIG. 2—Testing semiconductors for thermoelectric power (A), point-contact rectification (B), resistivity and Hall effect (C) and thermal conductivity (D)

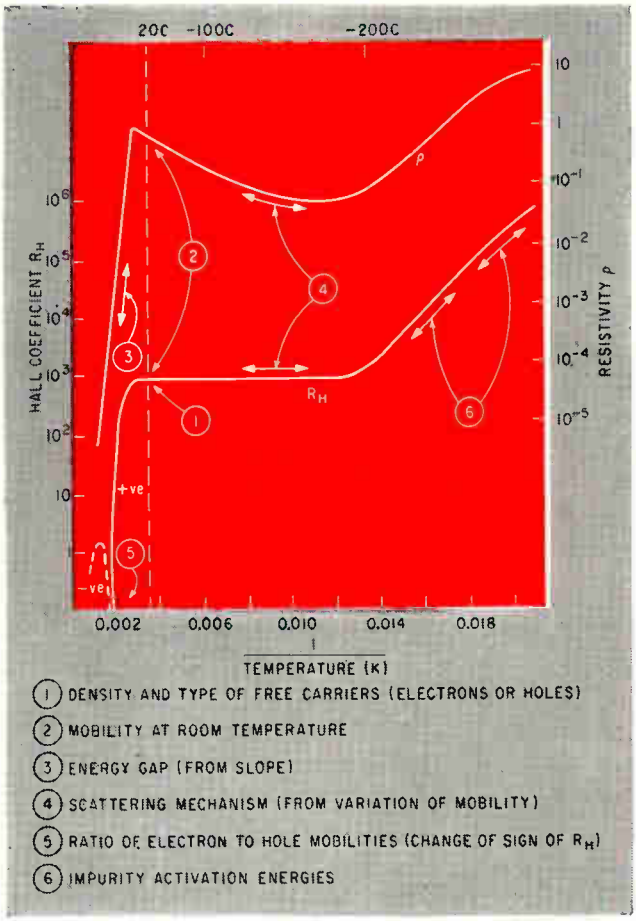

FIG. 3—Variation of resistivity and Hall effect with temperature

are the same at every point, unlike a mixture of two different materials like that shown in the photomicrograph. Each crystalline phase has a characteristic x-ray pattern and within the precision of the method, x-ray analysis will allow the establishment of the single-phase nature of the material.

Metallographic observations on polished and etched sections will allow for the detection of amounts of second phase which could not be detected by the powder x-ray technique. Single crystal x-ray analysis will also establish the crystal structure of the material.

The thermal-analysis technique determines, in addition to the melting point, if the alloy is single phase (absence of eutectic or precipitate) and if it melts congruently (does not dissociate before complete melting) or incongruently. This latter information is of importance for zone refining and crystal growing procedures. Occasionally a knowledge of the complete phase diagram is required. The phase diagram shows the temperature-composition relationship existing in a given alloy system.

After the existence of a new compound is established, it must be zone refined and single crystals grown so that the intrinsic properties can be determined. Following this, the materials are doped with known quantities of impurities so that the extrinsic properties can be determined.

A number of semiconducting ternary compounds reported in the literature are listed in Table I on page 104. The information is far from complete, and much important research remains to be done. Only when some of the gaps have been filled will it be possible to add to this table a list of potential applications for each material.

EVALUATION OF NEW SEMICONDUCTORS—After a new compound has been predicted and prepared, and when good single-phase specimens are available, various physical measurements are made. These measurements determine whether the compound is a semiconductor. Further experiments indicate how the particular semiconductor may be used in devices. For instance, the mobilities of electrons and holes are measured (if possible) because high mobilities are required for many semiconductor devices.

THERMOELECTRIC POWER—One of the first parameters which is quickly measured on each ingot is the thermoelectric power (Fig. 2A). Two metal probes are pressed onto the specimen—one warm and the other cool—and the voltage produced between these probes is measured. The sign of this voltage tells immediately whether the material is *n*-type or *p*-type. (If the warm probe is positive, the specimen is *n*-type; if the warm probe is negative, the specimen is *p*-type.) If this procedure is refined so that the two temperatures and the thermoelectric voltage can be determined accurately, then the thermoelectric power (Seebeck coefficient) can be measured. Values from a hundred microvolts per degree to several millivolts per degree are common for semiconductors. In metals, the thermoelectric power is usually small (less than ± 40 μv/degree C). Insulators cannot be measured with simple equipment because of the high impedance between the probes.

RECTIFICATION—Point contact rectification is another characteristic of semiconductors (Fig. 2B). If a potential is applied to a specimen between a large-area metal contact and a sharp metal point, rectification may be observed. If forward current flows when the point contact is negative, the material is *p*-type and if it flows when the point contact is positive, the material is *n*-type. Ohmic behavior is typical of metals and impure semiconductors.

CONDUCTIVITY AND HALL EFFECT—Electrical conductivity and its temperature variation are basic to the definition of a semiconductor. The measurement of conductivity is therefore essential in any semiconductor investigation. Conductivity depends on the density of free electrons or holes and on the velocity with which they move in an applied field (mobility). This dependence is expressed in the equation $\sigma = Ne\mu$ where σ is the conductivity, N the density of electrons or holes, e the electronic charge and μ the mobility. To determine N and μ separately, it is necessary to make further measurements. A most useful property to measure is the Hall coefficient (Fig. 2C).

When current flows in a semiconductor and a magnetic field is applied perpendicular to this current,

the moving electrons or holes tend to be deflected and a potential difference is established perpendicular to both the current and the field. This is the Hall effect. The Hall voltage is proportional to the current and to the field and the factor of proportionality is the Hall coefficient. The sign of the Hall coefficient is, by convention, positive for p-type material, negative for n-type material. Its magnitude depends on the density of carriers but not on their mobility. It can be shown that $R = \pm r/NE$ where R is the Hall coefficient, and r is some constant which depends on the subtler properties of the carriers but which is usually close to unity. The measurement of R therefore gives the density of carriers (and their sign). The product $R\sigma$ is the Hall mobility.

There are many different methods for measuring the conductivity and Hall coefficient in semiconductors and certain precautions must always be observed. It is important to use separate contacts for the current leads and the voltage probes and to avoid drawing current through the voltage probes. This eliminates the errors which may arise from contact resistance and rectification. In Hall measurements, a poor choice of specimen shape may cause current distortion and may lead to serious errors. Many other pitfalls, such as inhomogeneity, anistropy, surface contamination and nonlinearity may be encountered in these measurements. These are the subjects of continuing research.

A wealth of information is contained in the variation of conductivity and Hall coefficient with temperature (Fig. 3). The variation of the density of carriers with temperature depends on the energy gap of the material (the energy required to produce a hole-electron pair) and the activation energy of the impurities. Changes of sign in the Hall coefficient often occur as the temperature is changed. These give information about the ratio of the mobilities of electrons and holes. The variation of mobility with temperature depends on the mechanism by which the carriers are scattered as they move through the material.

OPTICAL MEASUREMENTS—Many applications of semiconductors depend on their optical properties—their transparency in the infrared region of the spectrum, the photovoltaic and photoelectromagnetic effects, electroluminescence and photoconductivity. Measurements of these properties on new semiconductors are important not only as indications of their potential usefulness in optical devices but also as means of determining the fundamental properties of the materials (Fig. 4). The absorption coefficient of a thin semiconductor specimen as a function of wavelength gives information about the energy gap, impurity ionization energy, effective mass of the free carriers and the dielectric constant. Photoconductivity measurements yield information on lifetime and diffusion of the electrons and holes. The photoelectromagnetic effect depends on the mobilities of the carriers and on the surface recombination velocity.

Solid-state spectroscopy is an important field of research which is indispensable to the study of luminescent materials (which overlap the fields of semiconductors and insulators). Many of the classical experiments of atomic spectroscopy are being adapted to solid-state systems, where they are helping to shed light on many of the properties of electrons bound to impurities.

THERMAL CONDUCTIVITY—Thermal conductivity (K) of semiconductors is of obvious device importance. For transistors and similar devices, it is desirable to use a material with a high thermal conductivity to minimize local heating. On the other hand, low thermal conductivity is one of the most important requirements for any thermoelectric material. It enables large temperature differences to be maintained in thermoelectric refrigerators and minimizes the conducted heat loss in generators. The thermal conductivity of semiconductors is also of theoretical interest. Heat is carried by the free electrons (as in metals), by the vibrating atoms (as in insulators) and by other mechanisms such as the diffusion of electron-hole pairs down a temperature gradient. It is important to separate the contributions from the various mechanisms because some are intrinsic properties of the material and others depend on the impurity concentrations.

The measurement of thermal conductivity is very simple in principle (Fig. 2D). It is merely necessary to pass a measured amount of heat through a specimen of known dimensions and to measure the temperature difference across the specimen. The heat

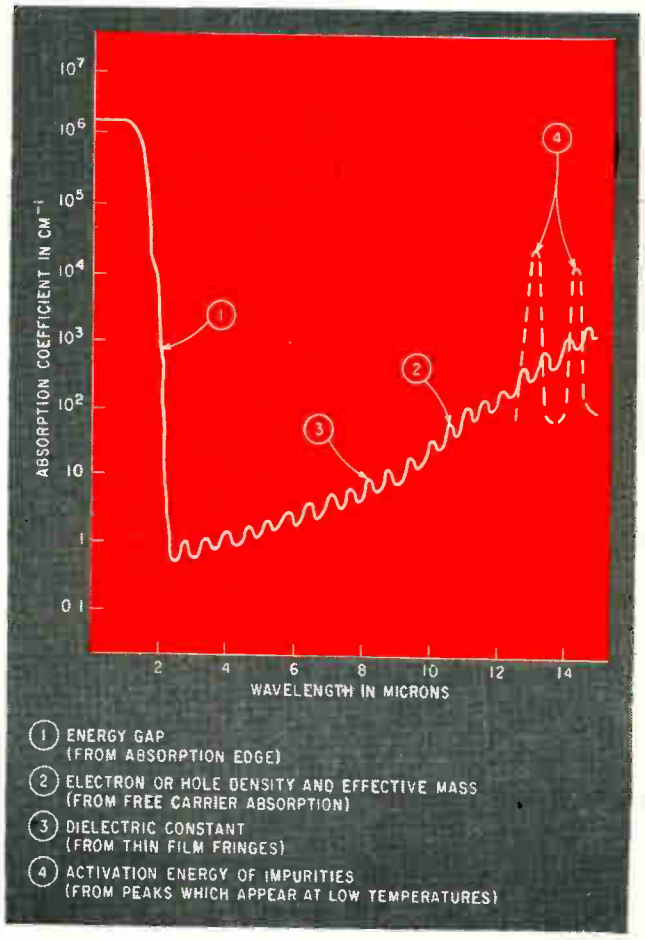

FIG. 4—Variation of infrared absorption with wavelength

flow per unit area per unit temperature gradient can then be calculated. However, in practice it is difficult to make good thermal contacts between the specimen and the heat source and sink and to assure that all of the heat flows through the specimen. Careful experimental procedure is required, including thermal shielding and operating in an evacuated chamber to eliminate convection and conduction in the air between the source and sink.

THE CASE OF $AgSbTe_2$—By way of summary and illustration, the prediction and investigation of the new ternary compound silver antimony telluride will be described. The starting point for the prediction of this compound was the mineral Miargyrite ($AgSbS_2$). Nature has supplied other substitute compounds—the minerals Matildite ($AgBiS_2$) in which bismuth is substituted for the antimony, and Wolfsbergite ($CuSbS_2$) in which copper is substituted for the silver. It was predicted that if the substitution of tellurium for the chemically similar sulfur would produce a single-phase material, a new semiconducting compound would be found.

When pure silver, antimony and tellurium were melted together in the exact proportions and then cooled, the result was a clean solid ingot composed of large crystals—the first promising indication that a new compound had been made. The ingot was zone refined, and again the outward appearance was encouraging. X-ray analysis showed that the crystal structure was the same as that of Miargyrite with one important difference. Both have the structure of rock salt which is a simple cubic lattice with sodium and chlorine atoms alternating in a regular arrangement. In both, the sulfur or tellurium atoms fill the chlorine sites. In $AgSbS_2$ at room temperature, the silver and antimony atoms alternate regularly in the sodium positions, whereas in $AgSbTe_2$ they are arranged at random on these sites.

The thermal analysis again pointed up this difference. When $AgSbS_2$ is cooled from a high temperature, there is a heating effect (a bump in the cooling curve) when the compound solidifies from the melt, and another effect as the structure of the crystal changes from disordered to ordered. The second effect is absent in the $AgSbTe_2$ cooling curve. This compound remains disordered down to room temperature.

Metallographic examination revealed that the material was often single phase, but under certain conditions another phase, which was darkly stained by the acid etch, appeared. A specimen which was rich in this second phase was examined by x-ray crystallographic methods and an extra pattern of lines was found besides those of $AgSbTe_2$. These lines were characteristic of another semiconductor, silver telluride.

Measurements of thermoelectric power were the first indication that $AgSbTe_2$ is a semiconductor. On each ingot the thermoelectric power was positive (p-type material) and its magnitude was close to 200 μv/degree C. No point contact rectification was observed on any of these ingots. The resistivity was fairly low, ranging from 0.004 to 0.01 ohm-centimeters, and it varied only slightly in the temperature range −200 C to +200 C.

The Hall effect showed an interesting and, at first, bewildering anomaly. It was sometimes positive, as expected in a specimen with p-type thermoelectric power; but in some specimens, with similar conductivity behavior and still with p-type thermoelectric power, the Hall effect was negative. The variation of this n-type Hall effect as the temperature was lowered added to the mystery: the Hall coefficient decreased to zero at about −200 C and then changed sign to become positive. No simple explanation for this behavior could be found within the usual theory of semiconductors, until it was observed that the n-type Hall coefficient and the dark stained regions on metallographically polished surfaces were found in the same specimens. It then became obvious that the n-type Hall coefficient was contributed by the small fraction of silver telluride in these specimens, even though the other properties were still dominated by the $AgSbTe_2$. This unusual phenomenon is still being investigated.

The most interesting property of $AgSbTe_2$ is its thermal conductivity. It was suspected that the heavy atoms and the disordered structure would result in low thermal conductivity in this material. Experiments have shown that this is indeed the case. The measured lattice component of the thermal conductivity (the part associated with the atomic vibrations and not the electrons, $K_L = 0.006$ watts/cm degree C) is about one hundred times smaller than that of germanium, and three times lower than the best known thermoelectric compounds such as bismuth telluride.

This material is therefore potentially useful for thermoelectric refrigeration and for power generation at moderate temperatures (it melts at 575 C). However, the electrical properties of the compound as it is now made are not good enough to make $AgSbTe_2$ superior to the best thermoelectric alloys. Research is continuing, and there is reason to believe that these properties can be improved.

The compound $AgSbTe_2$ has been added to the growing list of new semiconductors, but much remains to be learned before it can win a place on the short list of most useful semiconductors. This same statement applies to all of the other ternary compounds in the table. As research on these and other new semiconductors continues, our fundamental knowledge of solid-state science will be enhanced. Novel and improved devices for electronics may be the result.

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Wire Gage Provides Continuous Measurement

Simple circuit for measuring wire thickness uses nondestructive method to provide continuous indication. Instrument can measure copper wire as small as AWG size 46

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AN ELECTRONIC wire gage using a principle normally employed in proximity detectors offers two essential advantages over conventional methods for measuring tolerance of diameter (or resistance per length) of electrical wire. First, the test is non-destructive in that insulation of the wire need not be removed as for making contact in measuring resistance per length. Second, any length of more than an inch can be measured. This allows continuous measurement of wire as it is discharged from a spool.

An instrument with these properties enables manufacturers of precision wire to check their product continuously during the drawing operation. On coil winding machines, the test instrument can be inserted between spool and winding spindle. Meter indication shows the thickness of the wire which is actually used, not only of a sample. Moreover, excessive stress during the winding operation can be detected and output of test instrument may be used to adjust the tension automatically.

Principle of Operation

A piece of conductive material within the magnetic field of a coil acts like a shorted turn on a transformer, lowering the coil's Q. If the coil is employed as part of the resonant circuit of an oscillator, amplitude of oscillation is decreased by inserting a conductive probe into the coil.

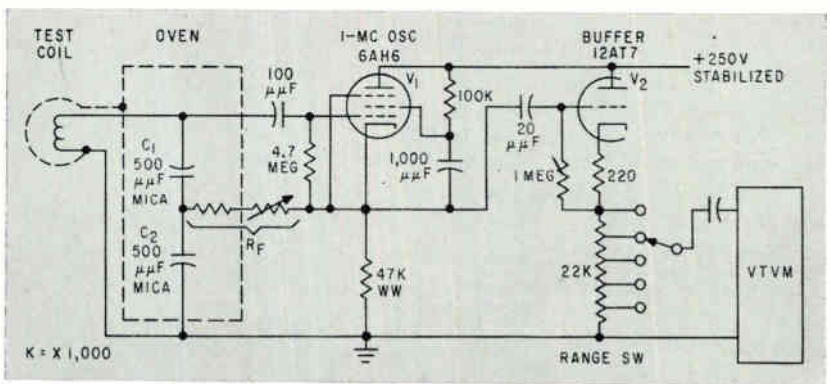


FIG. 1—Stability of measuring circuit is determined by stability of feedback resistance

This principle has been in use for several years for detecting the presence of conductive parts. In proximity detectors, oscillation ceases if a metal piece comes in the vicinity of the detecting coil. The investigation reported here proved the method to be apt for accurate quantitative measurements as well. Amplitude of oscillation decreases with diameter and conductivity of a wire fed through the coil in an axial direction. With the prototype instrument, copper wire as small as 1.5 thousandth of an inch in diameter can be measured.

Table I—Ratio of AWG Numbers

AWG Number	D	D^2	D^4
N + 6	1	1	1
N + 5	1.12	1.26	1.59
N + 4	1.26	1.59	2.52
N + 3	1.41	2	4
N + 2	1.59	2.52	6.35
N + 1	1.78	3.16	10.01
N	2	4	16

Oscillator

The equipment (Fig. 1) consists of an oscillator including the detecting coil, and a vtvm for measuring the oscillator's amplitude. A tube circuit originally described as a Q multiplier[1], is used for the oscillator. Employing one pentode only, this cathode follower type oscillator has excellent stability.

For measuring smallest wire sizes, a frequency around 1 mc proved best suited. The test coil acts as the inductance of the resonant circuit. Its specifications are: length $\frac{1}{16}$ in., inside diameter, $\frac{1}{8}$ in., 110 turns of magnet wire, AWG (American Wire Gage) No. 39.

Shielding of the coil requires spe-

cial attention. Distance between outer shield and coil should be not less than one inch (Fig. 2). The shield is slit to avoid its acting as a shortened turn.

Of the two coil terminations, the one from the inner layer is used as ground. In spite of this precaution, the capacitive effect of the wire probe may be too great, especially when measuring sizes thinner than AWG 40. This is indicated by a variation between readings with the probe grounded and not grounded.

As a remedy, a capacitive shield may be installed inside the coil when the instrument is intended to measure extremely thin wire. This inner shield must also be slit. To keep damping action small, this inside shield should be as thin as practicable, not more than 0.0001-in. copper, 0.00015-in. brass, or 0.0002-in. Constantan or similar resistive material. Start of the winding and connection lead of about the same size wire are soldered to the shield. Care should be exercised to produce a small joint with little solder, since any coherent mass of conductive material in this sensitive area reduces the sensitivity by biasing the coil's Q.

For the same reason, condensing moisture must be kept from forming a continuous film on the coil's surface. Condensation is prevented by impregnating the coil in wax. Finally, the coil is fixed in place by filling the space between coil and outer shield with wax.

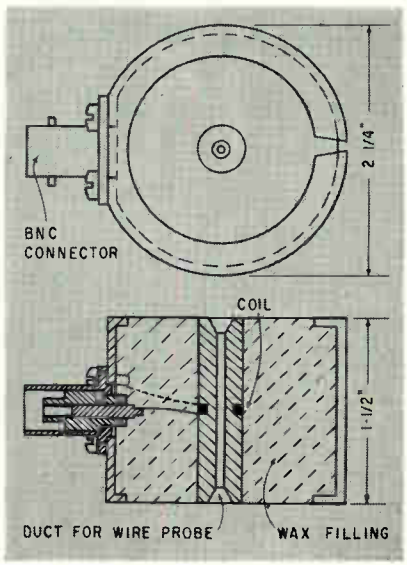


FIG. 2—Construction details of coil are outlined

Relation of Wire Sizes

Table I shows the numerical relation of AWG numbers to wire diameter, D. The ratios shown apply to any sequence of numbers of the AWG system. For example, taking AWG 34 as N, $(N + 6)$ means AWG 40, which has half the diameter, and a quarter of the cross section of AWG 34.

The fourth power of diameter, displayed in column D^4 of the table, characterizes the attenuating action of a wire probe in the test method described. This fact is considered in measuring stranded wire. Sixteen parallel, insulated strands cause the same attenuation of the oscillator amplitude as a single wire of twice the bare diameter. This is in contrast to usual resistance-per-length measurements, in which four strands are equivalent to a single wire of twice the diameter.

Due to this peculiarity, stranded wire with strands not insulated from each other can not be measured properly with this instrument. Readings would vary within the limits of second power and fourth power of the equivalent diameter, depending on incalculable contact between strands.

Scale

Figure 3 shows the typical attenuation of oscillator amplitude caused by wire probes of different size. Attenuated amplitude, E_A, is displayed in percent of amplitude without probe, E_1. With different wire sizes and certain corresponding values of E_1, proportions are the same over the entire usable region of oscillator amplitude. Therefore, symbol N is used for wire sizes, representing any AWG number.

Assuming a linear indication of voltage, the meter scale can be directly derived from this characteristic, as presented on the right-hand side of the diagram. Without probe, meter reading is full scale ($E_A = E_1 = 100$ percent). A probe of AWG number N, for example, AWG 40, brings the reading down to point N of the scale. In this case, a probe of AWG 41 will read $N + 1$; AWG 42, $N + 2$; and so on. For size N, the scale is subdivided in percent deviation from nominal diameter.

With this information it is possible to build a multirange instrument for measuring several AWG numbers, using a common meter scale for all ranges. Individual values of oscillator amplitude without probe, E_1, required to produce the scale proportion of Fig. 3 for different wire sizes, are plotted in Fig. 4. Meter sensitivity has to be adjusted in each case to produce

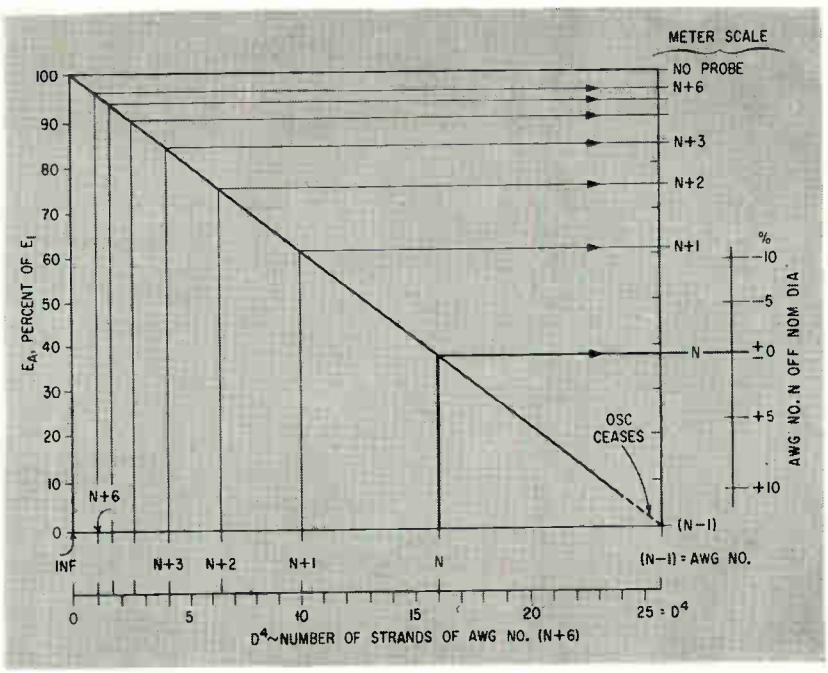


FIG. 3—Size of wire being checked is determined by relationship of voltages

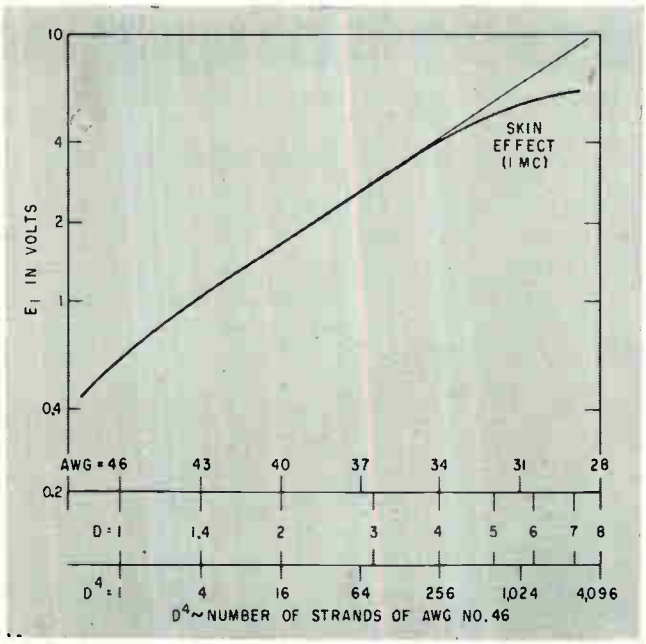


FIG. 4—Oscillator output without probe is a function of wire size, N

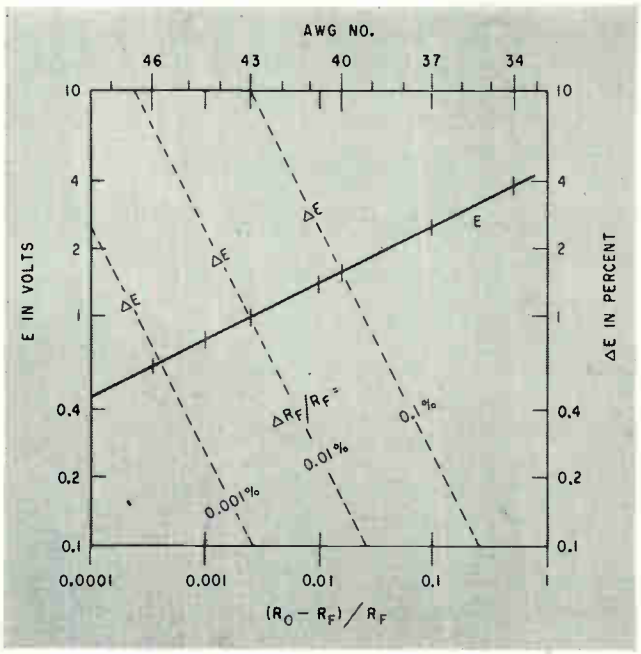


FIG. 5—Stability is affected by variation of feedback resistance

full scale reading without probe.

Output amplitude of the oscillator, E, is adjusted by varying the feedback resistor R_F (Fig. 1). The highest value of feedback resistance with which oscillation occurs, R_o, is in the order of 4,000 ohms. By decreasing R_F below this value, amplitude of oscillation increases. The solid line of Fig. 5 shows the empirical relationship of amplitude, E, versus ratio $(R_o - R_F)/R_F$

Knowing from Fig. 4 the values of oscillator amplitude required for the different ranges, the corresponding feedback resistor for producing these amplitudes can be found from Fig. 5. Related by amplitude $E = E_1$ in both diagrams, the scale of AWG numbers is entered in Fig. 5.

Stability and Sensitivity

Dashed lines of Fig. 5 referring to the right hand scale, ΔE percent, allow calculating the stability of the instrument in different ranges. Considering, for example, AWG 46, a variation of feedback resistance $\Delta R_F/R_F = 0.01$ percent would cause a deviation in amplitude, $\Delta E = 7$ percent. This is equivalent to an error of approximately 4 percent in reading wire diameter. The same line, $\Delta R_F/R_F = 0.01$ percent, indicates an error $\Delta E = 1$ percent for range AWG 43, equivalent to 0.5 percent in wire diameter.

Both these calculations assume a resistance variation of 0.01 percent. With the temperature coefficient of 20 ppm per degree centigrade of good quality precision wire resistors, this value would be reached by a temperature change of 5 C. Close tolerances like this are achieved by housing the fixed portion of R_F in a temperature-controlled crystal oven.

Oscillator output amplitude may be measured by means of any conventional vtvm circuit. Interaction between the indicating circuit and the oscillator is prevented by attaching a buffer amplifier to the oscillator.

The range selector switch is conveniently incorporated in this buffer stage, as shown in Fig. 1. Taps of the cathode resistor are calibrated by using the information shown in Fig. 4.

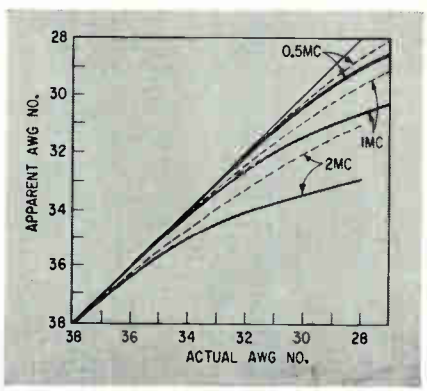


FIG. 6—Variation of skin effect with wire size and frequency is shown

Oscillator amplitude is adjusted by using the continuously variable part of the feedback resistance, R_F, to produce full scale reading with no probe. The potentiometer should be of low temperature coefficient wire, and preferably a multiturn type for sufficient resolution in a multirange instrument.

Skin Effect

For measuring copper wire heavier than AWG 38, influence of skin effect must be considered. Figure 6 shows the behavior of copper wire at three different frequencies. Dashed lines present apparent resistance per length. Full lines show apparent results with the electronic wire gage.

In designing a common-scale, multirange instrument, skin effect sets the useful limit toward heavier sizes. Renouncing the possibility of measuring extremely thin wire, heavier wires can be tested by employing a lower frequency. Lower frequency designs of the instrument are less critical as to environmental capacitive influence on the test coil.

Reference

(1) H. E. Harris, Simplified Q Multiplier, Electronics, p 130, May 1951.

Circuit Modifications For

Electronic methods are used to accelerate conventional electromechanical counters by a factor of 3 or more without attendant contact and flyback problems. Counter life is not shortened

By **RONALD L. IVES,** Palo Alto, California

THE AVERAGE operating rate of simple electromechanical counters has been increased from about 10 cps in 1940 to about 25 cpst at this date. Current instrumentation often requires faster operation, preferably at low cost and at no impairment of operating life.

Electromechanical counters can be improved by modifying either the electrical or the mechanical design and construction, both of which set limits on the amount of acceleration which is feasible.

Mechanical modifications to increase operating rate are few and relatively simple, but sometimes quite effective. Most common speed-increasing adjustment is to minimize the armature—core spacing, tighten the return spring and oil the pivots. With poorly designed counters, with which the improvement labor cost may exceed the purchase price, such adjustments are quite effective, producing an increase in the operating rate of up to 50 percent. With better grade counters, where attention has already been paid to mechanical design, little improvement in this manner is possible.

Counters having flap armatures can be accelerated in many instances by reshaping the armature so that while the magnetic circuit is substantially unchanged, the mass of the armature is reduced.

Electrical Modifications

Electrical circuit modifications to increase operating speed are numerous, fairly simple, very productive and lead to rate increases of as much as 300 percent. Most effective method—vacuum tube drive—not only increases speed by a factor of up to three, but also virtually eliminates contact troubles and flyback problems. Properly applied, these electrical acceleration means do not shorten the life of the counter and make no inordinate demands on the power supply.

Battery of six accelerated electromechanical counters as used in IGY anemometer experiments

All electrical methods of accelerating electromechanical counters depend for their operation on a shortening of the time constant of the electrical circuit of the counter. This is substantially the drive magnet coil, and its time constant can be stated as L/R, in which L is the inductance in henries, and R the resistance in ohms. Inductance L here is not a constant as the properties of the magnetic circuit change during the operating cycle.

The simplified formula for the buildup of current in an inductance is $T = (L/R)\ ln\ (E/E - Ri)$ where T is the pull-in time of the counter armature, L is the inductance of the coil in henries, R is the resistance of the coil in ohms, E is the voltage across the coil and i is the instantaneous coil currents in amperes.

As L in this formula is built into the counter and is not subject to easy alteration, T can be reduced to speed up counter operation only by increasing E or R. Both methods are useful and a combination of them using vacuum-tube drive seems most effective.

The simplest method of increasing E is by direct overvolting the counter. This speeds up armature pull-in time but tends to slow up armature release due to overmagnetization of the core. Serious flyback troubles are also introduced with attendant shortening of contact life.

When adequate spark absorption means are added to the circuit, damping retards armature release so that little net gain results from overvolting and the equilibrium temperature of the counter coil is likely to be abnormally high.

To offset the disadvantages of direct overvolting while attempting to retain its advantages, two modifications—pulsed overvolting and sliding overvolting have been developed.

Pulsed Overvolting

Pulsed overvolting is the application of an excess voltage to a

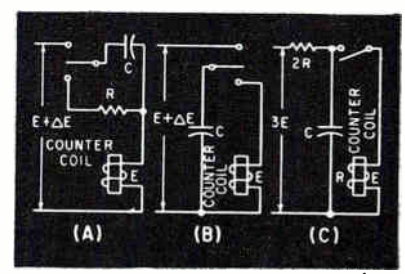


FIG. 1—Circuits for sliding overvolting of a counter coil

Boosting Counter Speed

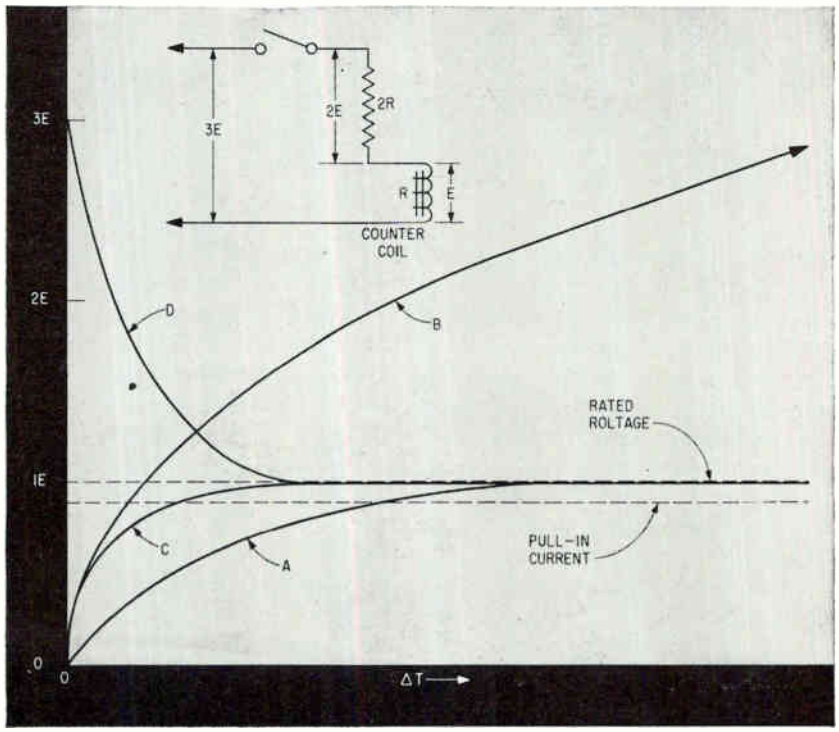


FIG. 2—Coil current buildup at rated voltage (A), current buildup at elevated voltage (B), buildup when switch is closed (C) and change in voltage across coil (D)

counter coil for a limited time. The reasoning involved here is that if a counter operates satisfactorily with 100 v applied for 0.1 seconds, it should also operate satisfactorily, and much faster, if 500 v are applied for 0.02 seconds. Experiments show that change of armature pull-in time with change of voltage is approximated by $P_2/P_1 \doteq (E_1/E_2)^{-3}$ where P_1 and P_2 are the armature pull-in times and E_1 and E_2 are the corresponding applied voltages. Voltage is applied in each case for the full armature pull-in time.

This method of counter acceleration is somewhat superior to direct overvolting, as the core is not overmagnetized. This leads to a reduction in flyback problems, contact burning and coil heating. Insulation and mechanical factors limit the useful acceleration attainable by this method to approximately a factor of three.

Sliding overvolting is the application of an excess voltage to the counter coil when the circuit is first completed. This voltage is then reduced, so that it falls to or below

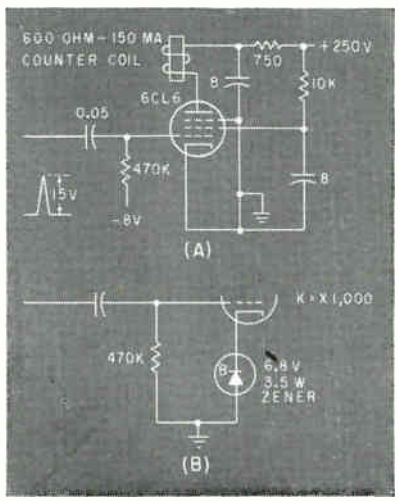


FIG. 3—Medium-sensitivity counter accelerator (A), with Zener diode biasing (B)

the normal operating voltage of the counter during the pull-in time. Methods of applying sliding overvolting to a counter coil are outlined in Fig. 1. It may be noted that these are the familiar relay slammer circuits used during World War II. In the first two circuits (A and B), which require a double-throw contactor, the capacitor value is about 1.2 times the minimum for dependable operation of the counter at the voltage applied. In both instances, the applied voltage is considerably higher than the rated operating voltage of the counter.

In Fig. 1C, constants for dependable operation of a counter at about twice the rated speed are shown. Capacitor value here is about 0.6 of that needed to operate the counter if charged at the supply voltage, and then discharged through the counter coil. This circuit operates with no serious trouble from contact failure, flybacks or coil heating. With this circuit, counter life at double rated speed is substantially rated life and this appears to be the optimum non-thermionic counter acceleration circuit using only elevated voltage.

Another means of accelerating electromechanical counters to increase the circuit resistance. This also calls for an increase in voltage, so that the equilibrium voltage across the coil is substantially the rated operating voltage. The operating circuit, and relation of coil current, supply voltage and voltage applied across coil, are shown in Fig. 2. Here, curve A shows the current buildup in the counter coil when rated voltage is applied. Counter armature pulls in when the current reaches the pull-in point. Curve B shows current buildup at a greatly elevated supply voltage. Here, the current reaches the operating point in a relatively short time. Curve C shows the current buildup in the counter coil when the switch in the circuit insert is closed. Current here reaches the operating value much faster than when only the rated voltage is applied to the coil, but somewhat slower than when an excessive voltage is applied directly. Change of voltage across the counter coil, during the current buildup of curve C, is shown in curve D. This is a very simple application of the sliding overvolting previously discussed. It is widely used in industrial counting, and gives a counter acceleration by a factor of more than

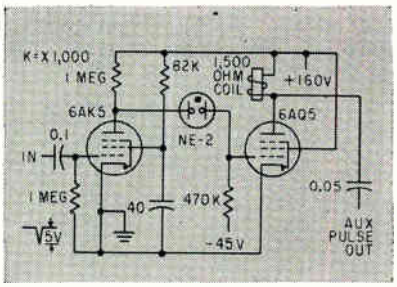


FIG. 4—Sensitive amplifier and counter driver uses neon tube coupling

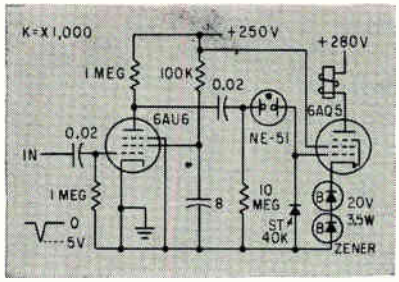


FIG. 5—Improved counter-accelerator permits simplified power supply

two without apparent shortening of counter life.

Thermionic Counters

When use of contacts is undesirable, as in photoelectric drive circuits, thermionic counter drives are commonly employed. These permit use of both pulsing and sliding overvolting and give a maximum of counter acceleration with a minimum of overheating and other damage to the counter coil and mechanism. Circuit of a thermionic counter accelerator, having moderate sensitivity, is shown in Fig. 3A. This accelerator is designed for industrial use, employs off-the-shelf components, and does not need readjustment when the tube is changed. By its use, operating speed of most electromechanical counters can be doubled. Counters used in this circuit commonly last somewhat longer than the rated service life.

The power supply can be simplified, and the installation made more compact, by securing the hold-off bias from a Zener diode, as in Fig. 3B. As the sustaining current for the Zener voltage drop comes largely from the screen circuit of the pentode, this circuit simplification does not impair counter operation or life.

Sensitivity of this circuit can be increased, by a factor of approximately two, by hand picking the tube used, and then adjusting the plate and screen voltages for optimum operation. This expedient is undesirable in most industrial installations because a counter circuit so adjusted will not necessarily work well with any good tube in the socket.

A more sensitive circuit, designed for operation from photocell anemometers at I. G. Y. installations in Antarctica and at other difficult locations, is shown in Fig. 4. This consists essentially of a starved 6AK5 amplifier neon-coupled to a 6AQ5 counter driver. As commercially constructed, these counters were arranged in batteries of six, with a single power supply, energizing not only the counters, but also the anemometer lamps and photocells.

Consistently attainable operating speeds of slightly more than 60 cps. were noted with counters rated at a maximum operating speed of 25 cps. Ultimate life of the counters in this service is not known, those used in Antarctica having passed 50 million counts without maintenance. Some power supply difficulty was experienced due to condensation in the selenium rectifiers. This is reducible by use of hermetically sealed selenium rectifiers and seems to be no problem when silicon rectifiers are used.

Because accelerated counters respond to 60 cycle signals, a number of precautions were necessary to prevent spurious counts from line pickup; and additional precautions were found desirable to prevent the leakage fields of the counters, particularly on release, from triggering other circuits.

Tests with a variety of counters of European and American manufacture show that operation can be accelerated by a factor of 2 to 2.5 by use of the circuit of Fig. 4, or rather obvious modifications thereof, provided the counter is of good mechanical design without shortening its rated service life. Counters of this type are built like a good-grade clock, using steel, brass, and plastic. Poorly-made counters can also be accelerated but their service life at high counting rates is very short as they start ejecting gear-teeth, ratchet pawls and small springs after only a few thousand operations. These counters are constructed of pot metal, soft aluminum and inferior plastics.

Improved Circuit

Satisfactory though this counter-accelerating circuit has proven in use, advances of the art have made possible some improvements by which a counter can be accelerated safely by a factor of more than three, and the power supply can be simplified at the same time. This improved circuit is shown in Fig. 5.

In this circuit, higher voltage operation permitting higher operating speeds, is made possible by use of a 6AU6 in place of the 6AK5 formerly used. The coupling between the 6AU6 and the 6AQ5 is changed to capacitative plus neon so that failure of the 6AU6 will not put the 6AQ5 into continuous heavy conduction leading to tube and counter burnout, with possible damage to the power supply. Replacement of the 6AQ5 grid resistor by a silicon diode corrects the tendency of the tube to bias itself off at high count rates. Lastly, the bias supply is eliminated by use of a pair of Zener diodes in the cathode circuit of the 6AQ5.

Dependable count rates with this circuit using a counter rated at 25 cps exceed 75 cps. A small additional rate increase can be brought about by lightening the counter armature, as previously outlined, or by reducing the coupling capacitors until the pull-in pulse is about 0.9 of the pull-in time. Under these conditions, the armature coasts for the last 10 percent of its travel, and the armature bounce (after contact with the magnet core) accelerates the return stroke. This means possible a dependable count rate of about 85 cps.

Further armature acceleration is possible by this method, but dependable counts at rates exceeding 85 cps are not now attainable because of coasting of the first number wheel, which produces overcounts of up to four in any operation. A slight redesign of the counter mechanism would probably make sustained counts more dependable at rates slightly exceeding 100 cps.

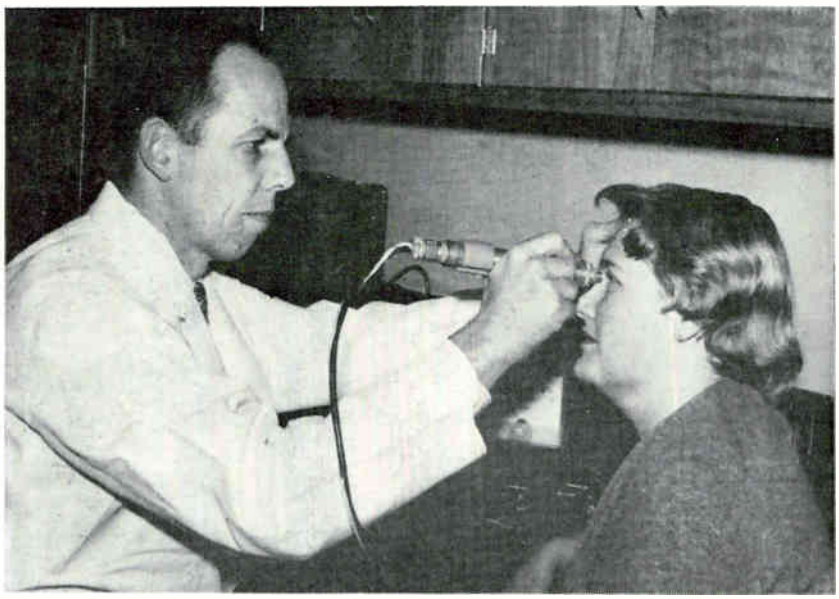
Electronic Tonometer For Glaucoma Diagnosis

Glaucoma can be detected by a probe that measures pressure within the eyeball. Early diagnosis makes ultimate cure possible

By **R. STUART MACKAY** and **ELWIN MARG**, U. of California Medical Center, San Francisco, Cal.

OF all people over forty, it is estimated that two percent are going blind from what is known as simple glaucoma. In this malady an increase in pressure, if not detected and corrected in time, causes irreparable damage to the optic nerve. Its onset is diagnosed earliest by measuring the pressure within the eye using devices called tonometers, after which the pressure can be relieved by drugs or surgery. A new electronic tonometer has been conceived that is so fast and gentle that it does not require anesthetics and yet it is more accurate because it does not respond to extraneous factors that lead to uncertain readings in the classic devices.

Conventional tonometers measure pressure in one of two ways. Either a plunger is placed upon the front surface of the eye in a vertical position and the indentation due to loading with a known weight measured, or else the area flattened by pressing a transparent plate against the eye with a given force is measured optically. Bending of the cornea introduces an uncertainty into the reading because of its stiffness or rigidity. The difficulty is increased in an astigmatic eye where the curvature may be different in different directions. Even the surface tension of tears introduces an uncertain component of force.



Eye pressure measurement can be completed in less than one second

Probe is shown with shield removed

Close-up of central unit and probe

Operational Principles

Figure 1 shows the arrangement of the new tonometer. The eye is momentarily flattened beyond the pressure sensitive region. Since the bending takes place at the periphery of the probe, the central plunger is not acted upon by bending forces. Any tension in the tissues is a centrifugal force that does not act on the pressure sensitive area. The probe is a small handheld device that is momentarily touched to the eye. As long as the front surface of the probe remains approximately flat, essentially the only variable that will be recorded is the intraocular pressure.

In the present device flatness, as well as freedom from drift caused by changes in amplifier gain or changes in resiliency of the mechanical components, is assured by a feedback mechanism. Any tendency for the plunger to be deflected inwards is sensed by a sensitive motion transducer and is counteracted by the resulting change in

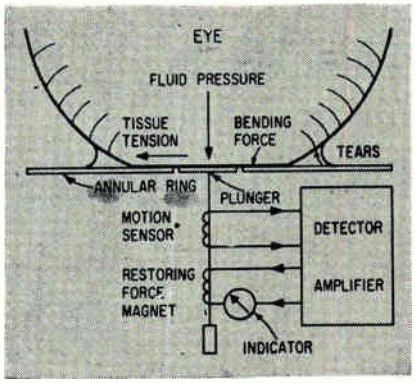


FIG. 1—Magnetic feedback is phased so that plunger resists eyeball pressure and remains approximately co-planar with surrounding annular ring

current in a direct coupled magnetic actuator. A measure of the pressure is then obtained by recording the current to the feedback magnet. The scale is linear and free from involved calibration because the plunger never moves appreciably and thus changes in transducer sensitivity with deflection, or variations in restoring force field, are not introduced.

In using the device the probe is momentarily pressed against the eye. As the force of contact increases, the recorded reading will increase until the plunger, which is about two millimeters in diameter, is covered. The further increase in force will not change the reading until the pressure within the eye begins to be raised by the external force. Thus the reading, which can be recorded on a pen-writer, displays a plateau whose elevation is a measure of intraocular pressure (Fig. 2).

Circuit Operation

The requirements of the motion-transducer are twofold. It must (1) be extremely sensitive to small displacements and (2) very little force should either be required by the transducer, or reflected back into the system by it. The transducer employed made use of the motion of a ferrite core which altered the inductance of an adjacent coil. The change in inductance is measured by a circuit resembling some types of frequency-modulation detectors. The circuit is shown in Fig. 3.

Changes in position of the moving ferrite core cause a signal to be developed across capacitor C_1, with signal polarity dependent upon the displacement direction. The signal (voltage) is fed to the d-c amplifier via the shielded probe-cable and the output from the d-c amplifier feeds the transistor-pair, Q_1 and Q_2. The amplified signal drives the restoring coil which forces the probe into the plane of its surrounding annular plate. The actuator consists of the voice coil and magnet from a small loudspeaker.

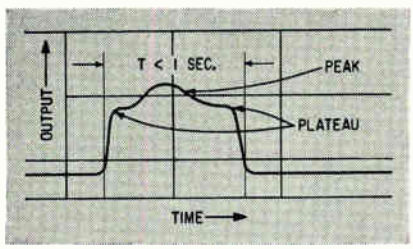


FIG. 2—Recorded response as probe is applied to, and taken away from, the eyeball. The peak indicates extra pressure caused by probe

The signal from the displacement sensor is about 0.1 volt per micron of movement of the plunger. The feedback system applies a force of about 0.8 gram to the eye for a normal intraocular pressure of 16 millimeters of mercury. The deflection of the system is 0.6 microns for a pressure of 40 millimeters of mercury. A change in oscillator frequency from 5 megacycles down to 100 kilocycles decreases the sensitivity to uselessness.

In Fig. 3, T_1 and T_2 are Miller transformers, type 1467, the primary of T_1 being L_1. Coupled to T_1 and T_2 are L_2 and L_3, which each have 16 turns in two layers of No. 22 wire. The primary and secondary of T_2 are labeled L_4 and L_5 respectively. The probe is shielded and the shield has an axial slit so that it does not act as a shorted turn. The probe shield is grounded to the shield of the connecting cable. This connecting cable carries both radio frequency to the probe and the detected signal from it.

The plunger diameter is approximately 2 millimeters and the diameter of that part of the eye flattened by the surrounding plate is approximately 3 millimeters. The mass of the moving parts in the device is kept to a minimum so that accelerometer or seismograph effects are minimized in the recording as the probe is moved. Problems of friction were minimized in the design of the probe but their remaining interference was removed by including in the feedback loop a small 200 cycle voltage signal (fed in by T_3). The resulting small amplitude motion introduces no noticeable signal but eliminates the effects of static friction.

The help of Mr. Raymond Oechsli in perfecting the circuits and the probe is gratefully acknowledged.

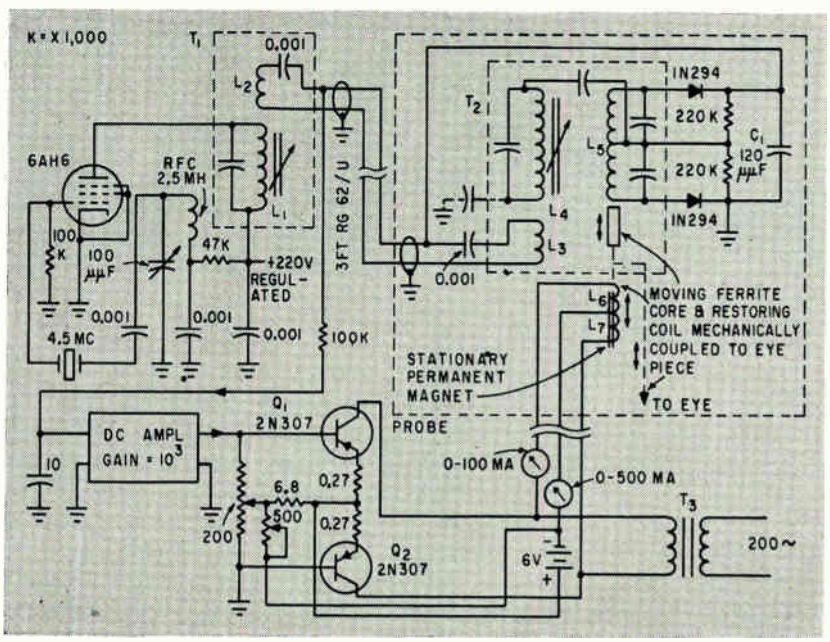


FIG. 3—Circuit diagram shows interconnection of oscillator, probe, and d-c amplifier

Office setup suggests one practical application for monoscope character generator which has been developed at Stanford Research Institute

Character Generator for Digital Computers

Speed with which machine-to-person information links can process information has lagged behind computer capabilities. This monoscope tube, operating in the speed range of computers and memory devices, provides readout directly on a cro or on paper

By **EARLE D. JONES,** Research Engineer, Stanford Research Institute, Menlo Park, California

A COMPACT AND economical monoscope tube apparatus which generates well-formed alphanumeric characters for display at high speeds is described in this article. In this apparatus, the character generation function is completely separated from the character display, thus providing a degree of flexibility not available in some other methods. With repetitive digital information, for instance, an ordinary laboratory oscilloscope may be used to display the characters.

This monoscope character generator may also be used to drive certain types of hard copy printers, either by optical transfer of visually presented information or directly for special types of electrostatic printing tubes.

Input to this monoscope is derived from conventional six-wire parallel binary information. A standardizer at the input supplies uniform and consistent electrical pulses to the generator, permitting the device to be driven by a wide variety of sources.

Sources of Information

Excellent results have been obtained from two sources of input information. First, a 36-position ring counter employing beam switching tubes has synthesized the necessary digital information on six wires. The beam switching tube outputs were sampled off through diodes to six wires.

The device has also worked from information stored in digital form on a six-track magnetic tape. A 360-character message was encoded on the tape and read off at a tape speed of 60 inches per second to give a character rate of approximately 10,000 per second, which is in the speed range of computer and memory devices. (With minimal changes, this rate could be increased to 20,000.) Equally satisfactory performance can be expected from an information source such as a magnetic drum, a paper tape or an electric typewriter.

Information can be displayed on commercially available equipment. If the input information is repeated faster than 20 times per second, the characters may be displayed, without flickering, on any conventional cathode ray tube device. For nonrepeating or low-repetition rate information, a direct view storage tube is suitable. Portions of a message can be selected and displayed as long as desired on a tube face. Otherwise, the message can run in its entirety for the observer and can be stored if desired.

Character quality is limited only by the raster frequencies (and therefore, video bandwidth) and

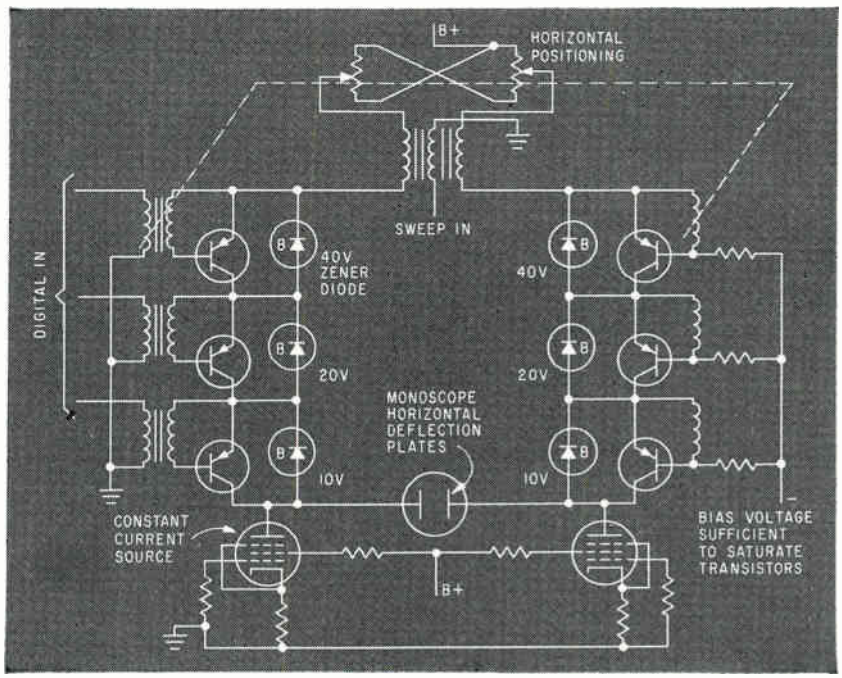


FIG. 1—Simplified schematic of horizontal decoding and deflection circuit

the finite spot size of the monoscope tube. Present techniques utilize about 400 picture elements in the small raster to cover a character and any guard space around it. For a 10 kc character rate (one character each 100 microseconds), about four megacycles of video bandwidth is required. To operate at faster character rates, the switching transistors should be faster and a higher frequency raster should be employed, resulting in wider video bandwidth requirements. Character quality is superior to character display systems utilizing a simple dot matrix for character writing.

Monoscope Construction

Video waveforms necessary to write characters are generated in a monoscope tube—a fundamental cathode ray device. The tube comprises a conventional electron gun and an aluminum target enclosed in a vacuum envelope. All of the desired characters and symbols are on the metal target in printer's ink. A six-wire system makes up to 64 different characters and symbols available, including one for spaces. These are arranged in eight rows of eight characters each on the target.

Preparation of the monoscope target is by common photoengraving and printing techniques. This enables complete freedom in the selection of the style of type, symbols or simple pictures. In the preparation of the target the characters can be located in the matrix in order to conform to six-unit binary codes which vary with machines. Type font or character-selection code can be changed by replacing the monoscope tube (a $100 to $200 item).

Monoscope Operation

As a constant-intensity electron beam is scanned across a character, the secondary emission curent from the target is modulated; aluminum and carbon, the chief ingredient of the ink, exhibit different secondary emission coefficients. The resulting video signal is amplified and used to intensity-modulate the display tube.

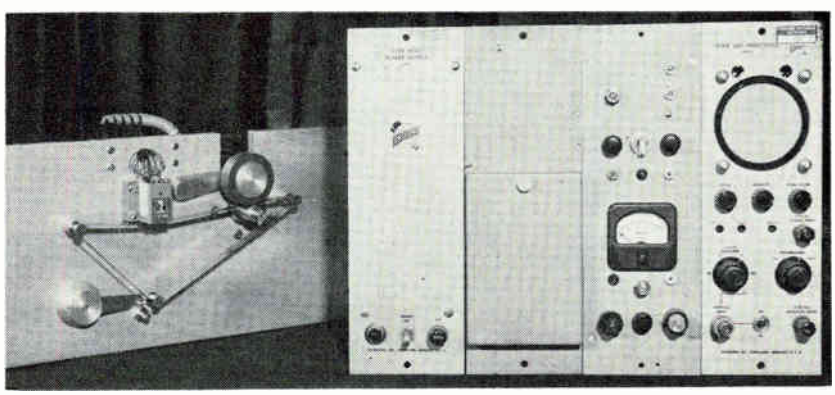
The monoscope beam is scanned in a television-like raster which covers only one character on the matrix. The display device is swept in synchronism with the monoscope and modulated with the video signal; thus, the character appears on the face of the tube. The character is positioned to its proper sequence in a word by deflecting the display device.

A character is selected by positioning the small raster to a specified location on the 8 by 8 character matrix. This requires an accurate horizontal and vertical deflection of the beam. This is accomplished in the course of deriving horizontal and vertical deflection voltages from the digital input information. The vertical component of the raster is a 200 kc sinusoidal or sawtooth voltage while the horizontal component is a once-per-character (10-kc) sawtooth. To select a character from an 8 by 8 matrix, eight distinct voltage levels are needed, both in the horizontal and vertical deflection circuitry.

Input information in digital form must be decoded in order to be read as alphanumeric characters. The six-track digital input can be thought of as two three-track sources. From one three-track binary arrangement, eight distinct codes can be derived.

Input information channels 1, 2, and 3 therefore may be decoded to determine one of eight horizontal positions merely by adding binary pulses whose amplitudes are in the ratio 1:2:4. Channels 4, 5, and 6 may be decoded similarly to determine one of eight vertical positions.

The instability and drift nor-



Small loop tape recorder (left) drives system. From left, units shown are: power supply; monoscope chassis and decoding and deflection circuitry; companion unit, providing sweep circuits for both monoscope and display scope, and pulse standardization equipment; and small monitoring display scope

The 7 and 9 pin Miniature Series, T, TR and NW Series are variously covered by Military Specifications:

MIL-S-9372B (USAF)
MIL-STD-242B (Ships)
MIL-S-19786A (Navy)
SCL-6307/2 (Signal Corps)

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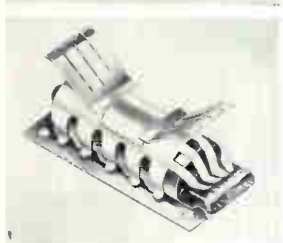
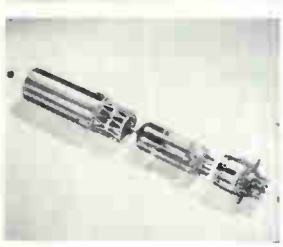
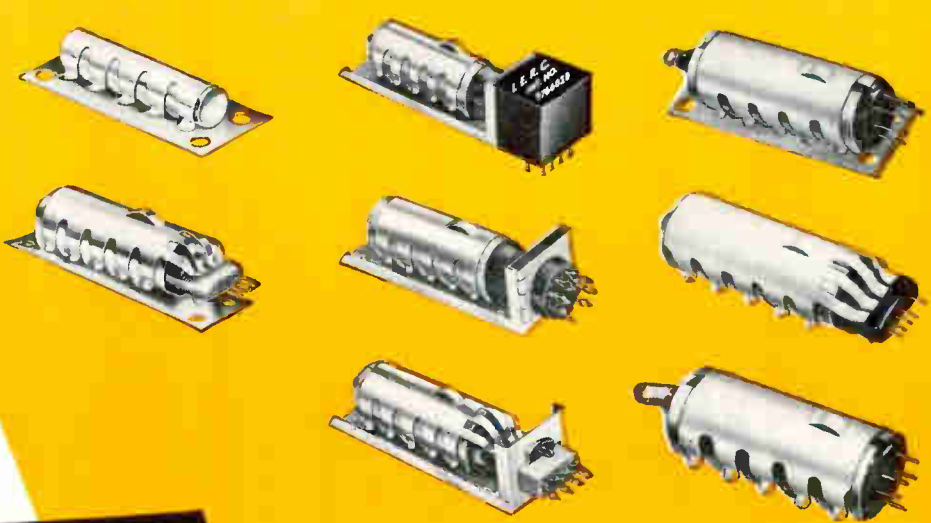




SUBMINIATURE AND MINIATURE SHIELDS



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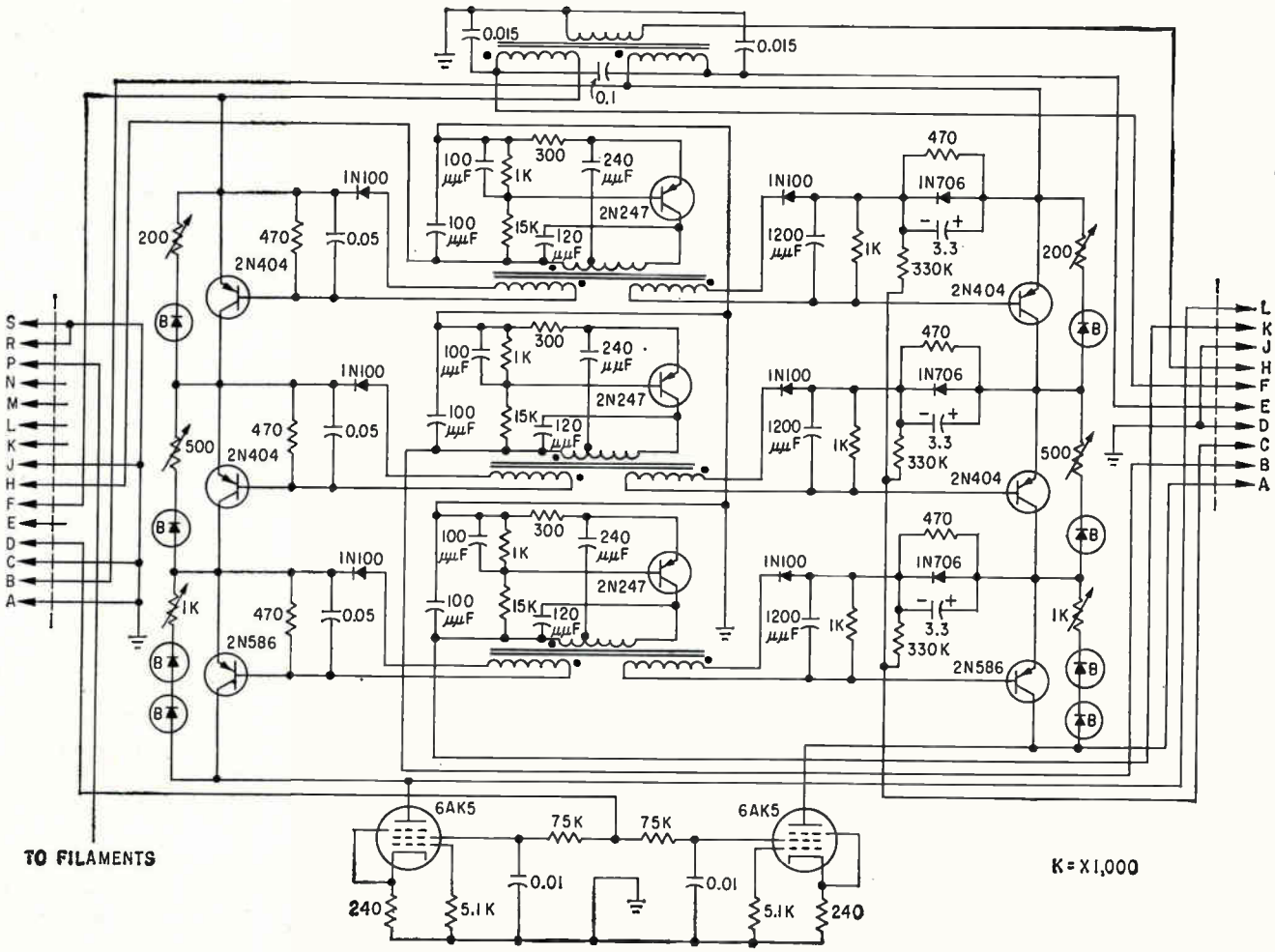


FIG. 2—Complete schematic of horizontal decoding and deflection circuit. Vertical deflection circuitry is identical except for slightly different Zener voltages of the voltage-reference diodes

mally associated with cathode ray tube devices is overcome by a simple but highly effective combination decoding and deflection circuit (see Fig. 1 and 2). The voltages applied to the four monoscope deflection plates are developed across voltage-reference diodes which are driven from constant current sources. This arrangement provides stable d-c levels without amplification.

A series string of three voltage-reference diodes is connected to each of the four monoscope deflection plates (see Fig. 1). The three diodes have breakdown voltages in the ratio 1:2:4. A transistor is connected across each diode and is biased so the constant current may be shunted around the diode or through it, depending on whether or not the transistor is saturated.

The transistors associated with one deflection plate are all normally biased OFF while the transistors associated with the other plate are biased to saturation. In Fig. 1, the right deflection plate will be B+ potential (less the saturation voltage of the three transistors). Because the transistors are biased OFF and the current is through the diodes, the left plate is 70 volts below B+ potential. The transformers which couple incoming pulses to the transistors are polarized to turn off the saturated transistor and saturate the open transistor. The voltage across either diode string can vary from zero to 70 volts in 10-volt increments. As voltage excursions on each deflection plate are equal in amplitude and opposite in polarity, true push-pull deflection results. Thus eight levels of horizontal deflection are established by eight input pulse combinations.

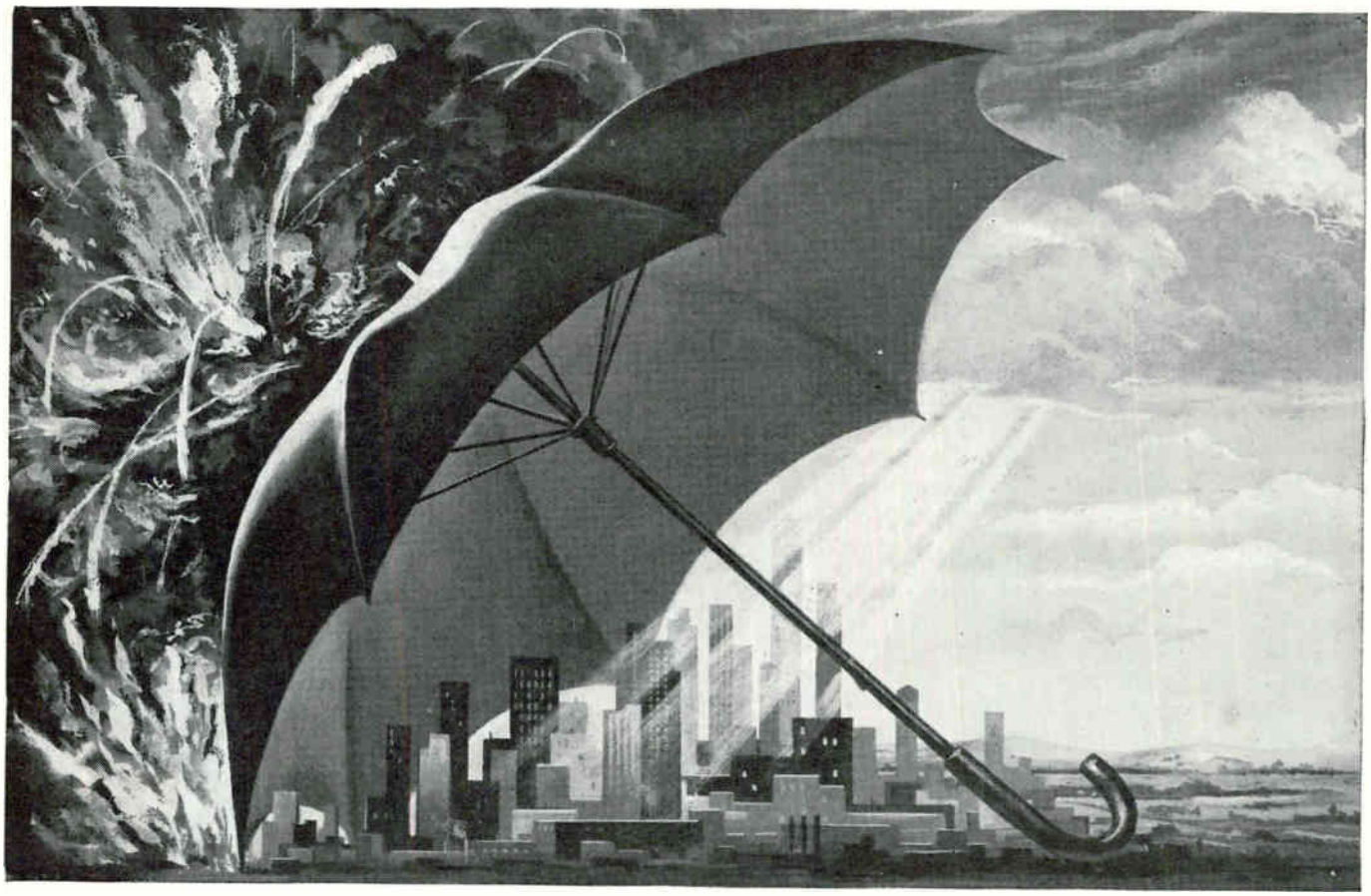
Vertical deflection circuitry is identical to the horizontal except for slightly different Zener voltages of the voltage reference diodes. A higher voltage is required in the vertical direction because of a slightly lower deflection sensitivity.

With the eight voltage levels on each deflection axis, 64 characters are defined by the binary information on the six-wire input.

Results

Excellent stability of deflection has been obtained and is due to three prime factors: the voltage-reference diode is a constant-voltage device with a low incremental impedance; the voltage-reference diodes are driven from constant current sources; and, series-string voltage-reference diodes are used with breakdown voltages near the zero-temperature coefficient point of operation, reducing temperature sensitivity.

The system was developed by W. E. Evans, L. J. Kabell, the author and other members of the Video Systems Laboratory of Stanford Research Institute for the A. B. Dick Company of Chicago as a component of that firm's Videograph equipment.



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URGENT PROBLEMS RELIABLY SOLVED

Solid-State Electronic Tuning

By T. W. BUTLER, JR., and G. A. ROBERTS, University of Michigan Research Institute, Ann Arbor, Mich.

LONG-TIME goal of circuit designers is to use solid-state tuning devices (back-biased diodes, ferroelectric capacitors and increductors) in stable, high-accuracy receivers and transmitters. However, stability and set-on accuracy of these devices are limited.

A generalized frequency synthesizer is under development that accomplishes this goal. Its frequency stability is determined by a reference crystal oscillator or atomic standard. Typical stability is 10^{-7} for crystal control. Frequency precision is determined by the reference oscillator and is typically 10^{-6} for crystal control.

Choice of components and their state of development determine maximum electronic tuning range. For example, tuning ranges available with existing components are 10 to 1 up to about 10 mc and 2 to 1 up to about 100 mc using increductors, 3 to 1 up to about 100 mc using ferroelectric capacitors, and 2 or 3 to 1 up to about 100 mc using back-biased diodes (varactors).

Increments of tuning may be made as small as desired, and the synthesizer costs less than an all-crystal synthesizer. It is easily adaptable to microminiaturization, and remote control is possible over low data rate channels. Tuning to desired frequency is rapid.

Operating Principle

High stability and set-on accuracies at any desired frequency can be obtained by suitably mixing outputs of crystal oscillators' but the cost, weight and size of crystal banks with associated switching mechanisms are prohibitive.

Electronic tuning may be obtained with such components as varactors and ferroelectric capacitors in a voltage-tuned oscillator.[2, 3] However, these relatively unprecise components do not generally allow open-loop set-on accuracies greater than about 5 percent.

It is possible to achieve the characteristics of a crystal-controlled oscillator with the tuning versatility of a voltage-tuned oscillator by combining them through a phase-lock loop system.

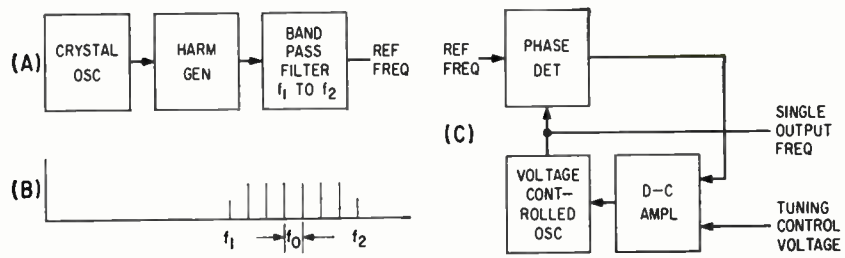


FIG. 1—Discrete frequency reference (A), shown with its frequency spectrum (B), is combined with phase-lock oscillator (C) to form discrete frequency generator

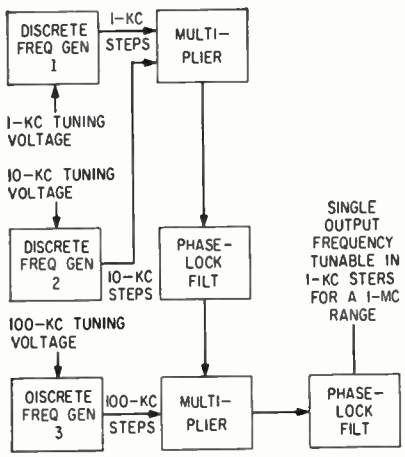


FIG. 2—Modulor-type discrete frequency generators in frequency synthesizer permit range expansion

For example, an oscillator could tune over a 1-mc range in increments of 1 kc by having 3 decade sets of harmonics and subharmonics of the single crystal reference readily available. The voltage-tuned oscillator can be brought near the desired crystal harmonic where the phase-lock loop takes over and pulls the voltage-tuned oscillator into precise frequency alignment with the selected harmonic. Stability and set-on accuracy are then functions of the reference crystal oscillator.

Figure 1 (A and B) is a block diagram of the discrete frequency reference and its frequency spectrum, while Fig. 1C is a block diagram of the phase-lock oscillator. A complete discrete frequency generator (DFG) consists of both. The DFG will have output frequencies that are spaced in frequency an amount equal to the harmonic generator fundamental frequency. The number of different frequencies that can be selected is a function of voltage-tuned oscillator accuracy. About 20 is a reasonable figure.

By using several DFG's, each with different incremental steps, combining and taking the mixed output, it is possible to cover as large an overall range with increments as small as desired. The lower limit will be set by noise and reference oscillator stability.

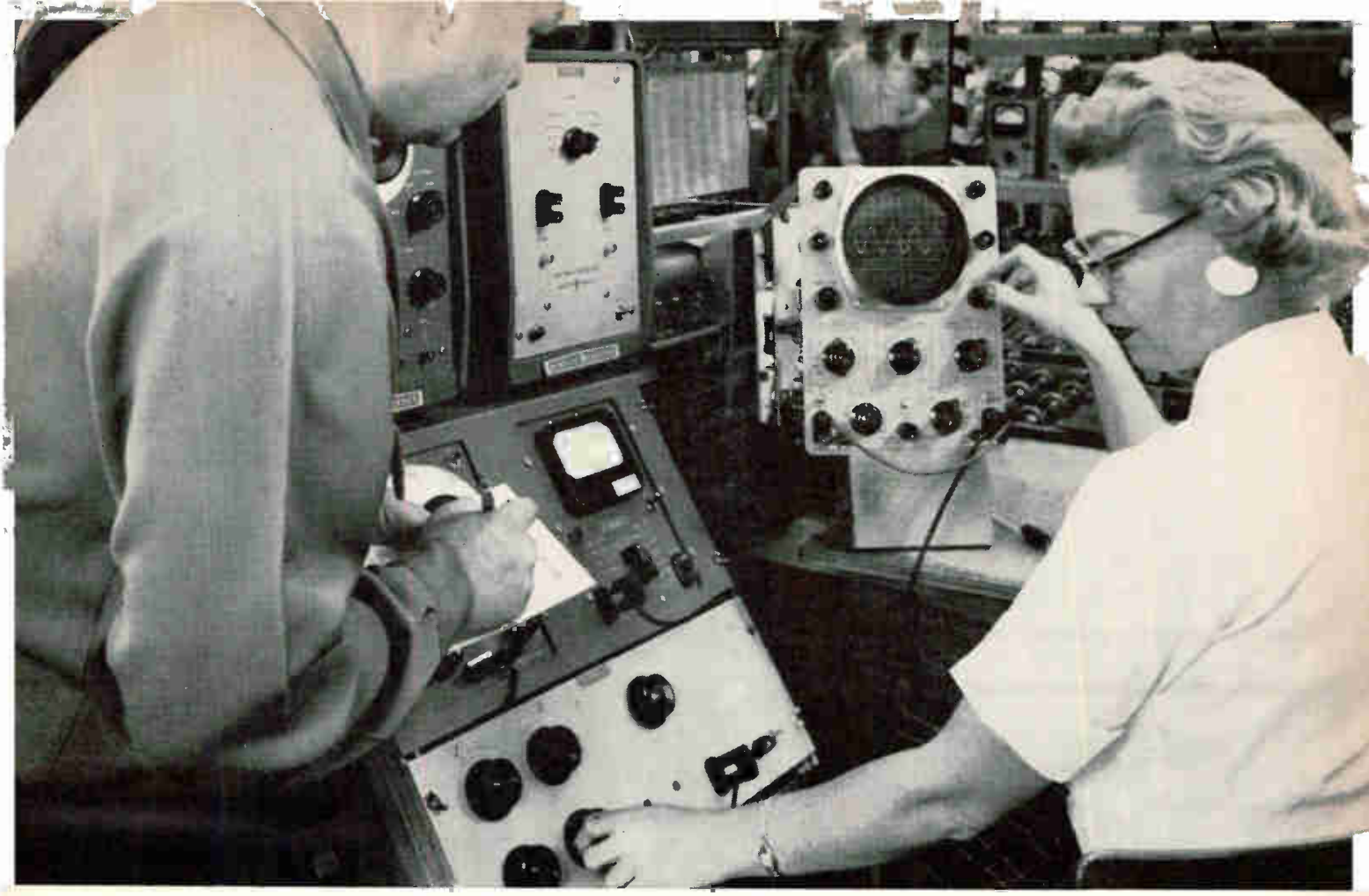
Frequency Synthesizer

A block diagram of the frequency synthesizer is shown in Fig. 2. The DFG's are decade devices and constructed in module form so that system range can be extended. Synthesizer output may be translated to any desired frequency by heterodyning with a desired fixed frequency. For ssb work, the ssb generator should have fine frequency control so that infinite resolution is possible in the 1-mc range. This provision permits setting on frequencies that might fall in between the 1-kc increments.

If additional stability were needed, DFG's with 100-cycle and smaller increments could be added to the system.

REFERENCES

(1) R. L. Craiglow and E. L. Martin,



HEWLETT hp PACKARD specifies Tung-Sol tubes for high stability calibration generator

The Hewlett-Packard Voltmeter Calibration Generator calibrates high impedance voltmeters and oscilloscopes with extreme accuracy. An exceptionally stable source for a wide range of precision voltages, the premium instrument speeds up production and maintenance testing.

To assure high stability and low distortion performance, which are listed among the unit's principal advantages Hewlett-Packard selected Tung-Sol 6550's for the 400 cycle power amplifier. As Hewlett-Packard reports: "Tung-Sol's 6550 shows unusual insensitivity to load changes."

What this means, of course, is that under varying loads the 6550 drive, with its tight characteristics, holds to a minimum any change in the unit's already minimal distortion (less than 0.2%). In addition the 6550 helps to provide long-term stability.

Like all Tung-Sol components, the 6550's optimum performance and dependability stems from Tung-Sol's deep-rooted component know-how. Every step in the manufacturing process is carefully disciplined. Stringent quality control guarantees uniformly high performance in any one lot or from lot to lot. And exhaustive life tests under severe overload assures adequate safety margins.

Maybe you're up against some exacting component requirements. If so, you'll be steering a wise course by getting in touch with Tung-Sol applications engineers. They're component experts who will gladly study your design and recommend the units that will do the job . . . precisely. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX:NK193.

For prompt and competent technical consultation on Tung-Sol components call the Tung-Sol Commercial Engineering office near you. SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.

TUNG-SOL®

Frequency Control Techniques for Single Sideband, *Proc IRE*, p 1697, December 1956.
(2) T. W. Butler, Jr., Ferroelectrics Tune Electronic Circuits, ELECTRONICS, p 52, January 16, 1959.
(3) T. W. Butler, Jr., and G. A. Roberts, Voltage-Variable Capacitor Selection Guide, ELECTRONICS, p 52, July 24, 1959.

Computer Searches for Patents

PATENT searching using computer techniques is being tested at the U. S. Patent Office. Officials say it may accomplish in about half an hour a job that formerly took a skilled researcher up to a full day.

Patent Commissioner R. C. Watson said the new system is being tested on a mass of patent data covering chemical compounds that form the basis for many commonly used plastics. This area, covering the polymer chemical group, is one of the broadest and most difficult in patent research. If successful, the system could be adapted for most problems in patent searching in the chemical field.

The system relies on rapid calculation by a general-purpose computer that can process data cards turned out by a punched card machine. The Patent R & D Office and du Pont adapted the agency's punched-card file, which had been processed only on specially built equipment, to commercially available data-processing equipment.

A Bendix G-15 digital computer successfully searched for patent information by a serial scanning technique.

Advantages

Technology is advancing so rapidly that time-consuming patent searches can deter invention and capital investment in new products and processes. Besides helping patent searchers, the computer records on magnetic tape the areas of invention already mechanized and therefore available for subsequent searches.

While searching for specific patents, the computer identifies areas of invention or discovery that may have been overlooked. For instance, in searching for patented chemical compounds capable of performing a certain job, the machine may also be instructed to indicate those compounds that have similar character-

istics. Thus, searchers are provided with a list of alternate materials that may prove to be cheaper or more acceptable.

Fast-Response Overload Protection

By FRED W. KEAR,
Integrated Dynamics Div.,
Globe Industries, Inc., Albuquerque, N. M.

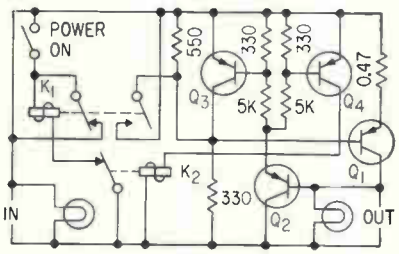


FIG. 1—Current greater than 3 amp drops base voltage of Q_2, rapidly cutting off output

THOUSANDS of dollars worth of transistors and other components have been saved with a transistorized overload circuit. Fuses were found to be unsatisfactory because of their time delay. The circuit switches power off much faster than conventional current protection devices.

The overload circuit in Fig. 1 is useful for production and maintenance testing with low d-c voltages. Current greater than 3 amp flowing through the 0.47-ohm resistor in the emitter circuit of current-switching transistor Q_1 drops voltage on the base of voltage-sensing transistor Q_2. This drop causes Q_2 to saturate, dropping bias voltage and causing Q_3 and Q_4 to saturate.

Transistor Q_3 opens the circuit immediately and keeps it open for the duration of the overload. For complete short circuits, Q_4 latches cut-off relay K_2, providing positive protection. Even if Q_3 were to fail, Q_4 would open the circuit, providing more reliable protection.

Transistor Q_4 also provides protection against fast-rising surges that would tend to damage Q_4 before relay K_2 could operate. The transistors are provided with heat sinks to protect them from heavy loads or extended periods of undetected overloads.

Resistors can be selected to protect circuits using greater load currents or supply or load voltages.

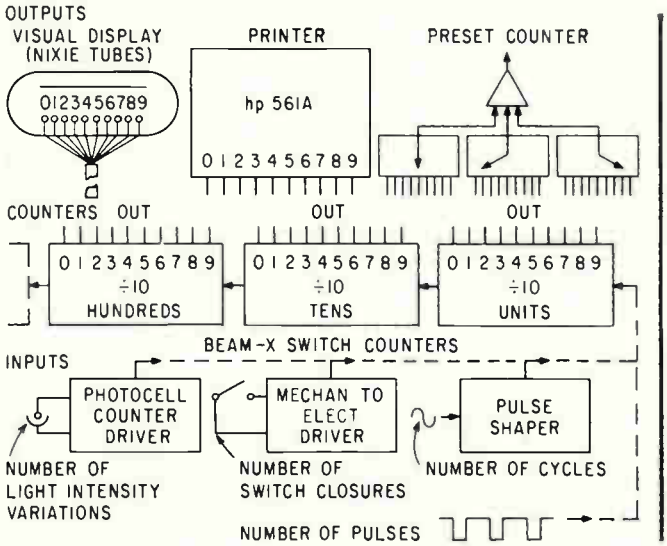


FIG. 1—Switching tubes used in decade counting for frequency, period and occurance measuring equipment

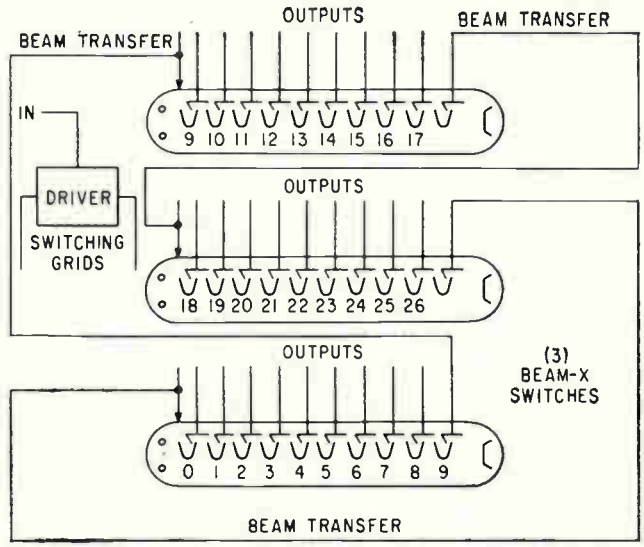


FIG. 2—Multiposition functions are performed by switching tubes used in industrial control systems and automatic positioning

Small Beam Switch Extends Applications

BY ELIMINATING heavy external magnets and magnetic shields, and by improving tube performance, and cost and packaging, a new family of beam switching tubes are bidding to claim an extended market.

Beam switching tubes are already employed to perform functions of counting, distributing, programming, sampling, frequency dividing, gating, timing, coding, decoding and multiplexing. Smaller, less expensive versions of the beam switching tubes may assure wider use in commercial, military and industrial applications.

The BEAM-X switch, developed by Burroughs Corp., Plainfield, N. J., is functionally similar to its predecessor, but is ten times lighter, five times smaller and costs half the price.

How Used

A few applications are given to show typical ways in which the new decade switch can be used. Each application cited is one in which beam switching tubes are already employed. In Fig. 1, pulses which represent photocell outputs, mechanical switch closures or some frequency, are delivered to the switching grids of the first BEAM-X Counter. The tenth output of this tube is used to advance the succeeding switch one position. Thus, with two tubes, 99 counts can be accumulated and with three, 999 and so on indefinitely.

In addition to the cascade or carry output, current is available at each end of the ten positions to activate visual readouts, show the progress of the count, activate a printer for recording information upon command, or to perform useful work at the end of a preset number of events.

Multiposition Functions

The individual outputs of the new decade tube can be utilized to perform multiposition functions sequentially. In Fig. 2, the tenth output of each switch transfers the beam from switch to switch. Driving pulses are delivered to all tubes in parallel so that synchronous operation is assured. The nine constant-current outputs per switch can be used for multichannel communications in gating, timing or sampling applications such as airborne telemetry.

Data Conversion

In data processing there is a need to convert information rapidly from one form to another. The small tube handles this job by accepting binary coded decimal instructions and producing either decimal or analog equivalent as a useful output. This technique is used in air traffic control systems to display the decimal equivalent of a plane's binary identification number.

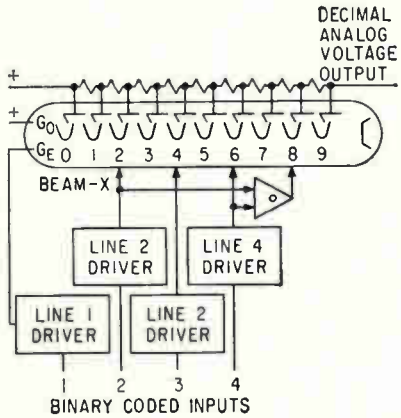


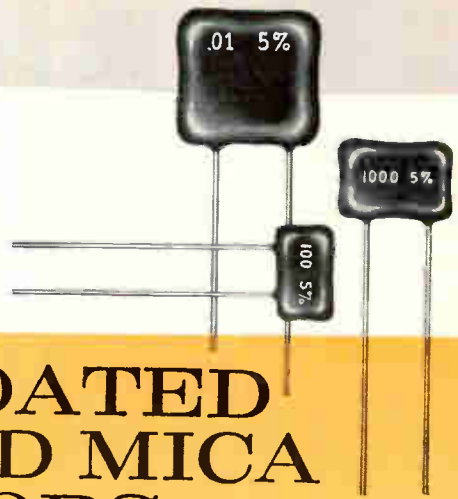
FIG. 3—Data conversion application of new beam switching tubes for analog to digital conversion. This technique is used in air traffic control systems to display the decimal equivalent of a plane's binary identification number

The first of this new series of beam switching tubes, the BX-1000, weighs 1½ oz and has a volume of 3 cu in. This device is designed for over 1 mc operation and tested to operate at 55 v supply.

The output electrode can be

OUTSTANDING IN PERFORMANCE

type D



RESIN-COATED SILVERED MICA CAPACITORS

Sangamo Type D mica capacitors combine the excellent electrical performance characteristics of silvered mica with a multi-layer, protective case of high moisture-resistant thermo-setting resins.

temperature range — The Type D is designed to operate over the temperature range of −55°C to +125°C at rated working voltage without derating.

tolerances — Available in capacitance tolerance values of ±20%, ±10%, ±5%, ±2%, ±1% (or ±1 mmfd, whichever is greater).

insulation resistance — The insulation resistance of these capacitors will exceed 3,000 megohms at 125°C.

moisture resistance — Insulation resistance shall be greater than 1000 megohms as measured in accordance with paragraph 2.6.2 of EIA specification RS-186-A, Method 2. Paragraphs 2.4 and 2.6.1 do not apply. The test shall continue for 10 cycles, as described in paragraph 2.5.

thermal and immersion cycling — Insulation resistance shall be greater than 3000 megohms after being subjected to temperature cycling between −55°C and +125°C, as outlined in Method 102-A, Test Condition D, and followed by Method 104-A, Test Condition A, of MIL-STD 202A.

Write for Bulletin SC59-10

TYPE	DC WORKING VOLTAGE - VOLTS.	CAPACITANCE RANGE - MMF.
D-15	500	5-400
	300	5-800
D-20	500	100-2000
	300	100-4000
D-30	500	1000-10000
	300	1000-20000

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC-59-10

operated at other convenient values. Switching grids would be biased to about 25 v driven with 50 v signal. In transistorized systems switching grids are caused to operate from a 12 v signal.

Ferroelectric Is Also Ferrimagnetic

THE NATIONAL Bureau of Standards has discovered a series of materials that show simultaneously both ferroelectric and ferrimagnetic* properties. The generalized composition is a barium niobate containing any one of several rare earths plus iron oxide, and has a single-phase crystalline structure. As the two properties seem to be mutually dependent in these materials, the composition should find application in new electronic components where a coupling between dielectric and magnetic effects is desirable or where a magnetic material having a high dielectric constant would be useful.

Both Properties

Ceramics with magnetic properties have been known for a long time, but until now none had been known to show both ferroelectric and magnetic properties at the same time. Whether or not such a material could exist is not stated by theory. P. H. Fang and R. S. Roth of the Bureau's mineral products laboratory postulated the existence of the material and then examined nearly 90 dielectric compositions before finding one with both types of properties. Once this composition was discovered, additional similar structures were postulated by substituting other atoms at appropriate locations in the crystal.

Samples of the material are made following the usual ceramics laboratory procedures: the constituents are mixed, pressed into pellets, and fired until the materials sinter. Its formula is $(Ba_{6-H}\ R_{2x})\ (Nb_{10-x}\ Fe_{1-x})\ O_{30}$, where R is a rare earth and x varies from 0 to 1. The structure is described in terms of the tungsten-bronze structure.

* Ferrimagnetism as distinguished from ferromagnetism, is the property of a material with only partial resultant magnetization because of the presence of antiparallel magnetic spins.

Some of these compositions were made with the rare earths neodymium, samarium, europium, or gladolinium in one part of the structure, and with varying amounts of iron in another part of the structure. All show both ferroelectric and magnetic properties in a single-phase crystalline form. The presence of both the rare earth and the iron seems to be necessary for the material to show both properties simultaneously; the kind of rare earth has a substantial effect on the Curie points of the composition.

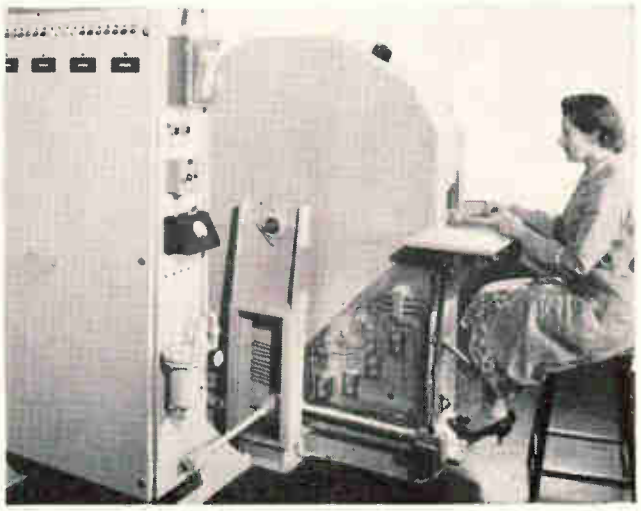
Verification

Ordinarily, ferroelectrics have high dielectric permittivity and very small magnetic permeability; ferrimagnetics have high magnetic permeability and very small dielectric permittivity. The material discovered by the Bureau has both of these properties to an appreciable extent. Ferroelectric properties have been confirmed by the presence of the dielectric hysteresis loop and the piezoelectric resonance. The piezoelectric effect was measured on a polarized ceramic disk. Ferrimagnetic properties are verified by the presence of the remanent magnetization and the effect of the replacement of different rare earth ions on the ferrimagnetic Curie temperature.

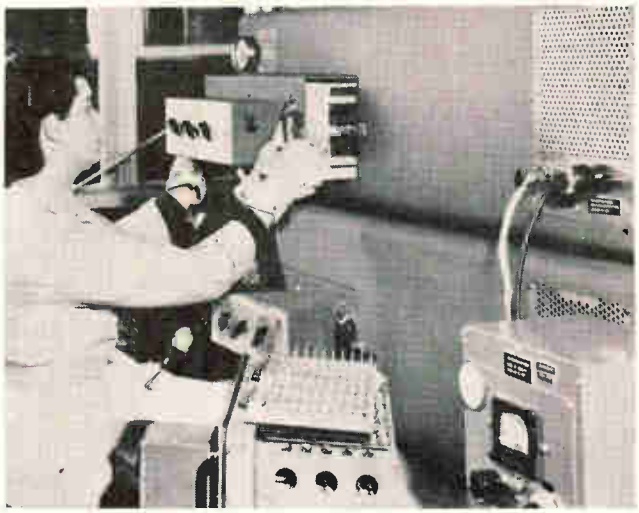
Rare Earth Ions

There seems to be some correlation between the ferroelectric and magnetic properties. When the rare earth ion is Nd^{+3}, both effects exist only below room temperature. On the other hand, with the rare earth ions Sm^{+3}, Eu^{+3}, and Go^{+3}, the materials show both properties above room temperature. However, when the rare earth ion is La^{+3}, neither ferroelectric nor ferrimagnetic effects were observed down to the temperature of liquid nitrogen. The relaxation dispersions of the dielectric permittivity and the magnetic permeability occur in the same frequency region, around 20 megacycles.

The ferroelectric coercive field shows a strong temperature dependence and large temperature hysteresis. The magnetic coercive field is nearly 1,000 oersteds.



In manually-loaded prototype, operator merely checks polarity and pushes loading slide. Sorting bins are at left of operator's feet



In conventional high-temperature testing, operator loads fixtures, waits for temperature to stabilize, switches, logs and unloads

Wheel in Oven Makes 150 C Tests

WHEEL-SHAPED component carrier is employed in a test set recently developed and put into use by Sperry Semiconductor Division, Sperry Rand Corp., South Norwalk, Conn. The equipment classifies silicon diodes according to reverse current characteristics at high temperature.

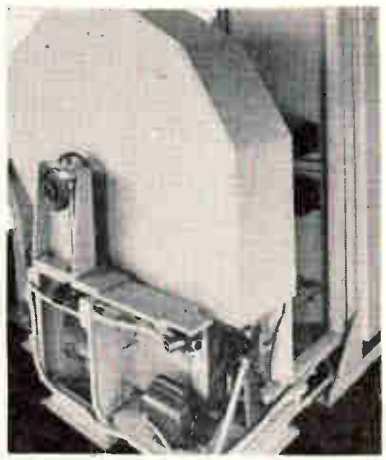
The wheel is upright and enclosed in an oven. This design promotes close temperature control in the oven, mechanical simplicity and compactness.

With manual loading and automatic testing and unloading, the machine has a top rate of 1,200 diodes an hour. The rate depends on test specifications. Normally, the diodes are held under high potential for 20 minutes at 150 C before classification, to eliminate drift. At this cycle, the testing rate is 720 an hour.

The machine can be adapted to test other parameters. A second model under construction will have automatic loading. Additional machines with the same concept are planned.

The wheel has 200 loading positions, each a pair of lead-holding clips. The circumference is divided into 40 segments, each carrying 5 diodes and equipped with a resistor to protect the other 4 diodes should the fifth diode malfunction or be improperly loaded.

Loading station. Polarity checker with buzzer is at right, loading slide at left



Side view of oven, showing mechanical drives

During the warmup and stabilization period, the diodes are under load from a common power supply. This supply simultaneously loads 32 segments, or 160 diodes, as they approach the test positions. During test, each diode is individually loaded from a second power supply.

Loading and Operation

The operator places each diode's leads across 2 bar contacts to check polarity. The diode is then placed in a slide bar which is pushed into the oven, placing the diode leads adjacent to the wheel. As the wheel steps, a pair of contact clips lift the diode off the slide bar. As the wheel continues to step, a cam presses against the leads, seating them in the contacts.

The entry portion of the oven is overheated to compensate for the diodes entering at room temperature. Temperature is then stabilized during the half-revolution leading to test positions. The oven is electrically heated. Thermostatic controls are placed at 3 points, with an additional safety thermal overload.

Diodes are stepped through 4 test

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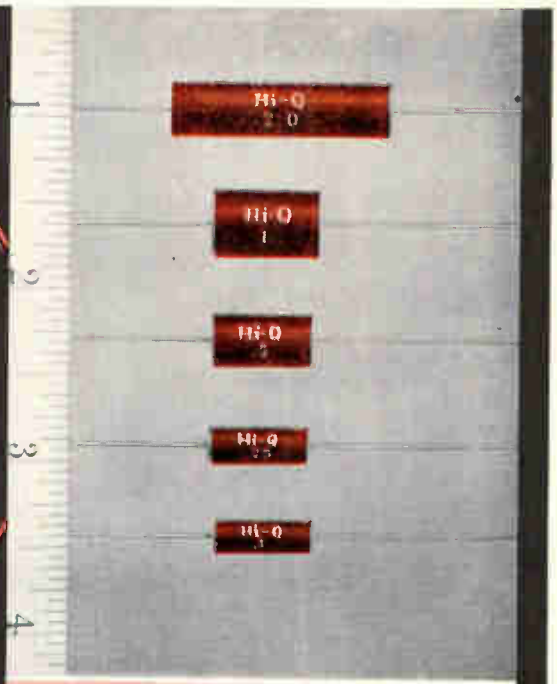
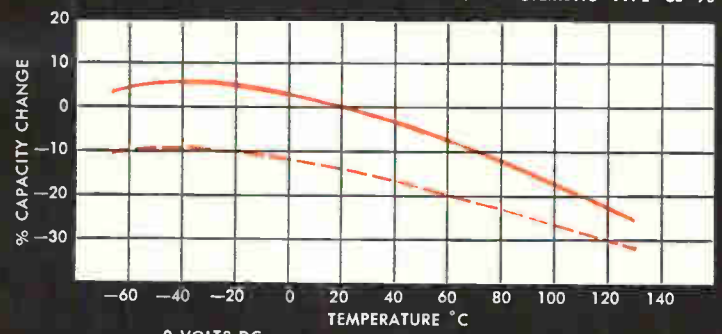


TYPICAL CEROL CAPACITOR TEMPERATURE CHARACTERISTIC TYPE CL 90



Specifications for Ceral Capacitors, Type CL90

Part Number	Cap. Mfd.	D Max. in.	L Max. in.
CL90V104AM	.1	.210	.690
CL90V254AM	.25	.260	.690
CL90V504AM	.5	.350	.690
CL90V105AM	1.0	.480	.690
CL90V205AM	2.0	.400	1.44

Cap. Tol. = ±20%
P.F. = 2% Max.
T.C. (0 Voltage) = +15% −25% over temperature range of −55°C. to 125°C.
T.C. (100 V. applied) = +15% −35%
Working Voltage = 100 VDC at 85°C. derate to 50 VDC at 125°C.
Test Voltage = 300 VDC
Insulation Resistance = 100 Meg.—Mfd. minimum
Series Resistance < .25 ohms at 8 to 10 mc.
Other requirements per MIL-C-11015B
Leads axial #22 gauge 1½" ±⅛" long

New from Hi-Q . . . a major breakthrough in the design and construction of ceramic capacitors that provides extremely high capacity ceramic units in ranges previously unattainable. CEROL capacitors are rolled ceramic capacitors in the high capacitance range of paper and plastic film dielectrics but in much smaller physical sizes and with superior electrical characteristics.

Designed for general applications in bypass-coupling, filtering and blocking circuits, CEROL capacitors offer excellent electrical characteristics for critical applications in decoupling and pulse circuits where low series resistance at high frequencies together with extremely miniature sizes are required. The extremely low series resistance of CEROL capacitors makes them ideal for computer applications.

CEROL capacitors are currently available in capacitance ratings of .1, .25, .5, 1.0 and 2.0 mfd for operation at 100 VDC at temperatures between −55°C to 85° and at 50 VDC up to 125°C. Capable of withstanding severe environmental conditions CEROL capacitors will meet or surpass all the applicable requirements of MIL-C-11015B.

Write today for detailed information on these remarkable new capacitors to . . .

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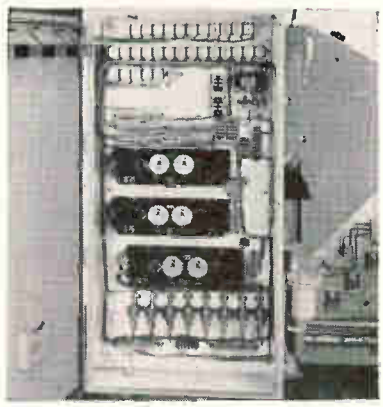


Instrument cabinet contains meters and relays. Power supplies are mounted on other side

positions, each representing a reverse current level. Each time a diode enters a test position, the indexing mechanism locks the wheel's position. The contacts are isolated from the common power supply and grasped by air-actuated test contacts leading from the test power supply. If the diode meets the level set at the first position, it is pulled from the contact by hook-shaped fingers and is dropped into a bin. Otherwise, it is retested at the next positions.

Instrumentation consists of 3 Sensitrol microammeter relays, associated relays to operate the selectors, the power supplies, calibrating fixtures, trouble and indicator lamps and buzzers, and fail-safe relays. Power supplies are provided with voltage range selectors and are kept in calibration with voltmeters. The meter relays are monitored by precision resistors and periodically calibrated with instruments. Test ranges are variable. A typical group of classifications is: up to 4.5 μa, 4.5 to 13 μa, 13 to 27 μa and 27 to 50 μa.

Poly-Glycol Improves Acid Flux Performance

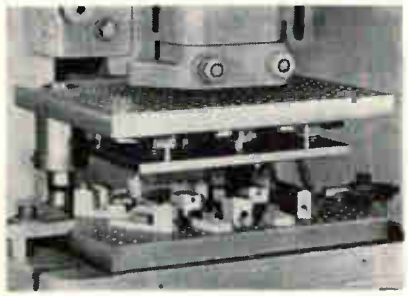
SOLDER FLUX of the zinc chloride type, as well as resin flux (ELECTRONICS, p 96, July 31, 1959), is improved by using polyethylene glycol as solvent, according to the Tin Research Institute, Greenford, Middlesex, England.

With polyethylene glycol, the flux spatters very little, spreads the solder over a larger area and flux residues can be easily washed off

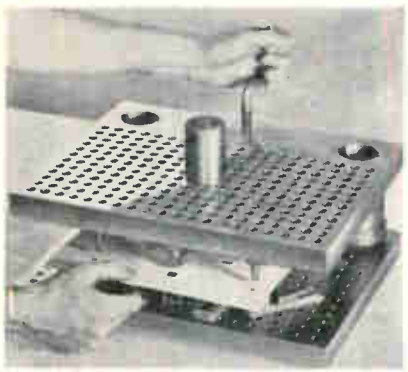
with water. Water solvent, by comparison, spatters severely, evaporates and retards solder spread, and develops a hard to wash film, contributing to subsequent corrosion problems.

Polyethylene glycol is also reported to be a good vehicle for hydrazine hydrochloride and bromides, organic amine hydrochlorides and acidified resinous fluxes as well.

Adjustable Punch Set Uses Peg-Hole Plates



Punching setup installed in press



Setup can be put together and adjusted with template outside of press

PUNCH and die kits suitable for multiple-hole punching of short-run sheet metal parts are announced by O'Neil-Irwin Mfg. Co., Lake City, Minn. The kits contain dies and punches in a variety of shapes, die holders and die sets with holes on ½-inch centers. Holes can be punched anywhere within the area of the die sets by changing the location of the holders or rotating the dies in the holders. Setups can be made either in the press or outside it. The punches and dies are chrome steel and will punch material as thick as 16 gage, in mild steel, or ¼ inch, in aluminum, to 0.005-inch tolerances.

On The Market

Inverter
single phase

TEMCO AIRCRAFT CORP., P. O. Box 6191, Dallas 22, Texas. New single phase inverter is designed specifically to supply accurate 400 cycle power to rate gyro packages. It is suitable for any application requiring small quantities of 26 ± 1.0 percent volt a-c power. Occupying only 20 cu in., the unit is capable of delivering 20 w at 400 cycles ± 0.1 percent with an input voltage of 28 ± 4 v. Distortion is less than 4 percent. Efficiency exceeds 60 percent at full load. The single phase inverter meets or exceeds all applicable portions of MIL-E-5272.

CIRCLE 301 ON READER SERVICE CARD

Terminals
feed-through type

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. Designed for use in plug-in components, the Cambion 1030 and 1031 feed-through terminals fit into 7- or 9-pin miniature sockets. These have pin diameters of 0.040 in. and

are available in six different mounting shank lengths. Terminal 1032, with a pin diameter of 0.032 in., is available in five different mounting shank lengths. All are of quality brass, finished with 0.0003 in. silver plate and coated with water dip lacquer. Terminals are quality-controlled and guaranteed.

CIRCLE 302 ON READER SERVICE CARD

D-C Amplifier
differential type

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Chopper stabilized, the model 516 true differential d-c amplifier features low noise of 14 μv rms over the entire bandwidth of d-c to 25 kc. High output of ±100 ma at 10 v, with continuous variable gain to 1,000 X, makes it a flexible general-purpose instrument. It is available in individual case or eight to a 19 in. rack.

CIRCLE 303 ON READER SERVICE CARD

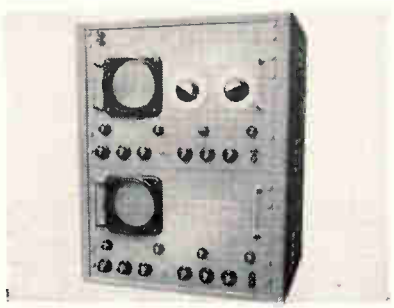
Switch Attenuator
high power

KEARFOTT CO., INC., 14844 Oxnard St., Van Nuys, Calif., announces a ferrite switch attenuator that may be used in high power transmitter circuitry. Model W662-3A-2 is ideal for range adjustment, static testing and slow modulation up to 250 kw. Frequency range is 8.5 to 9.6 kmc; maximum attenuation, 35 db min.; minimum attenuation, 0.5 db max.; vswr max., 1.3 bilateral; peak power, to 250 kw; average power, at 250 w; switching time, 20 millisec; switching rate at 2 cps; driving power, 100 w max.; weight, less than 4 lb.

CIRCLE 304 ON READER SERVICE CARD

Spectrum Analyzer
log-linear scan

PROBESCOPE CO., INC., 8 Sagamore Hill Dr., Port Washington, N. Y. Telemetering analyzer with automatic optimum logarithmic display of subcarrier channels and simultaneous linear display of individual channels is available in the model TA-100L-120L. All f-m/f-m sub-



carrier channels will be linearly displayed along the horizontal axis of the log scan crt and at the same time individual portions of the spectrum can be analyzed on a second crt. Frequency ranges are 350 cycles to 85 kc or 120 kc logarithmic display and 13 cycles to 85 kc or 120 kc linear display. Sweep width, 150 cycles to 22 kc. Other features: 60 db dynamic range, 500 μv sensitiv-

NEW FROM JFD LUMPED CONSTANT DELAY LINES

Meet the newest addition to the growing family of JFD precision electronic components.

Designed with compactness, ruggedness and reliability in mind, new JFD lumped constant Delay Lines upgrade your prototype or production project.

Compare the advantages of the standard JFD lumped constant delay lines:

- High delay-to-rise time ratio with minimum signal attenuation.
- Tolerance of ±5% max. on delay and characteristic impedance.
- Temperature range of −55° C to +125° C.
- Delay time thermal stability of 50 parts per million per degree centigrade.
- Up to 25 Mc bandwidth.
- Virtually linear phase shift.
- Hermetically sealed metal cases for maximum resistance to shock, vibration and humidity.
- Meet all applicable MIL specs.

Typical Standard Delay Line Characteristics

Delay Time 5 μ sec.		10 μ sec.		25 μ sec.	
Rise Time	Size	Rise Time	Size	Rise Time	Size
1.0	1 1/8 x 1 1/8 x 2 1/4	2.0	1 1/2 x 1 1/2 x 3	5.0	1 7/16 x 1 7/16 x 2 7/8
.5	1 5/16 x 1 5/16 x 2 5/8	1.0	1 5/8 x 1 5/8 x 3 1/4	2.5	1 3/4 x 1 3/4 x 3 1/2
.3	1 3/8 x 1 3/8 x 2 3/4	.6	1 3/4 x 1 3/4 x 3 1/2	1.5	2 7/16 x 2 7/16 x 4 7/8
.15	2 1/4 x 2 1/4 x 4 1/2	.3	2 1/4 x 2 1/4 x 4 1/2	.75	2 3/4 x 2 3/4 x 5 1/2

Range of characteristic impedance: 50 ohms to 2000 ohms ±5%.
Attenuation: Less than 1db per μ sec. up to 3 μ sec. delay; 6db max. up to 50 μ sec. delay.
Temperature stability: 50 parts per million per degree C from −55° to +125° C.

Whether your application calls for standard or custom-built lumped constant or distributed constant delay lines, our engineering staff will be glad to review your needs and submit recommendations. Closer tolerance delays and impedances are available, in forms, sizes and terminal designs to match your needs. Write for Bulletin No. 213A.

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CIRCLE 135 ON READER SERVICE CARD

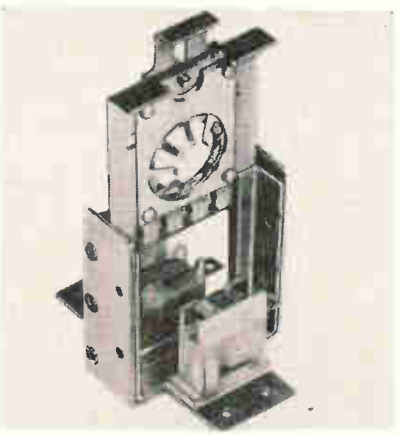
ity and linear and logarithmic amplitude scale.

CIRCLE 305 ON READER SERVICE CARD

Steel Clamp
self-aligning

TIMBER-TOP, INC., 36 Brooklyn Ave., Freeport 8, L. I., N. Y., has designed a self-aligning stainless steel clamp that permits the secure fastening of components with base flanges or grooves. Synclamps are available in 8 different sizes with the same o-d of 0.390 maximum. Ideally suited for hard-to-reach places, these standard fasteners are self-locking and withstand extreme environmental conditions. Self-alignment is quickly and easily accomplished because of a nylon insert. When the screw is tightened, the nylon insert is stripped which allows the clamp to self-align perfectly. The more the screw is turned the tighter the clamp seats.

CIRCLE 306 ON READER SERVICE CARD



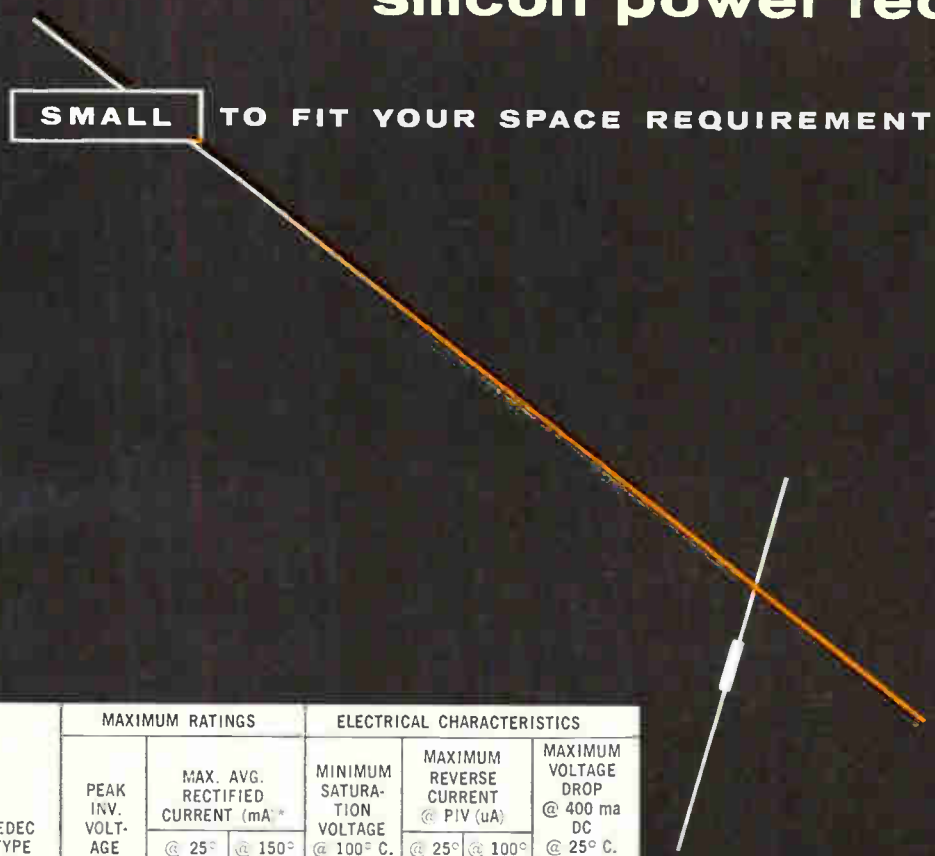
Tube Socket
for planar triode

INSTRUMENTS FOR INDUSTRY, INC., 101 New South Road, Hicksville, L. I., N. Y., has designed a tube socket for GE's GL6299 uhf planar triode that enables the designer to quickly realize practical uhf lumped constant circuitry with absolute as-

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

Automatic MINIATURIZED silicon power rectifiers

SMALL TO FIT YOUR SPACE REQUIREMENTS



JEDEC TYPE NO.	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
	PEAK INV. VOLTAGE (V)	MAX. AVG. RECTIFIED CURRENT (mA)*		MINIMUM SATURATION VOLTAGE @ 100° C. (VOLTS)	MAXIMUM REVERSE CURRENT @ PIV (uA)		MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
		@ 25° C.	@ 150° C.		@ 25° C.	@ 100° C.	
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	360	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

*Resistive or inductive load

We've shrunk the size, but not the quality. All the outstanding characteristics and reliability you expect of products from General Instrument Corporation are present in these miniaturized units. Data sheets on these and other Automatic silicon rectifiers are available upon request.

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GENERAL INSTRUMENT CORPORATION

65 Gouverneur Street, Newark 4, N. J.
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surance of bandpass stability as tubes are changed. The XV-100/6299 permits tube removal and replacement with absolute seating every time. Precise engineering and design techniques permit the miniaturized tube socket to be used to 1,000 mc or higher with no resonance over the band. Applications are for broadband circuitry and receivers, amplifiers, mixers—or where both frequency stability and low noise factors are important. Price ranges from $25 to $14 depending on quantity.

CIRCLE 307 ON READER SERVICE CARD

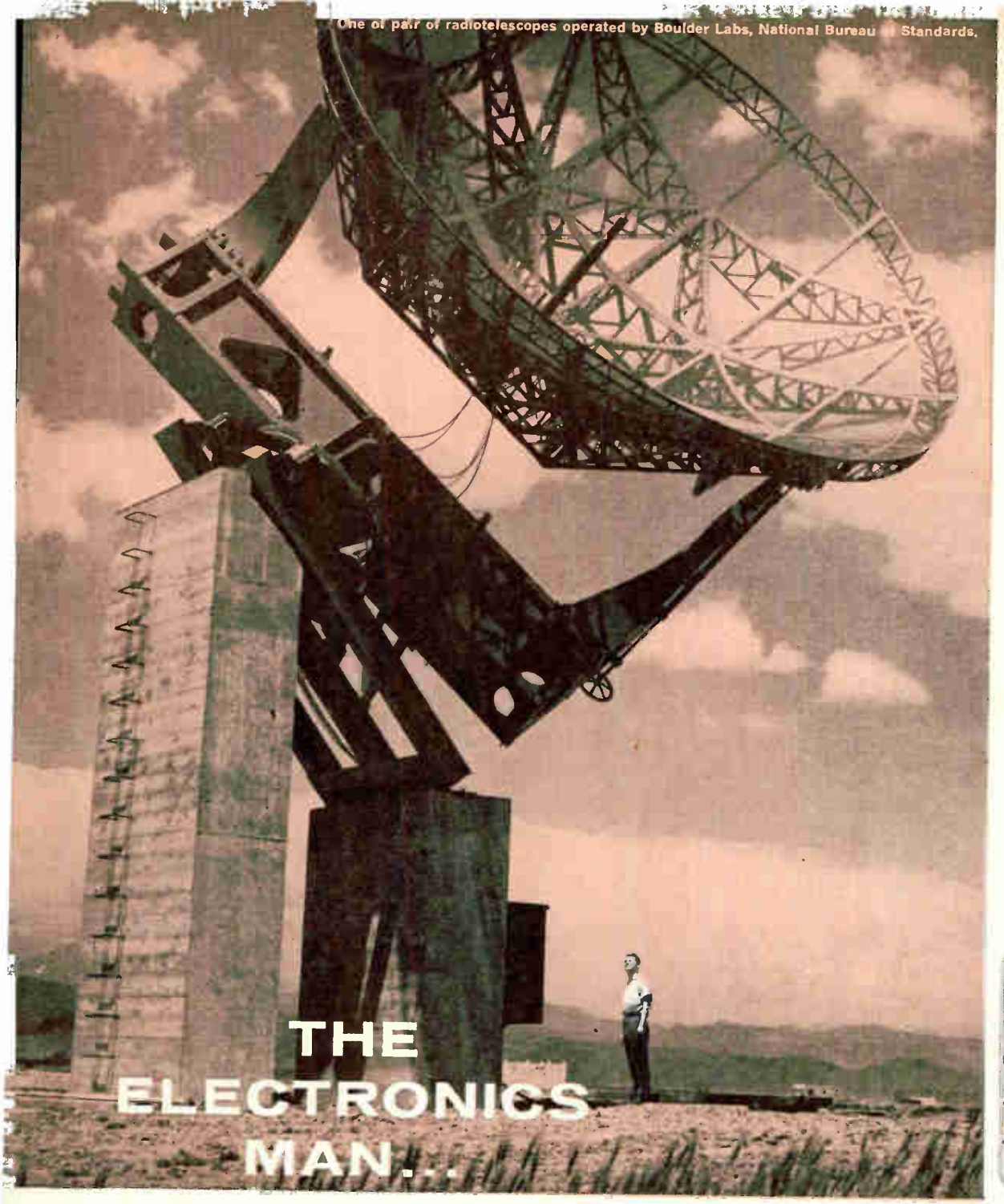
Leak Detector
ultrasensitive

CROSBY-TELETRONICS CORP., Westbury, N. Y., has developed an ultrasensitive mass spectrometer leak detector with important military and civilian applications. The machine accurately detects, locates and measures the size of leaks in vacuum, pressure or hermetically sealed systems, devices or components. Leak rate sensitivity is 10^{-13} standard cubic cm per sec. The equipment is sensitive to helium only. Presence of other gases in the equipment cannot give false indications.

CIRCLE 308 ON READER SERVICE CARD

Audio Tube
with rattle control

GENERAL ELECTRIC CO., 212 N. Vignes St., Los Angeles 54, Calif. The 7581 is a 30-w beam-power pentode for high quality audio power output. It has a low-loss, mica-filled base which also pro-



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A man in one industry usually sells to another. A steel man sells to the automotive industry. A packaging man sells to a soap company.

The electronics man is different.

The electronics man sells a large portion of his output to another electronics company. The design man may be the key to selling a President. The President of one company may sell to the design man of another. The project engineer is responsible for product design, but may also determine market potentials for new products.

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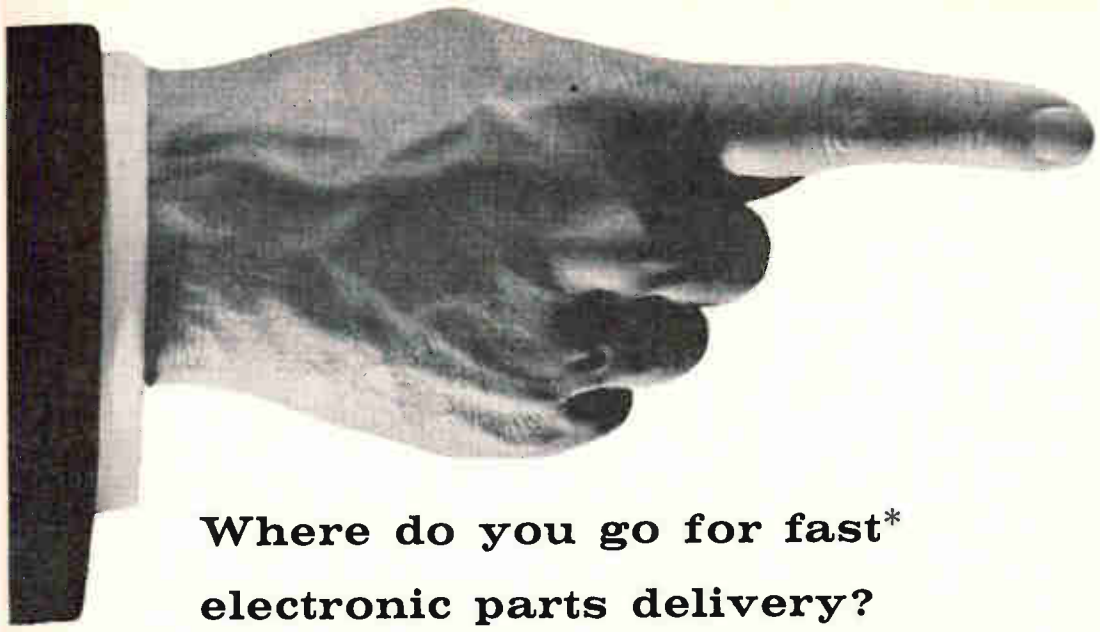
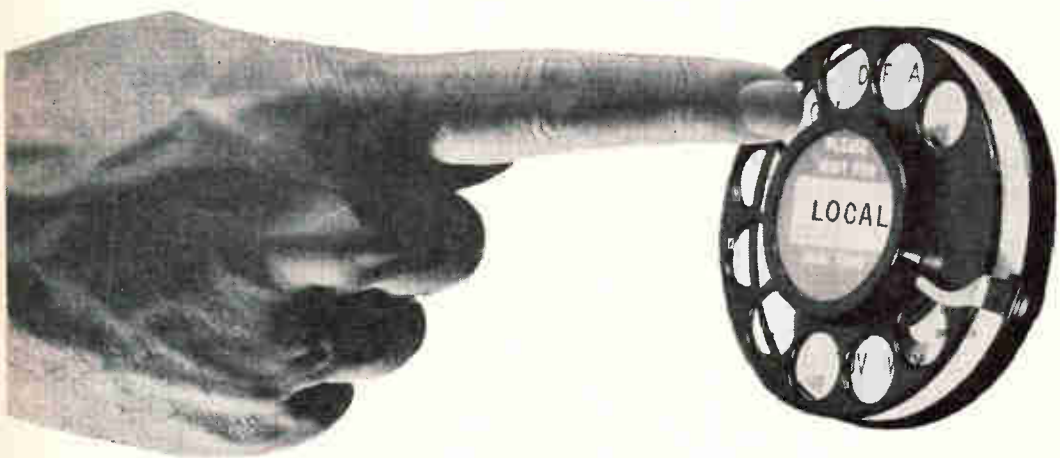
and in the **electronics** BUYERS' GUIDE



Where do you go for fast* electronic parts delivery?



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vides good r-f performance. It has a special rounded-top envelope which provides rattle control, thereby reducing the possibility of microphonic action under vibration; a controlled-knee characteristic which assures users freedom from signal distortion from this source in properly designed circuits; and a new bonded metal anode of aluminum, copper and iron which prevents hot spots and permits exceptional heat dissipation.

CIRCLE 309 ON READER SERVICE CARD

Sensing Element
solid state

BERKELEY/DYNAMICS, 2831 — 7th St., Berkeley, Calif. Model P-CE solid state photorelay sensing element features direct operation of relays or counters without amplification. The photosensitive unit will operate standard relays or solenoid actuated devices wired in series with model P-CE. Coil resistance of solenoid or relay should be approximately 2,200-2,800 ohms, maximum current 50 ma at 115 v a-c. The sensing element is a compact, rugged, moisture resistant cadmium sulfide cell. Model P-CE has threaded mounting hub for ½ in. conduit. List price, $10.

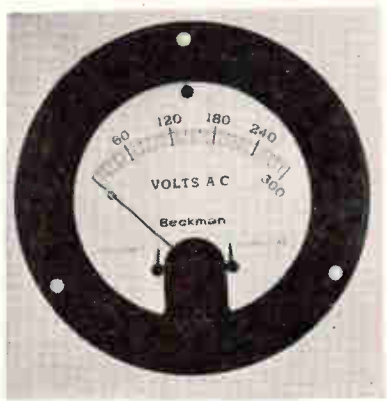
CIRCLE 310 ON READER SERVICE CARD

Digital Test Units
low-speed

DIGITAL EQUIPMENT CORP., Maynard, Mass., announces a low-cost line of coordinated low-speed digital test equipment building blocks. The 3000 series operate at speeds up to 500 kc, as compared with speeds up

to 5 mc in the company's present line of high-speed units. However, they are directly compatible with the high-speed units, since both employ the same logical techniques. Prices on the low-speed units average about half the cost of the comparable high-speed units. The 3000 series include an inverter, NOR diode, flip-flop, delay, clock, pulse generator, and pulse amplifier.

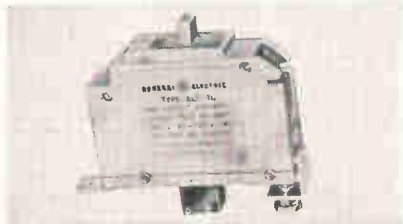
CIRCLE 311 ON READER SERVICE CARD



Panel Meters
military style

HELIPOT DIVISION OF BECKMAN INSTRUMENTS, INC., 2500 Fullerton Road, Fullerton, Calif., has announced a line of 3½ in. panel meters. Built in accordance with MIL-M-10304A, the new line features voltmeters, ammeters, microammeters, and milliammeters. There are 61 standard models now available.

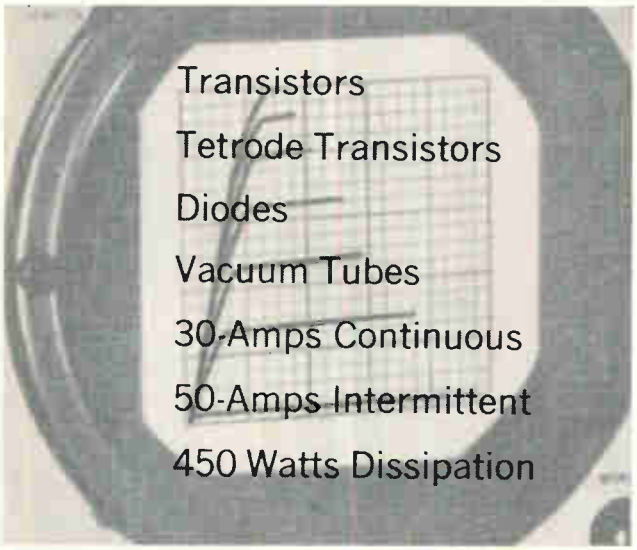
CIRCLE 312 ON READER SERVICE CARD



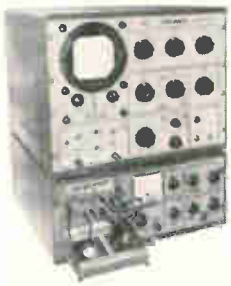
Circuit Breaker
low impedance

GENERAL ELECTRIC CO., Circuit Protective Devices Dept., Plainville, Conn. ALB-1C low impedance, high shock circuit breaker is available in ratings 5-75 amperes, and features inverse time delay action. A quick-make, quick-break device, it has a thermal bimetal and independent

NEW CURVE TRACER with Tube Adapter



For complete information write for bulletin #TT108.



Baird Atomic

Baird-Atomic, Inc.
33 UNIVERSITY RD.
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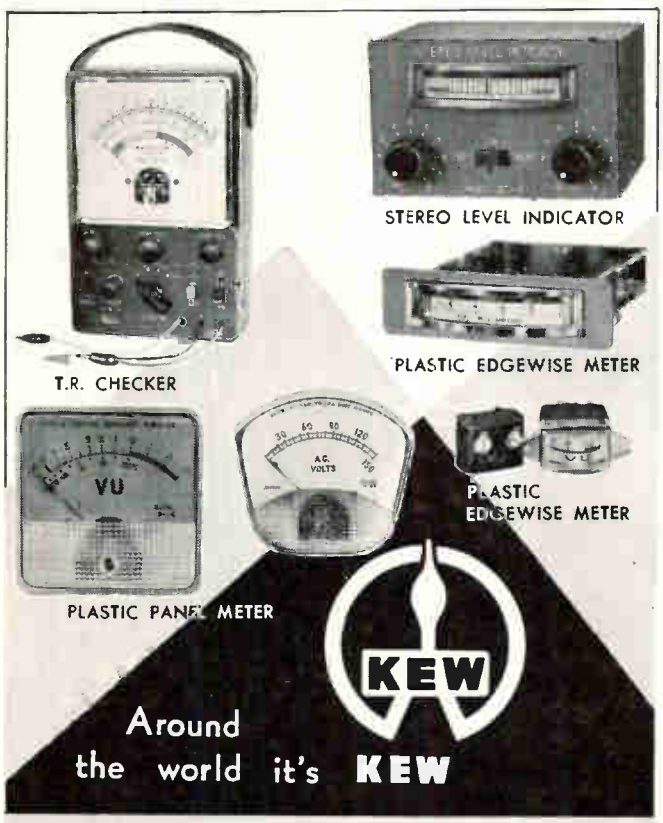
CIRCLE 204 ON READER SERVICE CARD



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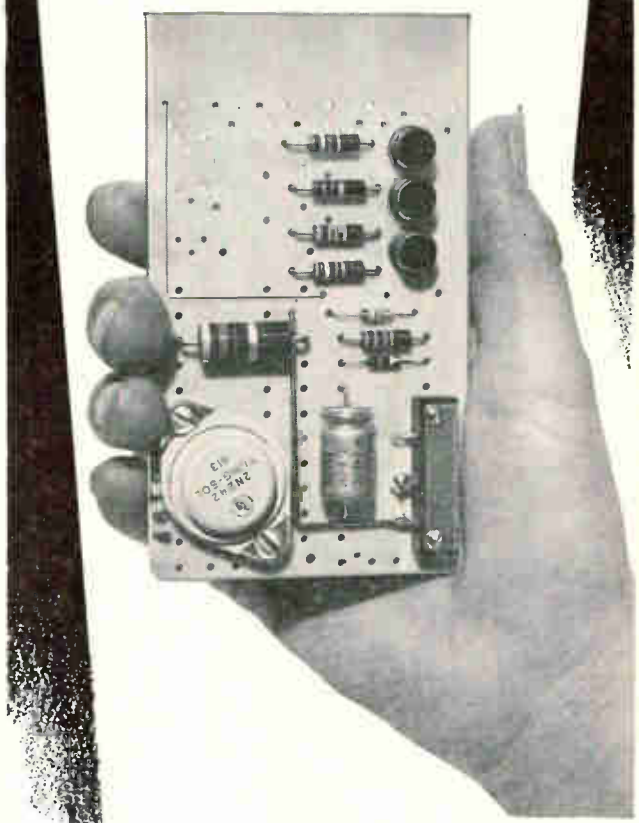

• How to get the optimum performance and reliability from an electronic component is often directly related to research and engineering "know-how" of transistor circuitry.

The Acme Electric research and engineering staff have a wealth of experience to develop assemblies in this specialized field of manufacturing. A letter outlining your problem will have our prompt attention.

ACME ELECTRIC CORPORATION
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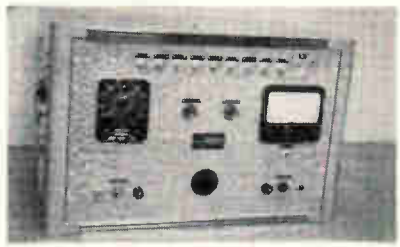
Acme ACME Electric

CIRCLE 143 ON READER SERVICE CARD

magnetic trip element and is available with or without an auxiliary switch. Interrupting capacity: 5 ampere breaker—1,500 amperes, 125 v a-c and d-c; 800 amperes, 300 v a-c; and 10-75 ampere breakers—1,500 amperes, 125 v a-c and d-c; 2,500 amperes, 300 v a-c. Unit meets MIL-C-17588.

CIRCLE 313 ON READER SERVICE CARD



Automatic Test Set
multiconductor cable

PESCHEL ELECTRONICS, INC., Towners, Patterson, N. Y. Automatic unit features dielectric testing up to 5 kv rms; any number of test positions to order; voltage continuously adjustable up to 5 kv rms; test duration or dwell time adjustable from 1 to 120 sec; maximum short circuit current limited to 5 ma. Other features include built-in test cage with terminal board for components, easily accessible through top lid of cabinet, with electrical interlock to prevent application of high voltage when lid is open. Built-in test cage obviates need for an auxiliary cabinet with interconnecting cables at high voltage.

CIRCLE 314 ON READER SERVICE CARD

Coaxial Switch
manually-operated

JERROLD ELECTRONICS CORP., 15th and Lehigh Ave., Philadelphia 32, Pa. Designed for use wherever r-f energy is to be switched from one circuit to another, the CS-250 transfers r-f energy from 0 to 1,000 mc with a maximum vswr of 1.1 up to 500 mc and 1.2 up to 1,000 mc. The unit is a four terminal, two position

STACKPOLE

Coldite 70+®

fixed composition RESISTORS

Today's slickest looking resistors . . . and every bit as good as they look! Designed to MIL-R-11 specifications, they're unmatched for load life and moisture resistance. And now, for the first time, you can get such resistors in a full line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (½-watt) types IMMEDIATELY from distributors' stocks.

Now! PICK 'EM OFF DISTRIBUTORS' SHELVES!

. . . for military prototypes, small runs, production emergencies or "hurry-up" projects

. . . in any standard value or tolerance

These selected STACKPOLE distributors have them!

Complete stocks—and we mean *complete*—in the hands of the 28 selected Stackpole distributors listed below help you handle every job with highest quality resistors, fully proved and accepted for critical applications.

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BROOKLYN, N. Y.
Electronic Equipment Corp.

CLEVELAND, OHIO
Pioneer Electronic Supply Co.

DALLAS, TEXAS
Wholesale Electronics Supply Co.

DAYTON, OHIO
Srepco, Inc.

DENVER, COLO.
Denver Electronics Supply Co.

GLENDALE, CALIF.
R. V. Weatherford Company

INDIANAPOLIS, INDIANA
Radio Distg. Co.

KANSAS CITY, MO.
Burstein-Applebee Co.

MELBOURNE, FLORIDA
Electronic Supply

MIAMI, FLORIDA
Electronic Supply

NEW YORK, N. Y.
Harvey Radio Co.

PHILADELPHIA, PA.
Alma Radio Co.

SAN DIEGO, CALIF.
Radio Parts Co.

SCRANTON, PA.
Fred P. Pursell

SEATTLE, WASH.
C & G Radio Supply Co.

ST. LOUIS, MO.
Interstate Supply Co.

SYRACUSE, N. Y.
Morris Electronics of Syracuse

TACOMA, WASH.
C & G Radio Supply Co.

WASHINGTON, D. C.
Electronic Wholesalers, Inc.

WATERBURY, CONN.
Band Radio Supply Co. Inc.

WEST PALM BEACH, FLA.
Goddard Distributors, Inc.

WICHITA, KANSAS
Interstate Electronic Sup. Corp.

WILBRAHAM, MASS.
Industrial Components Corp.

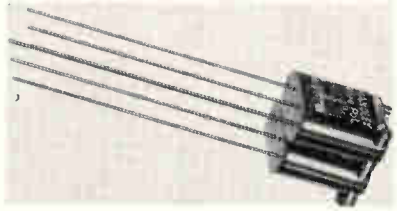
WINSTON-SALEM, N. C.
Dalton-Hege Radio Supply

. . . and G C/STACKPOLE, TOO!

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

transfer switch, coaxially mounted in a rugged die cast metal frame. Its dull wiping, self aligning switch contacts are silver, mounted in a Kel-F dielectric. Insertion loss is less than 1/10 db to 1,000 mc. Isolation between the open and closed circuit is 58 db at 100 mc and 40 db at 1,000 mc. CS-250 is available with BNC connectors at 50 ohm impedance.

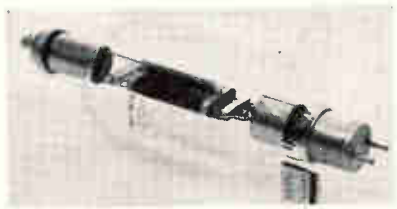
CIRCLE 315 ON READER SERVICE CARD



Trimming Pot stackable

HANDLEY, INC., 2030 Colorado Ave., Santa Monica, Calif., announces model 1W-STK trimming pot. Two to ten may be stacked in a row, firmly held together by a steel bolt and nut. Because of the unusual configuration, placement and length of the leads, lead screw position (on top), this stacking feature offers outstanding accessibility and compactness. Trimmer withstands 100 g acceleration, exceeding MIL-R-19; withstands 50 g shock, exceeding NAS 710, Proc. III; and temperature range is from −55 C to 140 C with 1.3 w at 40 C. Small worm gear adjustment, free of back lash, delivers high friction loading.

CIRCLE 316 ON READER SERVICE CARD



H-V Rectifier for radar use

PEK LABS, INC., 4024 Transport St., Palo Alto, Calif. Rated at 75 kv piv and 800 w average plate dissipation, the PEK 5973 h-v rectifier or surge limiting diode is ideally suited to applications where low tube drop is important such as in

NOW TEST TRANSISTOR BETA IN THE CIRCUIT WITHOUT POWER ON!

New Sierra 219A Transistor Tester
reads Beta directly in the circuit; also measures I_{CO} and Beta out of circuit. Simple operation, completely portable. Battery powered; easily used anywhere.

DON'T TAKE IT OUT!

Consider the real advantages of testing transistors in the circuit. Downtime, and damage to transistors, is greatly reduced. Complete assemblies are quickly checked out. Quality control "ounce of prevention" is simplified during manufacture.

Beta is read simply and directly in or out of the circuit; a basic function of the Sierra 219A is to electrically isolate the transistor under test permitting accurate in-circuit tests. I_{CO} is measured on a straightforward dc basis; collector potentials of 3, 6, or 12 vdc may be selected.

For complete information and demonstration, telephone your Sierra representative now.

SPECIFICATIONS

Test Ranges:	Beta, 10 to 100, I_{CO}, 0 to 50 μamp
Accuracy:	In-circuit ± 20% for external loadings above 500 ohms Out-of-circuit ± 10%
Power:	Mercury or zinc-carbon battery; 1,000 hrs. average service life; meter indicates battery output
Temperature Range:	32° to 122°F for specified accuracy
Dimensions:	9" high x 7⅝" wide x 6½" deep; weight 16 pounds
Accessories:	Test leads supplied
Price:	$250.00 f.o.b. factory Delivery from stock

Data subject to change without notice

sierra

SIERRA ELECTRONIC CORPORATION

A Division of Philco Corporation

6251A BOHANNON DRIVE • DAvenport 6-2060 • MENLO PARK, CALIFORNIA, U. S. A.

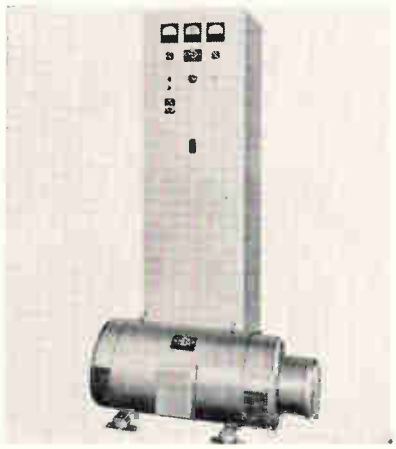
Sales representatives in all principal areas

Canada: Atlas Instrument Corporation, Ltd., Montreal, Ottawa, Toronto, Vancouver

Export: Frazar & Hansen, Ltd., San Francisco, Los Angeles

radar where it is used as a charging diode or limiter. It is also suitable for use in h-v power supplies for dielectric or cable testing, or in air cleaners or precipitrons. As a rectifier it will operate at an average of 1.25 amperes to 40 kv and one ampere to 75 kv. As a limiter, peak currents as high as 20 amperes at 75 kv apply.

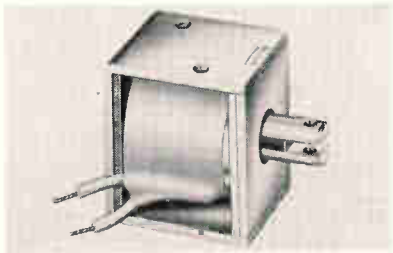
CIRCLE 317 ON READER SERVICE CARD



Power Package
brushless

ELECTRIC MACHINERY MFG. CO., Minneapolis 13, Minn. A 400 cycle motor-generator set complete with controls serves as the power supply for a new computer. The m-g set is rated 7.5 kw at 1,714 rpm with a three phase, 208 v output. An a-c exciter and silicon diodes replace the usual commutator and brushes. The free standing control provides complete starting and protective arrangements with metering and voltage regulator.

CIRCLE 318 ON READER SERVICE CARD



Solenoid
a-c or d-c

GUARDIAN ELECTRIC MFG. CO., 1621 W. Walnut St., Chicago 12, Ill. No. 28 midget solenoid is available a-c

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

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

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

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

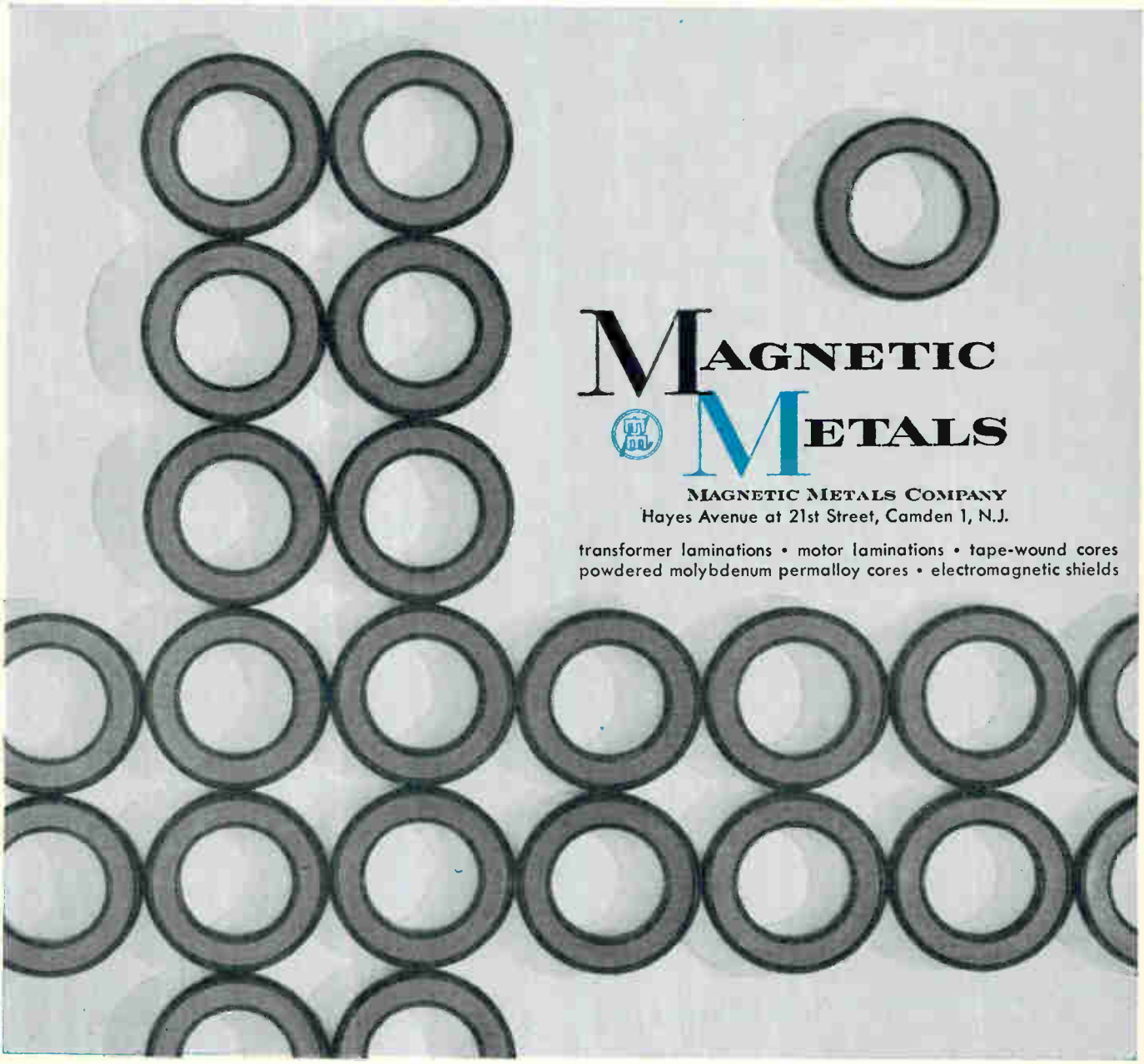
Closely-controlled annealing—Annealing—perhaps the most critical phase of the core-making process—is done under precisely regulated atmospheric and temperature stabilized conditions to hold Centricore magnetic performance to uniformly high levels.

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

WRITE FOR BULLETIN C-3

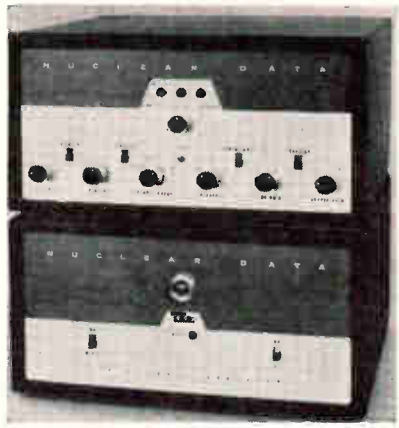
SIZE	MATERIAL	THICKNESS
1	HIGH NICKEL Hymu 80 Squaremu 79 Super Squaremu 79	.001"*
THRU	LOW NICKEL Squaremu 49 Carpenter 49	THRU
225	GRAIN-ORIENTED SILICON Crystaligned Microsil	.004*

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



or d-c, intermittent or continuous duty. It has tapered plug and plunger for greater power. Plunger strokes from ⅛ in. to ½ in. with a lift of over 41 oz. Overall dimensions: 1⅛ in. by 1 in. by 1⅝ in. Weight: approximately 3½ oz.

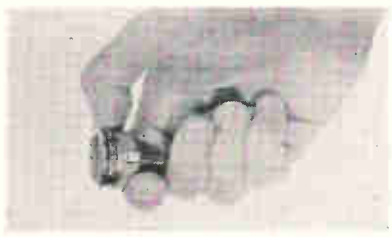
CIRCLE 319 ON READER SERVICE CARD



Analyzer
256-channel

NUCLEAR DATA, INC., 145 No. Washington, Wheaton, Ill., announces a completely solid state 256-channel analyzer with ferrite core memory. Analyzer weighs 37 lb, is 1 cu ft in size. Circuits float in foam rubber in stainless steel cabinet. Power required for portable operation on batteries is 9½ w. Performance is said to exceed vacuum tube models. Live time is printed out. Logarithmic and linear analog outputs.

CIRCLE 320 ON READER SERVICE CARD



Pressure Switch
subminiature

THE BRISTOL CO., Waterbury 20, Conn. Adjustable pressure switch exceeds requirements of MIL-E-005272B for performance up to 200 psi under vibration, shock, and acceleration test conditions. Volume of unit is less than 1 cu in. and weight slightly over 1 oz. A Ni-Span C pressure capsule and a

This NEW resistance soldering tool practically eliminates tip replacement...provides void-free solderjoints

...MEETS CRITICAL DEFENSE STANDARDS FOR SOLDERJOINT RELIABILITY, QUALITY

For aircraft and missile applications—where solderjoint reliability is a precious must—General Electric's new Resistance Soldering Tool provides the void-free solderjoints necessary for reliable, high-quality connections.

This new tool is particularly useful for soldering multiple-prong plugs. It heats work evenly throughout, allowing complete solder melting in only one operation. Call your nearby G-E Apparatus Sales Office or write for Bulletin GEA-6588, General Electric Company, Schenectady 5, N. Y. 758-1

GENERAL ELECTRIC

CIRCLE 230 ON READER SERVICE CARD

Applied Research inc.

BROADBAND MULTICOUPLERS

30 to 1100 mcps

one to three octave bandwidth

maximum isolation—high gain

minimum noise figure—low power drain

Model HFM Multicouplers facilitate the operation of from four to 16 receivers from one antenna. They consist of a broadband, low noise, high gain amplifier followed by a passive multicoupler distribution system.

The multicoupler can be used in any type of communications system where it is necessary to operate two or more receivers from one antenna while maintaining maximum isolation between receivers.

TYPICAL PERFORMANCE CHARACTERISTICS

Model	HFM-6(AC)-326	HFM-12(A)-50110
Frequency Range	30—265 MC	500—1100 MC
Gain	>10 DB	>10 DB
Noise Figure	6 to 8 DB	7 to 11 DB
Number of Outlets*	From 4 to 16	From 4 to 16
Isolation*	>30 DB	>30 DB
Peak to Valley Ratio	±1.5 DB over band	±2 DB
Input and Output Impedance	50 ohms	50 ohms
VSWR Input	1.5	1.5
VSWR Output	1.75	1.75
Power Requirements	105-125 VAC	60 CPS

*To customer requirements.

Applied Research inc.

76 South Bayles Avenue, Port Washington, N.Y.

CIRCLE 151 ON READER SERVICE CARD

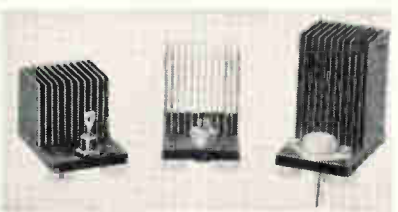
snap-action switch are contained in an all stainless steel housing. The pressure-setting adjustment is simple, and the setting is positive, even under severe shock and vibration conditions.

CIRCLE 321 ON READER SERVICE CARD

Stepping Motor high precision

G. H. LELAND, INC., 123 Webster St., Dayton 2, Ohio. The Syncramental motor is used to rotate potentiometers, counters, rotary switches, tape advances and various control mechanisms. A special clutch mechanism replaces the use of ratchets, permitting the translation of pulses to incremental shaft positions with 99.9999 percent accuracy and dependability. Motor is available in unidirectional and bidirectional models, ranging in weight from 4 to 13 oz, with angular increments of 36 deg per pulse, up to 15 steps per sec, and load capacity up to 2 lb-in. starting torque.

CIRCLE 322 ON READER SERVICE CARD

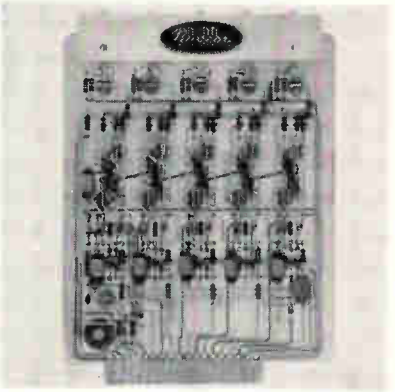


Radiators for semiconductors

WAKEFIELD ENGINEERING, INC., 11 Broadway, Wakefield, Mass. Range of the R-5000 series is 5 w to 100 w dissipation ratings, with forced convection. Illustrated are: R-5010 with rectifier, R-5020 with Zener diode, and R-5030 with transistor. With forced convection applied to the R-5030, for example, a transistor nominally rated by its manufacturer at 10 w may be conserva-

tively operated at 30 w. The R-5000 series is available in copper or aluminum. A surface machined flat to within 0.0002 in. is provided for mounting the semiconductors.

CIRCLE 323 ON READER SERVICE CARD



Shift Register transistorized

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 308 is a 5-stage transistorized shift register capable of operating at 300 kc. Set and reset inputs, and ONE and ZERO outputs are available for each flip-flop stage. Units may be serially cascaded to assemble a shift register of any length. A common buss is provided to reset all stages simultaneously. Model 308 is fabricated on a 5 in. by 6 in. glass-epoxy p-c card 1/8 in. thick, and is used with an 18 pin p-c receptacle. Only one voltage, −12 v, is required. Standard output levels are −6.8 v for ONE and −0.2 v for ZERO.

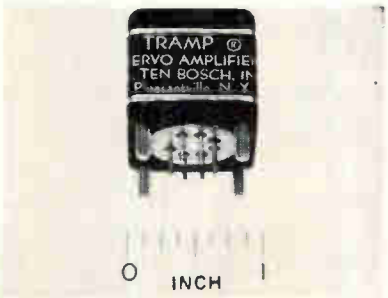
CIRCLE 324 ON READER SERVICE CARD

Rotary Trimmer super compact

SUBMINIATURE INSTRUMENTS CORP., 3705 Sunnyside Drive, Riverside, Calif. "Trimquate" trimmers are easily mounted in two planes without additional brackets. They have a shaft torque of 3 oz in., friction clutch to assure precise setting, are adjustable from either side. Self

phasing segmented units can be easily ganged. Three types of housing are available—aluminum, aluminum and molded, and stainless steel. A newly developed method of applying installation material to metal housing provides an inexpensive easily controlled procedure of application which yields a very high dielectric strength insulation. Process is used on both aluminum and stainless steel.

CIRCLE 325 ON READER SERVICE CARD



Servo Amplifier subminiaturized

M. TEN BOSCH, INC., Pleasantville, N. Y. Model 1800-0900 is a potted, hermetically sealed, plug-in transistor servo amplifier. It is primarily intended to receive signals from a synchro control transformer and to operate a 400 cycle, 3.1 w per phase servo motor or equivalent. The amplifier is designed to meet the environmental requirements of MIL-E-5400.

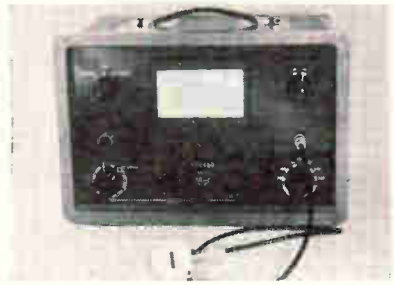
CIRCLE 326 ON READER SERVICE CARD

Pressure Transducer high g level

WHITE AVIONICS CORP., Terminal Road, Plainview, L. I., N. Y., offers to control, telemetry, and propulsion pressure measurement systems designers a potentiometric output type transducer capable of performance under high g level environment (to 50 g's at 3 kc) and yielding infinite resolution. Model

100 is available for pressure ranges 0-15 to 0-300 psi for corrosive and noncorrosive liquids and gases in a configuration 1½ by 1½ by 1¼ in., weighing 6 oz or less.

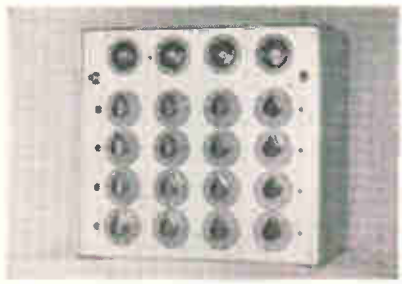
CIRCLE 327 ON READER SERVICE CARD



Bolometer Bridge for microwave use

N. V. PHILIPS' GLOEILAMPENFABRIEKEN, Eindhoven, Nederland. Type PP4460 bolometer bridge is designed for low power measurements of microwave fields. It operates on the principle of a change of resistance being produced in a thermistor, when exposed to a uhf power field. The thermistor is part of the feedback circuit of an oscillator, the output of which is inversely proportional to the microwave power striking the thermistor. Power is measured in three ranges: 0-0.1; 0-1 and 0-10 mw with an accuracy of better than 5 percent at full scale deflection. The meter is as well calibrated in db (0 db = 1 mw).

CIRCLE 328 ON READER SERVICE CARD



Preset Counters transistorized

OXFORD ENGINEERING CO., 47A River St., Wellesley Hills 81, Mass. The 2000 series preset counters are available from 3 to 6 digits, and from 1 to 6 preset banks. Illustrated is the model 2044, 4-digit and 4-bank counter. Some features include: all electronic circuitry; solid state power supply; plug-in output

relay; cold-cathode counting tube elements; reinforced fiberglass cabinet; low power drain, less than 10 w at 115 v a-c.

CIRCLE 329 ON READER SERVICE CARD

Test Set semiautomatic

PESCHEL ELECTRONICS, INC., R.F.D. No. 1, Patterson, N. Y. Semiautomatic test set features integral construction for nondestructive hipot testing a group of components or multiconductor cable. The table top cabinet houses a 0-10 kv a-c/d-c sensitive hipot tester, a central panel for control of testing sequence, and a heavy lucite interlocked door leading to a large compartment for the group of components to be tested. The electronic fault relay is adjustable in six steps from 5 to 5,000 μa. Dual scale panel meters show voltage and leakage current on each component being tested. Cabinet measures 22 in. wide by 36 in. high by 15 in. deep.

CIRCLE 330 ON READER SERVICE CARD

Miniature Filters for telemetering

KELVIN ELECTRIC CO., 5907 Noble Ave., Van Nuys, Calif. Series F-185 telemetering band-pass filters meet MIL-T-27A for long term stability and reliability under adverse en-

AVON GEARS

Consistently Perfect

FINE PITCH GEARS for Commercial and Precision Applications

- "Specific" for electronic equipment, control components, small tools, motors, and UNCOMPROMISING SPECS.
- Exacting tolerances held . . . from commercial grade to ultra precision.
- Generated in wide range of steels, non-ferrous metals, and non-metallic materials.
- Capacity range: 12 to 200 d.p., and maximum O.D. of 7½".

Make AVON Your "Gear Department"

Avon is completely tooled to follow your specifications precisely, and to produce the very best precision or commercial grade Fine Pitch gears for your specific needs. At Avon you can get one gear . . . or a million of ALL types, ALL classes, from ALL materials.

Avon has a modern complement of the finest inspection equipment procurable . . . truly a setup tuned to the exacting tempo of the "Space Age." Your gear formula is followed with the utmost care. Result: Accurate assembly of your most critical units!

Avon's fifty years aggregate gear engineering experience guarantees an end product exactly as specified. We will be glad to work with you on any development project requiring Fine Pitch gearing . . . for either commercial or precision applications. You can depend on AVON. Send drawings or descriptions for free estimates.

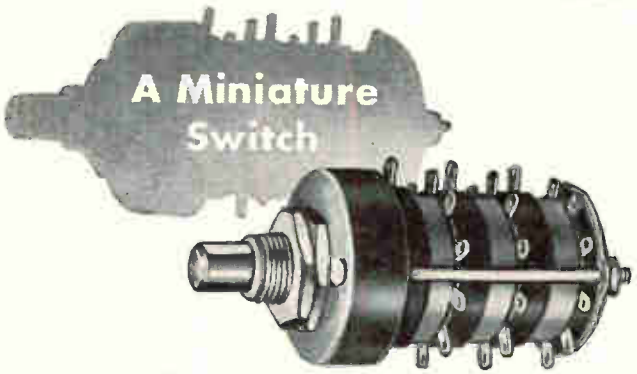
PRODUCTION • EXPERIMENTAL • CONSULTING

age

AVON GEAR AND ENGINEERING CO.

2009 RICE STREET • MELROSE PARK (Chicago Suburb), ILLINOIS

CIRCLE 210 ON READER SERVICE CARD



...with Positive Detent Action

Grayhill Series 24

This fully enclosed one inch diameter miniature tap switch, designed for high reliability in military and commercial applications, provides accurate indexing by precision detent mechanism. One to 10 decks, 2 to 10 shorting or non-shorting positions per deck. 36° indexing. Break 1 amp. 115 V. AC, or carry 5 amps. Has passed many military environmental tests including explosion test per MIL-E-5272A Procedure 1.

Write for Complete Specifications

Grayhill

Phone: Fleetwood 4-1040
523 Hillgrove Ave., LaGrange, Ill.

"PIONEERS IN MINIATURIZATION"

CIRCLE 211 ON READER SERVICE CARD

AMPERITE PREFERRED

by design engineers—because they're

MOST COMPACT • MOST ECONOMICAL
SIMPLEST • HERMETICALLY SEALED

Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

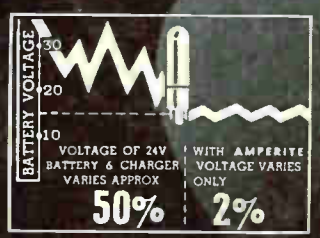
Also—**Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

TYPES: Standard Rodio Octol, and 9-Pin Miniature . . . **List Price, $4.00.** Standard Delays

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

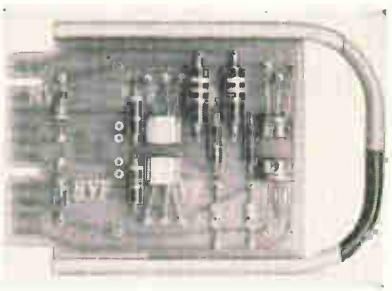
Telephone: CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 161 ON READER SERVICE CARD

vironmental conditions. All channels (23) from 400 cps to 70 kc are available. Series measures ¾ by 1½ by 2¼ in., channels 1 through 6; ¾ by ¾ by 1⅜ in., channels 7 through 18 and A through E. Insertion loss is less than 6 db; relative attenuation is less than 3 db in pass-band, greater than 15 db at adjacent channel edges; impedance range 1K to 100K ohms, in and out; operating level, 10 v max.

CIRCLE 331 ON READER SERVICE CARD



Solenoid Driver transistorized

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass. Model SD-102 contains two independent solenoid driver circuits. Each circuit amplifies the output of a standard M-PAC to drive a solenoid load of up to 50 v at 150 ma. A diode in each circuit suppresses inductive kick. Power requirements: +20 v at 12 ma, −90 v at 4 ma. Input requirements: approximately 0.5 ma into a 30 K input impedance.

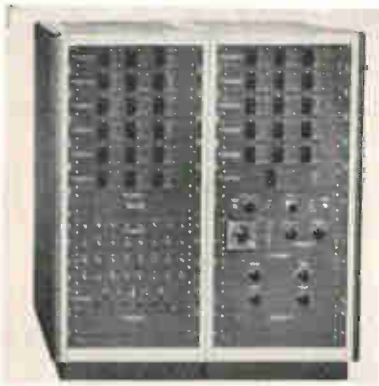
CIRCLE 332 ON READER SERVICE CARD

Motor Generator small, lightweight

KEARFOTT CO., INC., 1500 Main Ave., Clifton, N. J. The M863-05 integrating motor generator is only 2½ in. long, is thermistor compensated, and yields an output of 0.5 v per 1,000 rpm. Having a linearity of but 0.06 percent through the 0-3600 rpm range, the component is ideally qualified for missile appli-

cations where space and weight considerations are critical. It weighs 3.9 oz, and can operate through a temperature range of −54 C to +105 C.

CIRCLE 333 ON READER SERVICE CARD



Time Analyzer 32-channel

ELDORADO ELECTRONICS, 2821 Tenth St., Berkeley 10, Calif. System 0900 time analyzer accurately counts and stores digital information in 32 consecutively gated channels. Channel scalers have a double pulse resolution of 1 μsec. Channel widths are variable from 1 μsec to 0.08 sec. They can be identical or weighted with last channels up to 8 times the width of the first channel. Each of the 32 channels has two electronic counting units and a 4-digit mechanical register to provide storage of 10^6 digits. Each channel accurately counts pulses beginning no more than 1 μsec apart at rates to 2,500 counts per sec.

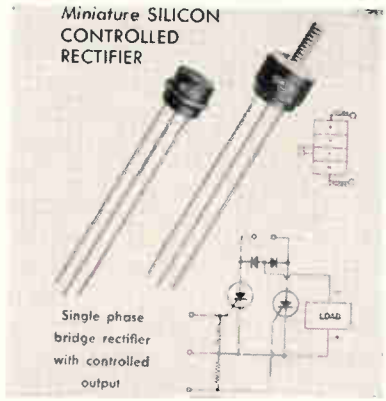
CIRCLE 334 ON READER SERVICE CARD

Modulation Monitor self-calibrating

GATES RADIO CO., Quincy, Ill. Model 5693 broadcast modulation monitor will read the time values of positive and negative peaks regardless of the presence of carrier shift. With the fastest meter allowable, it will

give correct peak indications on single program pulses as short as approximately 50 millisec, and will measure the true peak amplitude of program or tone regardless of the wave forms encountered. Self calibration and accuracy of indication make the monitor ideal for the annual proof-of-performance measurements. An oscilloscope is not even necessary.

CIRCLE 335 ON READER SERVICE CARD



Silicon Rectifier controlled output

SOLID STATE PRODUCTS, INC., One Pingree St., Salem, Mass. Precise power control of loads up to 300 w with extremely low losses can be achieved reliably with a new line of miniature silicon controlled rectifiers. At 100 C these units control up to 1 ampere (continuous) per cell with an input signal level of only 2 ma. Switching efficiency on the order of 98 percent is typical. At 2 amperes the maximum drop is 2.5 v. The junction is ruggedly mounted on high alumina ceramic, positively insulating all active elements from the case. Minimum heat sink requirements with peak recurrent ratings to 30 amperes are afforded with very low internal dissipation, operating over a temperature range of −65 C to +50 C.

CIRCLE 336 ON READER SERVICE CARD

Power Supplies airborne type

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer Rd., Houston 27, Texas, announces models TPC-18A and 19A airborne transistorized power supplies. They are designed for direct, plug-in re-

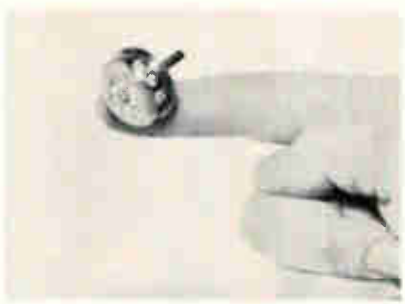
placement of D-10A dynamotors as the power supply for aircraft communications and navigation receivers, using a transistor multivibrator circuit to deliver voltage at high efficiency with good regulation and provide protection against overload or short-circuit.

CIRCLE 337 ON READER SERVICE CARD

Terminals
Teflon top

THE SPHERE CO., INC., 25 Amity St., Little Falls, N. J. New line of terminals has an outer insulator of solid Teflon. Features: extremely high dielectric strength, insulation resistance; non-carbon tracking; high resistance to temperature extremes; tough physical characteristics, abrasion and chemical resistance; extremely low moisture absorption. They range in size from 1/4 in. to 1/2 in. in diameter. Head styles are turret, slotted, double and single lug. Terminals range in height from 1/8 in. above the mounting panel to 1/2 in.

CIRCLE 338 ON READER SERVICE CARD

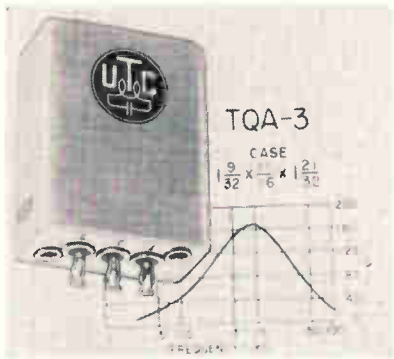


Rotary Pots
subminiature

SUBMINIATURE INSTRUMENTS CORP., 3705 Sunnyside Dr., Riverside, Calif. "Turnquate" precision pot features include: subminiature size, humidity sealing, dual outputs or two circuits in this tiny size, 10 or 20 output circuits in 2 1/2 in. long, 200 C stainless steel high temperature units, 200 K resistance, 40 g vibration, self phasing without

loosening screws or clamp bands, superior noise level with new principle in design, improved moment of inertia due to compact design, less torque values with seals.

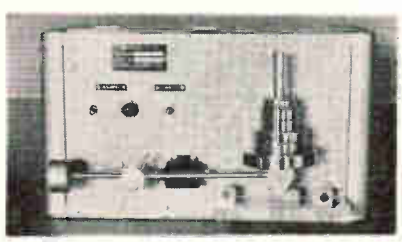
CIRCLE 339 ON READER SERVICE CARD



Toroidal Inductors center tapped

UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N. Y. Type TQA precision inductors provide an ideal solution to stable oscillators for frequencies from 400 cycles to 75 kc. They are center tapped for oscillator circuits and employ an extremely stabilized core for maximum temperature stability. Units are available as stock items in 19 inductance values ranging from 7 mhy to 22 henries, laboratory adjusted to 1 percent accuracy. Maximum Q is approximately 160 at 7.5 kc ranging down to 20 at 400 cycles and to approximately 30 at 75 kc for low inductance values.

CIRCLE 340 ON READER SERVICE CARD



Wire Tester abrasion-scrape

PESCHEL ELECTRONICS, INC., R.F.D. No. 1, Patterson, N. Y. Conforming to MIL-W-19583 (Navy) requirement to determine abrasion resistance of film-insulated high-temperature magnet wire, model TS-2 abrasion-scrape tester is a device that repeatedly scrapes the wire with the cylindrical surface of a No.

11 steel needle. Length of the scrape motion in one direction is ¾ in. The device is equipped with an electrical circuit providing 12 v at approximately 5 ma between the needle and the wire sample. Circuit is so designed that failure is detected and the device shut off when the film is worn through to the copper for approximately ⅓ of the stroke length.

CIRCLE 341 ON READER SERVICE CARD

Microwave Amplifier
general-purpose

ALFRED ELECTRONICS, 897 Commercial St., Palo Alto, Calif. Model 549 offers broad band amplification with gain of 30 db and 10 mw output from 10.5 to 16 mc. Use of a twt, permanently magnet-focused, also provides versatile modulation features. Phase modulation, which is used in Doppler shift simulators and Doppler radars, may be accomplished simply through a front panel connector which is capacitively coupled to the twt helix. Simple, rugged design, plus use of quality components in a conservative circuit, assures virtually troublefree operation.

CIRCLE 342 ON READER SERVICE CARD

Converter
4 decimal digit

EPSCO, INC., 275 Massachusetts Ave., Cambridge, Mass. Model MTD-704 is a 4 decimal digit voltage-to-digital converter. It translates input analog voltages into 4 binary-coded decimal digits, plus sign and overflow digits. Input full-scale voltage range is ± 10 v d-c.

with provision for an extended range of ± 12 v d-c. Maximum conversion rate is 5,000 independent conversions a second. Linearity and accuracy are rated at 0.01 percent. The all solid-state unit is built to meet the rugged environmental requirements of MIL-E-4158B.

CIRCLE 343 ON READER SERVICE CARD

Integrated Test Unit for lab use

RESEARCH COUNCIL INC., 1062 Main St., Waltham 54, Mass. The Thermion integrated test unit (Thermion I.T.U.), model B210 combines in one unit the functions of: (1) supplying variable power to up to several Thermions, and (2) monitoring and selecting the internal test points in any of the Thermions under evaluation. Among the many test conveniences available, the unit incorporates techniques of design and construction to assure accurate performance of temperature measurements. The effects of ambient temperature variations are eliminated and undesirable stray thermocouples avoided.

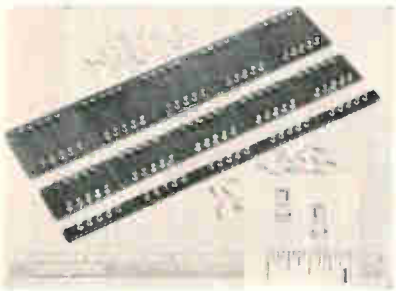
CIRCLE 344 ON READER SERVICE CARD

Bandpass Filter high shape factor

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. The BF-121 high shape factor bandpass filter is designed for video i-f strip applications. It has a center frequency of 40 kc, a 1-db bandwidth of 3.4 kc and a 50-db bandwidth of 22 kc. It has a shape factor of 6.5. Input imped-

ance is 51K ohms, and the output is to the grid of the next strip stage. Special high voltage 1,900 v d-c terminals are employed as a safety factor. Case size is 1¼ by 2 by 4 in. high.

CIRCLE 345 ON READER SERVICE CARD



Terminal Boards
3/32 or 1/8 in. thick

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. All-set terminal boards with Cambion No. 1010 castelated terminals are now available in 13¾ in. lengths and widths of ½, 1½, 2, 2½ and 3 in. One-half-inch wide board has single row of 25 No. 1010 terminals; all others, double rows of 25 terminals each. Terminals are mounted on ⅜ in. centers. All boards are sectioned into five 2⅝ in. sections for convenient breaking into suitable lengths. Each section is drilled for 14 terminals with 10 mounted. Hole size is 0.120 No. 31 drill. Terminals are brass per QQ-B-626a, furnished in 6 shank lengths from ⅜ in. to ⅝ in.

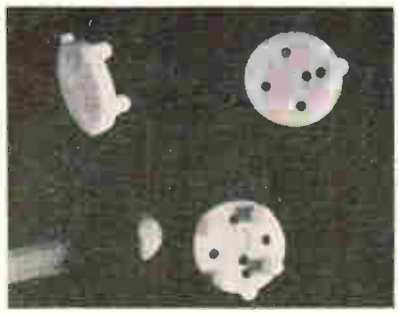
CIRCLE 346 ON READER SERVICE CARD

Accelerometer
remote indicating

M. TEN BOSCH, INC., Pleasantville, N. Y. Model 0013-5100 remote indicating accelerometer is a highly accurate instrument designed for automatic aircraft and missile control

systems and remote visual indication. Its small size and simple mounting arrangement provide for easy installation in crowded assemblies. The hermetically sealed air damped spring-mass system provides constant damping over the entire temperature range. Range is ± 7 g; natural frequency, 5.5 cps; damping ratio, 0.65; accuracy, 0.1 g; temperature, — 55 C to + 85 C.

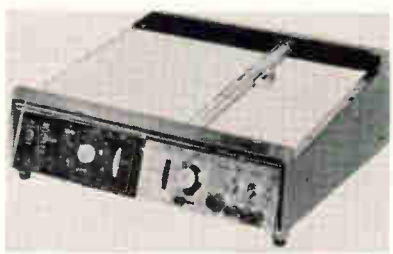
CIRCLE 347 ON READER SERVICE CARD



Transistor Pad
precision molded

THE DELBERT BLINN CO., P.O. Box 757, Pomona, Calif. New transistor pad provides an excellent mounting base for standard transistors. The spherical feet act as standoffs and provide the necessary lead length and air-space for thermal insulation when hand or dip soldering. The five holes will accept most combinations of lead wires. The transistor pads are precision molded of mineral-filled diallyl phthalate, which conforms to MIL-P-14D (MDG type) and Mil-P-4389. Nominal tensile strength is 5,500 psi. They resist continuous exposure to 400 F, and offer very high dielectric strength.

CIRCLE 348 ON READER SERVICE CARD

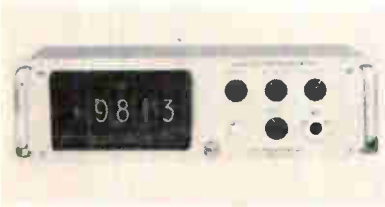


X-Y Recorder
integral input

F. L. MOSELEY CO., 409 N. Fair Oaks Ave., Pasadena, Calif. Model

2D Autograf recorder has a new, integral a-c/d-c input and a built-in X-axis time base. It operates directly from a transducer and eliminates the need for an extra a-c converter. D-C ranges provide accuracy and resolution of better than 0.2 percent. Input range is 7.5 mv to 150 v on the X-axis; 5 mv to 100 v on the Y-axis. The X-axis time base (5 steps) is 7.5 to 750 sec. Input resistance is 200,000 ohms/v. The recorder provides a zero offset and a vacuum paper hold-down. Pen speed is 20 ips for each axis.

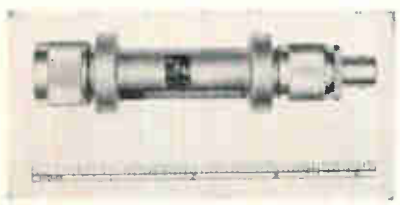
CIRCLE 349 ON READER SERVICE CARD



Digital Voltmeter
4-digit resolution

NON-LINEAR SYSTEMS, INC., Del Mar, Calif. The V64 is designed for a wide range of d-c measuring jobs and, with accessories, a-c and low-level d-c measurements. It features full 4-digit (0.01 percent) resolution, high input impedance and an average measuring time of 0.75 sec per reading. Its range without accessories is 500 v d-c in steps of ±9.999/99.99/500. Price is $825.

CIRCLE 350 ON READER SERVICE CARD



Crystal Mounts
video detector

AMERICAN ELECTRONIC LABORATORIES, INC., 121 N. Seventh St., Philadelphia 6, Pa. A new group of crystal video detector mounts provide a high tangential sensitivity down to 50 mc. The miniature octave band units utilize a slow wave structure to create a physically short line to match the crystal impedance to the input line. Ranges covered are 50 mc to 120 mc, 120 mc to 300 mc,

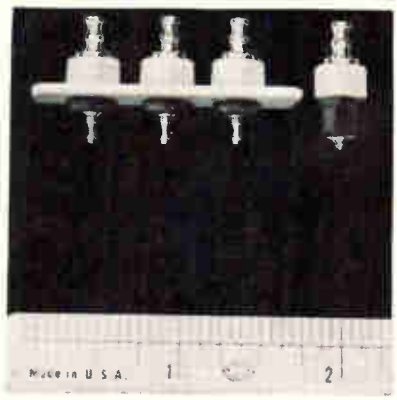
and 300 mc to 600 mc. Tangential sensitivities better than −55 dbm with selected MA408B or selected 1N23B crystals can be achieved.

CIRCLE 351 ON READER SERVICE CARD

D-C Amplifier
solid-state

VIDEO INSTRUMENTS CO., INC., 3002 Pennsylvania Ave., Santa Monica, Calif. Model 93 solid-state d-c amplifier features a combination of differential input and wide bandwidth. Another feature is that the amplifier can drive any of the new h-f galvanometers. Maximum current output is 100 ma at an output impedance of less than 1 ohm. Input impedance is higher than 50 K ohms, isolated by at least 100 megohms from the cabinet. Recovery time from overloads is 100 millisec maximum.

CIRCLE 352 ON READER SERVICE CARD

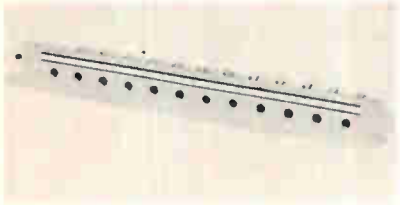


Hermetic Terminal
nonturning

LUNDEY ASSOCIATES, 694 Main St., Waltham 54, Mass., has available model 599 hermetic terminals for electronic components such as transformers and capacitors in the

intermediate voltage range (1,500 v operating). The nonturning terminal is a single-unit assembly (no loose parts). It has been proved by independent laboratory tests to meet MIL-T-27A specifications.

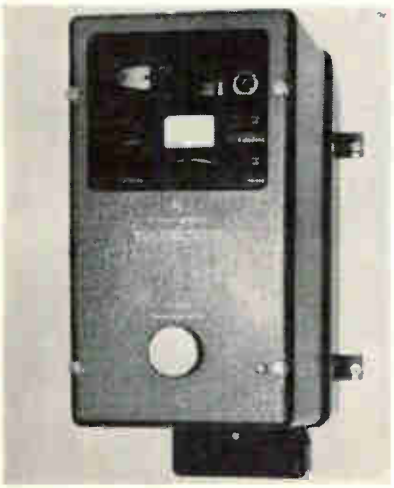
CIRCLE 353 ON READER SERVICE CARD



Jack Panels
video and r-f

NEMS-CLARKE CO., 919 Jesup-Blair Drive, Silver Spring, Md. Type 921 jack panel (illustrated) is made of aluminum and is 19 in. wide by only 1¾ in. high. It is provided with 12 type 925 jacks and is especially useful where space is at a premium. Types 928 and 929 are similar in construction to the 921 but are both 3½ in. high. Type 928 provides for 24 type 925 jacks; and type 929 provides for 48.

CIRCLE 354 ON READER SERVICE CARD



Overspeed Monitor
uses tach-generator

ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N. J. Type FDW overspeed monitor provides a means for accurate and very fast protection of steam turbines from excessive speeds. It employs a tach-generator which is directly coupled to the turbine shaft and delivers an a-c voltage whose frequency is strictly proportional to the rpm

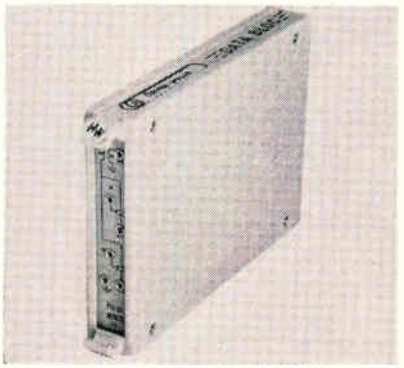
which it follows without inertia. The generator is selected to produce 600 cps at turbine speeds of 3,000 rpm. A discriminator provided in the overspeed monitor changes the frequency derived from the monitor into a proportional voltage. After differentiation, a d-c voltage is obtained which represents the rate of change of the turbine speed. If this exceeds a given limit, then an electronic circuit makes a normally-closed relay drop. This excites magnet type valves with the aid of which the steam supply is reduced.

CIRCLE 355 ON READER SERVICE CARD

Helitron 250-500 mc

WATKINS-JOHNSON Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. The WJ-207 helitron is a lightweight oscillator continuously voltage tuned over the 250-500 mc frequency band, providing a minimum of 3 mw output power. Maximum power output variation over the band is 6 db. It is electrostatically focused and therefore requires no focusing magnet. It is designed to withstand the severities of modern environmental extremes by utilizing rigid construction throughout, for example the metal-ceramic envelope.

CIRCLE 356 ON READER SERVICE CARD



Pulse Mixer high speeed

HARVEY-WELLS ELECTRONICS, INC., East Natick Industrial Park, East Natick, Mass. New pulse mixer consists of two gating transistors with a common output pulse transformer. It differs from the pulse

gate in that two pulse rates can be mixed and amplified. Electrical specifications are: input/output, negative 4-v, 1/10 μsec pulses; supply voltages and currents, negative 15-v, 30 ma; plus 10-v, 0.3 ma; and clamp voltage negative 4 v at + 20 ma.

CIRCLE 357 ON READER SERVICE CARD

Transistor Amplifier hushed type

MILLIVAC INSTRUMENTS, Division of Cohu Electronics, Inc., Box 997, Schenectady, N. Y. The VS-64A hushed transistor amplifier has an rms noise voltage, referred to the shorted-input terminals, of 50 milliμv (10^{-9} v), when used with a bandpass of 20 cps—300 cps. A typical audio-bandpass of 20 cps-14 kc generates only 160 milliμv noise voltage. The total available bandpass of the amplifier is 2 cps—180 kc. Noise voltage with this larger bandpass is in the order of 620 milliμv, which is 20 to 30 db less than can be expected of low-noise vacuum tubes operating under comparable conditions.

CIRCLE 358 ON READER SERVICE CARD

P-C Connector 44 contacts

CINCH MFG. CO., 1926 S. Homan Ave., Chicago 24, Ill., announces a

p-c connector with wire wrap termination. It maintains positive contact with a p-c board over a dimensional range of 0.57-0.072. It contains 44 contacts which are phosphor bronze with a silver plate of 0.0002 and 0.00003 gold plate finish. A plastic polarizing key is furnished with each connector, and this key can be inserted into the contact slot of any contact position.

CIRCLE 359 ON READER SERVICE CARD

D-C Bridge high speed

INDUSTRIAL INSTRUMENTS AUTOMATION CORP., 89 Commerce Road, Cedar Grove, N. J. Model AB-4-5 high speed d-c bridge can sort resistors into three groups automatically at rates of 5,000 pieces per hr. The equipment is capable of sorting to high accuracy over an extremely high and low range extending up to 100 megohms. A built-in 7-dial resistance decade is provided for setting to the nominal value of resistance being checked. Tolerance limits for the 3 bins is set by means of plug-in units. Resettable electromechanical counters tally the number of pieces in each bin.

CIRCLE 360 ON READER SERVICE CARD

Gold-Antimony Alloy for transistor mfrs.

ENGELHARD INDUSTRIES, INC., 113 Astor St., Newark, N. J., has developed a new gold-antimony alloy (No. 1549) with improved properties for transistor manufacturers. Available in rod or whisker wire in diameters from 0.25 in. down to

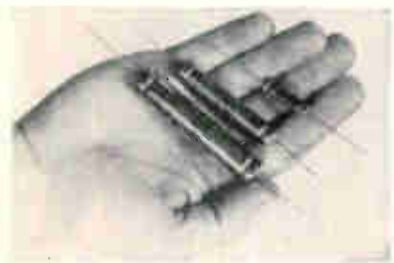
0.001 in. and in sheet down to 0.0015 in. thickness, the material consists of high purity gold containing 1 percent antimony and features completely homogeneous dispersion of the antimony-rich phase throughout the gold matrix. It is designed for use in imparting a controlled impurity (antimony) into a semiconductor crystal, usually silicon, by evaporation techniques. In this method of crystal doping, the alloy is heated until the antimony boils off, creating an antimony atmosphere from which the crystal picks up the desired impurity.

CIRCLE 361 ON READER SERVICE CARD

Disk Capacitors in 86 values

CENTRALAB, A Division of Globe-Union, Inc., 900 E. Keefe, Milwaukee 1, Wisc. The ID 500 vdew disk capacitors are available in 86 values ranging from 3.3 $\mu\mu$f to 0.05 μf. Depending on the capacity the size varies from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. diameter.

CIRCLE 362 ON READER SERVICE CARD



Tantalum Capacitor 300 v foil-type

GENERAL ELECTRIC CO., Schenectady 5, N. Y. New Tantalytic units, available for operation at 85 C (to 300 v) and 125 C (to 250 v), are

designed primarily for applications in missiles, computers and airborne electronic equipment where minimum size and weight are major considerations. Representative units illustrated are rated at 300 v and 1, 7, and 25 μf. A capacitance change of no more than 10 percent is specified after 2,000 hr operation at rated voltage and temperature. At −55 C the maximum capacitance change is 20 percent. Capacitance tolerances are tightened to ±15 percent. Units are available in seven case sizes and in both polar and nonpolar construction.

CIRCLE 363 ON READER SERVICE CARD

Count Rate Meter
transistorized

INTERSTATE ELECTRONICS CORP., 707 E. Vermont Ave., Anaheim, Calif. Model 502 completely transistorized count rate meter has eight scale ranges, extending to 600,000 cpm, displayed on a large three-in., easy-to-read meter scale. Three time constants are available, from a front panel mounted switch, as is a calibration control. The input is sensitive to a 250 mv negative pulse. Provisions are available on the rear of the instrument to drive either a 0-1 ma or 0-10 mv recorder. Price is $295.

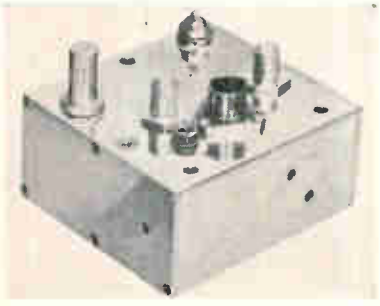
CIRCLE 364 ON READER SERVICE CARD

Oscillators
voltage-controlled

TELE-DYNAMICS INC., 5000 Parkside Ave., Philadelphia 31, Pa. Transistorized voltage-controlled oscillators are available for use in

extreme missile environments. Type 1250 are used for 0 to +3, 0 to +5, ±1.5, or ±2.5 v signals. Type 1251, operating with 0.25 v inputs is compatible with the recently available 1-v output pressure transducers. Type 1252, requiring only 20 mv for full deviation, are ideal for bridge instrumentation. Environmental characteristics are: −55 C to 125 C, 100 percent relative humidity, 30 g rms random vibration, 150 g acceleration, and 200 g shock. Types 1250 and 1251 occupy only 2.7 cu in.; type 1252, 3.7 cu. in.

CIRCLE 365 ON READER SERVICE CARD



VHF-UHF Cavities
miniature size

RESDEL ENGINEERING CORP., 330 S. Fair Oaks Ave., Pasadena, Calif. A series of six vhf-uhf cavities offering 36 combinations of size, power and function, operating in the frequency range 220 through 1,150 mc, have been developed for missile-borne and ground-based r-f equipment. All are designed for heat sink type mounting and the components are derated to provide maximum trouble-free operation. Features are minimum weight, optimum surface conductivity, corrosion protection, stable mechanical tuning, negligible backlash and built-in ruggedness for operation under severe environmental conditions.

CIRCLE 366 ON READER SERVICE CARD

Readout Display Unit
four decimal places

ADVANCE INDUSTRIES, INC., 640 Memorial Drive, Cambridge, Mass. New digital converter readout display unit provides rapid, positive, visual numerical readout of the out-

put of analog-to-digital converters. Model 411 Digitester is designed to readout the outputs of converters using binary-coded decimal codes and having outputs in the form of either open-or-closed contacts or suitable voltage level changes. It presents directly readout of the converter output to four decimal places.

CIRCLE 367 ON READER SERVICE CARD

Coaxial Switch
miniaturized

MICRODOT INC., 220 Pasadena Ave., South Pasadena, Calif. Type 90-01 spdt coaxial switch for 50 ohm cable is designed so that it can be directly inserted into a miniaturized circuit without adapters. Positive toggle action assures proper switching and panel mounting provides easy installation. Mating connectors are available for application at above or below 400 mc. Vswr is less than 1.2 to 2 kmc and insertion loss is 0.5 db at 2.0 kmc. Voltage rating is at 1,500 v maximum (60 cps) and crosstalk is better than 60 db to 2.0 kmc. Operative life is at a minimum of 50,000 cycles. Switch weighs only 1¼ oz.

CIRCLE 368 ON READER SERVICE CARD

VHF Preamplifier
low noise

COMMUNITY ENGINEERING CORP., P. O. Box 824, State College, Pa. Designed for use in the 50 to 200 mc range, the model 1001 vhf preamplifier has a noise figure of better than 3 db at 85 mc and 4.5 db at 200 mc with a nominal gain of 30 db. Unit is fixed tuned to required frequency. Bandwidth is 10 mc. Amplifier subassembly and in-

tegral power supply are mounted in light weight, solidly constructed chassis, on a standard size rack panel protected by an easily removable dust cover. Input and output impedance is 50 ohms. Standard type N connectors are used.

CIRCLE 369 ON READER SERVICE CARD

Silicon Rectifiers highly stable

DALLONS SEMICONDUCTORS, 5066 Santa Monica Blvd., Los Angeles 29, Calif., announces 20-35 ampere, 60-600 piv silicon rectifiers which contain solders within their construction which have a melting point in excess of 600 C. The ¼ in. stud construction houses a pure silver, heavy spring lead anode assuring ruggedness and high resistance to shock and vibration. Units have less than 5 ma reverse current, and maximum forward drop voltage at a test temperature of 25 C at 20 amperes, d-c, is 0.65 v.

CIRCLE 370 ON READER SERVICE CARD

Long-Life Encoder high-resolution

DATEX CORP., 1307 So. Myrtle Ave., Monrovia, Calif. Model C-804 shaft position encoder provides an output of 3,600 quanta per revolution in Datex code or 4,096 quanta per revolution in Gray code. It is capable of unlimited readout cycles and the sampling rate is limited only by the readout device. Use of brush contacts gives high current carrying capabilities and long life. A useful life of over 10 million revolutions has been obtained from this encoder. Unit uses an 8½-in. disk. It is 9 in. in diameter and 3½ in. high, exclusive of the shaft.

CIRCLE 371 ON READER SERVICE CARD

NEW BOOKS

Encyclopedic Dictionary of Electronics and Nuclear Engineering

By Dr. Robert I. Sarbacher

Prentice-Hall, Inc., New York, 1959, 1,417 *p*, $35.

THIS massive volume, issued as 1959 drew to a close, is a valuable addition to the rapidly expanding library of technical reference works. Electronics engineers — particularly those working in the nucleonics area — would benefit from owning or at least having access to this book; technical writers and editors should consider it a professional "must". Nontechnical people will find the lucid definitions most helpful.

Abbreviations (including those authorized by the military), acronyms, vernacular expressions, British words and proprietary terms are accurately defined. Illustrations are used somewhat sparingly, approximating one per page, probably because of length considerations. Cross references are adequate. Many accustical, chemical, electrical, mechanical, and mathematical terms applicable to electronics are included.

Most important contribution of the work may be its comprehensive standardization of terms. Definitions given are approved by every official professional society concerned, including the IRE and AIEE as well as by government agencies such as the AEC and FCC and by industrial groups such as RETMA and SMPTE.

The publisher's claim that ALL current terms are listed is a bit presumptuous. A cursory examination revealed that thin films, microminiaturization, vacuum deposition, tunnel diodes, sampling oscilloscopes, biaxial ferrite elements and varactors are not mentioned. Also, medical electronics is not listed nor are any of the terms related to this field.

One factor prospective buyers should consider is the relative expense of the book if their interest is solely in electronics. Less expensive, if not more complete, purely electronic dictionaries are available. —W.E.B.

Magnetic Materials

Verlag Chemie, GMBH, Weinheim/ Bergstrasse, West Germany, 1959, 580 *p*, $85.50.

THIS is a new volume in the comprehensive "Gmelins Handbook of Inorganic Chemistry." It is Supplement 2 of System No. 59, Iron, Part D, and also supplements Systems 58 (Cobalt), 57 (Nickel), 56 (Manganese) and 52 (Chromium).

The volume presents an exhaustive review of magnetic and electrial properties, applications, literature and patents, bringing up to date the volumes published in the 1930's. Data is introduced by a chapter on ferromagnetic theory and a new section covers ferromagnetic semiconductors.

Text is in German, but there are English marginal notes, table of contents and index. The text is supplemented by 308 graphs and numerous tables. Organization of data follows the Gmelin classification. The high price is apparently necessary because of the tremendous effort which has been expended to assemble information gathered from so thorough a literate search. G.M.

Linear Network Analysis

By Sundaram Seshu and Norman Balbanian. *John Wiley & Sons, Inc., New York*, 1959, 571 *p*, $11.75.

THIS book is intended for graduate students of electrical engineering who have completed course material on the theory of functions of a complex variable and the theory of the Laplace transformation.

The text reviews basic network theory and presents, in a mature fashion, a clear discussion of general network analysis including topological theorems such as "block diagrams" and "signal - flow graphs". It has adequate discussions on feedback notions and stability theory. Two-port networks are clearly discussed, as is also general filter theory.

The convolution theorem approach to network system problems is developed on the basis of the Laplace transformation and then

redeveloped using the superposition principle for linear systems and the impulsive response of the network. The DuHamel form of the integral for the response in terms of the step response of the network is also developed.

Methods employed in the text do not disregard mathematical subtleties. In those few cases in which to have maintained an exact mathematical presentation would have meant digressing too far afield from the immediate subject, the authors were careful to indicate source material where the precise mathematical theorems may be found to substantiate their statements. This is the case, for example, in the discussion of the impulse function.

I was pleased to note the abundance of excellent examples and subsequent careful discussions. Attention may also be directed to the excellent appendices which provide the relevant results of complex variable theory and Lapace transformation needed for the text.

DAVID JAGERMAN, *System Development Corp., Lodi, N. J.*

THUMBNAIL REVIEWS

Analog Methods — Computation and Simulation. By W. J. Karplus and W. W. Soroka, McGraw-Hill Book Co., Inc., New York, 1959, 483 p, $12.50. This second edition of a widely used book shifts emphasis from mechanical to electrical and electronic equipment. Reader learns to utilize linear and nonlinear computer elements in both special- and general-purpose design before he begins to interconnect these elements to solve laboratory problems. The chapter on network analyzer techniques has been completely revised and augmented to reflect recent developments. Discussion of mechanical differential analyzers and other outmoded techniques has been shortened considerably, but chapter dealing with mechanical computing elements has been retained.

Crystals and Crystals Growing. By A. Holden and P. Singer, Doubleday & Co., Inc., New York, 1960, 320 p, $1.45. Written primarily for students, this book suggests experiments to develop laboratory skill at growing crystals and for building simple models and apparatus. Theory and practice of art of modern crystallograph is explained and problems are given to sharpen visualization and thought.

Concise Dictionary of Science. By F. Gaynor, Philosophical Library, Inc., New York, 1959, 546 p, $10. This up-to-date encyclopedic-like dictionary provides concise definitions of terms and concepts pertaining to all fields of science. Newer sciences of virology, ensymology, cytogenetics, radio-chemistry, high energy and solid-state physics, and the like are covered. In committing an undertaking of such sweep to so few pages, many terms were omitted; however, the electronics man dealing in cross-field applications will find the definitions succinct and entirely comprehensible.

Ham Radio Handbook. By Robert Hertzberg, Arco Publishing Co., Inc., New York, 1959, 144 p, $2.50. This book tells how to learn code, select the proper transmitter and receiver and get a ham ticket. A special section treats mobile equipment.

Magnetism and Electromagnetism (71 p, $1.80) and **Advanced Magnetism and Electromagnetism** (96 p, $2.25). Edited by A. Schure, John F. Rider Publisher, Inc., New York, 1959. The first book is an elementary treatment of the major theoretical considerations of magnetism, magnetic circuits and electromagnetism. The second is a college-level companion volume which penetrates deeply into the various underlying details of the forces acting on a charge moving through a magnetic field, induction lines, and magnetic flux. Biot's Law, Faraday's Law, Lenz's Law, the Curie-Weiss Law and the domain theory of magnetism are also discussed as are the cyclotron, the mass spectrograph and terrestial magnetism.

Masers. By G. Troup, John Wiley & Sons, Inc., New York, 1959, 168 p, $2.75. This monograph, written by an Australian, is probably the first book published on masers. A discussion of the stimulated emission process is followed by a brief outline of methods used to obtain the conditions necessary for amplification. A review of the experimental work done is given together with a comprehensive bibliography.

Fourier's Series. By W. E. Byerly. Dover Publications, Inc., New York, 1959, 287 p, $1.75. This elementary treatise, originally written in 1893, is recognized as one of the most useful and practical expositions of Fourier's series, and spherical, cylindrical, and ellipsoidal harmonics. Reader is given 190 problems to solve. An appendix provides six tables of surface zonal harmonics, hyperbolic functions, and Bessel's function. Electronics men will find book helpful in all forms of advanced engineering, especially in communications, radar and acoustics.

Low-Frequency Amplifier Systems. Edited by A. Schure, John F. Rider Publishers, Inc., New York, 1959, 70 p, $1.80. This companion to another Rider book (Low-Frequency Amplifiers) treats, with special emphasis, coupling methods suitable for low-frequency range, phase inversion and inverse feedback as well as circuit design using vacuum tubes and transistors. Mathematics has been kept simple, but analyses are sufficiently extensive to permit technicians or students to fully comprehend pertinent theory.

The Physics of Television. By D. G. Fink and D. M. Lutyens, Doubleday & Co., Inc., New York, 1960, 160 p, $0.95. Written primarily for students, this book gives account of how men have learned to control electrons, photons, and electromagnetic waves to produce instantaneous moving pictures at great distances. Principles of physics as applied to television systems are discussed.

Proceedings of the Fourth Symposium on Magnetism and Magnetic Materials. American Institute of Physics, McGraw-Hill Book Co., Inc., New York, 1959, 322 p, $10.00. Some 150 papers reporting advanced research and development in the field are included. A third of the papers will interest design engineers, covering new materials or techniques for computer components, microwave amplifiers, waveguide, permanent magnets and magnetic instrumentation. Several papers discuss effects of environments or processing on the properties of magnetic materials.

The Measurement of Power Spectra. By R. B. Blackman and J. W. Tukey, Dover Publications, Inc., New York, 1959, 190 p, $1.85. This graduate-level book, reprinted from Bell System Technical Journal, views the topic from the point of view of communications engineering and such related fields as oceanography, aerodynamics, meteorology, seismology, economics, guided missiles, radar and acoustics. Authors explain various ways of getting practically useful answers in the measurement of power spectra using results from both transmission theory and the theory of statistical estimation. An appendix reviewing fundamental Fourier techniques, an index of notation and a glossary of terms are also included. Calculus is used extensively along with some advanced mathematics.

Printed Circuits. By Morris Moses, Gernsback Library, Inc., New York, 1959, 224 p, $2.90 (soft cover), $4.60 (hard cover). This is a how-to-do-it book written for radio hams, television and radio technicians, and experimenters. Development of the art and advanced applications are also discussed.

The Gentle Art of Mathematics. By D. Pedoe, The MacMillan Co., New York, 143 p, $3.50. Fascinating, thought provoking little volume wholly devoted to bringing modern mathematics into perspective. Those who wish to develop their mental capacities and those whose business is mathematics should read this book. Of particular interest to electronics men will be the chapter on "Automatic Thinking", a non-Carrollian approach to symbolic logic.

Moon Base—Technical and Psychological Aspects. By T. C. Helvey, John F. Rider Publisher, Inc., New York, 1960, 72 p. $1.95. Although professedly not science fiction, this booklet does little to dispel the aurora of sensationalism and fantasy surrounding moon travel. Avowed aim of the author is to show only problem areas in the construction of a moon base, but this limitation is not used to good advantage—the text is sketchy and the illustrations infantile. The erroneous impression that the discussion is on a high scientific level is conveyed by an early reference to the two-page glossary of technical terms and expressions used in the text.

Model Radio Control. By E. Safford, Jr., Gernsback Library, Inc., New York, 1959, 192 p, $2.65. This handbook covers all aspects of radio control from theory to construction of coders, decoders and other complex components as well as complete systems.

The Magnetodynamics of Conducting Fluids. Edited by Daniel Bershader, Stanford University Press, Stanford, Calif., 1959, 145 p, $4.50. Third volume in a series growing out of a Lockheed-sponsored symposium on magnetohydrodynamics. Seven authorative analyses of underlying behavior of conducting fluids in magnetic fields are given. Electronics men involved in handling of hot plasmas in magnetic bottles and ducts will find this book particularly valuable.

Microwave Data Tables. By A. E. Booth, Iliffe and Sons, Ltd., London, England, 1959. 61 p. 27s 6d ($3.85). A collection of 26 tables for use by engineers engaged in research and development of waveguides and similar transmission lines.

Technical Writing Manual. By C. K. Arnold, Electronic Periodicals, Inc., Cleveland, Ohio, 1959, 57 p, $2.50. This glossary of correct and approved usage of commonly misused words and phrases for engineers and scientists is a valuable contribution to the literature on the art of technical writing. Unfortunately, the high price tag may keep this short monograph from those who most need it.

Literature of the Week

ANALOG COMPUTERS. Computer Systems, Inc., 611 Broadway, New York 12, N. Y. A 4-page brochure describes the company's line of general and special purpose analog computers and accessories.

CIRCLE 380 ON READER SERVICE CARD

REINFORCED PLASTICS. General Electric Co., Missile and Space Vehicle Department, 3198 Chestnut St., Philadelphia, Pa., has available a collection of scientific papers on the behavior of reinforced plastics at very high temperatures.

CIRCLE 381 ON READER SERVICE CARD

STATIC INVERTER. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. Bulletin S-1035 covers the SIS3-40613 static inverter which features operating temperatures at 100 C, automatic voltage regulation, short circuit protection with automatic recovery, and reverse voltage protection.

CIRCLE 382 ON READER SERVICE CARD

ENVIRONMENTAL TESTING. Stavid Engineering, Inc., Plainfield, N. J., offers a 10-page brochure describing the company's environmental test laboratory.

CIRCLE 383 ON READER SERVICE CARD

CHOPPERS. Airpax Electronics Inc., Cambridge, Md. Series 310 choppers for operation at high temperatures are described in bulletin C-52.

CIRCLE 384 ON READER SERVICE CARD

TIME DELAY RELAYS. Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif. Bulletin 376-100REV covers 18 standard electronic time delay relays including factory preset, internally adjustable, and externally adjustable units.

CIRCLE 385 ON READER SERVICE CARD

AUDIO RESPONSE PLOTTER. Southwestern Industrial Electronics Co., 10201 Westheimer, Houston 19, Texas. Model ARP-2 audio response plotter, which provides permanent pen-written frequency response curves of any audio-range equipment, is described and

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illustrated in a single-sheet bulletin.

CIRCLE 386 ON READER SERVICE CARD

P-C RESIN FLUXES. London Chemical Co., Inc., 1535 N. 31st Ave., Melrose Park, Ill. A recent bulletin describes and illustrates results of a U. S. Signal Corps mirror test for corrosiveness of printed circuit resin fluxes.

CIRCLE 387 ON READER SERVICE CARD

DIRECTIONAL COUPLERS. Waveline, Inc., Caldwell, N. J. A six-page technical brochure describes microwave directional coupler design and operation.

CIRCLE 388 ON READER SERVICE CARD

DIGITAL COMPUTER. Autonetics, a division of North American Aviation, Inc. Industrial Products, 3584 Wilshire Blvd., Los Angeles 5, Calif., has published a 4-page bulletin describing RECOMP II, a general purpose, small size, all-transistor, single address, digital computer which solves problems of extreme complexity with split-second accuracy.

CIRCLE 389 ON READER SERVICE CARD

CONTROL UNIT. Wintriss, Inc., 20 Vandam St., New York 13, N. Y. A new electronic control unit that automatically stops injection molding machines when molds are closing improperly is described in detail in an illustrated bulletin.

CIRCLE 390 ON READER SERVICE CARD

INDUCTION HEATING. Lepel High Frequency Laboratories, Inc., Woodside, N. Y. Vol. 1, No. 6 of the Review features a story on the floating zone method for growing germanium or silicon crystals, zone refining and zone leveling. Also included is an article on coil design and construction.

CIRCLE 391 ON READER SERVICE CARD

MINIATURE CONNECTORS. H. H. Buggie Division, Burndy Corp., Toledo 1, Ohio. A catalog sheet illustrates and lists Bantam connectors now in production for prompt delivery of 18, 20 and 22 shell size configurations. Also discussed are modified Bantam connectors.

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Dorne: 10 o'clock scholar

An unique group of 10 o'clock scholars thrice weekly sets aside engineering tools, measuring devices and test equipment to return to the classroom. All on company time and premises.

"We believe that all work and no study makes for rusty engineers," explains Arthur Dorne, president of Dorne and Margolin, Inc., Westbury, L. I., electronics firm which specializes in airborne antennas. "Our bringing the campus to the plant is an easy way to keep our staff up to date with space age technology."

The company was organized by Dorne and a wartime colleague, Joseph Margolin, 12 years ago as a partnership. It was incorporated in 1953. Today employees are included in the stockholding group.

Education—the company pays for both in-plant and on-campus education—and stock ownership are but two of the programs undertaken by the firm in an approach designed to "make this the best place to work." The 140 employees and their families also are covered by a broad, company-paid medical, health, accident and life insurance program.

Dorne a graduate of the University of Pennsylvania (1939), first handled antenna design for a Washington engineering firm serving broadcast license applicants. Later he helped another firm pioneer in aircraft instrument landing systems.

When the war came, he joined the radio research laboratory operated by Harvard for the government. It was here Dorne and Margolin first worked together. This team shifted after the war to Airborne Instruments Laboratory in Mineola and then pooled resources and talents to form its own firm in 1947.

The company expects to gross about $2 million in the fiscal year ending next March 31. The research, development and manufacturing firm is broadening its activities to undertake contracts for electronic systems and components, Dorne says.

Dorne, who now lives in Glen Head, L. I., with his wife and child, is chairman of the Antenna and Propagation professional group of the Institute of Radio Engineers. He was an early writer in the field and was among those who authored and edited a two-volume book, "Very High Frequency Techniques" (McGraw-Hill, 1948), which incorporated findings of the wartime research at Harvard.

Temco Appoints Exec V-P & G-M

IN A MOVE to accelerate its projected program of getting more heavily into missile, electronic and aerosystem work, Temco Aircraft Corp., Dallas, Texas, has named Clyde Skeen, executive vice president and general manager. He comes to Temco from Boeing Airplane Company's Aerospace division, where he was vice president for weapons system program management.

Skeen took over Feb. 1 the day-to-day management of the company that is trying to convert from an airframe manufacturer and subcontractor into an aerospace corporation.

AIL Names Two Vice Presidents

AIRBORNE INSTRUMENTS LABORATORY, Deer Park, N. Y., recently announced the appointment of E. G. Fubini and G. C. Comstock as vice presidents. Both were formerly co-directors of AIL's Research and Engineering division.

Fubini was named vice president in charge of Research and Systems Engineering; and Comstock, vice president in charge of the Electronic Systems and Techniques division. Both divisions are newly created within AIL.

Ang Takes New Post at Mallory

CHOH-YI ANG was recently appointed director of the Materials Laboratories of P. R. Mallory & Co., Inc., Indianapolis, Ind. He will direct research and development of new structural and electronic materials and processes, heat resistant and semiconducting intermetallics, neutron and gamma radiation.

A member of the Mallory research and development staff since 1954, Ang has supervised investigations of tungsten alloys, copper alloys, electrical contact materials,

New Ketay size 15 integrating motor tachometer—

- **REQUIRES NO WARM-UP TIME**
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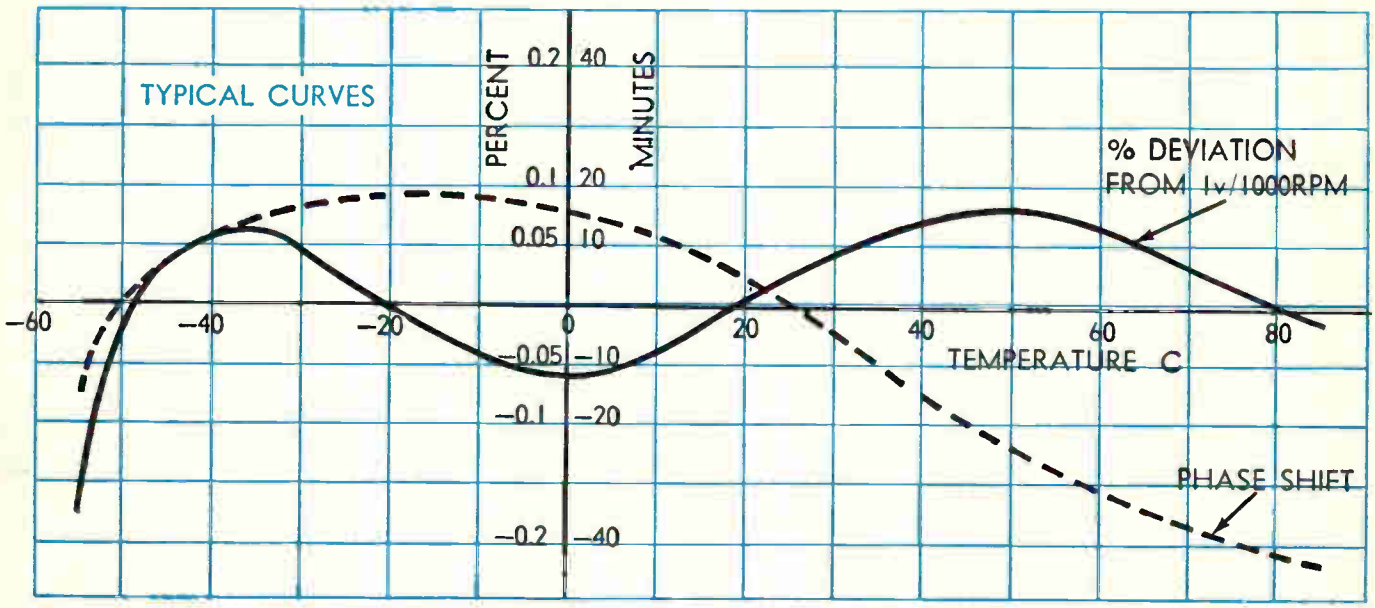
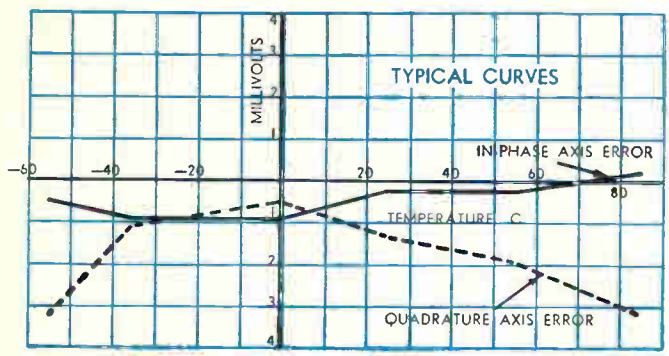


The Ketay integrating motor tachometer, Type 105P2Y has many features that assure high output-to-null voltage ratios and extreme accuracy over the entire temperature range of —55°C. to +80°C.

In addition, the Type 105P2Y will give instantaneous response, for no warm-up time is required at any temperature within the operating range. The Ketay design uses no heating elements, mechanical thermostats, amplifiers or external heat sources and, as a result, the unit has increased life, less weight and less power drain on the over-all system.

The unit will pass military environmental specifications called out in MIL-S-17806.



CHECK THESE GENERATOR SPECIFICATIONS:

Excitation (volts)	115
Frequency (cps)	400
Input current (nominal) amps	0.0275
Input power (nominal) watts	1.9
Output gradient per 1,000 RPM @ 25°C	1.0000 ± .05%
Phase shift with respect to input at 3600 RPM @ 25°C	0° ± 10′
Null voltage at 25°C. (Maximum Values)	
IN-phase Fundamental at zero speed	2MV
Quadrature Fundamental at zero speed	6MV
Total harmonic	10MV (RMS)
IN-phase axis error	1MV
Quadrature axis error	1MV
Linearity —0 to 4000 RPM (percentage of voltage output at 3600 RPM)	± .06%
Variation in output gradient with variation in ambient temperature (—55°C. to +80°C.)	± 0.2%
Variation in axis error with variation in ambient temperature (—55°C. to +80°C.)	±7MV ±18 MV
Variation in phase shift with variation in ambient temperature (—55°C. to +80°)	±1°
Warm-up time	None
Total unit weight (motor and generator)	15 oz.

Write for detailed specifications and drawings, or for information on other Ketay integrating and dampening tachometers.

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Commack, Long Island, New York

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cermets, intermetallics, powder metallurgy and other metallurgical processes.

Company Ends Facilities Move

AIRBORNE INSTRUMENTS LABORATORY, a Division of Cutler-Hammer, Inc., recently completed the move of all of its facilities to Deer Park and Melville, Long Island, N. Y.

A 157,000-sq ft building on a 92-acre plot in Melville houses most of AIL's research and development facilities.

The 493,000-sq ft building on a 102-acre plot in Deer Park houses general administration, engineering, and production facilities.

Epsco Worcester Names Sterling

APPOINTMENT of Howard T. Sterling as chief engineer of the Epsco Worcester division is announced. This division, located in Worcester, Mass., manufactures a complete line of graphic recording instruments for both industry and medicine.

Sterling has recently specialized in transistorized circuit development and brings with him an abundance of experience gained through 18 years in electronic and industrial instrumentation. His most recent affiliation was with Fischer and Porter Co., Hatboro, Pa., as chief electronic engineer. Prior to that, he was president and founder of Waveforms, Inc., in New York.

Yardney Electric Promotes Feld

SHELDON L. FELD has been named applications engineer at Yardney Electric Corp., New York City.

With the firm since 1956, Feld was formerly a project engineer in design and development. He will now handle Yardney Electric sales and applications engineering in the Midwest and Southeast.

News of Reps

Rep firm of **Cooper-Di Blasi**, Port Washington, N. Y., which has served the electronics industry since 1930, will now be known as **John DiBlasi Associates Inc.**, Personnel and address remain unchanged.

The Waltham Precision Instrument Co., Waltham, Mass., has appointed **R. C. Dudek & Co.** of Beverly Hills, Calif., to represent it in the states of California and Arizona.

Essex Electronics, division of Nytronics, Inc., Berkeley Heights, N. J., appoints **George W. Meeker** of Seattle, Wash., to handle its standard line of electronic components in Washington and Oregon.

Mid-Eastern Electronics, Inc., Springfield, N. J., names **Houser Associates** of Washington, D. C., to handle its line of power supplies, ultra high resistance measuring instruments and test equipment in Virginia, Maryland, West Virginia and the District of Columbia.

Appointment of **Production Methods Co.** of Chicago as its sales rep for a wide midwest area has been announced by The Narda Ultrasonics Corp., Westbury, N. Y., volume producer of ultrasonic cleaning equipment. Territory to be covered is Illinois, Indiana, Wisconsin and the Michigan peninsula.

Central Engineering Sales Co. of Chicago, Ill., has been appointed exclusive midwest rep for Radiation Instrument Development Laboratory, Inc., Chicago.

COMMENT

Transistor Oscillators

. . . W. E. Roach's article "Designing High-Power Transistor Oscillators" (p 52, Jan. 8) is well organized and most informative. However, there seems to be a mistake somewhere. Step 5 on p 55 says that Fig. 4D is "drawn as a grounded collector circuit." The drawing shows a transistor with the emitter grounded . . .

ROBERT R. RANSOM
LOS ANGELES

Reader Ransom picked up an obvious drafting error that author Roach had also called to our attention. There's another, less obvious, that goes with it: connection points E and C, which lead to the bias power supplies, are also switched.

Kudos: No. 1

In your Dec. 18 '59 issue of ELECTRONICS, you carried a story on the Stratolab Flight #4 on p 41. This article is the most concise and accurate we have read about the flight . . .

FRED B. FERSON
FERSON OPTICAL CO.
OCEAN SPRINGS, MISS.

Kudos: No. 2

The feature article on microwave fault-finding equipment ("Pulse-Coded Fault Alarm in Microwave Systems," p 83, Jan. 1) was well handled. Thanks for your careful editing . . .

J. B. BULLOCK
MOORE ASSOCIATES
REDWOOD CITY, CALIF.

Author Bullock's article was a pleasure to handle.

Kudos: No. 3

I'd like to compliment you on your clearly written article "Modern Communications Methods," p 93, Oct. 23 '59. This should give you a rough idea of how far behind I am in reading ELECTRONICS, but you know how the telephone business is—it's all over the place and you've got to go where it is . . .

I think we need more of this sort of article, as I think we assume too often nowadays that the younger engineers have a much fuller appreciation of the art than they actually do. In fact, you've got to crawl before you can walk, so maybe it wouldn't hurt to show some of the present working systems so that when new ones come out, some of the old wrinkles that have been showing through for so long will be gone.

ROBERT G. STONEMAN
MILWAUKEE

Profilometer

In the December 18 '59 issue of ELECTRONICS ("Electronics Assists in Highway Construction," p 69), we note that you improperly used the term *Profilometer*.

Profilometer is a trademark, registration #371,385, belonging to the Micrometrical Manufacturing Co., and is used to identify the instruments that company manufactures for measuring surface roughness.

Hereafter, if you desire to use our trademark, please . . . make suitable notation . . .

CHARLES H. GOOD
MICROMETRICAL DEVELOPMENT CORP.
ANN ARBOR, MICH.

Minification

I'm answering your request for takers (Comment, p 104, Jan. 22) . . .

I'm with Frank Smith as regards adopting *minify* to replace *miniaturize*. This field of technology is not unique in adopting *-ize* words, but it's one of the worst offenders. And between *-ize* and *-wise* (as in "voltage-wise, the circuit is . . ." etc.), I've begun to believe that the lyricist of "My Fair Lady" was right when he wrote "In America they haven't spoken it (English) for years."

With all the richly varied ways of expressing ideas that this language legitimately provides, I can't figure out why we have to put up with neologisms . . .

R. L. MULLEN
NEW YORK CITY

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RADAR TECHNICIANS — with training and experience in one or more of the following radar systems: MSQ-1, MSQ-1A, FPS-16, Nike, M-33, MPS-9, SCR-584, CPS-6, FPS-3 and FPS-20.

ELECTRONIC TECHNICIANS — with a solid background in electronics and several years experience in Telemetry, Data Converters, Oscillograph Recorders or Range Electronic Instrumentation.

For your opportunity to relocate in Florida with an electronics industry leader, address a confidential resume to D. D. Cox, Personnel Director, Vitro Weapons Services, 119 East Main Street, Fort Walton Beach, Florida, Dept. AW.

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Field or Liaison Engineer Dr. of Engineering European Universities. Age 50. Wide experience R & D Power Electronics, manufacturing licensee agreements with foreign companies. Speaks fluently French, Italian. Interested in overseas assignments. Best references. Present salary $14,000. PW-3610. Electronics. Class. Adv. Div., P.O. Box 12, N. Y. 36, N. Y.

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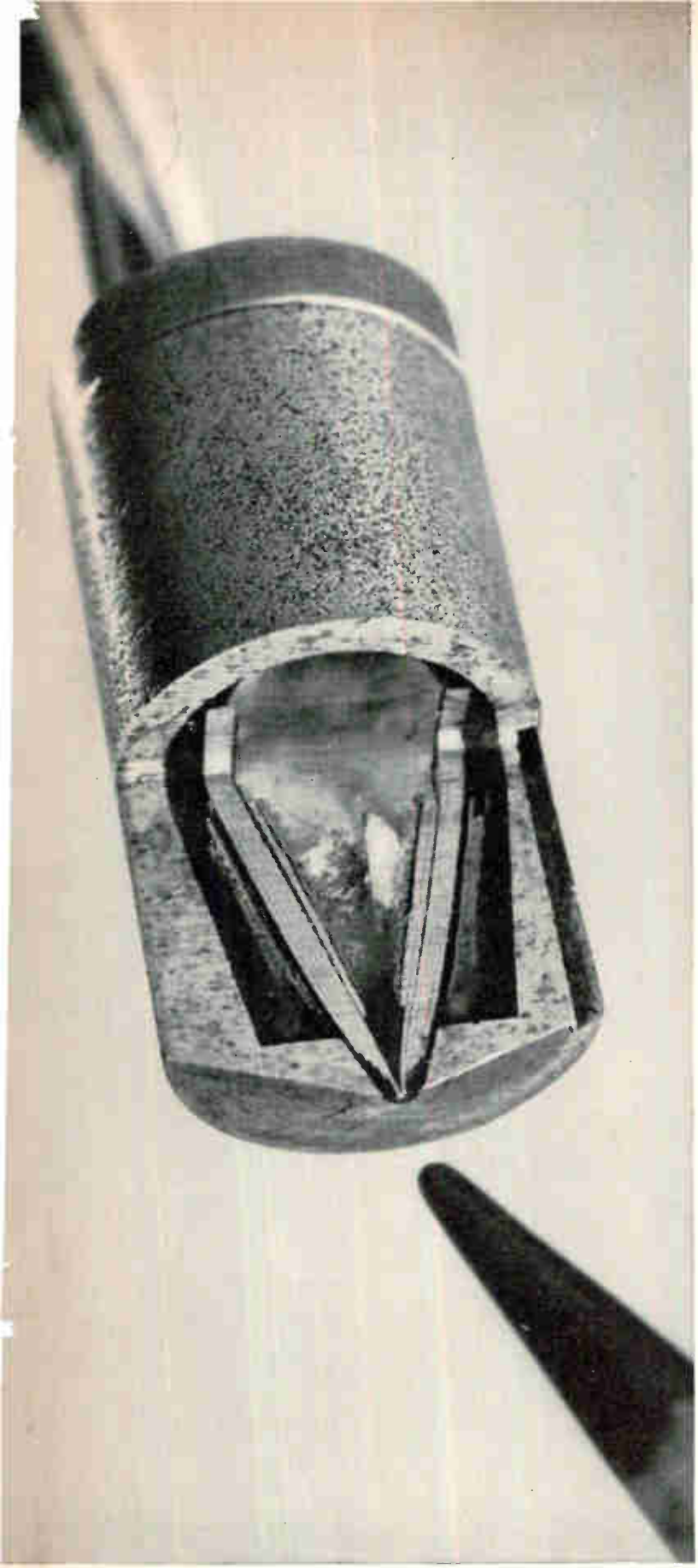
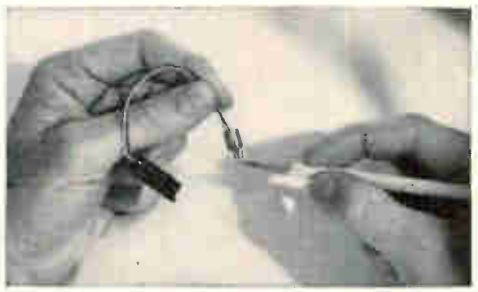
520 N. Michigan Ave., Chicago 11, Ill.



This high-resolution magnetic drum head, recently developed by IBM engineers, has made possible greatly expanded storage capacities for systems such as the 650 computer.

Opportunities in systems development



Expanding Computer Memory to Hold One Million Bits of Information

Some time ago IBM scientists were handed a knotty problem: how to develop a magnetic drum memory (for a system similar to the 650 computer) that retains present speeds and access time but multiplies storage capacity.

Starting with the existing system—operated at 125 kc., 50 bits per inch, and 20 tracks per inch—the engineers aimed at a memory of 500 kc., 200 bits per inch, and 40 tracks per inch. After months of work, they achieved their goal with advanced transistor circuitry and an improved read-write head which affords greater bit and track densities.

The result: Drum capacity has been expanded *eight times* to an unprecedented one million bits.

Although this accomplishment satisfies an immediate need, work is in progress to develop magnetic memories of even superior capabilities. Several positions are available on the development team assigned to this project. In addition, interesting opportunities exist on projects involving microwaves, optics, semiconductors, inertial guidance, and human factors engineering.

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Manager of Technical Employment, Dept. 554N2
IBM Corporation
590 Madison Avenue, New York 22, N.Y.

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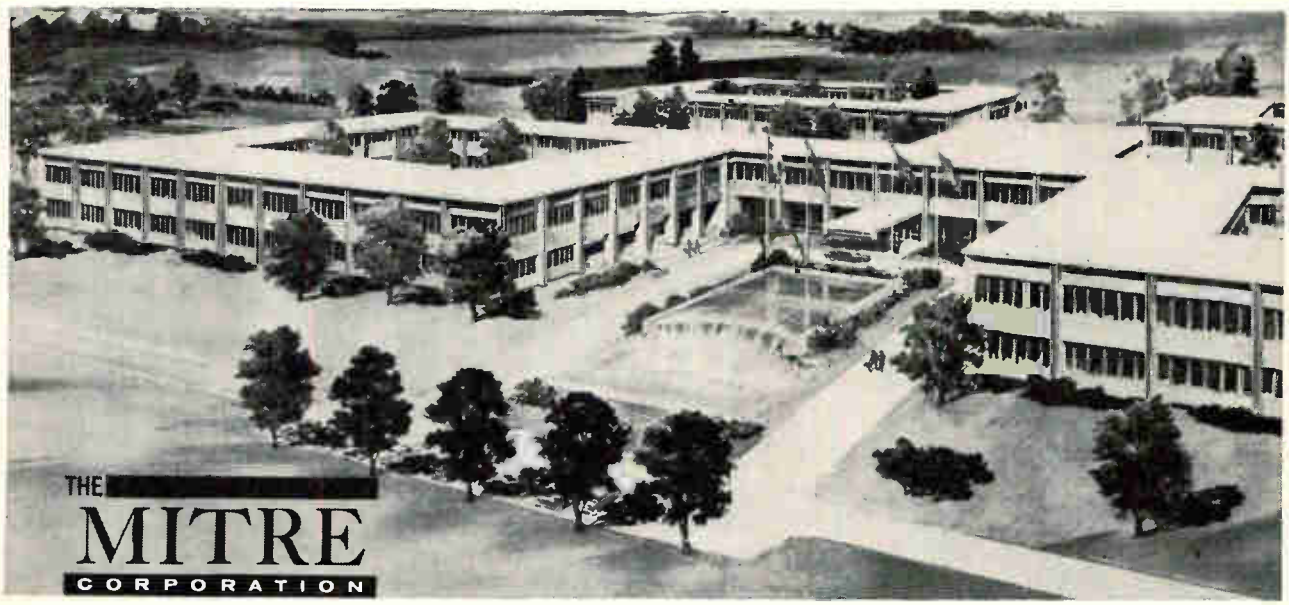

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The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

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1B24	3.75	6AG7Y	.90	F-375A	6.00	5528	2.00	5064	.90
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1B63A	10.00	6AR6	1.00	394A	2.50	5550	30.00	5967	7.50
C1K B	12.50	6AS6	.85	396A 2C51	2.00	5636	1.50	5969	7.50
1P21	30.00	6AS7G	2.75	398A 5603	4.50	5639	2.50	5975	2.00
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2AP1A	3.00	C6J	9.00	403B 5591	2.50	5644	2.50	5987	6.50
2BP1	4.50	6J4	1.00	404A 5847	10.00	5646	2.00	5992	3.00
2C36	25.00	6J6W	.60	408A 6028	2.50	5647	2.50	5993	4.00
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2C39B	16.50	6L6WGB	2.00	416A	50.00	5654 6AK5W	1.25	6005 6AQ5W	1.35
2C40	7.50	6SJ7WGT	1.25	417A 5842	10.00	5656	4.00	6021	2.00
2C43	7.50	6SL7WGT	1.25	418A	15.00	5670	1.25	6032	10.00
2C50	4.25	6SN7WGT	.75	420A 5755	6.50	5672	1.25	6037 QK-243	20.00
2C51	2.00	6V6GTY	.60	421A 5998	6.00	5675	7.50	6045	1.35
2C52	1.75	6X4W	.75	422A	8.50	5676	.65	6062	1.35
2D21	.50	6X5WGT	1.35	429A	8.50	5678	1.10	6072	2.25
2D21W	.85	7MP7	17.50	GL-434A	5.00	5684 C3J A	10.00	6073	.85
2E22	3.00	FG-17	3.85	450TH	35.00	5686	2.00	6080	3.25
2E24	2.25	HK-24	1.25	450TL	45.00	5687	1.50	6080WA	4.50
2E26	3.35	26Z5W	1.50	575A	15.00	5691	5.25	6087 5Y3WGTB	3.00
2J51	75.00	35T	4.75	578	5.00	5692	4.25	6097	1.25
2K25	8.00	35TG	1.75	631-P1	4.00	5693	3.75	6098 6AR6WA	4.00
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2K30	50.00	FG-67	5.00	676	27.50	5704	1.00	6100 6C4WA	1.35
2K33A	150.00	BL-75	5.00	677	27.50	5718	1.00	6101 6J6WA	1.15
2K34	85.00	FG-95	13.00	715C	7.50	5719	1.00	6106	1.00
2K35	150.00	100TH	9.00	719A	6.50	5721	135.00	6111	2.75
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2K42	125.00	FG-172	17.50	723A B	3.00	5726 6AL5W	.85	6115 QK-351	45.00
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2K45	30.00	231D	1.50	726C	7.00	5744	.75	6135	1.50
2K47	85.00	244A	5.00	750TL	50.00	5749 6BA6W	.75	6136 6AU6WA	1.50
2K50	50.00	245A	3.50	803	2.50	5750 6BE6W	1.50	6137 6SK7WA	1.50
2X2A	.85	249B	5.00	804	15.00	5751 12AX7W	1.75	6146	3.90
3AP1	1.25	249C	5.00	805	3.00	5763	1.35	6151	3.50
3B24W	3.25	250R	7.50	807	1.25	5777	125.00	6152	4.50
3B25	3.50	252A	6.00	807W	.85	5783	2.25	6177	50.00
3B28	3.75	254A	2.00	809	3.75	5794	3.00	6186 6AG5WA	2.00
3C22	35.00	257A	3.50	810	12.50	5787	3.00	6189 12AU7WA	2.00
3C23	5.75	259A	2.75	811	3.50	5794	3.75	6197	1.75
3C24 24G	2.00	262B	3.00	813	9.50	5800	4.00	6199	30.00
3C45	4.00	264C	3.50	814	1.00	5801	3.00	6201 12AT7WA	2.25
3D22	12.50	267B	5.00	815	1.50	5803	2.00	6202 6X4WA	1.75
3E29	5.00	271A	10.00	816	1.75	5814A	1.50	6211	.65
3J21	25.00	272A	3.00	828	8.50	5824	1.85	6236	165.00
3J31	35.00	274A	3.50	829B	7.50	5828	3.00	6247	6.00
3K21	125.00	275A	4.00	832	3.00	5829	.60	6263	12.50
3K22	125.00	283A	3.00	832A	6.50	5829WA	1.20	6264	10.00
3K27	150.00	287A	2.00	833A	40.00	5837	67.50	6265	2.50
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4C35	17.50	304TL	35.00	B72A	1.75	5852	2.85	6390	165.00
4E27	9.50	310A	4.75	B84	1.00	5854	.85	6438	4.75
4J52	25.00	311A	3.00	B85	.85	5876	6.00	6463	1.25
4X150A	10.00	313C	1.50	B89RA	75.00	5879	1.00	6482	9.50
4X250B	32.50	323A	6.50	913	7.50	5881 6L6WGB	2.00	6517	200.00
5BP1A	9.75	328A	3.00	918	.75	5886	3.85	6626/OA2WA	2.50
5C22	15.00	329A	5.00	927	1.00	5894	17.50	6627 OB2WA	2.50
5CP1A	9.75	336A	3.00	931A	3.50	5896	1.85	6754	15.00
5LP1	6.75	337A	2.50	959	.65	5899A	2.75	6897	16.50
5R4GY	1.10	339A	5.00	1000T	100.00	5902	2.50	8013A	3.00
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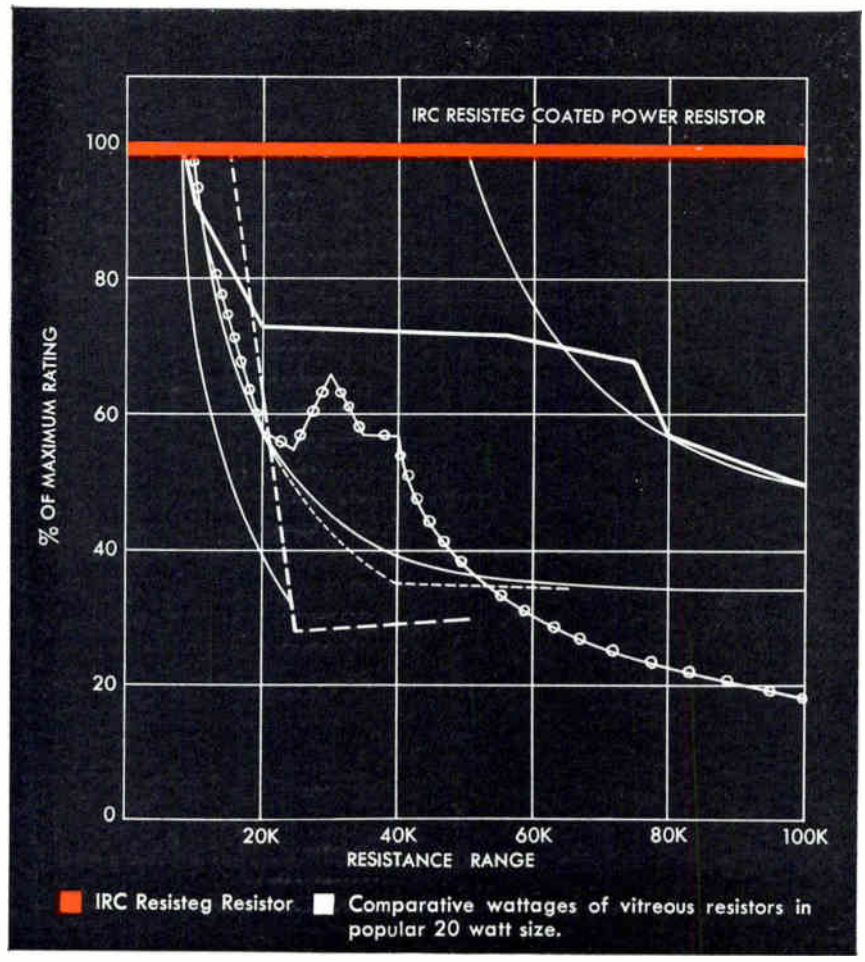

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COMPUTER TRANSISTORS

2N1300 · 2N1301

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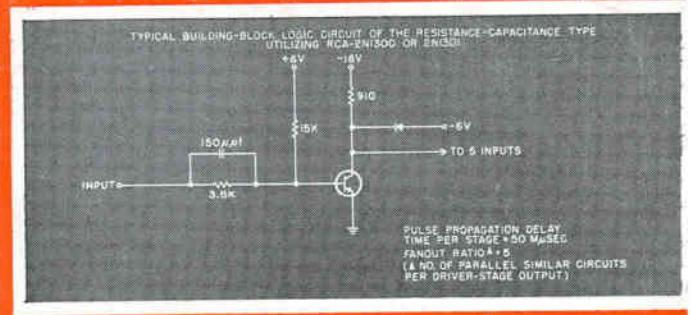

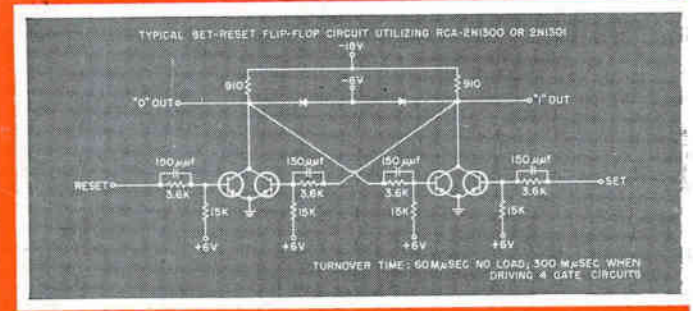

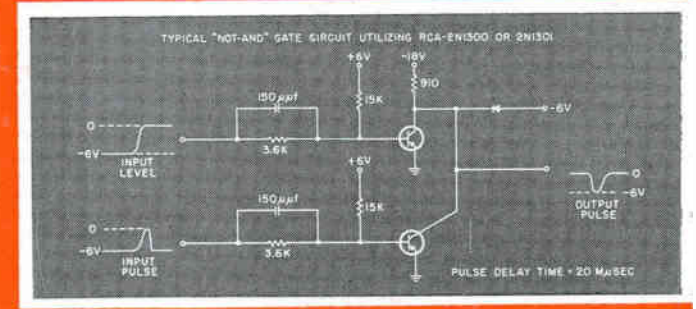

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RCA TYPE	Maximum Ratings—Absolute-Maximum Values							Characteristics: Common-Emitter Circuit, Base Input—Ambient Temperature = 25°C		
	Collector-to-Base Volts	Collector-to-Emitter Volts	Emitter-to-Base Volts	Collector Ma.	Transistor Dissipation Milliwatts			Minimum DC Current Transfer Ratio		Gain-Bandwidth Product▲ Mc
					at 25°C	at 55°C	at 71°C	at collector ma = −10	at collector ma = −40	
2N1300	−13	−12	−1	−100	150	75	35	30	—	40
2N1301	−13	−12	−4	−100	150	75	35	30	40	60

▲For collector ma = −10 and collector-to-emitter volts = −3

RCA's Germanium P-N-P Mesa Transistors 2N1300 and 2N1301 combine low-cost and quantity availability with these major benefits for designers of switching circuits:

- high power dissipation—150 milliwatts maximum at 25°C, 75 milliwatts maximum at 55°C
- fast switching times—made possible by high frequency response and low total stored charge
- rugged Mesa structure—with an extremely small base width to insure top performance at high frequencies
- high current transfer ratio—permits high fanout ratios (number of paralleled similar circuits per driver-stage output)
- high breakdown-voltage and punch-through voltage ratings—result of the diffusion process
- high current ratings—improves overall system speed
- especially well suited for use at pulse repetition rates up to 10 Mc
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors

Contact your RCA Field Representative for prices and delivery. For technical data, see your HB-10 Semiconductor Products Handbook, or write RCA Commercial Engineering, Section B-19-NN-2, Somerville, N. J.

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