A McGRAW-HILL PUBLICATION • PRICE ONE DOLLAR SEPTEMBER 12, 1958

electronics

engineering issue

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...page 84

FOR TOP RELIABILITY

MILITARY AND INDUSTRIAL

HERMETIC AUDIO AND POWER COMPONENTS... FROM STOCK

UTC stock hermetic units have been fully proved to MIL-T-27A, eliminating the costs and delays normally related to initial MIL-T-27A tests. These rugged, drawn case, units have safety factors far above MIL requirements, and are ideal for high reliability industrial applications. Listed below are a few of the hundred stock types available for every application. **Industrial ratings in bold.**

Typical Miniature Audios

RC-25 Case
61/64 x 1-13/32 x 1-9/16
1.5 oz.

Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response 2 db (Cyc.)	Max. level dbm
H-1	Mike, pickup. line to grid	TF4RX10YY	50, 200CT, 500CT	50,000	0	50-10,000	+ 5
H-2	Mike to grid	TF4RX11YY	82	135,000	50	250-8,000	+18
H-5	Single plate to P.P. grids	TF4RX15YY	15,000	95,000 CT	0	50-10,000	+ 5
H-6	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	95,000 split	4	200-10,000	+11
H-7	Single or P.P. plates to line	TF4RX13YY	20,000 CT	150/600	4	200-10,000	+21
H-8	Mixing and matching	TF4RX16YY	150/600	600 CT	0	50-10,000	+ 8
H-14	Transistor Interstage	TF4RX13YY	10K/2.5K, Split	4K/1K split	4	100-10,000	+20
H-15	Transistor to line	TF4RX13YY	1,500 CT	500/125 split	8	100-10,000	+20

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-20	Single plate to 2 grids, can also be used for P.P. plates	TF4RX15YY	15,000 split	80,000 split	0	30-20,000	+12
H-21	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	80,000 split	8	100-20,000	+23
H-22	Single plate to multiple line	TF4RX13YY	15,000	50/200, 125/500	8	50-20,000	+23
H-23	P.P. plates to multiple line	TF4RX13YY	30,000 split	50/200, 125/500	8 BAL.	30-20,000	+19
H-24	Reactor	TF4RX20YY	450 Hys.-0 DC, 250 Hys.-5 Ma. DC, 6000 ohms 65 Hys.-10 Ma. DC, 1500 ohms				
H-25	Mixing or transistors to line	TF4RX17YY	500 CT	500/125 split	20	40-10,000	+30

Typical Compact Audios

RC-50 Case
1-5/8 x 1-5/8 x 2-5/16
8 oz.

Typical Subminiature Audios

SM Case
1/2 x 11/16 x 29/32
.8 oz.

Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-31	Single plate to 1 grid, 3:1	TF4RX15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF4RX13YY	10,000	200	3	300-10,000	+13
H-33	Single plate to low imp.	TF4RX13YY	30,000	50	1	300-10,000	+15
H-35	Reactor	TF4RX20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF4RX15YY	25,000 (DCR800)	1,000 (DCR110)	.5	300-10,000	+10
H-39	Transistor Interstage	TF4RX13YY	10,000 CT (DCR600)	2,000 CT	2	300-10,000	+15
H-40A	Transistor output	TF4RX17YY	500 CT (DCR26)	600 CT	10	300-10,000	+15

Type No.	HV Sec. CT	DC MA*	Military Rating Fil. Secs.	DC MA*	Industrial Rating Fil. Secs.	Case
H-80	450	120	6.3V,2A	130	6.3V,2.5A.	FA
H-81	500/550	65/55	6.3V,3A-5V,2A	75/65	6.3V,3A.-5V,2A.	HA
H-82	540-600	110/65	6.3V,4A.-5V,2A.	180/100	6.3V,4A.-5V,2A.	JB
H-84	700/750	170/110	6.3V,5A.-6.3V,1A.,5V-3A.	210/150	6.3V,6A.-6.3V,1.5A.-5V,4A.	KA
H-89	850/1050	320/280	6.3V,8A.-6.3V,4A.,5V-6A.	400/320	6.3V,8A.-6.3V,4A.-3V,6A.	OA

Typical Power Transformers

Pri: 115V 50/60 Cyc.
*Choke/Cond. inp.

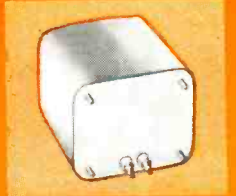
Type No.	Sec. Volts	Amps.	Test Volts	Case
H-121	2.5	10(12)	10 KV	JB
H-122	2.5	20(26)	10 KV	KB
H-125	5	10(12)	10 KV	KB
H-130	6.3 CT	.6(75)	1500	AJ

Type No.	Sec. Volts	Amps.	Test Volts	Case
H-131	6.3 CT	2(2.5)	2500	FB
H-132	6.3 CT 6.3 CT	6(7) 6(7)	2500	JA
H-133	6.3 CT	7(8)	2500	HB
H-134	6.3 CT	10(12)	2500	HA

Typical Filament Transformers

Pri: 105/115/210/220V except H-130 (115) and H-131 (115/220) 50/60 Cyc.

Typical Filter Reactors



Type No.	MIL Type	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Res. Ohms	Max. DCV Ch. Input	Test V. RMS	Case
H-71	TF1RX04FB	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	TF1RX04HB	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	TF1RX04KB	11	200	10	230	8.5	250	6.5	300	90	700	2500	KB
H-77	TF1RX04MB	10	300	9	350	8	390	6.5	435	60	2000	5500	MB
H-79	TF1RX04YY	7	800	6.5	900	6	1000	5.5	1250	20	3000	9000	7x7x8

And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION
150 Varick Street, New York 13, N. Y.
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electronics engineering issue

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 37 • SEPTEMBER 12, 1958

Issue at a Glance

Solid-State X-Ray Amplifier. X-rays excite a local area of photoconductor increasing its conductivity. Current then flows through corresponding area of phosphor causing emission of light. See p 84 ..... COVER

DIGEST CONTINUED ON NEXT PAGE

DIGEST continued

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By Y. P. Yu

Pulse Modulator Works into Variable Load. Fifty-volt, 0.25-μsec pulser permits life testing of one to fifteen microwave triodes with little change in pulse shape.....p 102
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Radiation Charts for Paraboloidal Antennas. Exponential illumination curves permit prediction of far-field secondary patterns.....p 104
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electronics

Sept. 12, 1958 Vol. 31, No. 37

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NEW!
HIGH-TEMPERATURE FABMIKA® CAPACITORS

. . . standard ratings for 260°C

. . . up to 310°C in special designs

Sprague's new FABMIKA Capacitors can really handle the HOT ones! . . . jet ignition, missile controls, atomic reactors . . . any high voltage d-c power supply where high temperature, small size, and light weight are important . . . especially where components are immersed in a dielectric fluid.

● Sprague's new FABMIKA Capacitors rely on a specially processed dielectric for their heat resistant properties. Developed through three years of research and manufacturing, this dielectric consists of silicone-bonded mica paper which can function effectively in temperatures up to 260°C and, in special designs, up to 310°C. There's a choice of four standard temperature ranges: from −55°C to +125°C, +165°C, +200°C, and +260°C.

TYPICAL INSULATION RESISTANCE	
Temp. °C	MΩ X μF
125	300 (min.)
165	100 (min.)
250	50 (min.)
260	10 (min.)

Maximum Dissipation Factor: .15% at 400 cy. 25°C.

● Radiation resistance is another outstanding characteristic of FABMIKA Capacitors. They have been application tested in reactors under high dosage rates without harmful loss of capacitance.

● Another important application is 400 cycle a-c power supplies where their low dissipation factor results in small capacitors with minimum rise in temperature under operating conditions.

● Miniature, high-reliability pulse forming networks are still another well tested application.

● FABMIKA Capacitors are available in four constructions: uncased (up to 200°C), uncased and clamped (up to 260°C), cast epoxy housing (up to 200°C), and drawn metal case (up to 260°C standard and 310°C special).

● For complete specifications, write for Engineering Bulletins to the Technical Literature Section, Sprague Electric Co., 000 Marshall St., North Adams, Mass.

SPRAGUE®
the mark of reliability

SPRAGUE COMPONENTS:

CAPACITORS ● RESISTORS ● MAGNETIC COMPONENTS ● TRANSISTORS ● INTERFERENCE FILTERS ● PULSE NETWORKS ● HIGH TEMPERATURE MAGNET WIRE ● PRINTED CIRCUITS

COOL TO THE TOUCH
Has customer appeal

TOO HOT
Uncomfortable to pick up

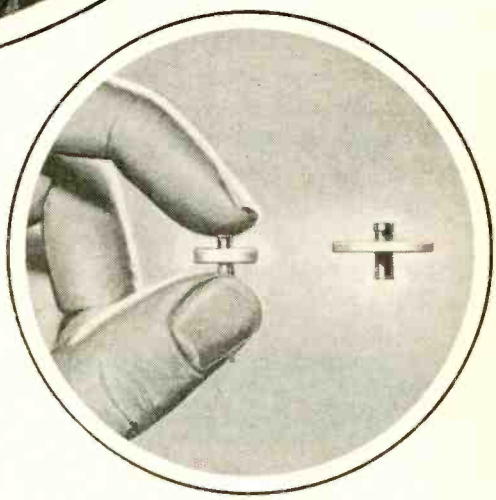
NOW... COOLER TV!

New miniature cathode for picture tubes cuts heat in half

A TV picture tube doesn't need a big, hot cathode. Superior's new miniature cathode provides just as much usable emission with only half the heat. So the TV set can run degrees cooler.

What's more, the miniature cathode needs less space. This means the electron gun can be smaller . . . the tube's neck narrower and shorter . . . the cabinet smaller and lighter.

Practical consumer benefits like these result from the superior performance characteristics of electron tubes with Superior cathodes . . . made constantly better by research. For information on Superior cathodes, write for a copy of Catalog Section 51, Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.



New miniature disc cathode. Compared side by side with standard size cathode. Superior's precision construction and fine materials insure uniformly excellent performance.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts, such as those used in the electron guns that go with this new cathode.

NEW AC REGULATOR

FAST RESPONSE—LOW DISTORTION

THE FRLD 750

This new Sorensen a-c regulator

- **cuts line transients 18 db or more in less than a cycle!**
- **holds line distortion to less than 0.35%!**
- **regulates to ±0.25% (combined line and load)!**

The new Sorensen Model FRLD-750 is ideal for powering null-testers, meter-calibrators, computer circuits and other critical equipment sensitive to power-supply-waveform distortion or line transients.

Can be used in multiples to regulate multi-phase power.

Prevents false triggering in critical pulse circuits.

Fits standard 19″ relay rack, or available in cabinet model; either can easily be converted to other by user. Finish can be supplied to match your other equipment.

Ask your authorized Sorensen representative for complete technical details or write us at the address below.

Sorensen

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN & COMPANY, INC.
Richards Avenue, South Norwalk, Connecticut

In Europe contact Sorensen-Ardag Eichstrasse 29 Zurich, Switzerland, for all products including 50 cycle 220 volt equipment

RAYTHEON

industrial cathode ray tubes

available in commercial and military types, many having MIL approval

or custom built to your exact requirements

Raytheon Cathode Ray Tubes meet the highest standards of quality and performance. They must pass the most extreme and rigid quality control tests known to the industry.

Design features available for your specific needs include:

- round or rectangular faces
- optical glass faces
- standard or narrow necks
- metal shells
- single or multi-guns
- high resolution guns
- screen persistences for visual or photographic use
- transparent screens
- high altitude anti-corona connectors

Representative applications and some of the Raytheon types include:

- radar indicators (5AHP7A, 7ABP7A, 10UP14A, 12ABP7A, 16ADP7)
- monitors (10SP4)
- oscilloscopes (3UP1, 5ADP7)
- flying spot scanners (5AKP24, 5AUP24, 5BNP16, 5WP15, 5ZP16)
- industrial and military television (17AVP7, 21FP7A)

RAYTHEON®

INDUSTRIAL TUBE DIVISION

Reliable Miniature and Subminiature Tubes • Filamentary Tubes
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CIRCLE 4 READERS SERVICE CARD

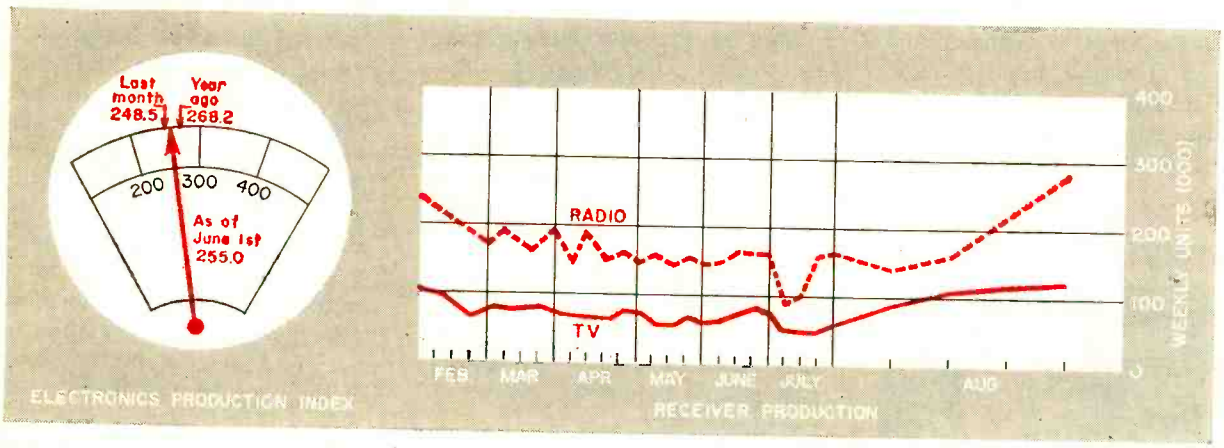
ELECTRONICS NEWSLETTER

NEW CLASS OF CERAMIC-TYPE THERMOELECTRIC materials that can convert the heat of a burning fuel, or other high-temperature source of heat, directly into electricity, is reported by Westinghouse Research Laboratories. The new materials are nonconductors of electricity. Says Westinghouse research director Clarence Zener: "As far as we know, our ceramic-type materials are the first solid-state thermoelectric substances to operate with what we consider are promising efficiencies at temperatures of 2,000 to 3,000 degrees Fahrenheit."

IGY SCIENTISTS of the U. S. and the Soviet Union appear to be neck-and-neck in the race to gather data on solar radiation. Despite the one-and-a-half ton weight of Sputnik III, launched May 15, the important instrumentation it contains for the measurement of the ejection of elementary particles from the sun seems to be similar in nature to the package aboard 38-pound Explorer IV, launched July 26 (ELECTRONICS p 7, Aug. 29). Newly translated description of Soviet instrumentation reports a fluorescent indicator which glows under the influence of cosmic particles; light emission is recorded by photoelectric cells and signals can be amplified, stored and telemetered.

TWO ELECTRONIC DEVICES FOR CARS were announced last week by the Chrysler Corp. and will be offered on all of its 1959 models. First is an electronically-actuated self-dimming inside rear view mirror which "flips" to divert glare from the driver's eyes when bright oncoming light strikes a photoelectric cell. Second is an automatic headlight-dimming device about half the size of a cigar which reacts to headlights of an approaching car, or the tail lights of a car in front, by controlling high and low-beam headlights.

JOINT USE OF CIVIL AND MILITARY RADAR in air traffic control will be undertaken this fall by the Civil Aeronautics Administration and the USAF Air Defense Command. So far there are plans to use jointly 31 new high-power, long-range radars, with additional joint use facilities expected to come later. CAA says the program will avoid "serious radar interference problems," improves coordination in the missions of the two agencies, and will save millions of dollars in equipment, installation and maintenance. New microwave links and air traffic control radar displays will provide civil traffic control centers with radar data from Air Force facilities and vice versa.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Aug. 22, '58	Aug. 15, '58	Aug. 23, '57
Television sets, total	130,556	124,527	205,881
Radio sets, total	286,656	227,114	292,626
Auto sets	80,971	45,565	79,962

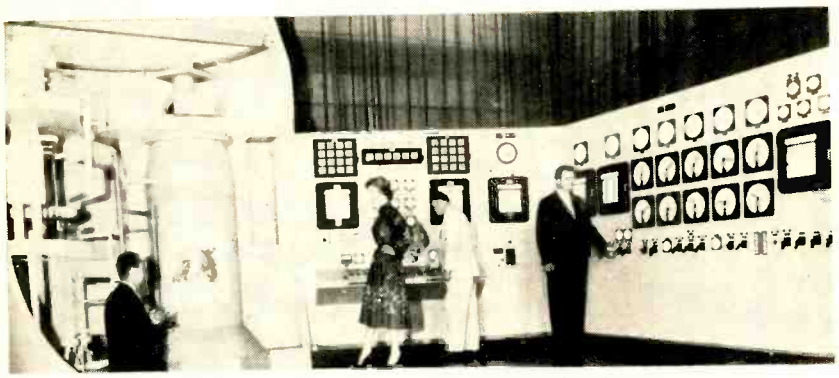
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Aug. 27, '58	Aug. 20, '58	Aug. 28, '57
Radio-tv & electronics	53.29	51.25	46.09
Radio broadcasters	67.44	66.73	57.87

FIGURES OF THE YEAR

Totals for first six months

	1958	1957	Percent Change
Receiving tube sales	190,406,000	221,175,000	—13.9
Transistor production	18,452,324	11,199,000	+64.5
Cathode-ray tube sales	3,689,587	4,814,659	—23.4
Television set production	2,167,930	2,722,139	—20.4
Radio set production	4,961,293	7,187,294	—31.0
TV set sales	2,177,652	2,810,403	—22.5
Radio set sales (excl. auto)	2,964,338	3,638,969	—18.5



Full control panel of a power reactor went to Geneva for the. . . .

Biggest Atomic Conference

UN's peaceful atom session told r-f fields produce more stable plasmas for fusion

FOR THE PAST two weeks, an estimated 1,800 scientists and engineers have been attending the biggest confab to date on atomic research, application and instrumentation: the second United Nations International Conference on the Peaceful Uses of Atomic Energy in Geneva.

Progress, through electronics, was the theme running through a number of the 2,300 papers presented at the conference. Cited were improved reactor design and control techniques made possible by computers, advances in high-energy physics due to new particle accelerators, increasing use of radioisotope tracers in medicine and industry. The last trend gives a boost to radiation detection and measuring equipment.

The United States bore down heavily on thermonuclear fusion research, in which electronics has a key role. About half of the 40,000-sq-ft U.S. exhibit was used to show nine of the experimental fusion machines operating at AEC laboratories. Nearly 100 conference papers dealt with fusion. The U.S. declassified all its fusion reactor work in time for the conference.

A report from Argonne National Laboratory indicates that plasmas (the basic fusion fuel) created and confined by radio-frequency fields are more stable than those produced by the direct-current magnetic pinch methods. Frequencies above 5 mc are used.

One of the phenomena being investigated is the formation in the plasmas of symmetrically shaped luminous bodies. The regular shape of the bodies may provide some much-needed answers to fusion control.

Another report described electronically controlled robot manipulators for hot-lab work. The robot, shown at the exhibit, has stereoscopic television for remote viewing and requires a half-ton of electronic gear.

Among new safety devices shown was an improved version of the Los Alamos walk-in whole-body radiation counter. Six 16-in. new multiplier phototubes and transistor circuits permit a reduction in cost and power consumption.

Four operating research and training reactors were shown with their instrumentation: Argonne's Argonaut and General Dynamics' TRIGA in the U.S. government exhibit, Atomics International and Aerojet-General low power models in the commercial pavilion.

Also shown by the U.S. and other countries were numerous reactor models and a reactor demonstrator, built by Leeds & Northrup. The demonstrator had the full control panel of a power-producing reactor, with a computer substituting for the reactor core.

The commercial pavilion contained 327 exhibits staged by firms and organizations from 13 countries. Of the 52 United States exhibitors, 13 were electronics firms showing such varied products as scintillation counters, reactor control systems, reactor simulators, millimicrosecond instrumentation and accelerators.

After the conference packs up today, many of the instrumentation specialists attending are expected to move on to Paris. The first International Symposium on Nuclear Electronics will be sponsored there next week by France's Society of Radioelectricians.

Growing Gems

Strain-free sapphires are formed in high-pressure reactor from aqueous solution of aluminum oxide at Bell Labs. Sapphires are used in infrared systems. Same method yields rubies for masers

Standards Set For Color Tv

BRIGHTNESS STANDARDS for color tv tubes are now available from the National Bureau of Standards.

Each set consists of three standards—red, green and blue, and a calibrated 500-w projection lamp. The glass standards closely match the three tube phosphors which act together to produce various colors in the image.

The standards are used to calibrate instruments for measuring color and brightness of tv tube output. To match the spectral energies of the phosphors as closely as possible, a light blue-green glass and a dark blue glass are combined as filters for the blue standard. A sextant green glass is used for the green standard, and a traffic-red glass combined with a blue-green glass for the red standard.

Each of these is fitted with an opal glass that diffuses light from the calibrated 500-w lamp.

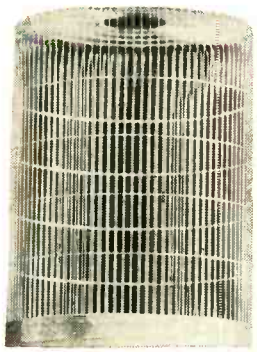
(Continued on p 12)

CHEMICAL DIVISION

FOR INDICATION OF O_2 OR H_2

MINOXO® INDICATOR . . . measures traces of molecular oxygen in other gases—from 1 to 10 parts per million, and from 1 to 100 PPM. High sensitivity and rapid speed of response enable it to be used for laboratory investigation and production quality control. SUPER-SENSITIVE DEOXO® INDICATOR . . . measures oxygen or hydrogen present as impurities in other gases—from 2 to 200 parts per million oxygen and 4 to 400 parts per million hydrogen. Dual range permits measurement up to .25% oxygen or .50% hydrogen.
Chemical Division, 113 Astor Street, Newark 2, N. J.

CIRCLE 100 READERS SERVICE CARD



BAKER PLATINUM DIVISION

FOR VACUUM TUBE GRIDS

PLATINUM CLAD TUNGSTEN WIRE . . . Because of its superior physical properties at elevated temperatures, tungsten provides the more rigid, refractory core material required by high power tubes; it also exhibits lower interaction with platinum. Platinum clad tungsten is readily hot stretched to take a permanent setting and lends itself to fabrication into grids employing conventional fixtures and spot welding procedures. Available in diameters from .001" and up.
Baker Platinum Division, 113 Astor Street, Newark, N. J.

CIRCLE 101 READERS SERVICE CARD

CHEMICAL DIVISION

24K GOLD IMMERSION SOLUTION

ATOMEX® . . . For depositing a thin layer of 24 Karat Gold by means of a simple bath. Such items as clock assemblies and metallized plastics receive a dense, uniform deposit of gold. Printed circuits protected in this manner retain their solderability for 12 to 18 months under ordinary storage conditions. More permanent than electroplating of comparable thickness, yet much simpler and cheaper. Expensive analytical control is unnecessary.
Chemical Division, 113 Astor Street, Newark 2, N. J.

CIRCLE 102 READERS SERVICE CARD

ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET
NEWARK 2, NEW JERSEY

Do You Have Critical Filter Problems?

SANGAMO MAY HAVE THE ANSWER TO YOUR PROBLEM

Sangamo Electric Company has been designing and building specialty filters since 1927. These filters have been used in a wide variety of metering, telephone and military equipment produced by Sangamo, and by a limited group of electrical and electronic manufacturers. Sangamo's thirty years of filter design and manufacturing experience is now available to the industry.

Here's a Typical Example: The filter illustrated was required for use in a circuit which was designed to amplify extremely small signals in the range of 25 KC to 26 KC.

BASIC OPERATIONAL AND DESIGN SPECIFICATIONS:

Meet applicable requirements for military apparatus.

Operate in a plate circuit of an amplifier presenting an effective generator impedance of 47,000 ohms and to drive the grid circuit of the following amplifier stage.

Operate at signal level as low as 10 microvolts.

Must be well shielded against external fields.

Passband ripple not to exceed 1 db. from 25 KC to 26 KC.

Minimum rejection shall be 35 db. at 28 KC and 40 db. at 23 KC.

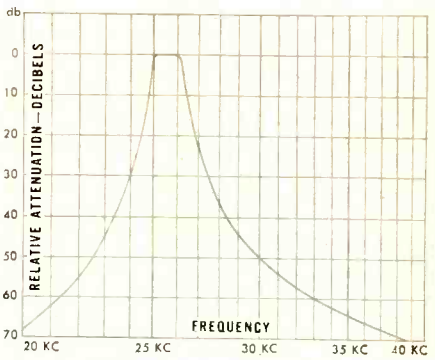
The phase shift, from one production filter to another, shall not vary more than 5° at any point in the 25 KC to 26 KC bandpass.

The phase shift and attenuation characteristics must be reproducible over a long period of years to insure properly functioning spare parts.

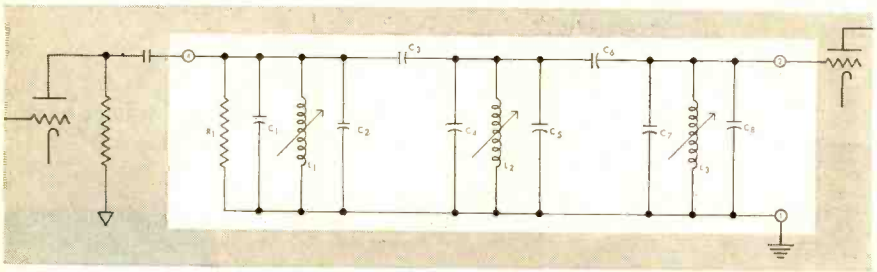
Temperature range 0° to 85°C.

SANGAMO SOLUTION TO PROBLEM

The above requirements were met by using three parallel tuned circuits properly coupled by capacitors. Selection of the L-C ratios, coupling, and circuit Qs were made in order to fulfill the overall response requirements and at the same time present the proper load to the driving amplifier stage. Stability requirements were obtained by using Sangamo silvered mica capacitors. Negative temperature coefficient capacitors were inserted in parallel with the tuned circuits to correct for the positive temperature coefficient of the inductors. A phase shift variation of 2.5° maximum from 25 KC to 26 KC has been consistently maintained during eight years of production on these units. The universal wound coils are enclosed in powdered iron cups with moveable slugs for precise adjustment of the response and the phase shift. These inductors manufactured by Sangamo have uniform distributed capacity and Q. The cup-enclosed inductance coils are in turn housed in a die-cast aluminum enclosure. This housing lends physical rigidity to the coupled structure and assists in minimizing magnetic interaction between the enclosed inductors. The entire filter assembly is enclosed in a hermetically sealed drawn steel case. The terminals are of the extremely rugged compression glass type.



Relative response curve of this Sangamo bandpass filter.

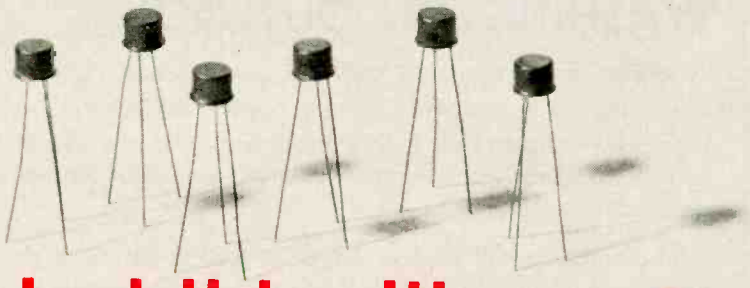


C_1, C_4, C_7—Temperature Compensators
C_2, C_3, C_5, C_6, C_8—Sangamo Silvered Mica Capacitors

Write us today for an engineering analysis of your specialized filter applications. Sangamo's engineers are ready to help you.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

SC58-5



Fairchild silicon transistors

Milli-micro-second switching speeds and high current too

Where applications require transistor performance beyond previously accepted high limits, Fairchild Silicon Transistors offer an exceptional three-way combination:

1) 50 milli-micro-second typical rise time — permits faster switching rates in computing devices. Total switching time is typically 0.2 microseconds.

2) 1 watt dissipation at 100° C. — Saturation resistance is 10 ohms maximum. Resulting high-current capability provides opportunities to increase equipment performance while reducing circuit complexity.

3) Silicon temperature performance — Maximum junction temperature of 175° C. gives low leakage and more safety factor at any lower temperature.

These characteristics are the outcome of the solid-state diffusion technique used at Fairchild. Other important accomplishments of this process are excellent reliability and a high order of electrical uniformity throughout large production runs.

The accomplishment of a research-production team
Singleness of purpose did it. Fairchild assembled a uniquely experienced team of research scientists and production engineers whose objective was to bring the advanced solid-state diffusion process under close control. They succeeded in putting laboratory-quality silicon transistors into quantity manufacture with firm product specifications exceeding anything previously offered.

2N696 and 2N697 SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation Case temp. 25° C. Case temp. 100° C.	 2 watts 1 watt		
h_{FE}	D.C. current gain		2N696 — 15 to 30 2N697 — 30 min.	I_C = 150ma V_C = 10v
R_{CS}	Collector saturation resistance		6Ω typical, 10Ω max.	I_C = 150ma I_B = 15ma

For full information and specifications, write Dept. A-9

FAIRCHILD
SEMICONDUCTOR CORPORATION

844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA

The unretouched scope face below shows the time comparison of input (positive) and output (negative) pulses in a non-saturating mode. Time base is 20mμsec. per large division on the scope face. Maximum collector current is 50 ma.

The standards can be used for calibrating photoelectric or visual photometers. After calibration, the photometers may be used to measure the luminance of color tv tubes.

A detailed report of the design and calibration of the kit is included with the standard set which sells for $250. Also included are instructions for calibrating photometers.

Portable Color Tv Uses Transistors

TRANSISTORIZED portable color tv system was demonstrated by Radio Corporation of America this week.

Power drain of the 65-pound combination is low enough to allow it to be operated from automobile-type batteries.

Developed primarily for closed-circuit operation, the system contains about 300 transistors. Unit shown above is picking up a microscope specimen and displaying it on a monitor and a standard color-tv receiver.

Electronics Aids Vision Studies

ELECTRONICS is helping to solve the mystery of how humans and certain animals are able to see color, say reports this week from University of Michigan.

Researchers have succeeded in "wiretapping" individual cells in the brain and testing their reaction to various colors.

A U-M team uses a delicate micro-electrode 1/25,000th of an inch in diameter. Made of tungsten, the probe is positioned with the aid of a microscope while the subject is anesthetized.

Once the electrode is in place, a

WASHINGTON OUTLOOK

WASHINGTON'S attitude on defense spending has taken a sharp turn which may slow down military electronic procurement. From a relatively easy post-sputnik policy on expenditures—in which a $2-billion boost in outlays had been planned—the pendulum has swung back to pre-sputnik economizing.

The outcome will be new delays in getting advanced projects under way, some reluctance to push R&D projects into production and faster decisions to wash out competing projects.

Behind this latest turnabout in Washington is the administration's new determination to trim Federal spending, reduce the growing budget deficit and thus pull reins on the runaway inflationary trend.

The Pentagon, which accounts for over half the total Federal budget, stands out as a crucial area in the administration's new campaign. However, the Defense Dept. is beset by a series of pressures pushing spending up and up.

First pressure is the need to improve U.S. defense preparedness in the face of growing Soviet military might. Thus, the administration has stepped up missile, electronic and other key projects. Congress has added $816 million to this year's defense budget for more military hardware production and for higher manpower levels.

The second pressure for increased defense spending stems from the inflationary trend against which the administration has now decided to fight back. Unit costs for all the expensive new military hardware are ballooning. And in many cases, costs for the bigger development projects are greatly exceeding initial estimates.

Finally, the recent crisis in Lebanon and the one shaping up in Formosa are combining to push military operating and maintenance expenses well over the original budget.

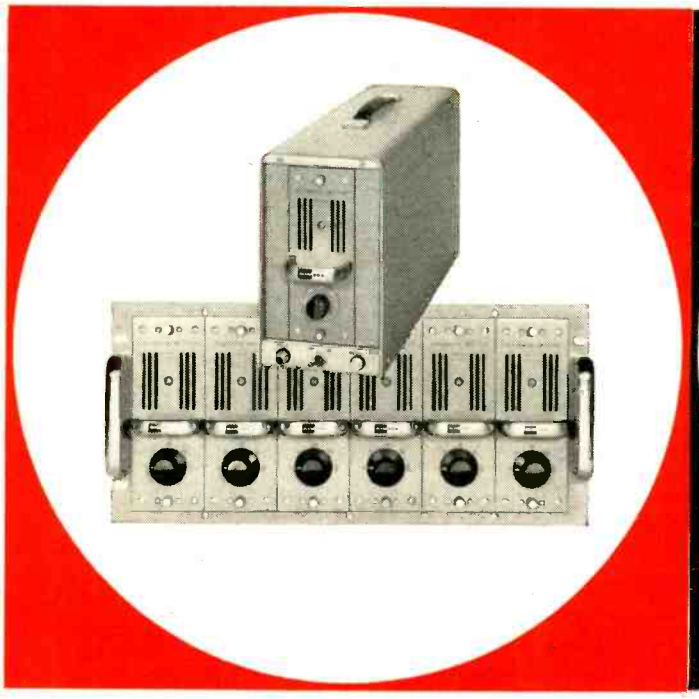
- **Against this background,** the Pentagon's new budget plans are shaping up. Few officials in Washington believe the rate of defense expenditures can be reduced in the face of these three basic pressures. Instead, the Pentagon's orders are to hold spending to a reasonable rate of increase and to contain the level of defense outlays.

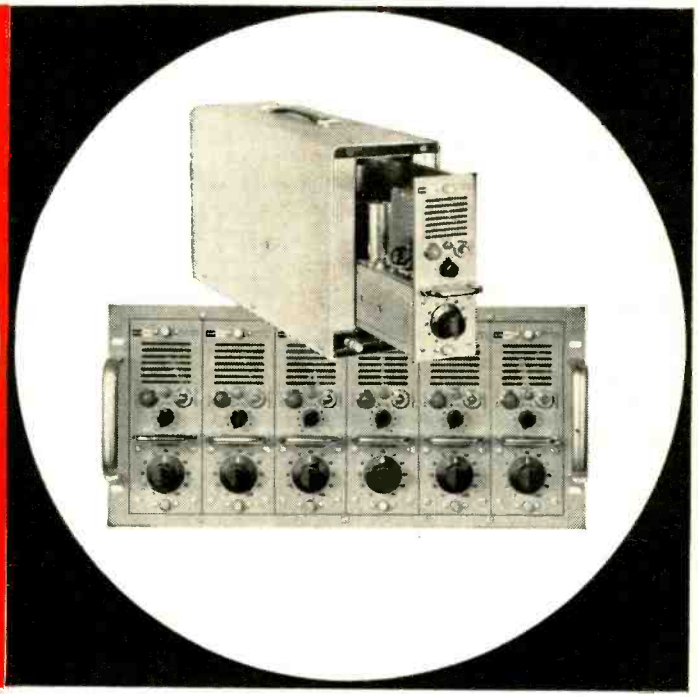
  The best guess is that the Pentagon will be unable to reduce significantly the $2-billion spending rise this year. Administration planners would like to trim the level of military manpower, both active and reserve. Congress, however, opposes reduction in force, wants the size of the Army and Marine Corps boosted.

  As of now, there's no intent to cut back existing weapon production and development projects. But the outlook for many projects—including some in electronics—for the future is dim. The fiscal 1960 budget is likely to omit many items for which additional financing is needed.

  Fiscal 1960 spending will most probably be fixed at about $42 billion, up $1 billion from the current level. But to hold the expenditure rise to this sum will involve deep cuts in the advanced plans of Pentagon strategists.

AMPLIFY MICROVOLTS WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier





NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 120 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19″ rack adapter modules. Price: 114A – $775; six amplifier module – $200; single amplifier cabinet – $125.

WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$575; six amplifier module–$200; single amplifier cabinet – $125.

5725 Kearny Villa Road, San Diego 11, California

KIN TEL
A Division of Cohu Electronics Inc.

beam of colored light is flashed in the subject's eyes. Cell response is detected in the form of an electrical impulse which is amplified by high fidelity equipment.

The researchers have found that there are four classes of cells which produce impulses only under stimulus of specific colors; red, green, yellow or blue. They have also discovered one class of cells that reacts only in the absence of light.

The electronic studies are expected to yield valuable information on the causes of color-blindness. Science to date has no definite answers on this subject.

Test animals are South American monkeys whose brain structure resembles the human. Previous tests on cats show them to be totally color-blind.

Sorting Unit Set For British P. O.

BRITISH Post Office's first electronic letter-sorting machine has been completed by Thrissell Engineering Co. of Bristol. The General Post Office has ordered 20 machines, each costing $42,000.

Machine was developed in collaboration with Electronic Instruments Ltd. of Richmond, Surrey, England.

Each sorter can handle 6,000 letters an hour, placing them in 144 compartments. But since addresses cannot be read at this speed, the operator, sitting at one end of the 17-ft machine, will handle approximately 3,000 letters an hour.

Letters appear individually at a window in front of the operator who presses a combination of buttons, coded to each place-name. The machine then dispatches the letter speedily to the correct compartment.

The selecting mechanism consists of memory units which mechanically trigger diverter blades. These route the letters to the correct row of boxes and then to their destined box.

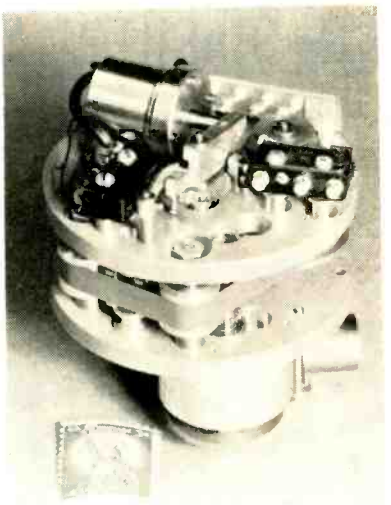
Equipment is basically an electronic switch control. It has 273 tubes, mainly of the cold-cathode type.

MILITARY ELECTRONICS

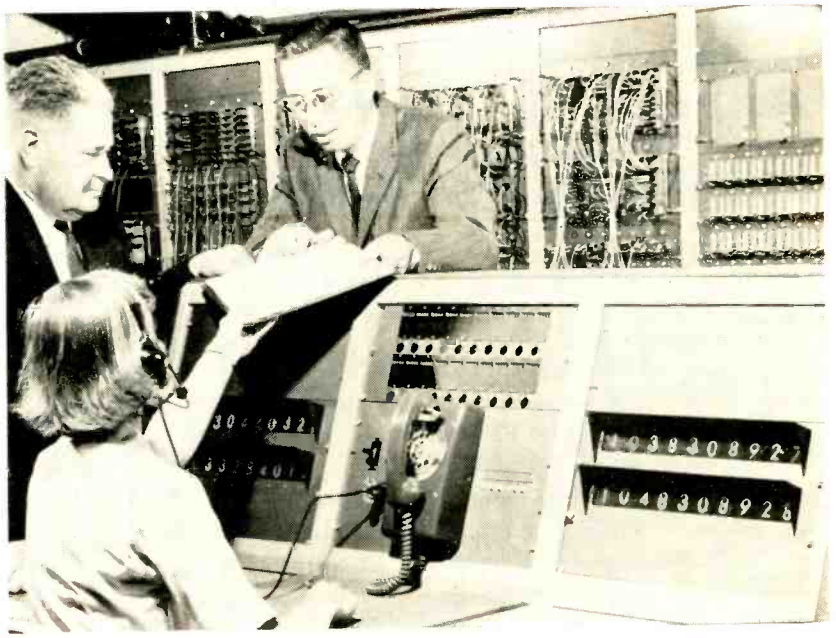
• **An Inertialess** Scanning Tracking and Ranging radar system—probably to be named INSTAR—is being developed as a technique for tracking shells for Army Signal Corps by W. L. Maxson. Philco is making a moving target indicator video processor for measuring Doppler frequencies. A Maxson computer will provide information to be fed into a trajectory computer for calculating trajectory data—origin and impact point. Components of Maxson's FASTAR technique (ELECTRONICS, p 12, Jan. 31) will be used.

• **Preliminary design** of a "No-Gimbal Pure Integration Inertial Guidance System" for aircraft, missiles and space vehicles is underway at Ford Instrument under a Wright Air Development Center contract.

• **Explorer III's** tape recorder (photo) answered some 500 of the approximately 600 ground-based radio interrogations during the 49 days before the high-power transmitter became too weak to transmit.



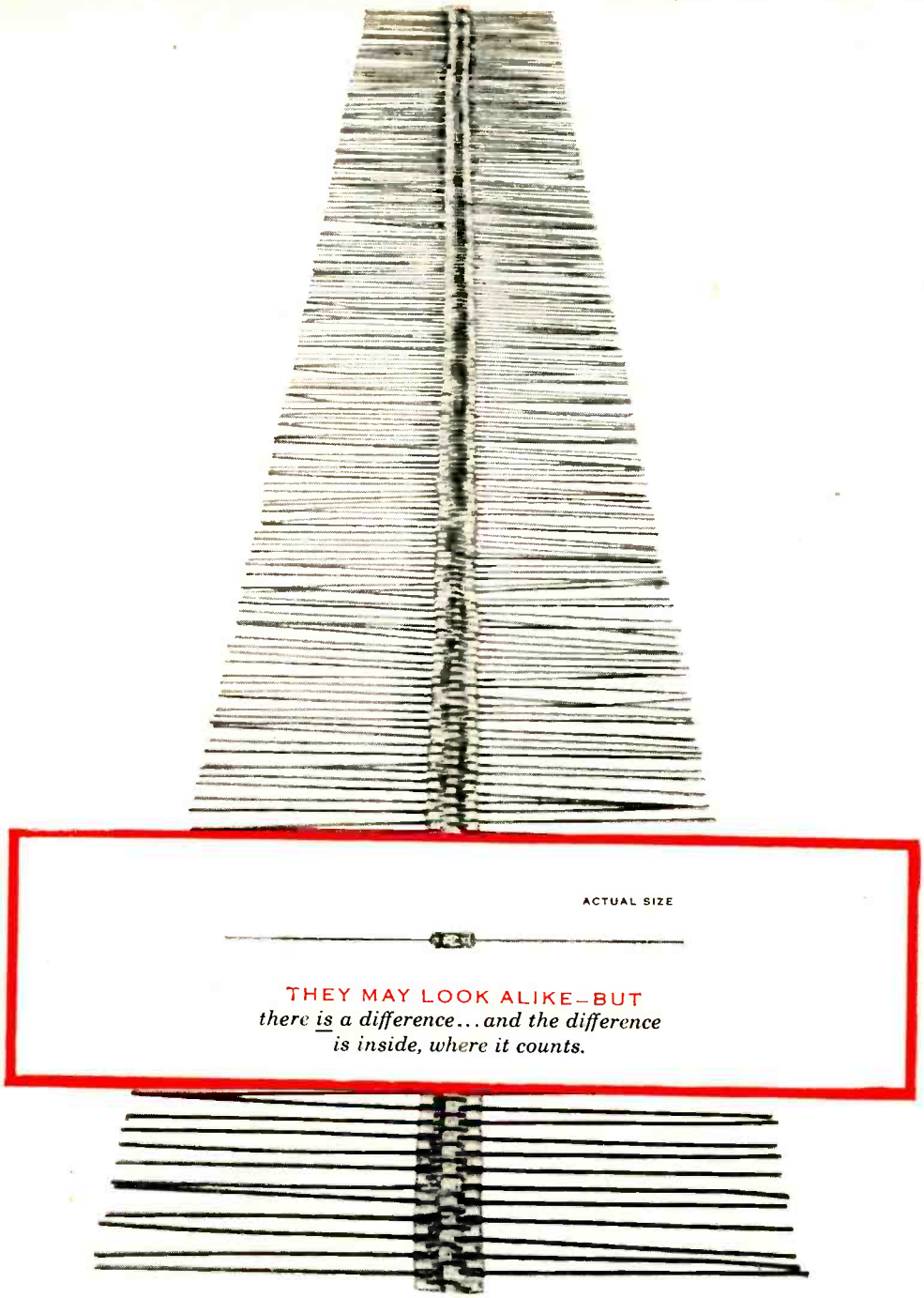
Spilling in five seconds—when it got within range of a receiving station—two hours, or 30,000 miles, of accumulated data, the recorder gave out at least ½ billion counts of cosmic and other radiation. Designed by George H. Ludwig, State University of Iowa graduate student, the eight-ounce, 2½-in. wide, recorder was built piece by piece in the university lab (ELECTRONICS, p 35, March 21).



New Lab Tests Systems

A SPECIAL INSTALLATION—which tests devices and systems without the need for building expensive one-shot equipment—went into high gear this week.

The test facility at Bell Tele-



All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied* and tiny (maximum dimensions: 0.265 by 0.107 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as... high back resistance...quick recovery... high conductance...or high temperature operation, *specify Hughes.* You will get a diode with mechanical and electrical stability built in. You will get a diode which was manufactured first of all for reliability.

*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.

For descriptive literature please write: HUGHES PRODUCTS, SEMICONDUCTOR DIVISION
International Airport Station, Los Angeles 45, California

HUGHES
SEMICONDUCTORS

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

phone Laboratories consists of a main computer that can be programmed to simulate the functions of the new device or system; readout gear for data collection; and an operations console (photo p 14).

Designed to determine customer reaction to new facilities, a test situation will work along these lines: A new telephone using pushbuttons instead of dials is to be tested. A shell incorporating the new design is placed over conventional equipment. Connections are made with the special test center, and users of the "new" equipment operate it as if it were the real thing.

During the tryout period, data on operational response is collected and studied. If results are favorable the new development will be put into effect.

Officials expect that the new test center, called Sibyl after the ancient wise-women, will eventually provide a better understanding of relationships between machines and the people who use them. Sibyl will collect a fund of information that will carry over to other projects and, firm says, reduce the need for extensive experimental work on new systems.

New Institute Attracts Firms

ARKANSAS is using a new Graduate Institute of Technology to lure electronics firms and other new industry. The institute, part of the University of Arkansas, is already in operation in Little Rock as an off-campus graduate training center.

It was authorized only last year by the state legislature after industrialists and educators argued that the Southwest had to provide top graduate training facilities if the area was to attract new technical industries and retain its young scientists.

Classes began in March in courses such as "The Structure of Matter" and "Instrumentation." This month, permanent air-conditioned buildings and laboratories to handle full courses of study are scheduled to be completed.

FINANCIAL ROUNDUP

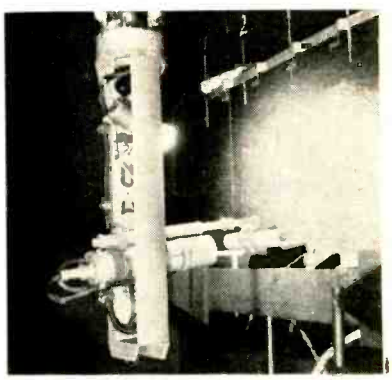
• **Baird-Atomic**, Cambridge, Mass., acquires 40 percent interest in **Ealing Corp.** of Natick, Mass., importer and distributor of scientific instruments. Purpose of the acquisition by the nuclear instrument firm is to provide a marketing outlet for scientific instruments used in teaching.

• **Acme Precision**, Dayton, Ohio, plans to purchase in near future **Cal-Tronics, Inc.**, Los Angeles electronics company. Cal-Tronics makes test equipment and components used in the missile field. Acme makes precision tools and products for the aircraft industry. Transaction will be for cash, but amount was not given.

• **New York Life Insurance** makes the first payment of $1.679 million for purchase of up to $4.3 million of mortgage bonds of **Texiacal, Inc.**, a real estate subsidiary of **Collins Radio Co.** Money is to be used for plant expansion, including a new manufacturing building in Cedar Rapids and an engineering laboratory in Dallas.

• **Pacific Automation Products**, Glendale, Calif., plans public offering of 125,000 shares of common stock through underwriting group headed by William R. Staats & Co. of Los Angeles, Calif. Glendale firm manufactures custom electronic cabling, also designs, produces and installs complete cabling systems for missile launching and testing sites. Amount of new money which company will receive is not known as price of stock has not yet been set. But $274,500 of proceeds will be used to retire short-term bank loans. Also, company may lend up to $200,000 to partially finance operations of its new subsidiary, **Space Electronics Corp.**

• **Ramo-Wooldridge Corp.** will give corporate status to its **Space Technology Laboratories.** Previously a division of R-W, the laboratories will become a separate corporation. STL has a large concentration of scientists and engineers whose efforts are devoted exclusively to ballistic missle and space problems. It has overall scientific responsibility for the Air Force's Thor, Atlas, Titan, and Minuteman missile programs. Gen. J. H. Doolittle will become board chairman on first of the year when separate incorporation process is expected to be completed.



Derrick heads controls show how tv (left) guides mechanical hand in grabbing radioactive cartridges as . . .

Tv Searches Inside Reactor

BRITISH Atomic Energy Authority scientists have recently designed a mechanical hand that uses a television eye in removing spent radioactive cartridges from the inside of atomic piles of the type used at Windscale.

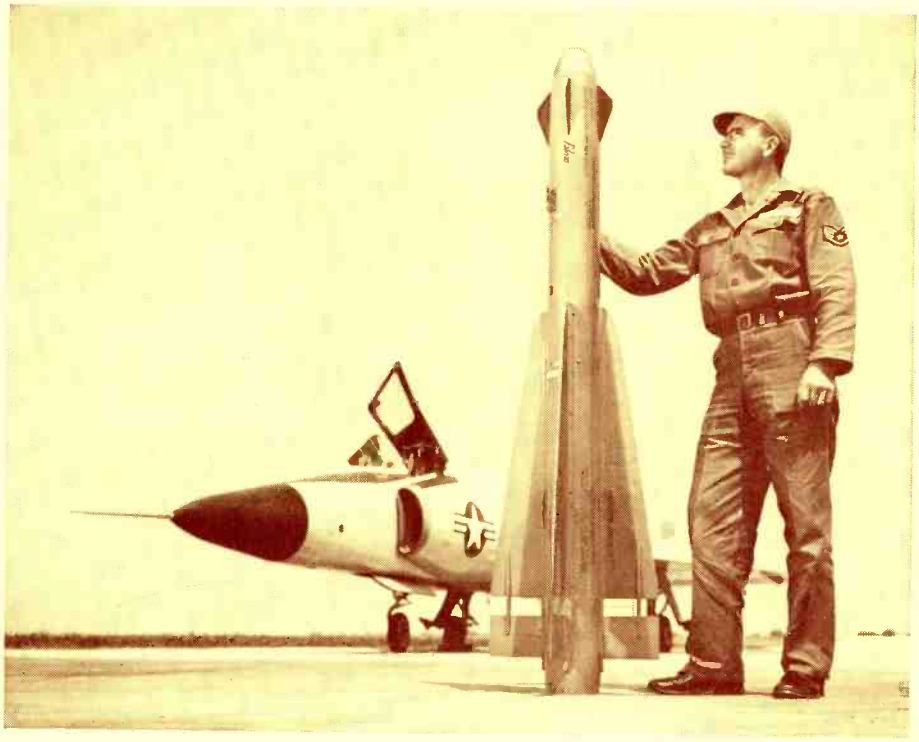
In this type of reactor, uranium

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

Deadly Hughes GAR-2A Falcon Missile Employs Six G-E 5-Star Subminiatures in Vital Control Sockets!



General Electric 5-Star high-reliability subminiature tubes help give dependable striking power to Hughes Aircraft Company's GAR-2A air-to-air missile, which seeks out its target by means of infra-red guidance.

Six 5-Star subminiatures are employed: Types 5899, 5902, 6021, 6111, 6112, and 6205. The Hughes Type GAR-2A missile complements the GAR-1D Falcon, which relies on radar guidance. Eight 5-Star subminiatures are used in the GAR-1D.

Tubes and other electronic components in Falcon missiles are compactly mounted on plug-in etched circuit boards. Miniaturization has been carried to a point roughly equivalent to compressing two television sets into a space no larger than a football.

Cold, Heat, Acceleration, Vibration—All Are Environmental Hazards

The tiny 5-Star Tubes that guide Falcons to their explosive destinations, must withstand the extreme cold of high altitudes, the heat of skin friction, the acceleration and vibration of launching and flight.

Dependable service under these conditions calls for special rugged qualities which General Electric has designed into all 5-Star subminiatures. These tubes, moreover, are built with extra care in a lint-free, dust-free factory, and undergo 100% tests that accurately reflect airborne and missile operating requirements.

On the next page will be found suggestions on how to conserve tube life and obtain top performance, when applying high-reliability tubes in compact circuits where temperatures may run high, as with missiles.

7077 UHF Triode Tests Prove Tube's Versatility, Show Low Noise Figure at 30–60 MC

Recent tests have confirmed that General Electric's new 7077 ceramic UHF-amplifier triode has an extremely low noise figure in the 30–60 megacycle region, and is well suited to IF-amplifier applications.

For receivers operating at microwave frequencies, 30–60 megacycles is an area of prime importance in the IF-amplifier circuit. Minimum noise here is essential, if the full potentialities of a low-noise microwave crystal mixer are to be realized.

Low shot-noise resistance and negligible transit-time loading help make Type 7077 an ideal choice for the cascode input stage of an IF-amplifier circuit. Besides the tube's electrical advantages, its physical features—small size, ruggedness, and high heat resistance—add to the 7077's value in military applications.

Complete data on IF-amplifier tests of the 7077 at varying band widths, may be obtained from any G-E office listed on the next page. Also, ask for information about sockets for the tube, already developed and available, and for noise, gain, and other performance characteristics at frequencies from 30 to 1000 megacycles.

Tear off and keep this sheet for reference. It contains useful tube-application data.

FOR MAXIMUM TUBE LIFE, AVOID HIGHER-THAN-RATED TEMPERATURES!

Promote Dependable Performance by Keeping Bulb Temperatures And Dissipation Levels within Published Tube Limits!

Sharp penalties in shortened life can result from tube operation which is in excess of rated limits for bulb temperature and dissipation. See life-test curves at right for evidence that high temperatures and high dissipation levels cut the number of operative tubes—the percentages dropping rapidly as heat and dissipation go up.

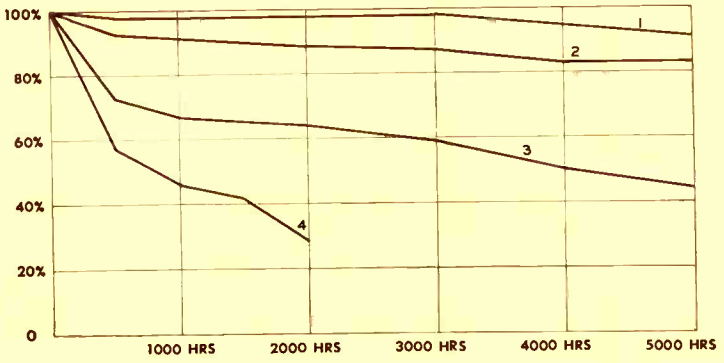
Excessive temperatures in tubes can cause reverse grid currents, loss of emission, shorted elements, glass-envelope failures, and other faults.

Ambient Heat Level, Internal Element Dissipation, Both Influence Tube Temperature

How hot a tube will run, is a joint result of the ambient temperature and the dissipation of the internal elements of the tube. Designers can reduce bulb temperatures mechanically, by using improved tube shields which permit the heat to flow by conduction to a heat sink—have good radiation efficiency—and allow free air circulation.

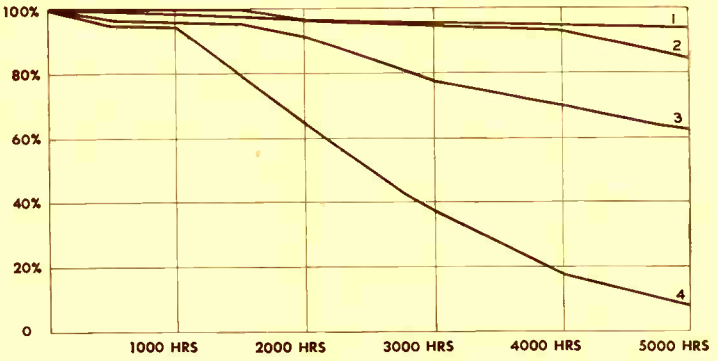
Normally, however, tube shields do not significantly lower the temperature of the internal tube elements. Here the circuit designer's control must be electrical—i.e., he should strive to avoid dissipation levels in excess of rated limits.

Observing these limits will increase tube reliability and greatly extend the span of tube life. More specific and detailed facts about tube operating temperatures can be obtained from any General Electric office at the bottom of this page.



TYPE 5654 HIGH-RELIABILITY MINIATURE

Life test results at varying temperatures. (Vertical scale shows percentage operative* tubes remaining. Horizontal scale, time.) Ambient temp for Curve 1 was 100 C, bulb temp was 125 C . . . Curve 2, 175 C and 192 C . . . Curve 3, 250 C and 263 C . . . Curve 4, 300 C and 312 C. Plate dissipation was maintained at 1.5 watts. The max rated bulb temperature of Type 5654 is 165 C.



TYPE 6005 HIGH-RELIABILITY MINIATURE

Life test results at varying dissipation levels. (Vertical scale shows percentage operative* tubes remaining. Horizontal scale, time.) Dissipation level, P_p+P_c2, for Curve 1 was 10.0 w. . . . Curve 2, 13.5 w. . . . Curve 3, 15.4 w. . . . Curve 4, 20.0 w. Bulb temperature was allowed to increase with dissipation. The max rated dissipation of Type 6005 is 13.2 w.

**By "operative tubes remaining" is meant tubes without any short, open, air leak, or heater-cathode leakage in excess of 100 microamperes.*

Tubes for the above tests were taken in lots of 200 or more from the production of all manufacturers with qualification approval. Accordingly, results are a composite for the industry.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

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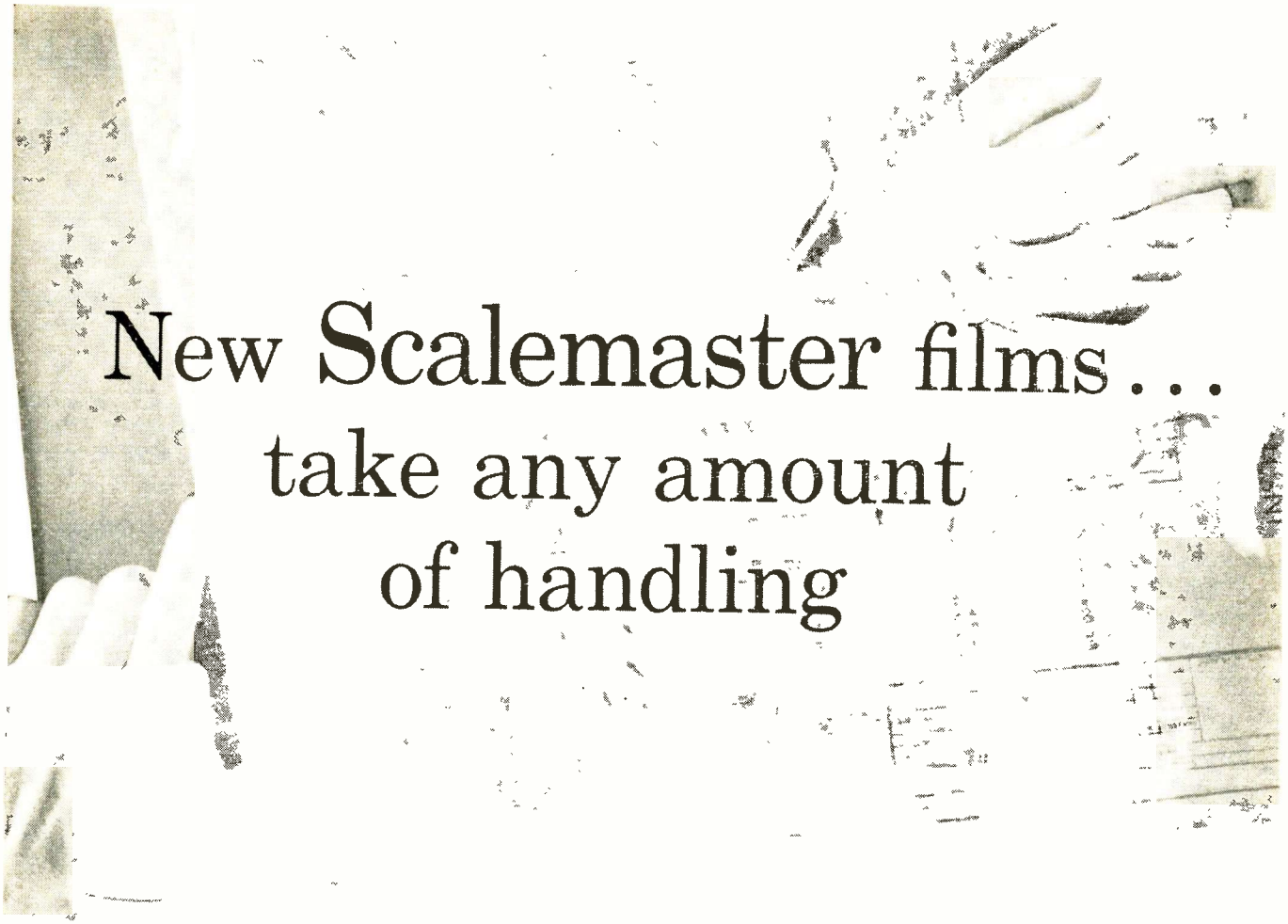


New Scalemaster films . . . take any amount of handling

Yours today! The engineering standard of tomorrow

You've never worked with films like these before! Scalemaster films are Mylar* with a very high degree of *extra stabilization* added through an exclusive Ozalid process. These extremely durable, dimensionally stable films safeguard your investment in valuable originals. They're practically impossible to tear—won't fray, crack, "dog-ear," or become brittle, and can be filed indefinitely without deterioration. And fast! Scalemaster films are extremely transparent for the fastest copies possible . . . and with maximum contrast. Your draftsmen can draw and dimension precisely in one operation . . . with accuracy never before attainable. In fact, in many fields, Scalemaster films can often help eliminate entire reproduction steps.

But why not see for yourself? Send for sample sheets of Scalemaster films today and test the performance advantages they give you. Write: Ozalid, Dept. L-9-12, Johnson City, N. Y.

*Du Pont's registered trademark

OZALID®

Products for Design

A Division of General Aniline & Film Corporation
In Canada: Hughes Owens Company, Ltd., Montreal

←CIRCLE 11 READERS SERVICE CARD

CIRCLE 12 READERS SERVICE CARD

cartridges are discharged from the graphite moderator. When spent, they are supposed to fall into a space between the discharge face and the outer concrete casing which acts as a shield. The spent cartridges are removed from this "discharge void" for disposal.

Problem arises when some cartridges fail to drop into the discharge void, and lodge on the arms of a burst cartridge detection scanner, or on ledges on the pile face. Not all of these can be dislodged with tools inserted through inspection holes.

Boom carrying the camera and grab is lowered through one of the access holes in the top of the pile. Thus, the face is systematically searched. The grab, in front of the camera, can grasp any cartridge in focus.

Meanwhile, at the Hanford atomic plant in Richland, Wash., closed circuit-tv is cutting costs by enabling studies of work progress in high radiation zones.

By watching work crews through tv monitors, replacement teams can see where each job must be resumed when it is their turn to relieve men who must stop work to avoid overdoses of radiation.

Two pickup cameras connected to remote monitors provide views needed to keep work running steadily.

Radio-Paging Field Spreads

TO DATE MORE THAN 100 radio-paging firms have sprung up throughout the country.

Typical of these burgeoning outfits is a firm which passes along upwards of 30,000 messages a month to 1,000 subscribers. With two 500-watt transmitters broadcasting at 43.58 mc, the agency extends service to busy doctors, traveling businessmen and field service people within a 40-mile radius.

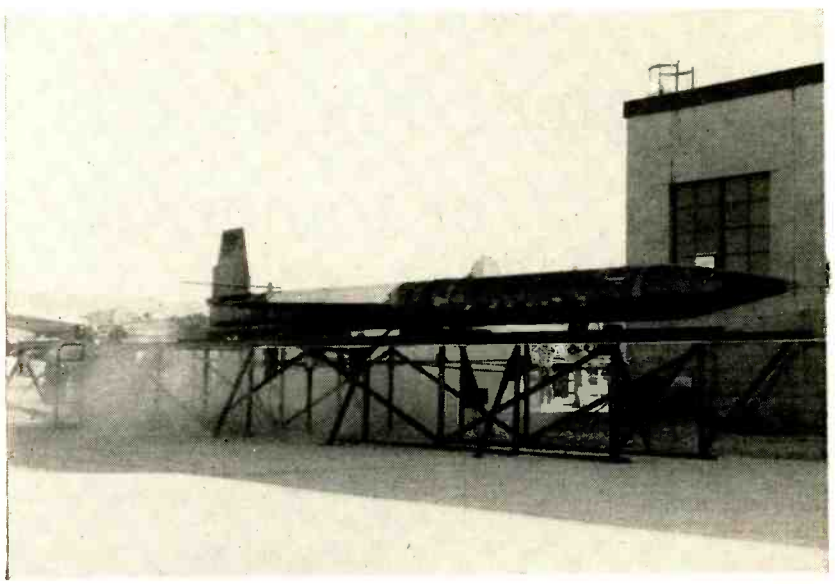
Each subscriber carries an unobtrusive six-ounce pocket receiver which he turns on at his leisure.

The plastic-encased receiver is seven inches long and one and a quarter inches wide.

Its superregenerative circuit uses two tubes, or one tube and one transistor, and derives its plate and collector potentials from a tiny 30-volt battery.

Another tinier battery supplies filament power.

Checking Ramjet Missile



All-electronic systems are operating and sending radio signals to nearby monitoring consoles as Lockheed's X-7 ramjet test missile gets an 18 G acceleration test on the G-Shooter. Distance traveled is two feet, time required is .04 of a second and velocity—reached after traveling only six inches—is 23 ft per second

MEETINGS AHEAD

Sept. 12-13: Communications Conf., IRE, Sheraton Montrose Hotel, Cedar Rapids, Iowa.

Sept. 15-19: Instrument-Automation Conf., ISA, Phila. Conv. Hall, Pa.

Sept. 18-19: National Assoc. of Broadcasters, Fall Conf., Buena Vista Hotel, Biloxi, Miss.

Sept. 22-24: National Symposium on Telemetering, Americana Hotel, Miami Beach, and Patrick Air Force Base (Sept. 25).

Sept. 24-25: Industrial Electronics, Seventh Annual Conf., IRE, AIEE, Rackham Memorial, Detroit, Mich.

Sept. 25: Engineering Problems in Space Medicine, IRE Medical Electronics, Univ. of Penn., Phila., Pa.

Sept. 26-27: Broadcast Transmission Systems, Annual Symposium, IRE, Willard Hotel, Wash., D. C.

Sept. 29-Oct. 3: Audio Engineering Society, 10th Annual Conv., Hotel New Yorker, N.Y.C.

Oct. 1-2: Radio-Interference Reduction, U.S. Army Signal Research & Devel. Labs, IRE, Armour Research Foundation, Chicago, Ill.

Oct. 2-4: Upper Midwest Trade Exposition, Electronic Wholesalers Assoc., Minneapolis Municipal Auditorium, Minn.

Oct. 6-8: Symposium on Extended Range and Space Communications, IRE and George Washington Univ., Lisner Auditorium, Wash., D. C.

Oct. 8-10: IRE Canadian Convention and Exposition, Electronics and Nucleonics, Exhibition Park, Toronto, Canada.

Oct. 13-15: National Electronics Conf., 14th Annual, Hotel Sherman, Chicago.

Oct. 20-21: Aero Communications Symposium, Fourth National, PGCS, Hotel Utica, Utica, New York.

Oct. 20-21: USA National Committee, URSI Fall Meeting, Penn State Univ., University Park, Pa.

Oct. 30-31; Nov. 1: Electron Devices Meeting, PGED, IRE, Shoreham Hotel, Wash., D. C.

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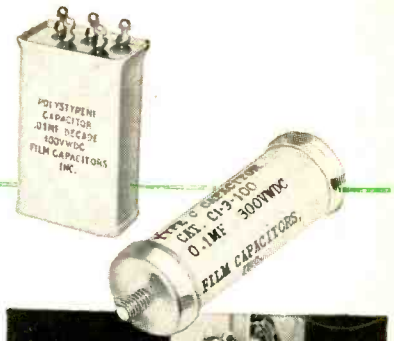
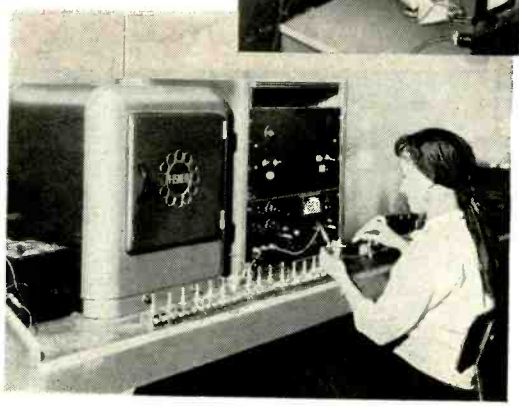
INSULATION RESISTANCE and CAPACITANCE STABILITY

POWER FACTOR and SOAKAGE



f-c-i Polystyrene Capacitors are wound with NATVAR® Styroflex



f-c-i polystyrene capacitors are available in hermetically sealed glass tubes, metal shells, bathtub cases, or metal cans. Operators like Styroflex because it winds easily, and testers find a minimum of rejects.

Film Capacitors, Inc., New York, manufactures capacitors for critical AC and DC circuitry applications—such as bridge arm elements, filter network components, standards of capacitance, RF tank circuits, storage circuits and computer circuits—where stability and high Q are essential.

Natvar Styroflex film is used as the dielectric in f-c-i polystyrene capacitors because of its uniformly high shock resistance and excellent dielectric properties. Because of its bi-axial orientation during the manufacturing process, it is completely flexible in all thicknesses, and easy to handle.

If you need an insulating material with the desirable characteristics of polystyrene—plus pliability, it will pay you to investigate Natvar Styroflex.

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- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated—varnished tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 24

Knee high to a grasshopper

but Fenwal's New Miniature, Hermetically Sealed THERMOSWITCH® Unit is Strong as an Ox

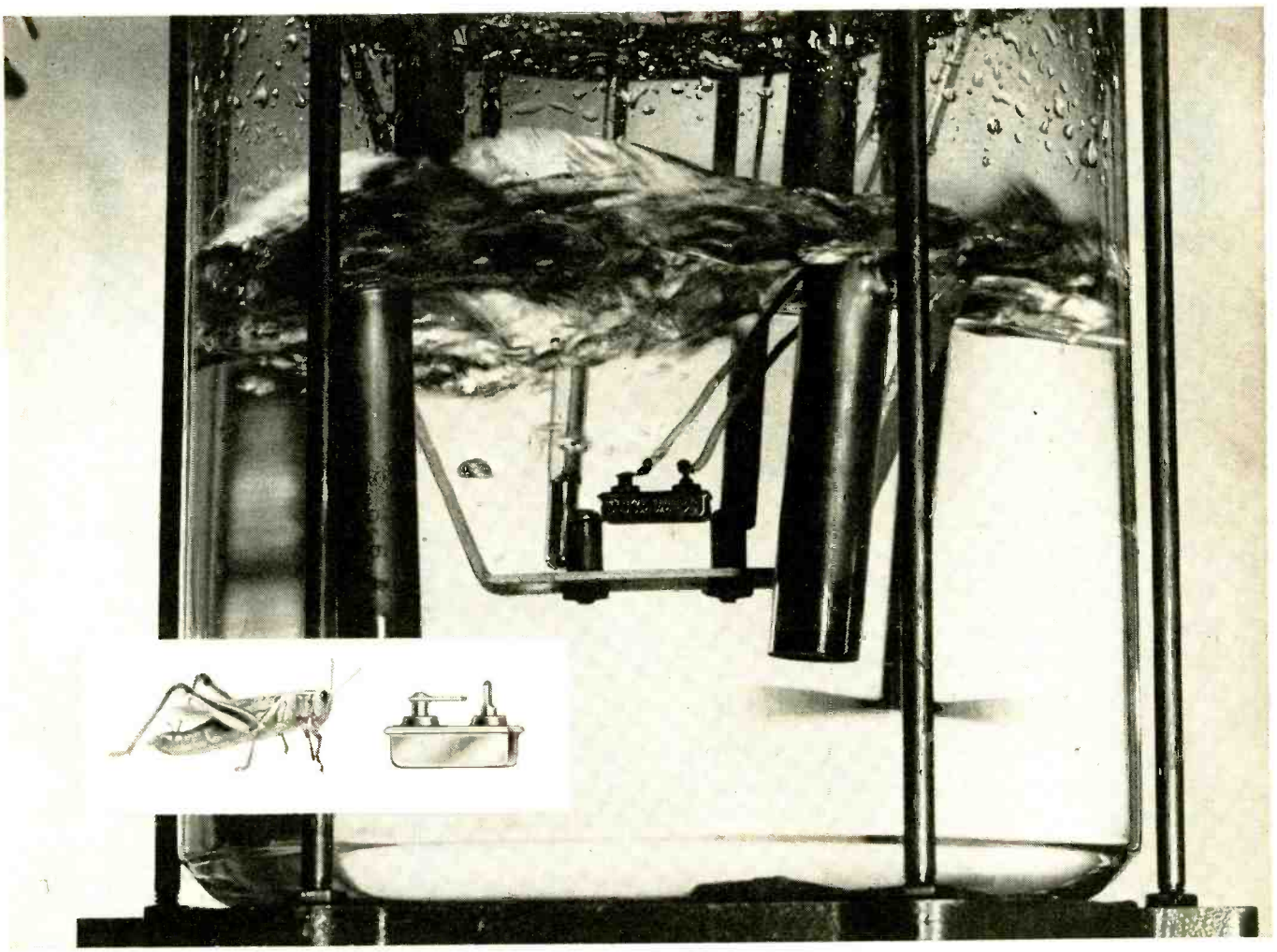
Here are acute temperature sensitivity, instant response, and the strength to withstand the most demanding conditions — all in *one unit only knee high to a grasshopper!*

It's hermetically sealed, yet field adjustable. Maintains control characteristics even with vibrations of 500 cps with 10G acceleration — *it's rugged!*

You get wide range and sensitivity, too. The new THERMOSWITCH unit controls temperatures from −20° to +200°F within 1°. Thin wall corrosion-resistant, drawn stainless steel case insures instant response to temperature changes — *you get precision control.*

You'll want to find out more about this tiny, tough, sensitive control. For more information on the new miniature hermetically sealed THERMOSWITCH unit, and other Fenwal miniaturized controls, write for our catalog or a sales engineer. Fenwal Incorporated, 209 Pleasant Street, Ashland, Massachusetts.

New Fenwal miniature THERMOSWITCH unit being agitated in liquid bath while maintaining temperature of liquid at 140°F ±1°. THERMOSWITCH unit weighs less than ⅓ oz., can withstand 10G acceleration at 500 cps vibration. Current capacity is 2.5 amps, 115 VAC, 2.0 amps, 28 VDC.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

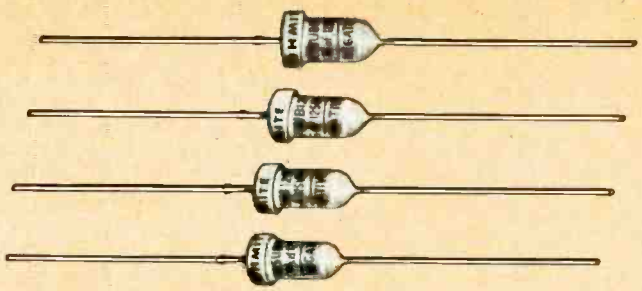
NEW OHMITE® "TAN-O-MITE®" TANTALUM CAPACITORS

Series TS Porous Slug Type

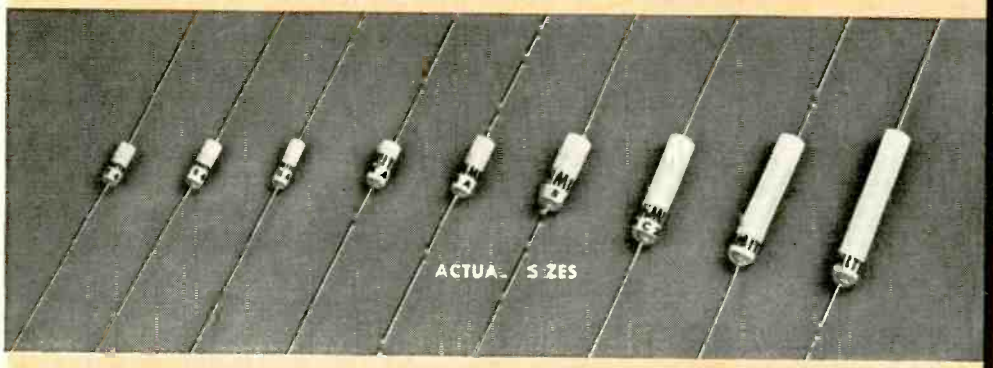
...The third in a variety of Ohmite Tantalum Capacitors

Ohmite offers you a *complete line* of quality tantalum capacitors including three types . . . all available from stock in reasonable quantities. New slug-type units employ a porous anode of sintered tantalum sealed into a fine silver case, externally uninsulated. Their stability of performance is unexcelled, with indefinitely long shelf life and exceptionally long operating life. Size "U" unit illustrated at right offers a range of 1.75 microfarads to 30 microfarads. Working voltages to 125 are available, depending upon capacity. These capacitors are polar units intended for d-c applications.

BULLETIN 159

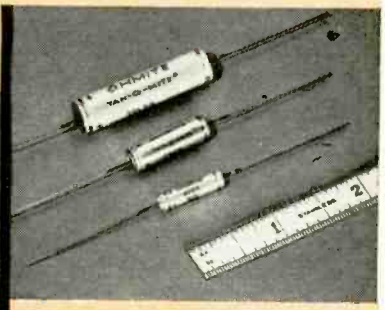


- High Capacity, Small Size
- Extremely Low Leakage Current
- Long Shelf and Operating Life
- Normal Temperature Range is —55°C to +85°C



SERIES TW WIRE-TYPE TANTALUM CAPACITORS These Mylar® insulated, subminiature, wire-type units feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperatures as compared to other kinds of electrolytics. Ultrasmall for low-voltage, d-c, transistorized electronic equipment, these tantalum capacitors have high stability, high capacitance, long shelf life, and excellent performance under temperature extremes of —55°C to +85°C. Available in nine subminiature sizes; .01 to 80 mfd. over-all capacitance range. Smallest size is .080 x .203 inch; largest is .134 x .812 inch. Six most popular sizes are recommended for distributor's stock.

BULLETIN 148



SERIES TF FOIL-TYPE
These capacitors are tantalum foil, electrolytic units for low-voltage, a-c and d-c applications where top performance and stability of electrical characteristics are required. Units feature unusually long shelf and operating life. Three sizes now available; .25 to 140 mfd. over-all capacitance range. Standard tolerance is ±20%. Working voltages up to 150. Polar and nonpolar units available.

BULLETIN 152

OHMITE® QUALITY Components

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

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

Westinghouse Roberts Test Technique Frees Reject-Strangled Production...

Perfectly paired Hipermag cores boost magnetic amplifier output*

Mr. Cliff Horstman checks performance readings for Hipermag cores using the Roberts Dynamic Tester. This production-line test eliminates costly and complicated testing at your plant. After the Roberts test, Hipermag cores are "pegged" here according to their performance characteristics. This practice assures perfect performance-matching every time.

A very high reject ratio was strangling magnetic amplifier production at the plant of a large eastern manufacturer. Analyzed by the company's own engineers, the problem was found to be a case of inadequate core matching. A core-matching specification based on sine current dynamic testing was attempted. However, since the application was a voltage regulator using voltage reset, the problem of matching maximum permeability to the required tolerances was practically insurmountable for production-line testing.

After Westinghouse engineers analyzed the problem, it was decided that matching cores at zero control point with the Roberts tester would help obtain the desired high yields.

Production-run cores matched by this procedure were flown to the manufacturer from the Westinghouse Greenville plant. These cores resulted in an immediate improvement in production-line performance.

The Roberts core-matching technique provides the closest approach to magnetic amplifier design for commercial testing of cores that exists today. This testing technique on standard Hipermag cores provides performance tailored to your magnetic amplifier application.

Let our engineers help you with your magnetic amplifier production problems. Call your Westinghouse representative . . . or write Specialty Transformer Department, Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pa.

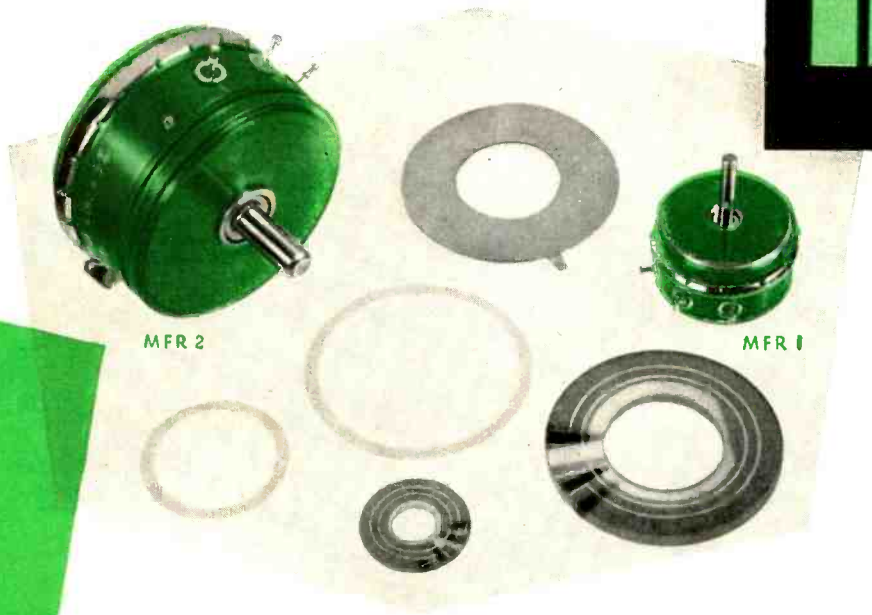
*Trade-Mark

J-70873

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

NEW PRECISION VARIABLE RESISTOR

...with no sliding wiper by



Super reliability is inherent through unique manufacturing techniques

These Rotary Metallic Film Potentiometers are the perfection of years of research and development

FEATURES:

- Complete Hermetic Seal
- Infinite Resolution
- High Temperature Operation
- Long Life
- Low Torque
- Exceptionally High Accuracy
- Extremely Low Noise

A patented compression contact eliminates the wear or friction caused by usual wiper contacts. A precious metal capsule contact provides dependable long life operation. The deposited metal film resistance element is encased and hermetically sealed. The ultimate in craftsmanship is employed in the manufacture to produce a potentiometer unparalleled for performance. This new concept of design makes possible super reliability under the most severe environmental conditions such as those encountered in airborne, missile and satellite applications.

Details will be sent upon request.

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± 1 COUNT AMBIGUITY ELIMINATED!

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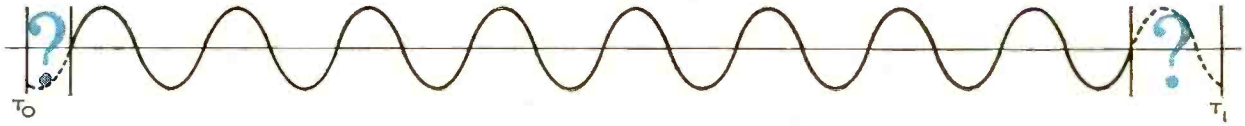
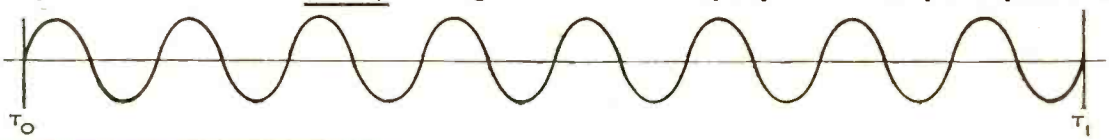
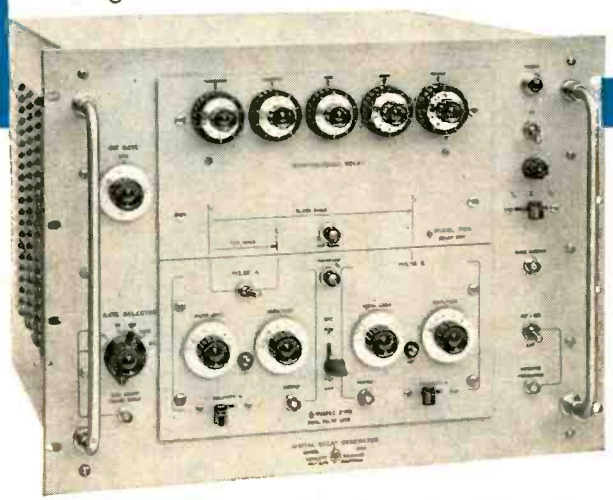


NEW -*hp*- 218A X counts *exactly*—timing wave starts with sync pulse and only full cycles counted!





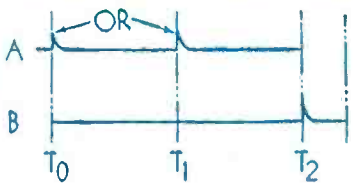
New ease, for precision

Time measurement and pulse simulation in radar, loran, Tacan, DME, oscilloscopes, computers, fast gates, pulse code systems —almost any fast circuit double pulse measurement with any kind of delay may now be made quickly and accurately with the new -*hp*- 218A Digital Delay Generator.

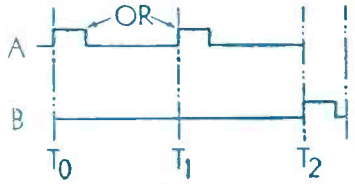
Constructed along rigid military standards, the -*hp*- 218A is basically a pulsed crystal oscillator synchronizable *in constant phase* with an initial trigger pulse (zero time) and two positionable terminating pulses. Time is counted with a 1 MC preset counter, and two independent output pulses (T_1 and T_2) are available in any relationship. For utmost present and future versatility, output pulses are generated through -*hp*- 219A series plug-in units.

Model 218A is a direct slave to an external trigger, 0 cps to 10 KC, or may be triggered internally over a 10 cps to 10 KC range. A push-button manual trigger is also provided. The two delay pulses are *separately and digitally adjustable* from 1 to 10,000 μsec with interpolation 0 to 1 μsec. Timing accuracy is ± 0.1 μsec ± 0.001%; time interval and pulse characteristics are directly selected on front panel controls.

Brief specifications appear alongside; for complete details see your -*hp*- representative or write direct. Also request -*hp*- Journal, Vol. 9, No. 8.



-*hp*- 219A Dual Trigger Unit contains two blocking oscillators supplying positive polarity trigger pulses to control auxiliary equipment. Pulse A available at T_0 or T_1; pulse B at T_2. Pulse characteristics identical to sync output pulse of -*hp*- 218A. (See "Specifications") $100.00.



-*hp*- 219B Dual Pulse Unit contains two pulse generators providing digitally delayed, fast rise time, high power pulses. Positive or negative polarity, amplitude variable 0 to 50 v, pulse width variable 0.2 to 5 μsec, rise time 0.06 μsec. Pulse A available at T_0 to T_1, pulse B at T_2. Internal impedance is 50 ohms. $450.00.

hp® offers the world's most complete

This new -hp- 218A Digital Delay Generator produces pulses accurately spaced in time, with spacing controlled by a crystal oscillator. The 218A is a perfect slave to any beginning or synchronizing pulse, even though random, and locks in constant phase during each counting period.

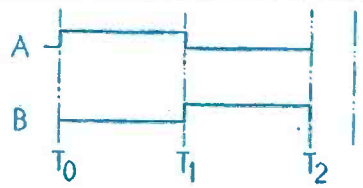
speed and 0.1 μsec accuracy time measurements

SPECIFICATIONS

-hp- 218A DIGITAL DELAY GENERATOR
(Plug-in necessary to operate)

Time Interval Range: 1 to 10,000 μsec, T_0 to T_1 and T_1 to T_2. Accuracy: ± 0.1 μsec ± 0.001% of time interval selected.
Digital Adjustment: 1 μsec steps, 1 to 10,000 μsec.
Interpolation: Continuously variable, 0 to 1 μsec.
Input Trigger: *Internal*, 10 cps to 10 KC, 3 decade ranges. *External*, 0 to 10 KC. Pos. or neg. pulses 2 to 40 v peak. Delay between external trigger and T_0 is 0.25 μsec ± 0.05 μsec.
Jitter: 0.02 μsec or less.
Recovery Time: 50 μsec or 10% of selected interval, whichever is larger.
Sync Output: 50 v pos. pulse, 0.1 μsec rise time (from 50 ohm source). Available at T_0, T_1 or T_2.
1 MC Output: 2 volt 1 MC pulses (from 500 ohm source) available at panel connector when counting on internal 1 MC oscillator.
Power: 115/230 v ± 10%, 50/60 cps, 525 watts.
Size: 14" high, 19" wide, 24" deep. Weight 75 lbs.
Price: -hp- 218A (cabinet) or -hp- 218AR (rack mount), $2,000.00.

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



-hp- 219C Digital Pulse Duration Unit produces a high power pulse with digitally controlled delay and duration. Pulse duration either T_0 to T_1, or T_1 to T_2. Both polarities available simultaneously; amplitude variable 0 to 20 v (from 90 ohms impedance) or 100 v (from 500 ohms). Rise or decay time 0.03 μsec (90 ohms). $350.00.

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selection of precision electronic counters

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TRANSISTORIZED PREDETERMINING COUNTERS

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A versatile group of transistorized production counters designed for industrial applications. Any number of decades can be furnished depending upon your requirements.

Can be operated by non-technical help merely by setting the selector knobs to the pre-set quantity within the range of the instrument. These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slitting, stacking and material handling.

The use of transistors means that heat — the enemy of reliability — has been eliminated. This reduces warm-up time and increases dependability. Printed circuits and simplified wiring further insure long trouble-free operations.

Standard counters are completely enclosed in attractive industrial cases, but can also be supplied without enclosures for panel mounting. A photo head to actuate these counters can be furnished in many configurations. Batch totalizers with push-button reset and special modifications of basic components can be furnished on request.

This is your complete package for predetermining counting at high speeds. Send for your copy of the new specification bulletin outlining the complete range of the series 1604 counter line today.

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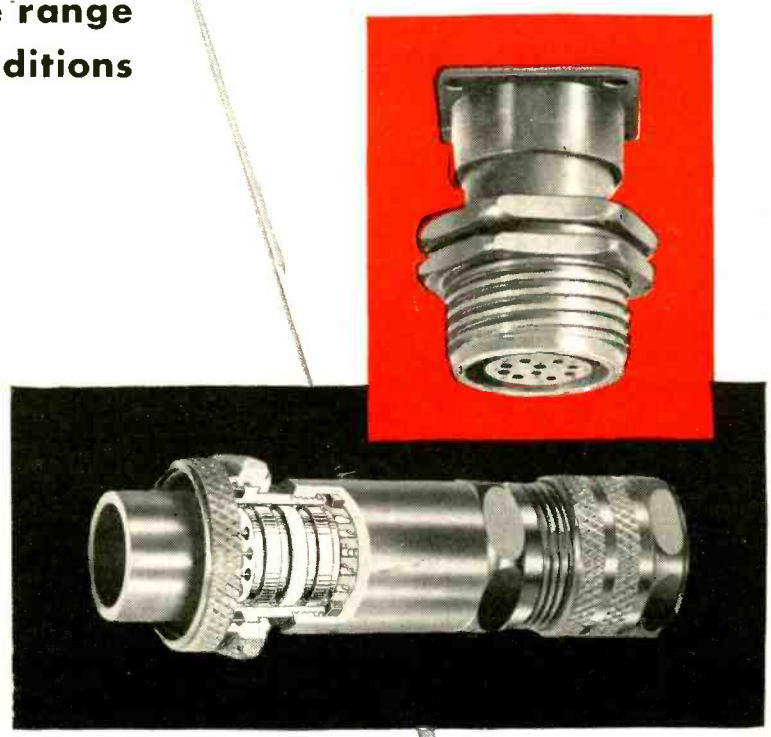
PYLE *star-line*® CONNECTORS

Assure long-lasting protection of vital connections under a wide range of extreme environmental conditions

Currently establishing itself as a performance leader in the missile systems field, Pyle-Star-Line connectors offer engineers an entirely new line of electrical connectors for universal military and industrial use.

With characteristics of construction and performance never before combined in compact, rugged, lightweight standardized connectors, they exceed NEC requirements and classes A, B, C and E of military specifications MIL C-5015C.



FEATURES

Tough, lightweight shell: Strength comparable to mild steel, yet weighs only ⅓ as much.
Anodic coating: Gives shell toughness of case-hardened steel. Takes up to 1800 volts to penetrate coating.
"Sandwich" insulation: Silicone laminate floats between two rigid discs. Silicone disc absorbs shock, lets contacts align themselves freely; rigid discs impart just the right amount of restraint. Gives all advantages of both flexible and rigid mountings.
Chamber sealing: Silicone insulation disc positively and completely prevents water, gas, moisture or dust from passing into shell.
Wide range of pin and socket configurations: Configurations from 2 to 100 poles available. Within each form size all inserts are interchangeable and reversible.

Environmental Limits of Pyle-Star-Line connectors	
Temperature	—80 F. to 225 F.
Pressure	300 PSI External, 200 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015C
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015C
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015C
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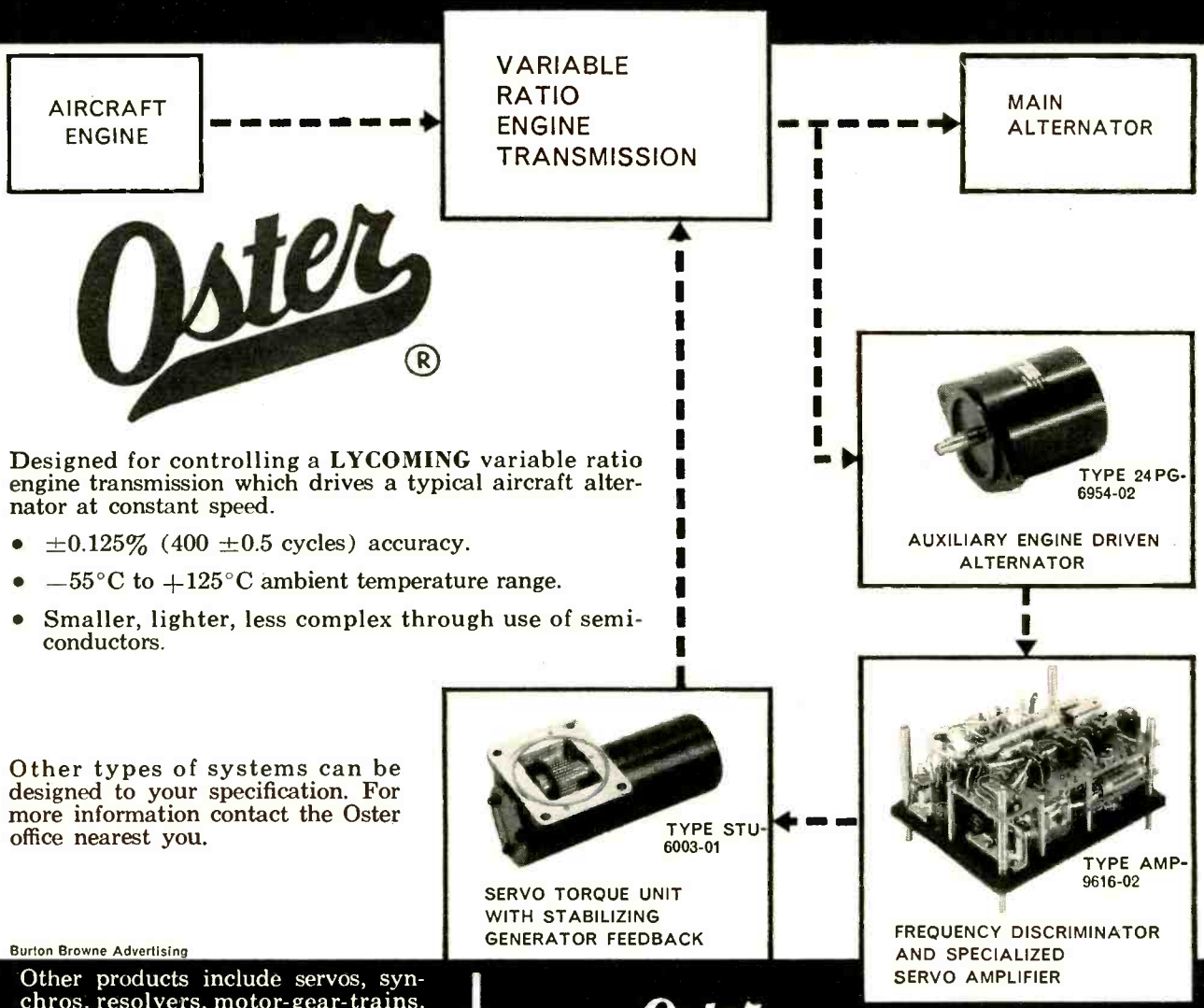
CONDUIT FITTINGS • CIRCUIT CONTROLS • LIGHTING EQUIPMENT

New Transistorized

FREQUENCY DISCRIMINATOR AND SERVO DRIVEN CORRECTION LOOP

±0.5 ~ accuracy



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Designed for controlling a **LYCOMING** variable ratio engine transmission which drives a typical aircraft alternator at constant speed.

- ±0.125% (400 ±0.5 cycles) accuracy.
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- Smaller, lighter, less complex through use of semiconductors.

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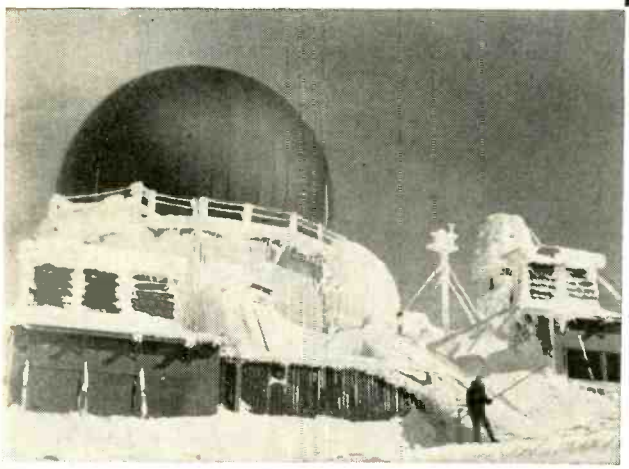
Engineers For Advanced Projects: Interesting, varied work on designing transistor circuits and servo mechanisms.
Contact Mr. Robert Burns, Personnel Manager, in confidence.

HOW TO SOLVE DESIGN PROBLEMS WITH

SILICONE IDEAS



This Arctic radar station typifies the extreme temperatures to which silicone dielectric fluids are subjected to—reliably.

New Electrical Grade Silicone Fluids Remain Reliable Under Tough Conditions

At extremely high desert temperatures or in the freezing cold of the Arctic, new G-E electrical grade SF-97 series silicone fluids assure uniform and reliable operation of equipment. Their uniform purity results from exacting manufacturing and quality control procedures. They stay liquid at temperatures far below other materials; undergo no change in dielectric constant at frequencies as high as 10 megacycles. Among their excellent electrical properties are high dielectric strength, high volume resistivity and low power factor.

General Electric silicone fluids are being used in capacitors, transformers, radar, television, and in systems where heat transfer is as important as dielectric strength. Write for more data.

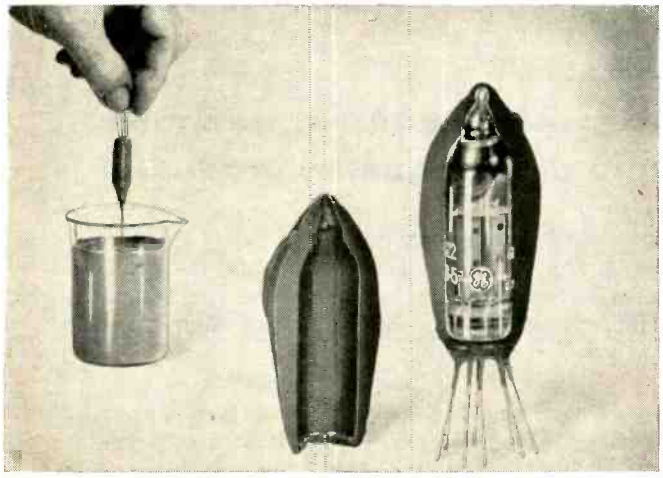
New Silicone Varnish Is Easier To Apply, Protects Over Wider Temperature Range

SR-155, General Electric's new silicone varnish, is a Class H insulating material which offers superior performance from —65°C to over 200°C. It will not craze or crack at sub-zero temperatures.

Because it easily handles excessive emergency loads, SR-155 increases the reliability of electrical equipment. Since it is suitable over a wide temperature range this one varnish can take the place of two or more, so manufacturing procedures and inventory can be simplified. Its smooth, glossy finish improves appearance. SR-155 penetrates deeper than other resins, "wets out" well and will not bubble. Write for application information.

Comparative Properties	SR-155	Silicone X	Silicone Y
Penetration & wetting	Excellent	Good	Good
Low temperature craze resistance	Excellent	Fair	Excellent
High temperature stability	Excellent	Excellent	Excellent
Overcoating	Excellent	Excellent	Fair
Blister free	Excellent	Excellent	Excellent

Chart compares essential properties of General Electric SR-155 varnish with other silicone varnishes.



Cutaway of RTV encapsulation. Cures without voids, can also be used for molding, filling, sealing, caulking.

New RTV Silicone Rubber Cures Without Heat, Does Not Shrink, Forms No Voids

Here is a brand new potting and encapsulating material that is easy to apply, cures at room temperatures and has outstanding heat resistance. Tough and elastic, G.E.'s new RTV room temperature vulcanizing compounds are stable up to 600°F, have excellent electrical properties. Viscosities vary from very pourable to spreadable. Can be applied by dipping, pressure gun, pouring or spreading.

RTV is quickly prepared for use: cures in any time you select up to 48 hours. 100% silicone solids (solvent free), it cures without shrinking or forming voids. Flows easily into complicated shapes. Write for technical data. Samples available for evaluation—just give us a brief description of your application.

Send for more information.

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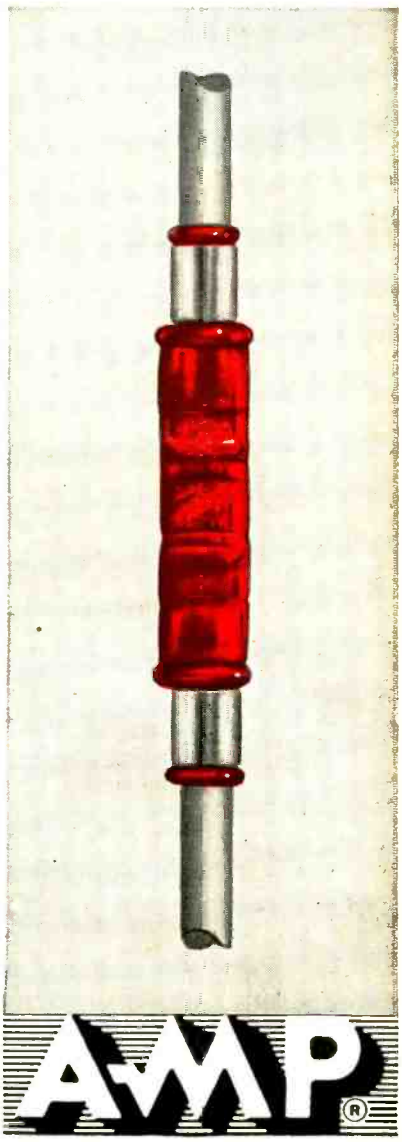

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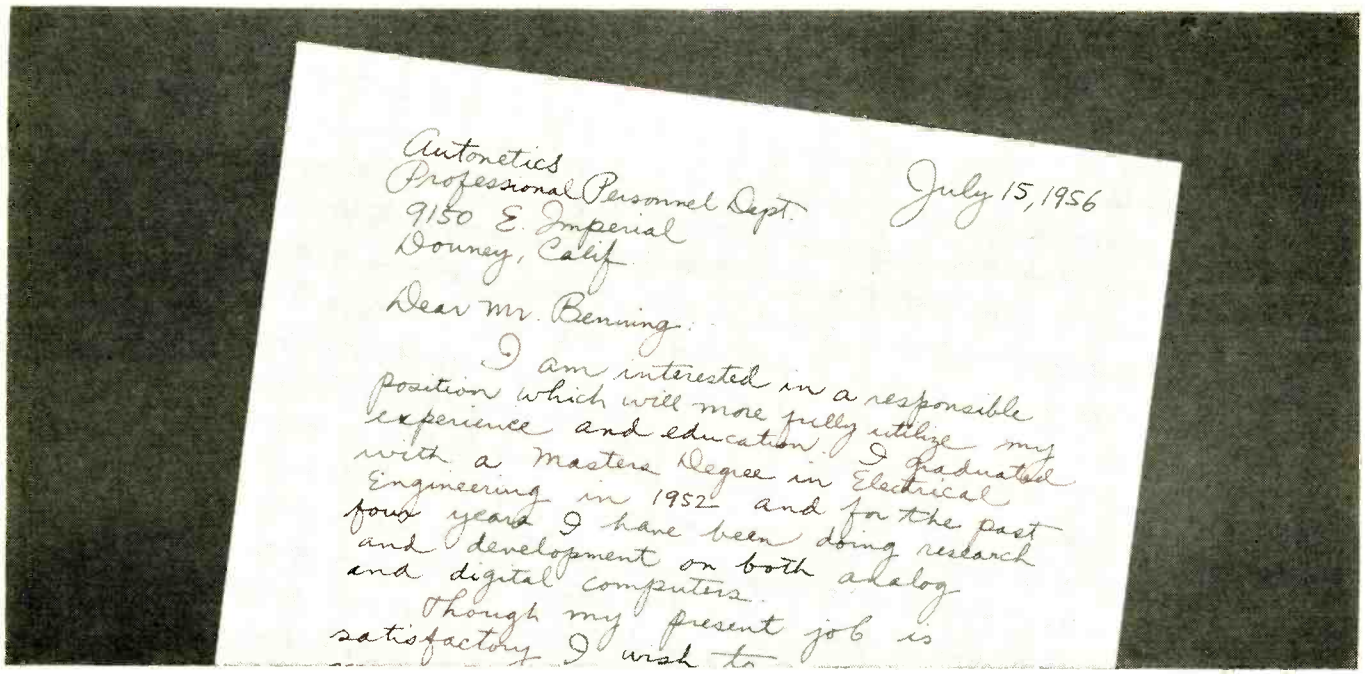

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Type 1504, 1505, and 1506 enable resistors, capacitors and inductances to be classified at a rate of 4000 units per hour when used in connection with the knee-operated Test Jig Type 3901.

The impedance deviation of the unknown unit from a known R,L or C standard are read off the instrument meter directly in %. Phase angle deviations are read off in radians. Impedance deviation ranges: ÷1.5% to +1.5%, ÷7% to +8%, and ÷25% to +35%. Phase angle deviation ranges: (÷1.5 to +1.5) × 10^{-2} radians, (÷7 to +7) × 10^{-2} radians, and (÷25 to +25) × 10^{-2} radians.

Interchangeable instrument meter scales.

4000 Units per hour

Write or phone for further information

Bridge Type	R	L	C	Bridge Frequency kc/s
1504	10Ω — 10 MΩ	2 mH — 100 H	50 μμF — 10 μF	1
1505	10Ω — 1 MΩ	0,2 mH — 2 H	30 μμF — 1 μF	10
1506	10Ω — 50 KΩ	20 μH — 20 mH	20 μμF — 01 μF	100

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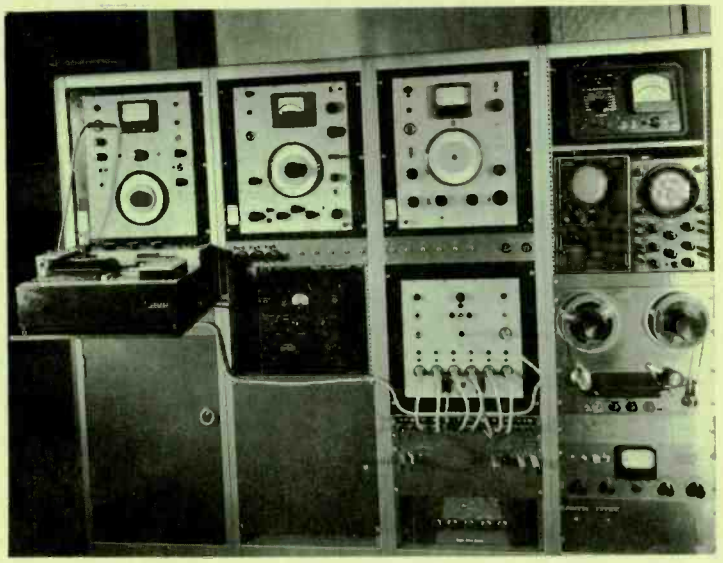

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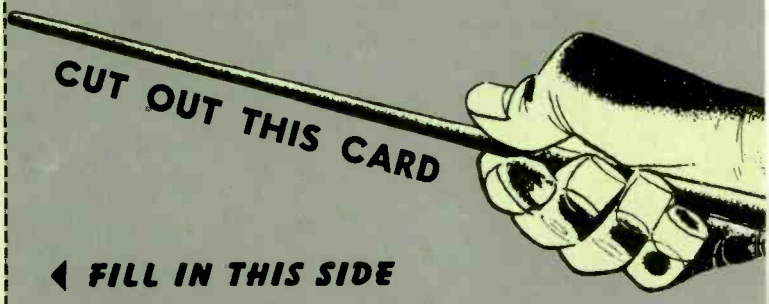

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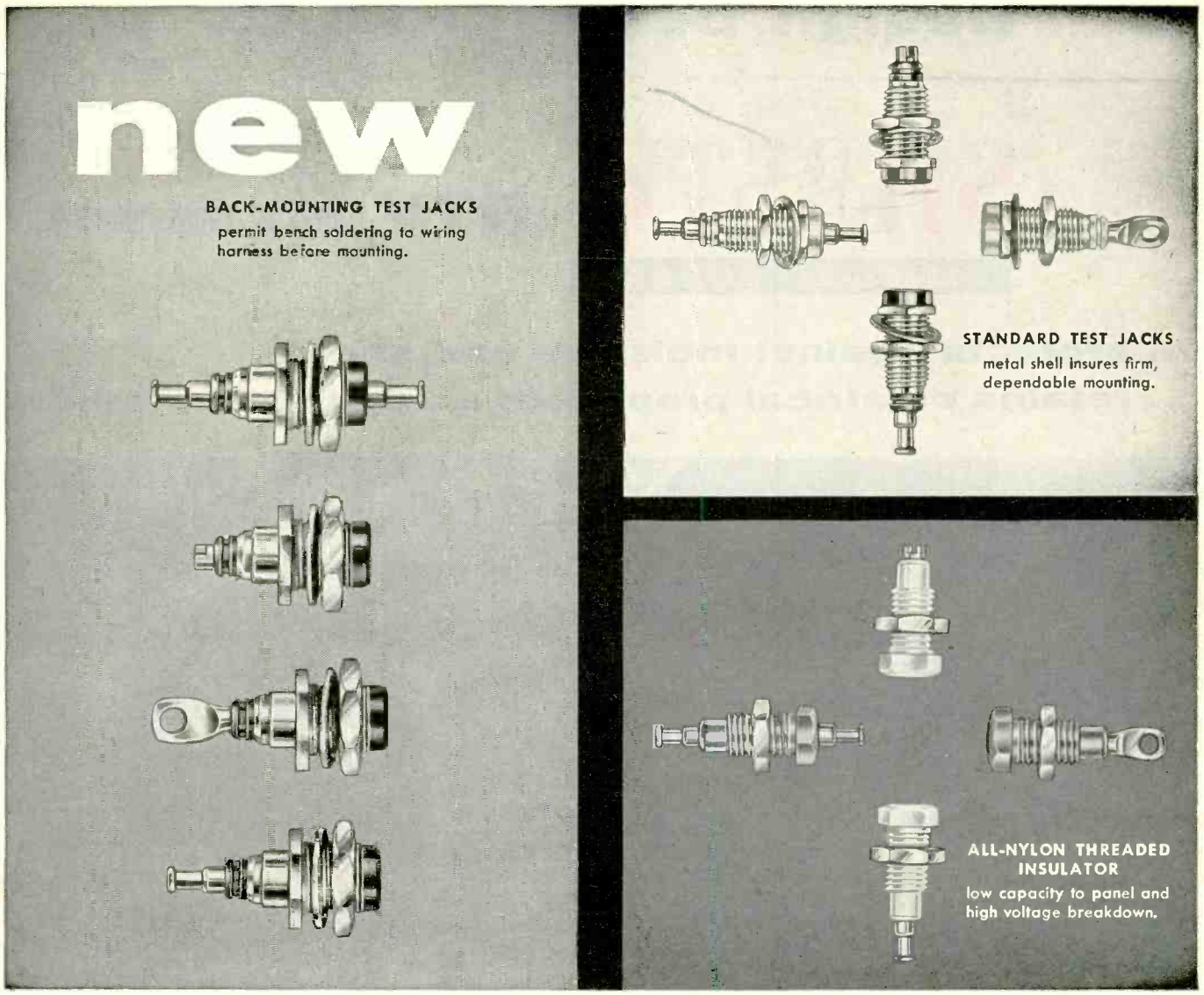

Test Jacks by Ucinite

The introduction of Ucinite's back-mounting jacks makes available for the first time a *complete* line of *high quality* test jacks suitable for use in equipment where long life and dependability are essential.

Ucinite Test Jacks, designed for standard .080 phone tips, are available in a variety of colors ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements.

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SILASTIC RTV cures at room temperature

SILICONE RUBBER

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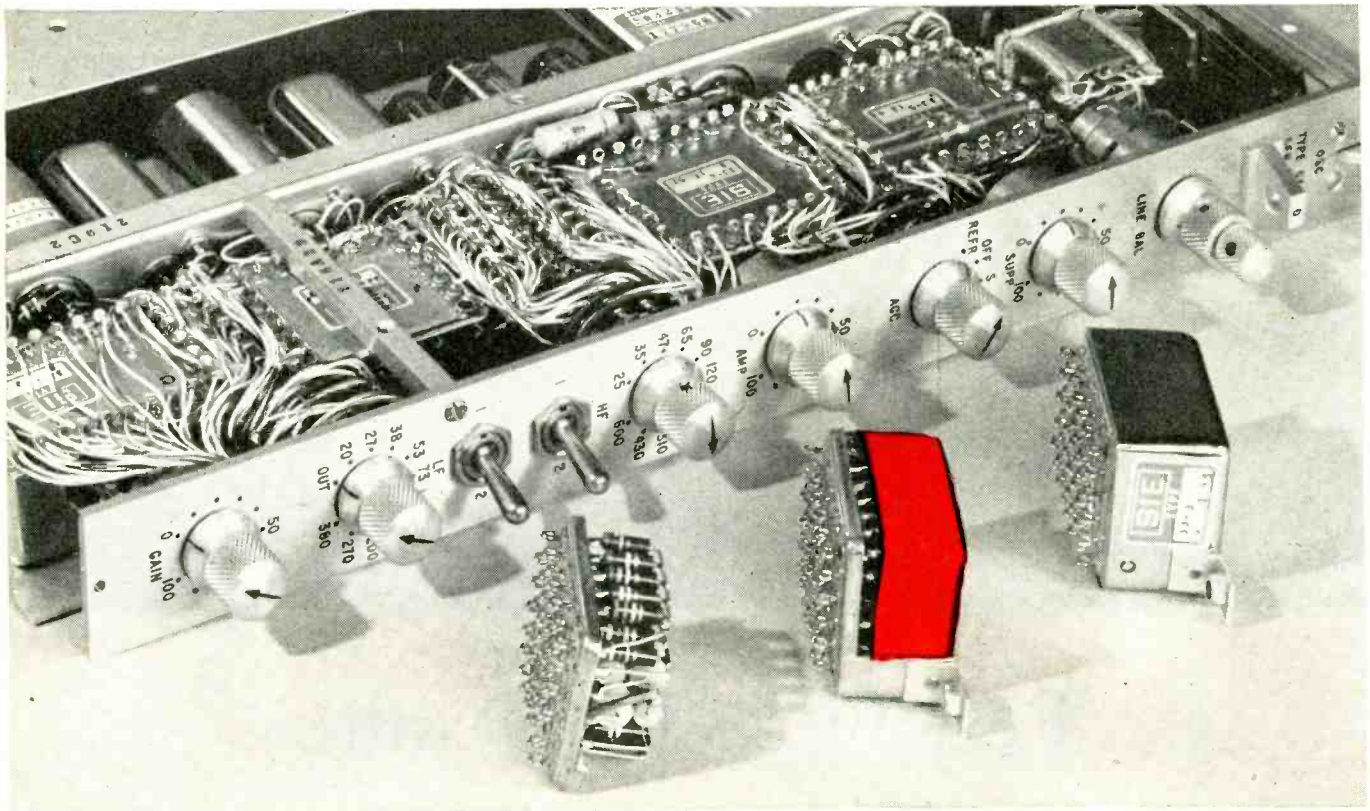

Potted with Silastic RTV, a component can (center) is ready for use in Southwestern Industrial Electronics' geophysical amplifier. Silastic RTV protects and seals circuits against many hazards.

TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range	—100 to 480F
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Dielectric strength, volts/mil	300 to 500
Surface resistivity at 50% Relative humidity, ohms	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

Protect and seal sensitive electronic instruments this new, "do-it-yourself" way. Silastic® RTV, the Dow Corning silicone rubber, vulcanizes at room temperature to form a rubbery silicone solid overnight. Simply apply with calking gun or by hand — no processing required. Parts made with Silastic RTV withstand temperatures from —70 to 250 C, resist moisture and oxidation, cushion vibration and shock. Dielectric properties are excellent. Use Silastic RTV for encapsulating, potting or calking. Free literature available.

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC.

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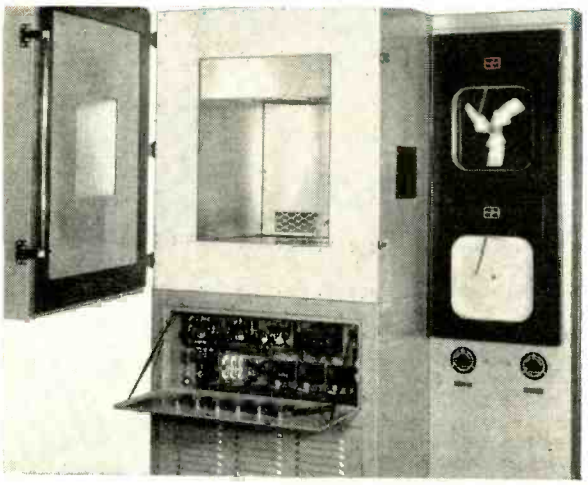

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SILICONE-GLASS LAMINATES SURVIVE DEEP FREEZE, OVEN HEAT

Virtually unaffected by temperatures as high as 250 C, silicone-glass laminates are ideal insulating and structural materials. They are lightweight, strong, moisture and arc resistant . . . have low loss factor, low moisture absorption. Can be drilled, machined, sanded, sawed. Supplied in various finished shapes by leading laminators.

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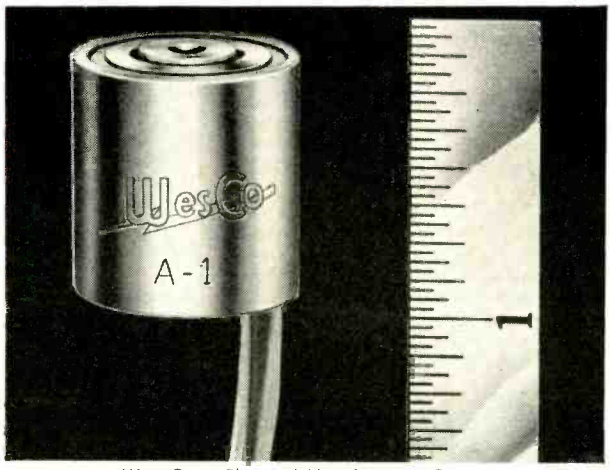

West Coast Electrical Manufacturing Corporation solenoid

SYLKYD ENAMELED WIRE AIDS MINIATURIZATION

Heat-stable Sylkyd® enameled magnet wire makes it possible to design smaller and more reliable electronic equipment. Equal in diameter to Class A wire, Sylkyd enameled wire is suitable for use in 180 C insulation systems; resists moisture, corona, most chemicals; has good shelf life and handling properties. Write for new illustrated brochure.

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SILICONE VARNISH GIVES LONG LIFE IN HIGH AMBIENTS

Impregnated with Dow Corning Silicone Varnish, the insulating components of miniature coils, servos, motors, transformers and other assemblies are bonded into moisture resistant insulation systems having high dielectric strength. Combined with other silicone components, silicone varnishes assure maximum reliability, permit operating temperatures up to 250 C . . . aid miniaturization . . . increase life while protecting against many chemicals, corrosive atmospheres, other environments.

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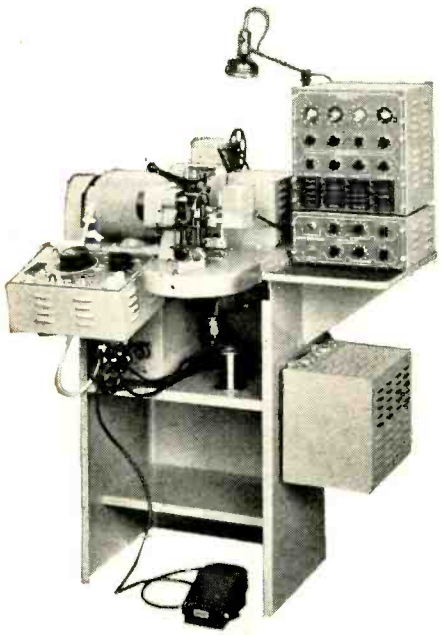
American Machine and Manufacturing Co. miniature coils

For further information on these products, write Dept. 489

BOESCH WINDING MACHINES

BOESCH



MODEL 300 TOROIDAL WINDER . . .

. . . A significant step toward automation

For toroidal coil sizes 0.218" ID to 5" OD, wire sizes #20 through #42 AWG, Boesch offers four machines . . . the new TW300 and TW251 and the well-known TW200 and TW201. Shuttle heads and shuttles ore interchangeable on all machines.

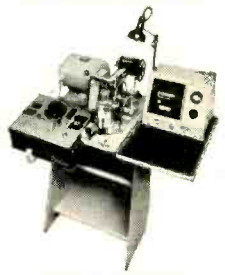
Electronic controls of the TW300 provide features never before offered in o toroidal winder . . . 100% accuracy in counting turns of ony size wire without physical contact . . . speeds up to 2000 turns per minute . . . 4-digit, 2 or 7 position predetermined turns counting . . . controlled acceleration and deceleration . . . automatic winding of ony segment configuration with exact repeatability . . . progressive winding of segments or continuous coils in either direction. A significant step toward automation of toroidal winding, the TW300 cuts production time ond operator fatigue, and offers unlimited flexibility in the production of new coil types with superior electrical characteristics.

A work horse of the industry, the TW200 is also a fully automatic high-production machine . . . wire spacing is variable, core rotates automatically for continuous winding, or oscillates through any angle between 45° and 180° for segmental winding. Available with predetermined mechanical footage counter for loading shuttle, with optional fixed or 0-1200 rpm variable speed, ond choice of 6-digit single-setting, or 5-digit 5-setting electronic predetermined-turns counters.

The TW201 is an economical production winder . . . a professional aid in the laborotory, a dependable winder in production. Core is oscillated manually by a single lever, but clamped mechanicolly. Winds standard coils without attachments. Available with same choice of counters and drives as the TW200.

The new low-cost TW251 is a packaged unit, complete and ready for operotion. Similar to TW201 but hos built-in non-predetermined turns counter and AC drive variable up to 1000 rpm. A slower-winding laboratory machine, but usable in production like TW201 by oddition of predetermined turns counter. Uses some speciol-purpose occessories as TW200 and TW201.

MODEL TW200 TOROIDAL WINDER

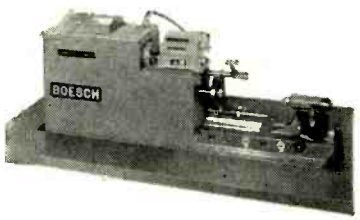


MODEL TW201 TOROIDAL WINDER

MODEL TW251 TOROIDAL WINDER

MODEL TW
TAPE WINDER

A motor-driven winder for applying non-adhesive tapes to toroidal cores and coils. Its quick operation makes it a highly valuable production tool, one minute's time to tape a core or coil is typicol. Speed is variable, handles coil sizes from ¼" ID to 4" OD, winds mylar, rayon, cotton, silk or glass tapes in widths ⅛", 3/16", ¼", ⅜", and ½". Tape overlap is continuously adjustable.



MODEL BW2
BOBBIN WINDER

A quick, rugged, versatile, completely outomatic winder for bobbins, solenoids, resistors, relays and other random-wound coils. Speed is variable to 8000 RPM, winds coils from 1/32 to 5 inches in length, diameters to 5 inches, wire sizes #17 through #50 AWG. Features single and multiple winding, automatic acceleration control, finger-tip controls, operator safety provisions, life-time lubrication, plug-in electrical components. Only 8 by 34 by 18½", one operotor can tend up to four machines ploced side by side.

MODEL SM
TOROIDAL WINDER

The first and only toroidal coil winding machine ever manufactured to wind toroids down to 1/16 of an inch ID. Speed is variable from 0 to 800 RPM, handles wire sizes #26 through #50 AWG. Features completely automatic operation, continuously variable shuttle speed, segmental and 360 degree winding, predetermined length-of-wire and turns counting, one-hand control to insert core and remove finished coil, mechanical core holder, automatic core rotation, dynomic broking, and variable wire spocing.

MODEL BPA
PERMEAMETER

Assure product uniformity and eliminate cost of trimming coils to inductance. This unique instrument grades toroidal cores before winding . . . meter displays percentage-of-nominal-turns deviation from standard . . . operator winds correct number of turns to obtain proper inductance for each coil even though core permeability vories from core to core. Available with either air- or manually-operated fixture, handles cores ranging in permeability from 14 to 125 and sizes from 0.3" ID to 5.28" OD. Overoll occurocy is 0.25%; lorge meter reods to 0.1%.

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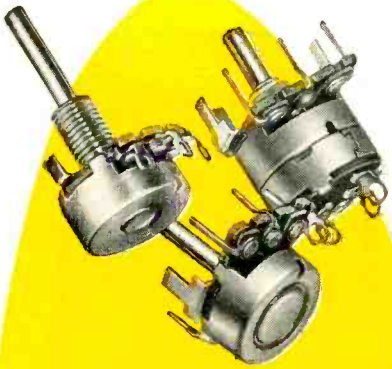
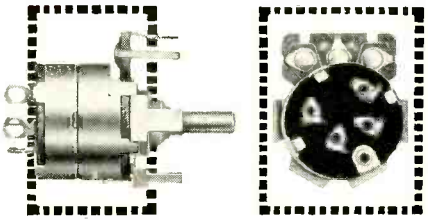
Boesch Manufacturing Co., Inc. Danbury, Conn.



WHEN IT COMES TO MINIATURE CONTROLS...

CHECK THE OVERALL SIZE...

including switch, if needed. For practical space-saving ability, Stackpole miniature "F" Controls lead the way — only 0.637" in diameter behind the panel for the entire length of *both* control and switch.



Photos show side and rear views of a Stackpole F Control with 2-pole switch. Dotted lines indicate behind-panel space occupied by a conventional "miniature" control.

Notice how Stackpole's small switch size perfectly complements the miniature control . . . saves precious chassis space where it's needed the most.

FEEL and HEAR THE SWITCH ACTION...

for the tease-proof, positive "feel" and audible "click" only a true snap-action switch provides. "B"-Series switches used on "F" Controls have the same time-proven mechanism as larger Stackpole control switches. They're U.L. Inspected for 1 amp. @ 125v ac-dc; 4 amps @ 25v dc.

CHECK THE COMPLETENESS OF BOTH CONTROL and SWITCH LINES

Printed wiring, wire-wrap, or standard lug terminals as well as fold-tab or threaded bushing mountings are available on all Stackpole miniature "F" controls. *Both* SPST and DPST switches can be supplied.

STACKPOLE

miniature "F"-series VARIABLE RESISTORS

Electronic Components Division

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

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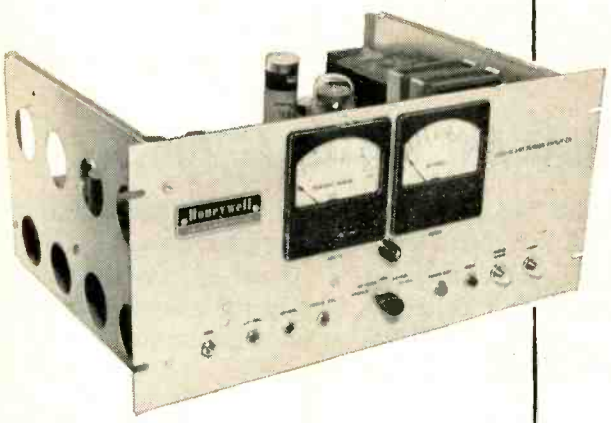
FIXED COMPOSITION CAPACITORS • CERAMAG® FERROMAGNETIC CORES
HUNDREDS OF CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.

AMPLIFIERS for nuclear reactor control



Log N and Period Amplifier

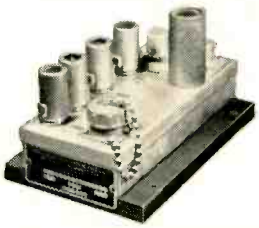
Typical of the extra value you get in Honeywell nuclear reactor control amplifiers is the Log *N* and Period unit. It combines basic time-proved circuits with exclusive Honeywell improvements developed through extensive experience in application and system responsibility for reactor control systems.

In this newly improved model, you get:

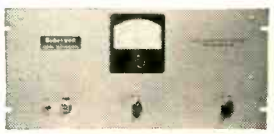
- **freedom from spurious scrams, gained by proper filter time-constants and extensive decoupling of all critical circuits;**
- **highly stable period section using chopper-type d-c amplifier;**
- **built-in period calibration, with quick and simple front panel adjustment and meter indication;**
- **calibration of both power and period sections during operation without scramming the reactor;**
- **independently adjustable warning and scram times. Scram adjustment covers 3 to 10 seconds, annunciation 3 to 30, and the settings do not interact;**
- **adapter plug speeds matching of amplifier to a particular reactor;**
- **115/230 volt, 50/60 cycle operation.**

Write for specifications on this Log *N* and Period amplifier, and for data on all pictured units. For assistance in applying these amplifiers to nuclear reactors, critical assemblies or simulators, call on your Honeywell field engineer . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, 10721 Hanna St., Beltsville, Md.

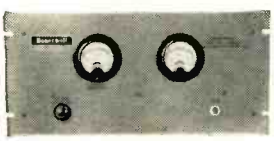
A1D-(P) Preamplifier



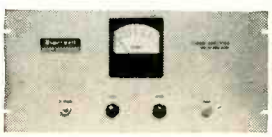
A1D-(R) Linear Amplifier



Log Count Rate Amplifier



C.I.C. Power Supply



Low Level Period Amplifier

Safety Amplifier

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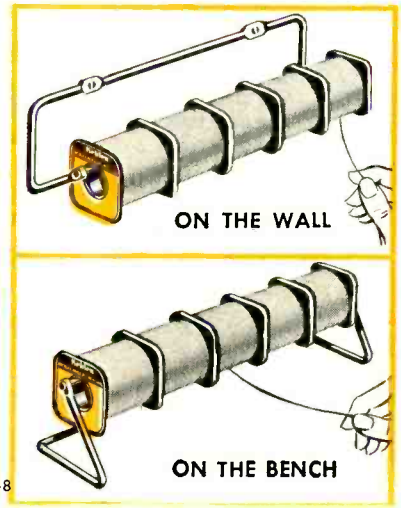
Each kit contains an assortment of Hook-Up Wire colors and types plus a portable metal dispenser rack for workbench or wall mounting. The dispenser rack provides a complete, compact, and convenient wire department for every working area at the user's finger tips, simplifies user Hook-Up Wire stock maintenance, and helps keep wire clean and orderly while keeping the workbench neat and efficient. Available at all Belden jobbers.

* Du Pont trademark



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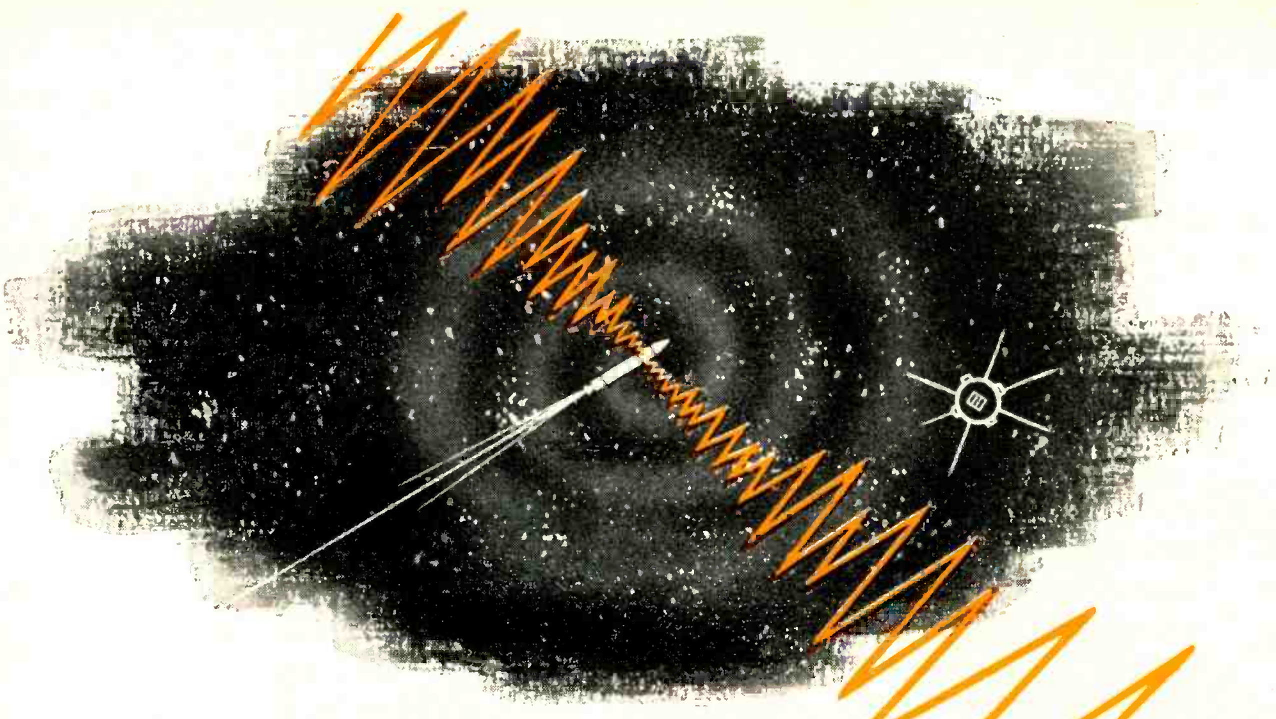


new constant delay filters

give minimum intelligence distortion and maximum phase linearity in radar, telemetering and other missile applications

Now . . . Burnell & Co.'s new Type 60051 Constant Delay Filter series provide delay constant to within 5% over the Pass Band — solve troublesome distortion caused by non-linear systems.

It has become apparent that the phase characteristics of telemetering filters are of greater importance than amplitude characteristics in creating intelligence distortion and minimum transient response of frequency modulated signals.

Inasmuch as delay is constant where the derivative of the phase function is truly linear it is an important measure of phase linearity. To obtain constant delay, a complete circuit configuration revision based on a lattice structure is required.

For compactness, a standard type 60051 housing is available. Upon special order JHU-APL housings for circuit replacements can be supplied.

For more detailed information on constant delay filters write for Bulletin CD-051.

BAND PASS FILTERS

Channel	Frequency	Part #	Delay in ms.	B/W
1	.4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30 KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.128	30%
E	70. KC	S-60073	.096	30%

CASE SIZE— 2 x 3½ x 4 13/16 H
INPUT IMPEDANCE = 500 ohms
OUTPUT IMPEDANCE = 500 ohms and to grid

LOW PASS FILTERS

Frequency	Part #	Delay in ms
400 cps.	S-60101	2.95 ms
560 cps.	S-60102	2.11 ms
730 cps.	S 60103	1.62 ms
960 cps.	S-60104	1.23 ms
1300 cps.	S-60105	905 ms
1700 cps.	S-60106	.681 ms
2300 cps.	S-60107	.511 ms
3 KC	S-60108	.392 ms
3.9 KC	S-60109	.302 ms
5.4 KC	S-60110	.218 ms
7.35 KC	S-60111	.160 ms
10.5 KC	S-60112	.112 ms
14.5 KC	S-60113	.0812 ms
22. KC	S-60114	0535 ms
30. KC	S-60115	0392 ms
40. KC	S-60116	.0294 ms
52.5 KC	S-60117	.0224 ms
70. KC	S 60118	0168 ms
22. KC	S-60119	.0738 ms
30. KC	S 60120	0541 ms
40 KC	S-60121	.0412 ms
52.5 KC	S-60122	.0309 ms
70. KC	S-60123	.0233 ms

CASE SIZE—1 11/16 x 1 3/16 x 2 1/4" H
INPUT IMPEDANCE equals 500/600 ohms
OUTPUT IMPEDANCE equals 500/600 ohms

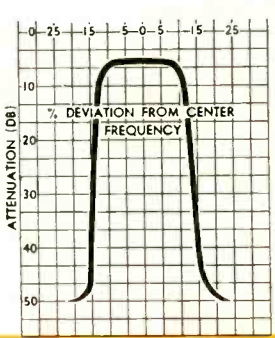
*optional impedance available on special order.

CONSTANT DELAY BAND PASS AND LOW PASS FILTERS ARE AVAILABLE WITH ATTENUATION SLOPES ILLUSTRATED:

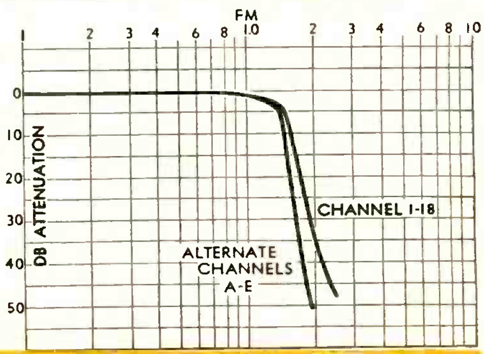
TECHNICAL DATA FOR BAND PASS FILTERS

FOR ± 7½% PASS BAND
1 Flat within 3 db over pass band
2 21 db at ± 15% of center freq.
3 40 db at ± 22% of center freq.
4 Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND
1 Flat to 3 db over pass band
2 23 db at ± 30% of center freq.
3 40 db at ± 44% of center freq.
4 Time delay over pass band constant to ± 7%



Constant Delay Band Pass Filters



Constant Delay Low Pass Filters

Burnell & Co., Inc.

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

Dept. E-8

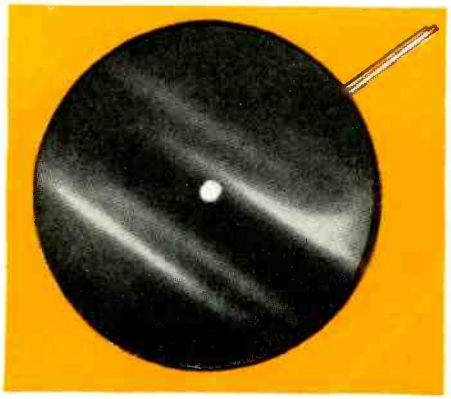
EASTERN DIVISION:
10 PELHAM PARKWAY, PELHAM MANOR, N. Y. • PELHAM 8-5000
Teletype: Pelham 8-5000

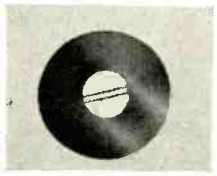
PACIFIC DIVISION:
720 MISSION STREET, SOUTH PASADENA, CALIFORNIA • RYAN 1-2841
Teletype: Pasacal 7578

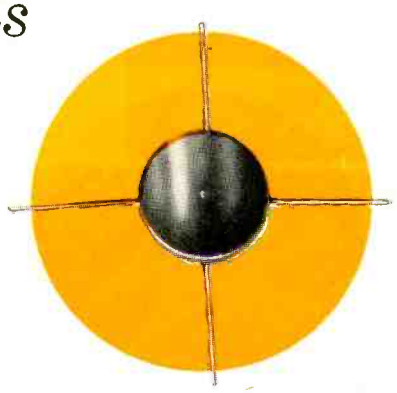
Burnell offers

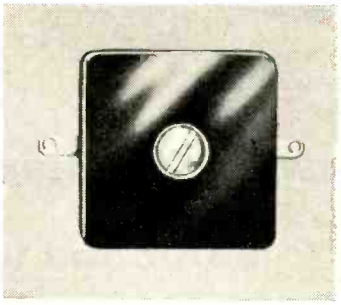
THE MOST

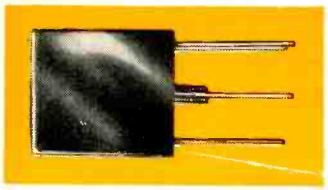
complete line of encapsulated toroids to meet your circuit needs

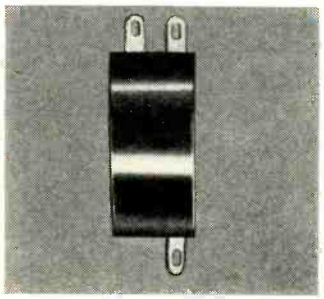












All components shown actual size.

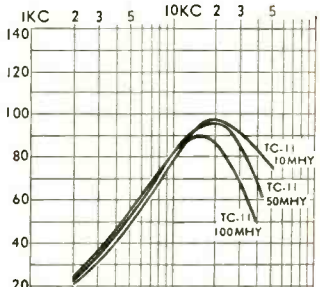
Burnell & Co., pioneers in the development of toroids, filters and related networks now offer the most complete—the most reliable line of encapsulated toroids.

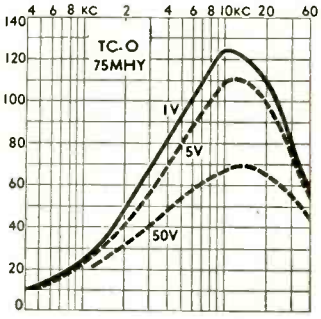
Burnell encapsulated toroids include the only encapsulated adjustoroids available anywhere—satisfy the toughest circuit demands in service-ability—light weight—miniaturization.

Burnell encapsulated toroids are particularly useful in guided missile and similar miniaturization fields where space and mounting are highly critical factors. Send for free, new Catalogue No. 104 covering scores of applications with schematics and performance curves.

COIL CHART

TYPE	NOMINAL UNCASED DIMENSIONS	WEIGHTS UNCASED (OUNCES)	MOULDED DIMENSIONS
TC 0	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 1	1 5/8" x 5/8"	less than 3	1 3/4" OD x 3/4" H
TC 2	2 9/32" x 15/16"	10	2 3/4" OD x 1/8" H
TC 3	1 1/2" x 5/8"	2 1/2	1 3/4" OD x 3/4" H
TC 4	1 7/32" x 19/32"	less than 2	1 5/16" OD x 23/32" H
TC 5	1 7/32" x 19/32	less than 2	1 5/16" OD x 23/32" H
TC 6	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 7	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 8	1 9/16" x 5/8"	less than 2	1 3/4" OD x 3/4" H
TC 9	1" x 3/8"	less than 1/2	1 1/16" OD x 1/2" H
TC 10	1 3/32" x 15/32"	1	1 1/4" OD x 5/8" H
TC 11	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 12	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 13	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 14	5/8" x 9/32"	less than 1/4	3/4" OD x 1/2" H
TC 15	1 7/8" x 7/8"	5	2" OD x 1" H
TC 17	1 3/32" x 15/32	less than 1	1 1/4" OD x 5/8" H
TC 20	1 3/32" x 15/32"	1	1 1/4" OD x 5/8" H
TC 27	1 9/16" x 11/16"	2 1/4	1 3/4" OD x 3/4" H





Burnell & Co., Inc.
PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
10 PELHAM PARKWAY
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TELETYPE: PELHAM 3633

Dept. E-9

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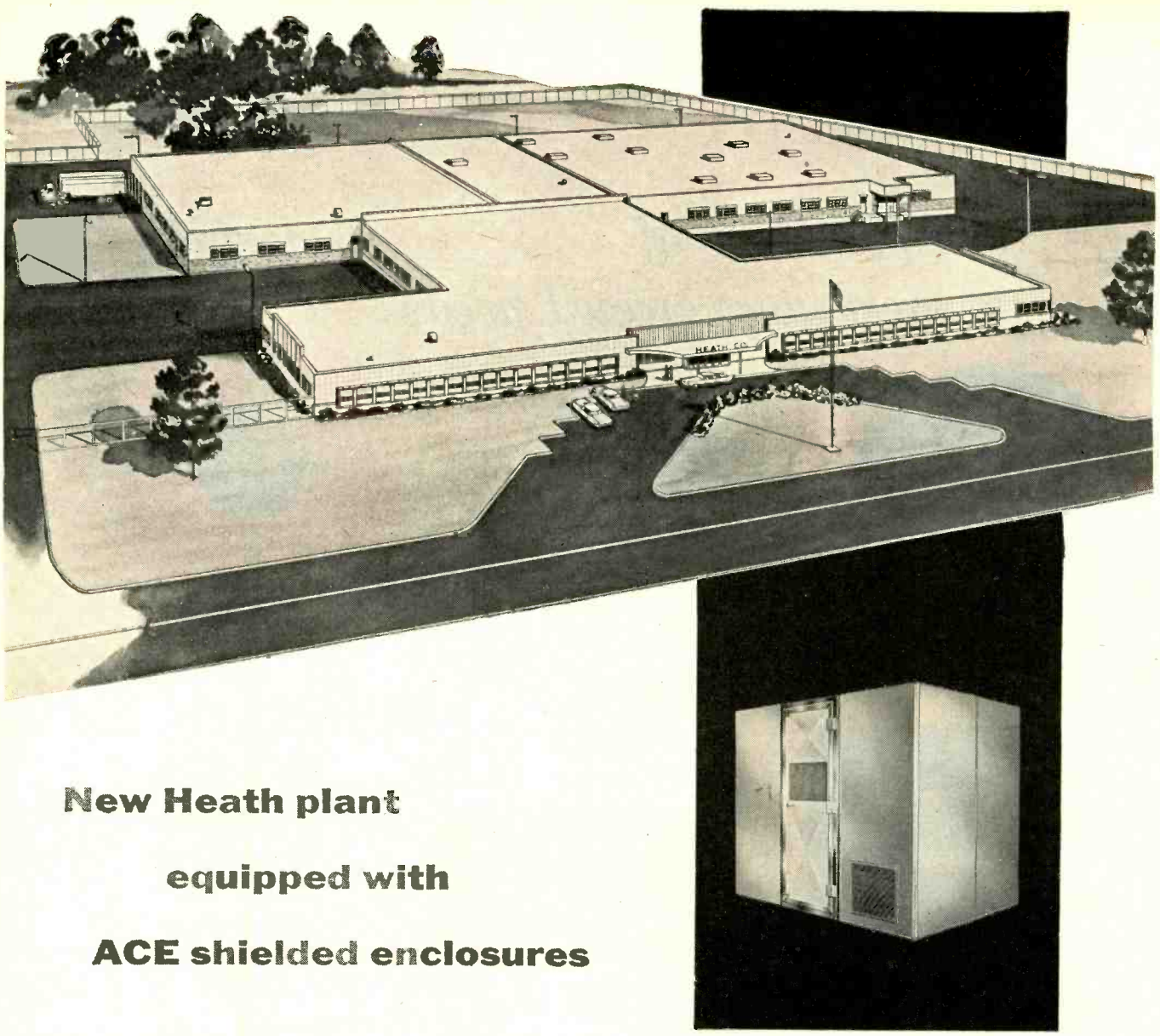
TELETYPE: PASACAL 7578



New Heath plant equipped with ACE shielded enclosures

Heath Company — manufacturer of the famous Heathkit line of Amateur Radio Kits, Hi-Fi Equipment and Electronic Instruments—believes in positive r-f interference protection. The company's new plant at Benton Harbor, Michigan, has ACE shielded enclosures for its design and development work . . . for repairs and alignment. All critical measurements are completely shielded from r-f interference.

ACE's patented RFI* and Cell-Type Designs guarantee high attenuation with dependable r-f interference protection at all frequencies. Modular construction permits quick-and-easy size changes. Enclosures are designed and constructed to ensure permanent r-f leak-proof performance.

• • •

Let an ACE Engineer help you work out an effective and economical solution to *your* shielding problem. Whether your problem involves one unit or many, you'll find that ACE has the experience and the facilities to handle the complete job. Write for free catalog on standard ACE enclosures.

*Lindsay Structure

ACE

First and Finest in Shielded Enclosures

ACE ENGINEERING & MACHINE CO., INC.

Tomlinson Road • Huntingdon Valley • Pennsylvania

CIRCLE 36 READERS SERVICE CARD

high reliability . . . extreme compactness . . .

IN THE

NEW SANBORN 850

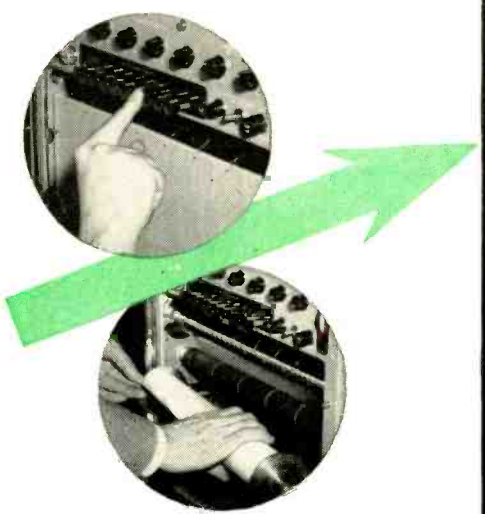
6- & 8-CHANNEL DIRECT WRITING SYSTEM

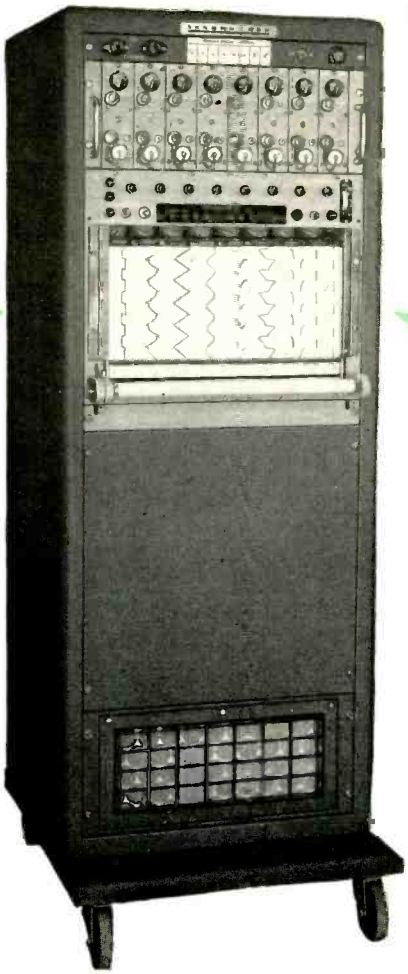
If you want a practical direct writing system for straightforward recording in the range from DC to 100 cps — such as computer readout, telemetry recording — look what the new Sanborn "850" offers in compactness, reliability and operating convenience. A complete 8-preamplifier module with power supply, plus an 8-channel flush-front recorder package containing power amplifiers and power supply at rear, occupy only 24½" of "850" panel space.

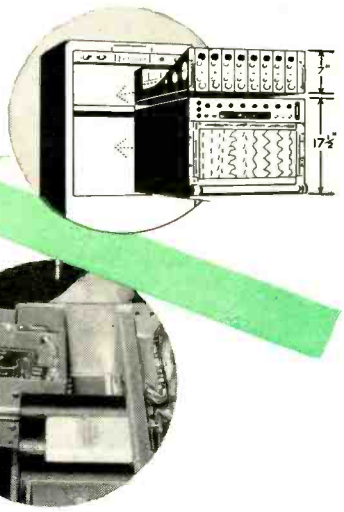
PERFORMANCE characteristics of an "850" include flat frequency response 0–70 cps, down 3 db at 100 cps (10 div. peak-to-peak amplitude) . . . thermal drift eliminated by current feedback power amplifiers . . . limiting at input to prevent amplifier saturation or cut off, so that damping is never lost . . . drift less than 0.2 div. for 20° to 40° C. changes, line voltage changes from 103 to 127 volts . . . gain stability better than 1% with 20° C. and 20 volt changes . . . linearity 0.2 div. over 50 divisions . . . clear, permanent, inkless recordings in true rectangular coordinates.

IN RELIABILITY, "850" features include fully transistorized power amplifiers and power supply . . . rugged galvanometers with low impedance, high current, enclosed coil assemblies and velocity feedback damping . . . JAN components wherever practical, such as MIL-T-27 hermetically sealed power transformers, MIL-approved electrolytics in power supplies, etc. . . . forced filtered air cooling for stable operation.

And in operating **CONVENIENCE,** an "850" system provides such advantages as nine electrically controlled chart speeds, selected by pushbuttons . . . a choice of interchangeable Preamplifiers (DC Coupling and Phase Sensitive Demodulator presently available, with others in development) . . . remote control of chart drive, speeds, timer and marker . . . monitoring connection points . . . a Recorder that loads from front and has built-in paper take-up and paper footage indicator.







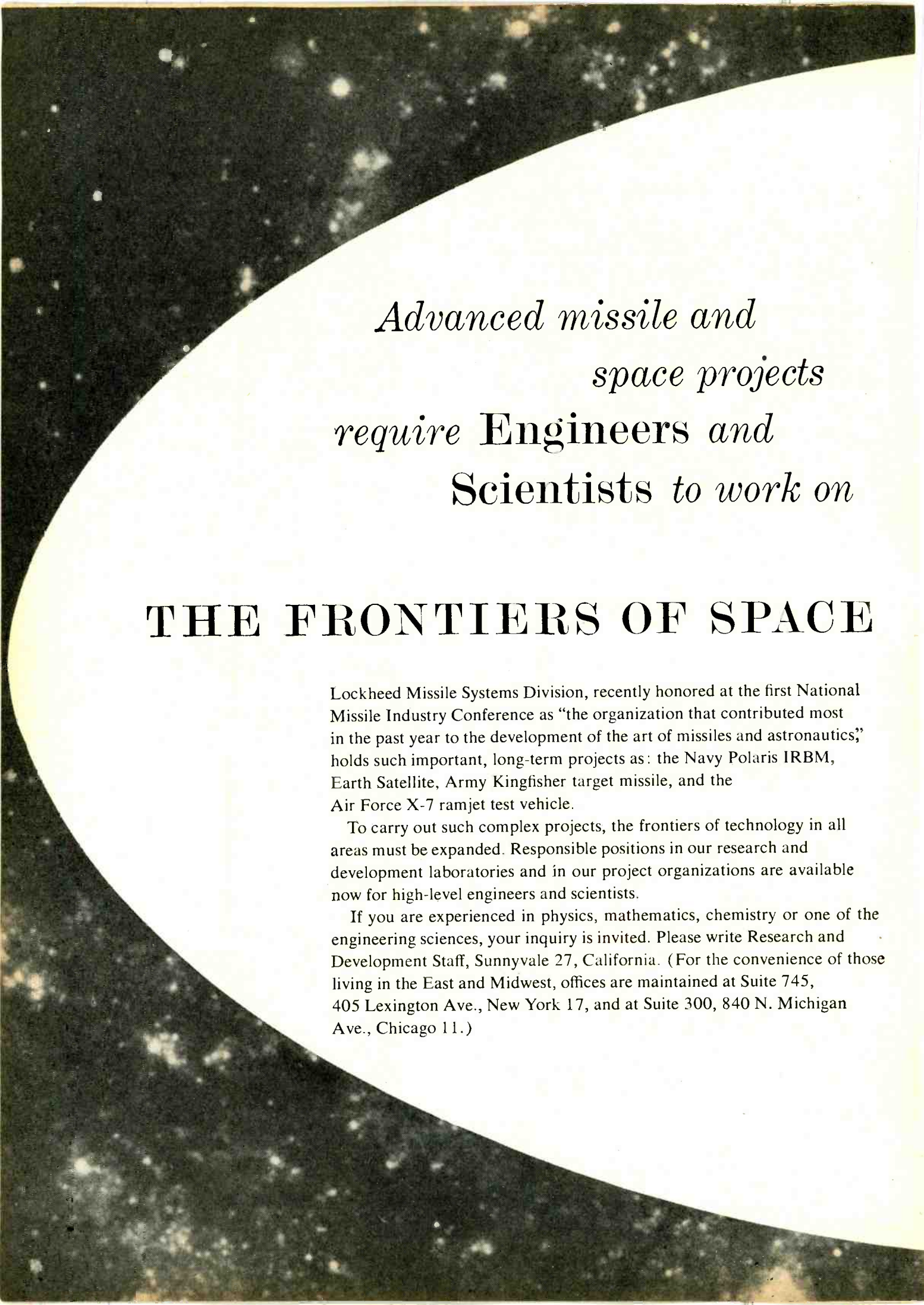
SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.

Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

(All data subject to change without notice)

"VISIT SANBORN BOOTHS 957-959 AT I.S.A. SHOW"



Advanced missile and space projects require **Engineers** *and* **Scientists** *to work on*

THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as: the Navy Polaris IRBM, Earth Satellite, Army Kingfisher target missile, and the Air Force X-7 ramjet test vehicle.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. Responsible positions in our research and development laboratories and in our project organizations are available now for high-level engineers and scientists.

If you are experienced in physics, mathematics, chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 27, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Ave., Chicago 11.)

FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry:

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight: water, air, outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

TECHNOLOGY

ENEMY SIMULATOR

The Kingfisher is the nation's fastest target missile, developed for the Air Force and currently being manufactured for the Army to test the accuracy of our newest supersonic weapons.

It is a ramjet target vehicle with Mach 2-plus capabilities. The Kingfisher not only has the speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ
COOKE AIR FORCE BASE, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Today's courier sits at a Kleinschmidt keyboard

The lightweight portable Kleinschmidt teletypewriter is a one-man communication center, transmitting and receiving printed communications at any location, under any conditions.

The mobility of our modern Army demands the receipt of vital information instantly and accurately. There can be no delays, no uncertainty. Kleinschmidt teletypewriters and related equipment, developed in cooperation with the U.S. Army Signal Corps, speed teleprinted communications between outpost and command control, provide both sender and recipient with an identical original simultaneously. Looking ahead . . . planning ahead . . . setting the pace for almost 60 years has made the Kleinschmidt name synonymous with development and progress in the teleprinted communications field. Now the engineering skill and research facilities of Kleinschmidt Laboratories, Inc., are joined with those of Smith-Corona Inc, forecasting boundless new achievements in electronic communications for business and industry.

Pioneer in teleprinted communications equipment

KLEINSCHMIDT LABORATORIES, INC.

A subsidiary of Smith-Corona Inc • Deerfield, Illinois

Here's the "workhorse"

GOOD-ALL
Metal Enclosed Capacitors are first choice of more and more engineers

Today, "CP" styles per the MIL-C-25A are the "WORK-HORSE" capacitors of military electronics. Soon, new specifications such as MIL-C-0025 (USAF) and MIL-C-25B will exert their influence . . . but regardless of the specification number, more and more engineers specify GOOD-ALL for their preferred sources. There are sound reasons why high quality is consistently maintained.

HERE'S WHY ENGINEERS ARE CHOOSING GOOD-ALL

- Well engineered designs
- Skilled assembly personnel
- Modern production facilities
- Rigid Quality Control

Good-All Specializes in these tubular types per MIL-C-25A

CP04-05-08-09 CP10 CP11 Special variations

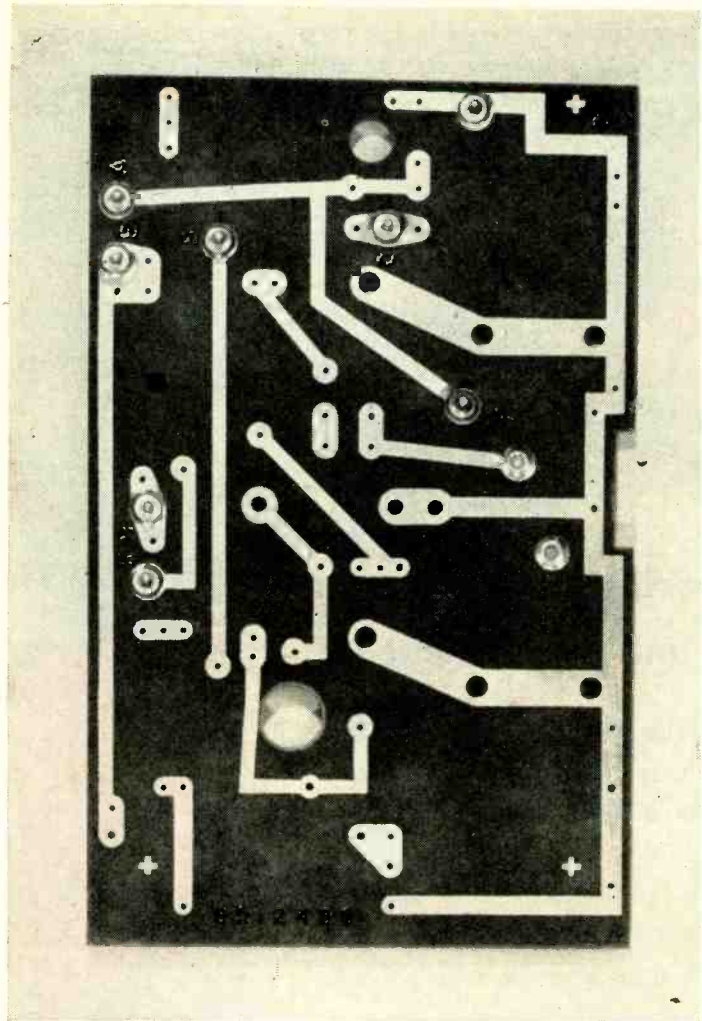
All popular values are available in stock for immediate delivery.

Good-All tubulars per MIL-C-25A now available at leading industrial distributors.

Good-All
CAPACITORS

GOOD-ALL ELECTRIC MFG. CO.
OGALLALA, NEBRASKA
A LEADING MANUFACTURER OF TUBULAR, CERAMIC DISC AND ELECTROLYTIC CAPACITORS

In Canada, 700 Weston Road, Toronto 9, Ontario



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 28E. For high mechanical strength, low moisture-absorption, and good insulation resistance, CDF Di-Clad laminates of epoxy resin laminated with glass fabric offer the designer a strong, reliable combination.

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.

†Trademark of Continental-Diamond Fibre Corporation
*Du Pont trademark for its tetrafluoroethylene resin.

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.

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Bird COMPANY • NEWARK 16, DEL.

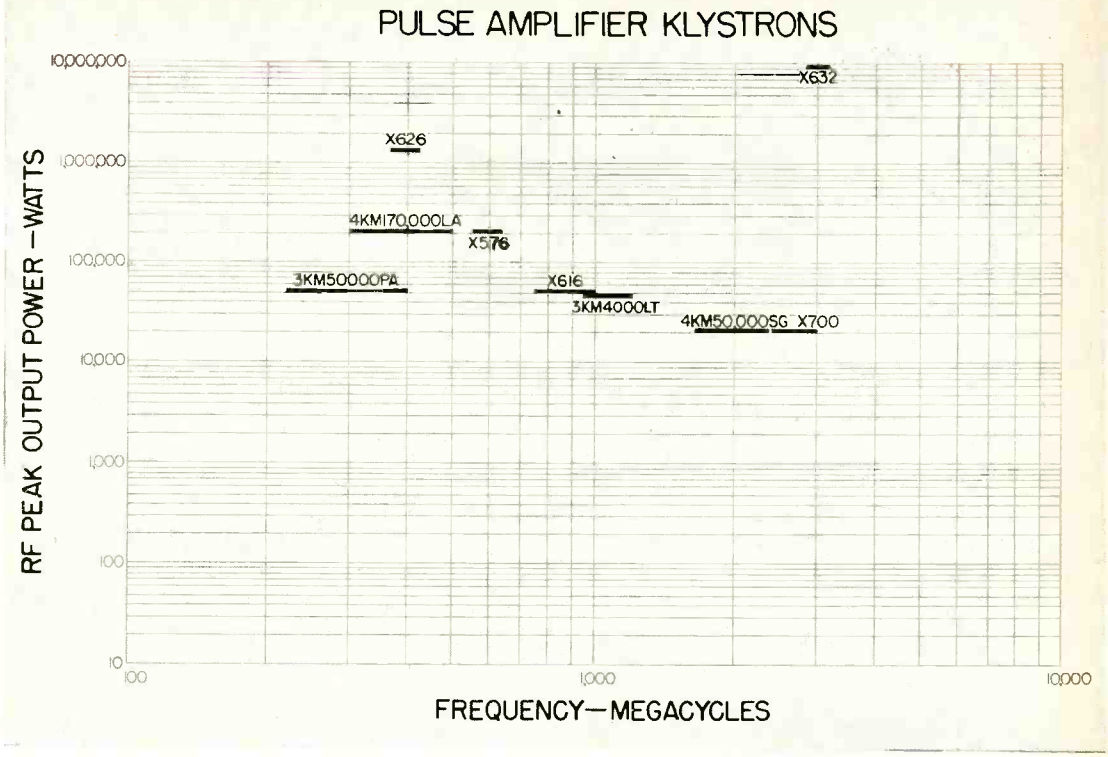
TYPICAL Di-Clad PROPERTY VALUES

	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

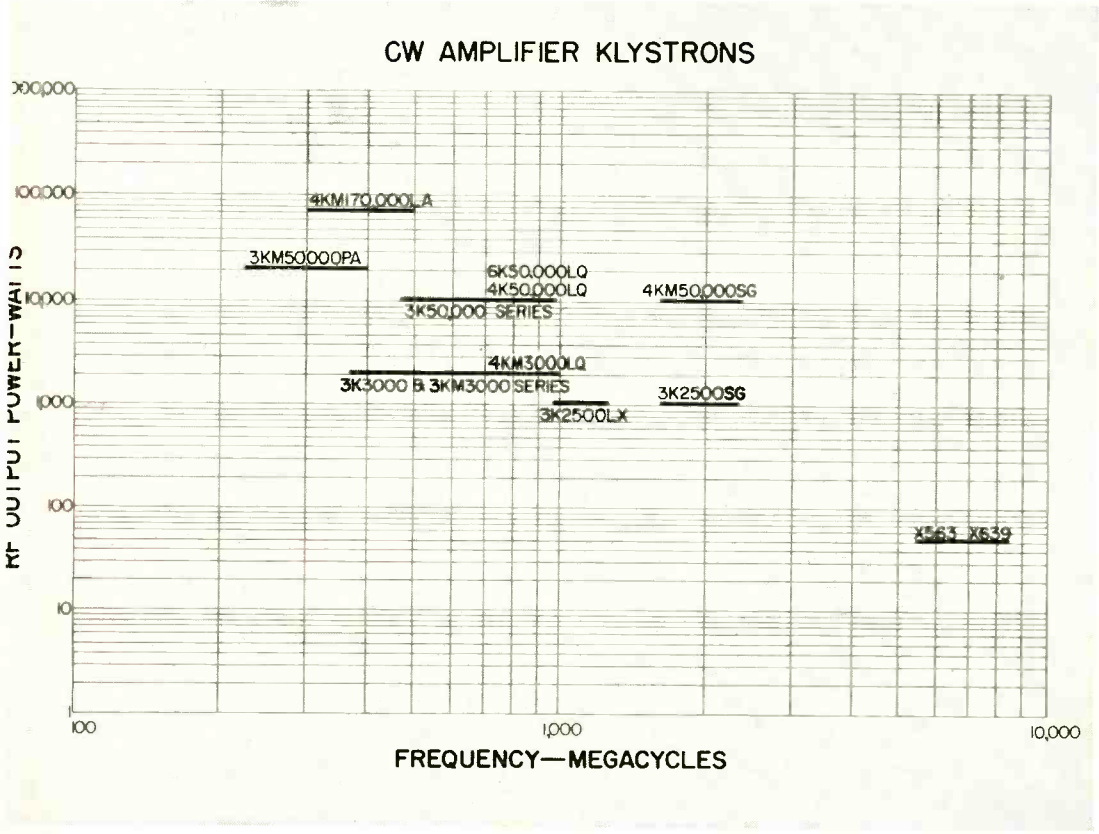
All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

Eimac First for Power Amplifier Klystrons



...Across the RF SPECTRUM



The exceptional ability of Eimac amplifier klystrons to conveniently and reliably generate high RF power at ultra-high and super-high frequencies makes them ideal for use in such important aeronautical applications as high-power ground-to-air communications, TACAN and other air navigational systems, super-power radar for missile tracking, tropo-scatter communications networks for early warning defense and other UHF microwave systems.

The broad frequency coverage and wide power range now offered by Eimac amplifier klystrons is shown in the accompanying charts. Frequency coverage extends into the SHF range, and multi-megawatt pulse output powers are available.

For more detailed information on Eimac's reliable, simplified approach to high power at high frequencies, write for a copy of Klystron Facts Case Five. The Eimac Application Engineering Department will gladly assist you in planning the use of Eimac power klystrons.

EITEL-McCULLOUGH, INC.

SAN CARLOS CALIFORNIA

Eimac First for Power Amplifier Klystrons

Eimac®

EIMAC DESIGNED AND MANUFACTURED PRODUCTS

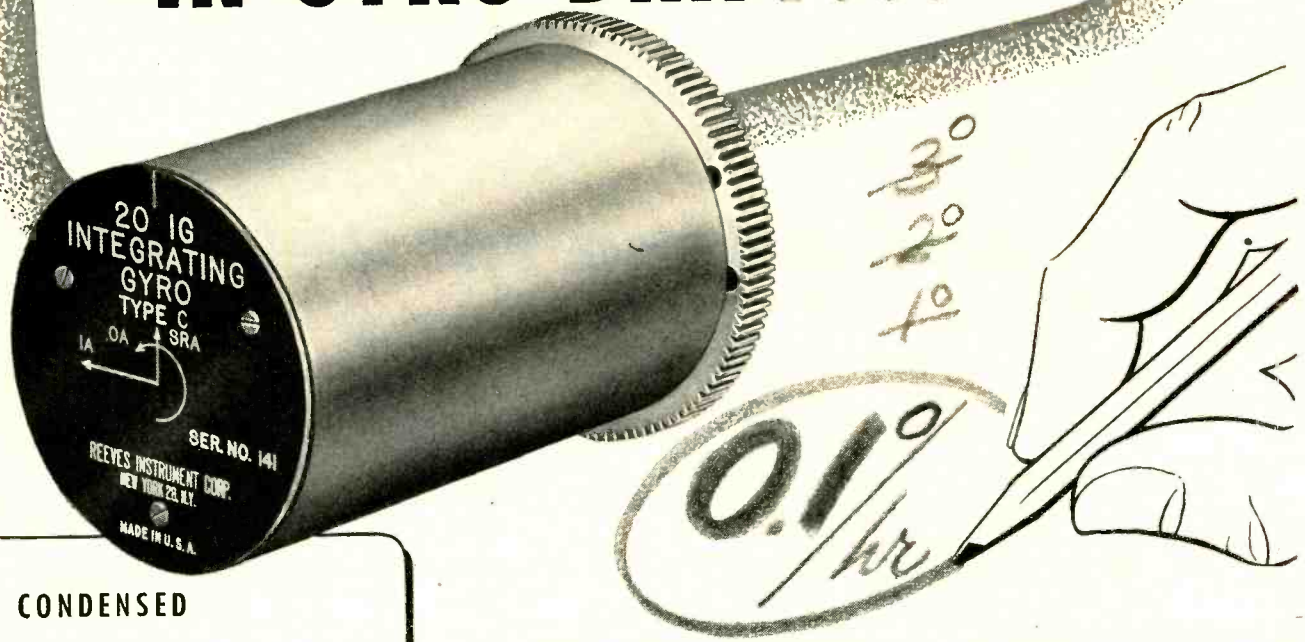
Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes
Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps
Traveling Wave Tubes

Eimac family includes more than 40 ceramic electron tube types

Reeves INSTRUMENT CORPORATION

achieves

DRAMATIC REDUCTION IN GYRO DRIFT...



CONDENSED PERFORMANCE DATA

Trimmed drift rate:
0.1°/hr. rms
0.3°/hr. max.

Mass unbalance:
5.0°/hr./g

Anisoelastic constant:
0.025°/hr./g² rms

Maximum command turning rate:
over 20°/sec.

Dimensions:
2" dia., 4" long

IN NEWEST DESIGN 20 IG INTEGRATING GYROS

Representing a major breakthrough by Reeves' gyro research laboratories, these advanced instruments show a small fraction of the drift rate hitherto considered low for high-performance units in this class.

Other characteristics are also outstanding, including extremely low anisoelastic constant and high command turning rate.

Of equal importance is the fact that these instruments measure up in every way to well-known Reeves standards of precision, ruggedness and RELIABILITY in regular production models. They are now available, and we invite your inquiries for detailed information.

Other Reeves Gyros and Accelerometers meeting equally exacting standards for performance and reliability include a comprehensive series of 10 IG, 20 IG and HIG 5 Integrating Gyros; 20 PIG Pendulous Integrating Gyros and 10A and 20A Linear Accelerometers. Technical information on request.

Reeves INSTRUMENT CORPORATION

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Roosevelt Field, Garden City, New York

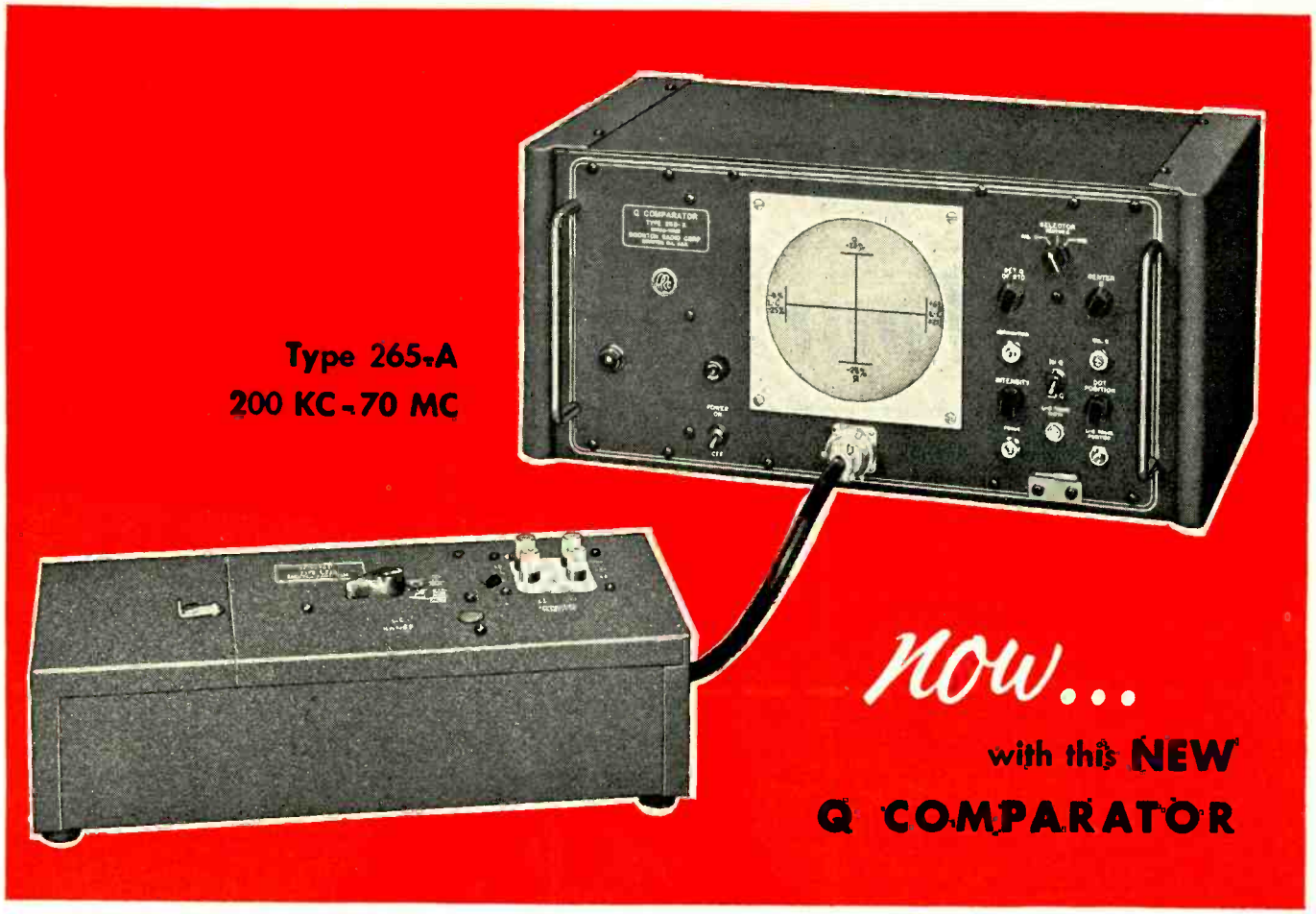
1RV58


REAC Analog Computers


Precision Floated Gyros


Precision Resolvers and Phase Shifters


Servo Mechanical Parts



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SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 200 Kc. to 70 Mc. in 11 ranges, using 6 plug-in inductors.

INDICATING SYSTEM: Large 5" cathode ray tube, calibrated in % Q on the vertical axis and % L-C on the horizontal axis.

TOLERANCE LIMITS: ±25% Q, calibrated in increments of 5%; ±5% and ±20% L-C, calibrated in increments of ±1% and ±5% respectively.

Q RANGE: 50 to 500

INDUCTANCE RANGE: 1 Microhenry to 10 Millihenries.

CAPACITANCE RANGE: 2 MMF. to 1000 MMF.

RESISTANCE RANGE: 1000 to 500,000 Ohms.

POWER SUPPLY: 105-125 Volts, 50-60 Cycles.

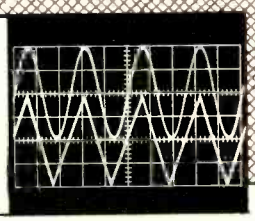
PRICE: $750.00 F.O.B. Boonton, N. J.

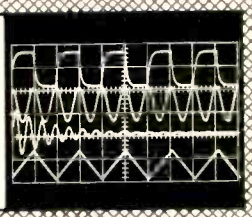
- **SAVES VALUABLE INSPECTION TIME**
  Gives you instantaneous readout
- **EXTREMELY SIMPLE TO USE**
  No operator training required
- **NO TUNING OR ADJUSTMENT NECESSARY**
  Gives simultaneous indication of both Q and L-C
- **ELIMINATES OPERATOR MEASUREMENT ERROR**
  Single readout on large CRT screen

Write for complete information

BOONTON RADIO CORPORATION
Boonton, New Jersey

Two Beams Four Traces

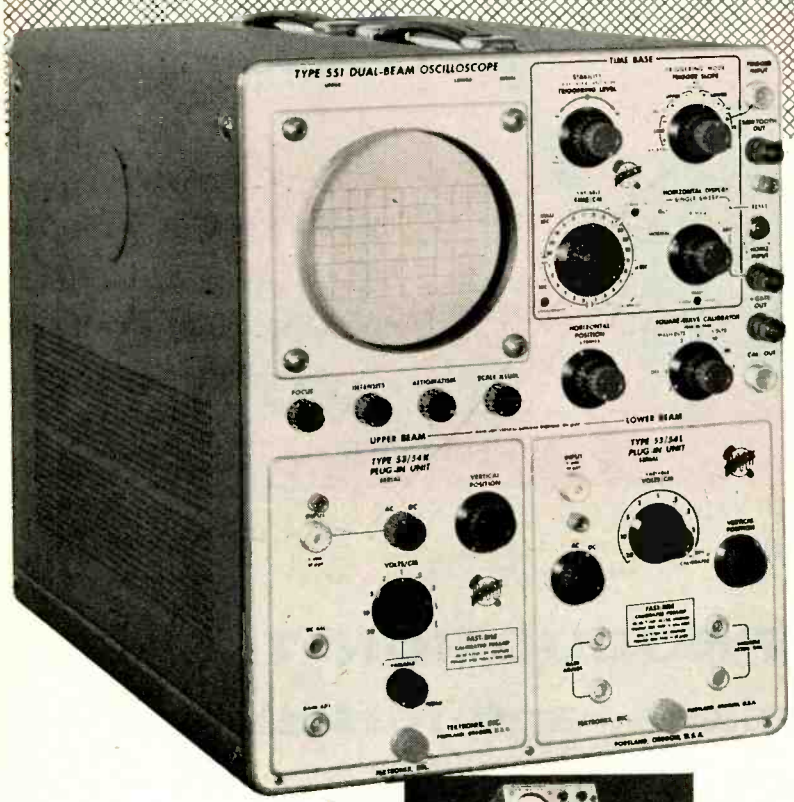




DC-to-25 MC

TYPE 551

TEKTRONIX®



When the job requires it, you can double up and display four different waveforms at once with this dual-beam oscilloscope. Type 53/54C Dual-Trace Plug-In Units in both channels make possible the four-trace display.

Less spectacular but more frequent uses of this versatile fast-rise oscilloscope include waveform comparison measurements on a dual-beam display in the dc-to-25 mc range, and all the usual and unusual applications of a high-performance laboratory oscilloscope.

TYPE 551 SPECIAL FEATURES

WIDE-BAND VERTICAL AMPLIFIERS
Main-unit risetimes—12 mμsec.
Passbands and risetimes with Type 53/54K units—dc-to-25 mc, 0.014 μsec.

SIGNAL-HANDLING VERSATILITY
All Type 53/54 Plug-In Units can be used in both channels.

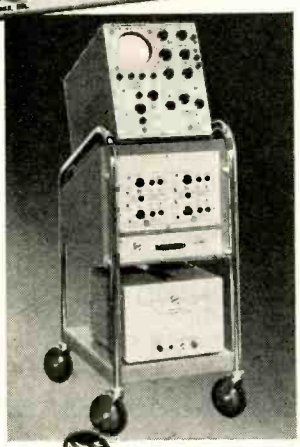
0.2 μsec DELAY NETWORKS

WIDE SWEEP RANGE
0.02 μsec/cm to 12 sec/cm.

SINGLE SWEEPS
Lockout-reset circuitry.

COMPLETE TRIGGERING
Fully-automatic or amplitude-level selection with preset or manual stability control.

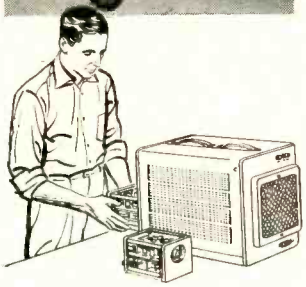
10-kv ACCELERATING POTENTIAL
Brighter display for fast sweeps and low repetition rates.



PRICE

without plug-in units	$1725
Type 500/53A Scope-Mobile	$108
Type 53/54K Fast-Rise Plug-In Preamplifiers, each	$125
Type 53/54C Dual-Trace Plug-In Preamplifiers, each	$275

Prices f.o.b. factory.



Please call your Tektronix Field Engineer or Representative for complete specifications and, if desired, to arrange for a demonstration at your convenience.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

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AlSiMag production is a science . . . but also an art. Technical knowledge and skilled craftsmen are equally important. Here exclusive techniques have been developed over more than half a century of specialized experience. Our engineers can often offer redesign suggestions to improve performance and reduce costs.

Designs carefully studied before orders accepted . . . but in almost 100% of the cases which are accepted, AlSiMag parts are produced to specification on promised schedule. Blueprint or sketch with details of operation will bring you complete information on AlSiMag for your application.

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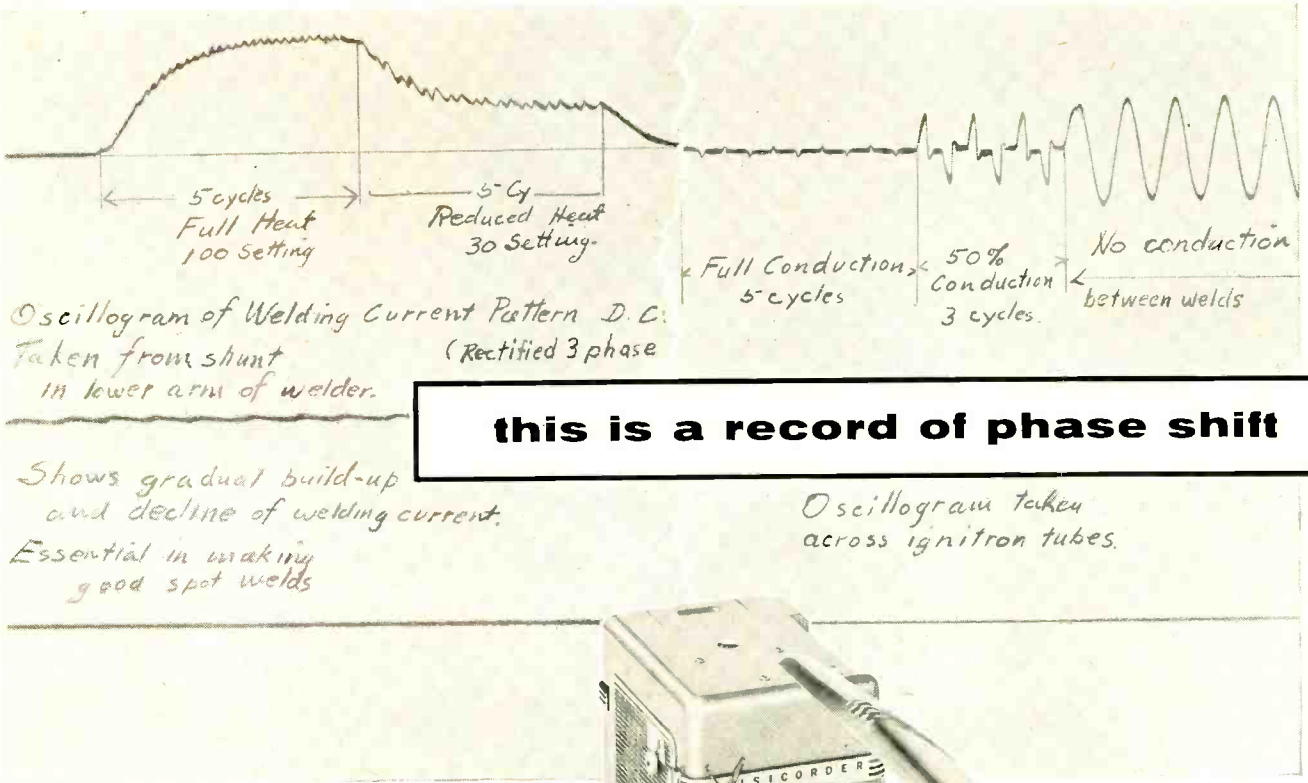
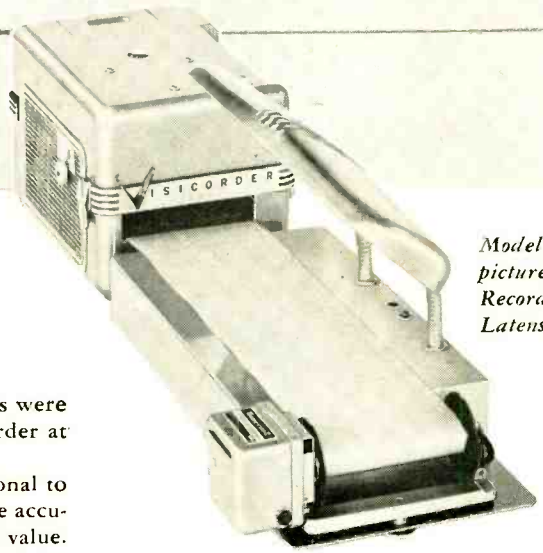


Visicorder Record — ⅔ actual size



Model 906A Visicorder pictured with Record Takeup and Latensifier Unit.

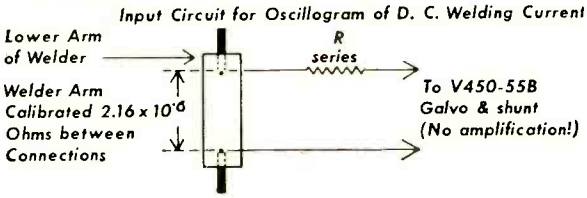
These welder phase-shift heat-control patterns were directly recorded with a Honeywell 906 Visicorder at Bristol Aircraft (Western) Limited in Winnipeg.

Since the welding heat generated is proportional to the square of the current value, phase shift must be accurately controlled in order to determine the heat value. If the phase shift dial is not accurately calibrated, the result is too much or too little heat, and a poor weld.

In this application, the Visicorder is an essential guide to accurate calibration, since ink-type recorders do not cover the sensitivities and frequencies needed and an oscilloscope would present a continually changing pattern since most recording periods are less than 10 cycles. The directly-recorded Visicorder patterns allow a convenient study of the exact time when the current wave form was being cut off.

Here is the circuit used in this test.

Input Circuit for Oscillogram of D. C. Welding Current



The Honeywell Visicorder is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new Accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

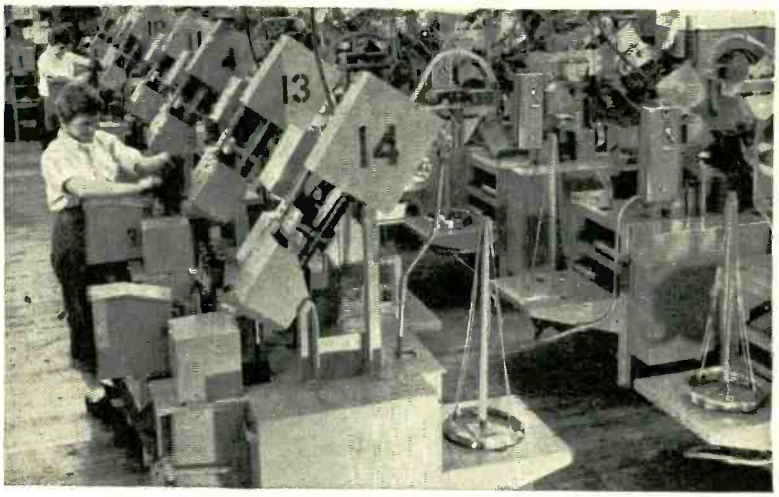
Honeywell

Industrial Products Group

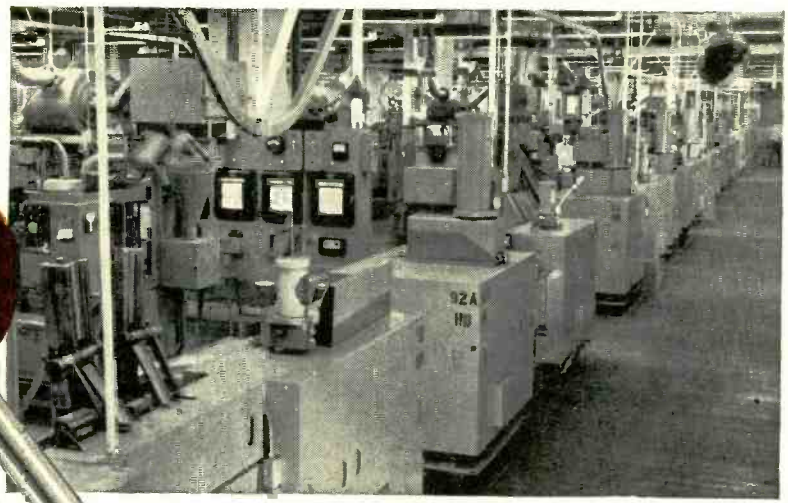
Reference Data: Write for Visicorder Bulletin

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

Miracle of Precision and Uniformity



AUTOMATIC HEADING MACHINES form heads on the end of lead wires to make sure they will be solidly anchored in the resistor body. Wire has been previously tinned for easy soldering.



AUTOMATIC MOLDING MACHINES take the resistance powder, insulation powder, and lead wires, and hot mold them under closely controlled high temperature into one integral unit.

AUTOMATIC COLOR CODING MACHINES apply color bands and oven-bake the enamel at high temperatures to assure that the color coding will withstand the maximum operating temperatures of 150°C and all types of cleaning solvents.

ALLEN-BRADLEY HOT MOLDED RESISTORS ARE PRECISELY CONTROLLED AT EVERY STAGE OF PRODUCTION

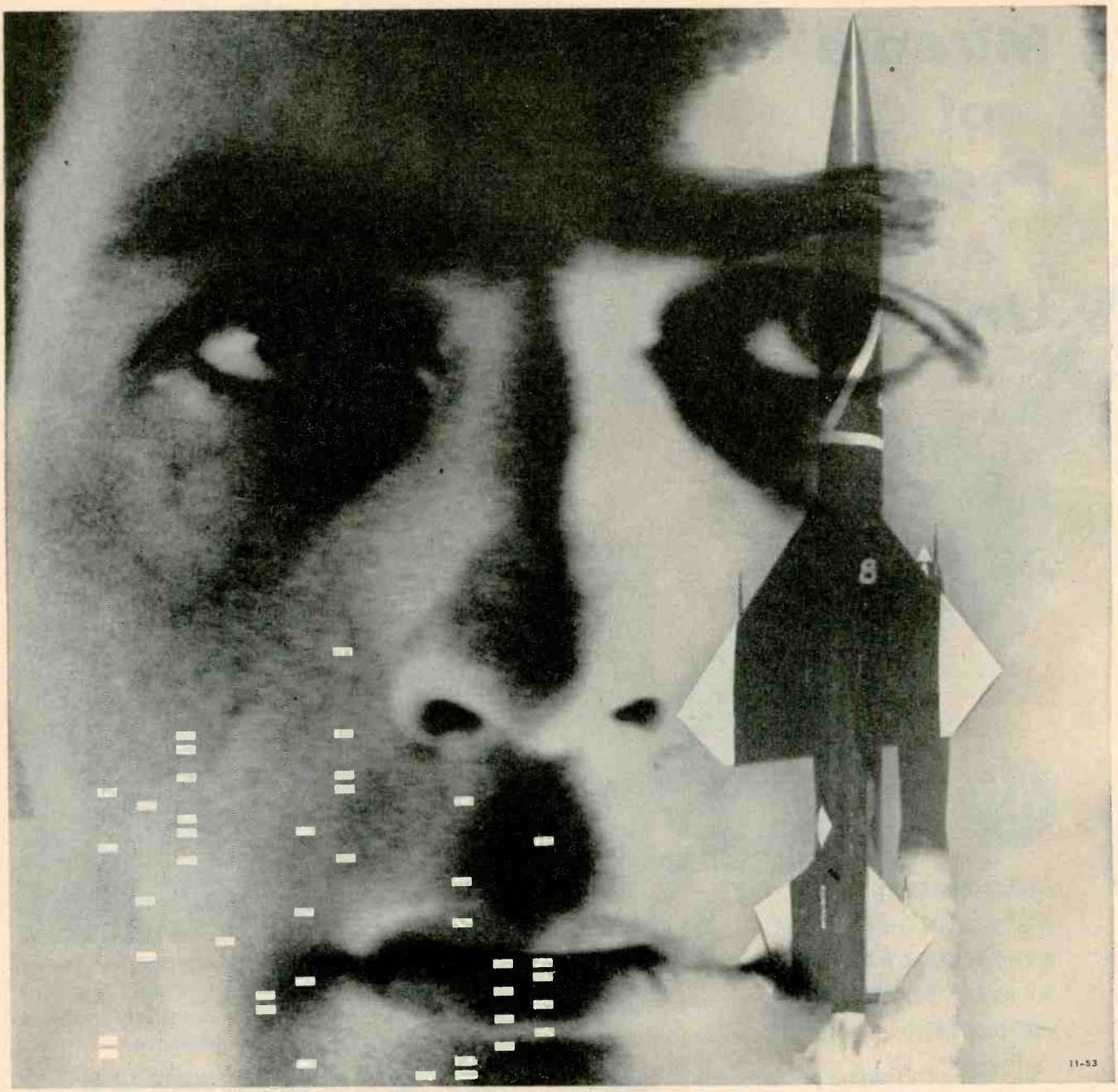
Allen-Bradley has been making precisely uniform resistors — not by the millions *but by the billions* — over the years. The *exclusive* hot molding process — developed and perfected by Allen-Bradley — uses specially designed automatic machines that incorporate precision control at *every* step of production. Shown here are a few of the special machines that make possible the amazing uniformity — from resistor to resistor, year after year — for which Allen-Bradley composition resistors are famous.

Allen-Bradley Co., 110 W. Greenfield Ave.
Milwaukee 4, Wisconsin

In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

ALLEN-BRADLEY
QUALITY

Electronic Components



Man-Machine Relationships: A New Field for Engineers and Scientists

A new field for Operations Research Specialists, Engineers, Computer Programmers and Behavioral Scientists has arisen from SDC's work on relationships of men and machine systems.

It involves two major projects: 1 *creating and conducting large-scale training programs in present and planned air defense systems; and* 2 *operational computer programming for SAGE.*

Attaining the most effective interaction between men and machines in these programs is of prime importance. It requires intensive effort in an unusual combination of technical and scientific areas. As such, it is a new field of endeavor.

Both programs also have these elements in common: • they are constantly changing in problems • they are long-range in nature • they are essential to the welfare of the United States.

The close interrelationship of these programs, the widely diversified specialists engaged in them, and the dominating influence of man-machine relationships make SDC's work unique. Operations Research Specialists, Engineers, Computer Programmers, Behavioral Scientists – all find their assignments reflect the unique qualities of this new field.

The growing complexity of SDC's work has created a number of positions in these fields. Inquiries are invited. Address: R. W. Frost, 2408 Colorado Avenue, Santa Monica, California, or phone collect at EXbrook 3-9411 in Santa Monica.

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SYSTEM DEVELOPMENT CORPORATION
Santa Monica, California

An independent nonprofit organization, formerly a division of The RAND Corporation

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ROTARY

MINIATURE: 8, 10, and 12 positions; up to 18 contacts per wafer.
Series A

SMALL: Up to 12 positions in phenolic, Mycalex, or steatite insulation.
Series F

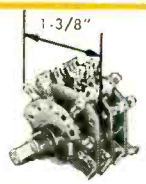
ADAPTABLE: 8, 10, 12, and 14 positions; many variations; economical.
Series J, K, N

GENERAL PURPOSE: Up to 12 positions; 30°, 45°, 60° throw.
Series H

LOW COST: Up to 12 positions; staked or strut screw construction.
Series QH

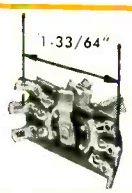
18-POSITION: Single or double eyelet fastening of clips.
Series L

24-POSITION: 15° throw handles complex circuits.
Series MF



LOW COST: 2 to 5 positions; fits in limited space.
Series 50, 53

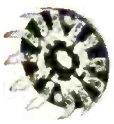
SIMPLE SWITCHING: Up to 5 positions combined with AC switch.
Series 52, 54



SIMPLE SWITCHING: Up to 4 positions; numerous variations.
Series 20

LEVER OPERATED: 2 to 5 positions; numerous versions using std. wafers.
Series 185

CONCENTRIC SHAFTS: Dual and triple shafts with many wafer types.



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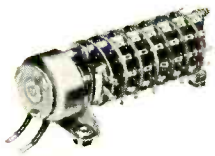
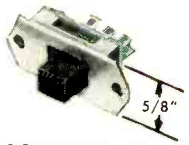
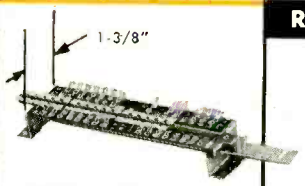


SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

SLIDE



2-POSITION: Shorting type with floating slider.
Series 70

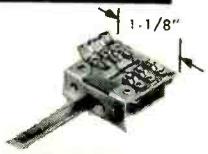


COMPLICATED SWITCHING: 2 to 4 positions; up to 20 poles; very thin.
Series 150

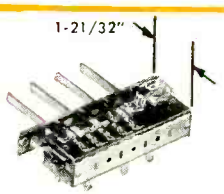
ROTARY SLIDE

COMPACT—2 to 4 positions; max. switching in min. space.
Series 160

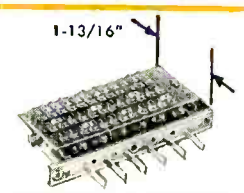
PUSHBUTTON



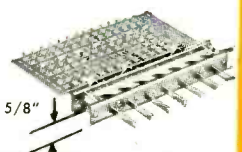
SINGLE BUTTON—1 to 4 poles; spring return and push-push.
Series 170, 175



SIMPLER CIRCUITS: 3 to 12 buttons; very adaptable unit.
Series 80



COMPLICATED CIRCUITS: 1 to 18 buttons, up to 32 contacts each.
Series 130



ULTRATHIN: 1 to 12 buttons; up to 14 contacts per button.
Series 131

EACH SWITCH IS PRETOOLED IN NUMEROUS VARIATIONS. DETAILS ON ANY SERIES ARE AVAILABLE ON REQUEST

For Recommendations on Unusual Applications, send us a sketch and short description.

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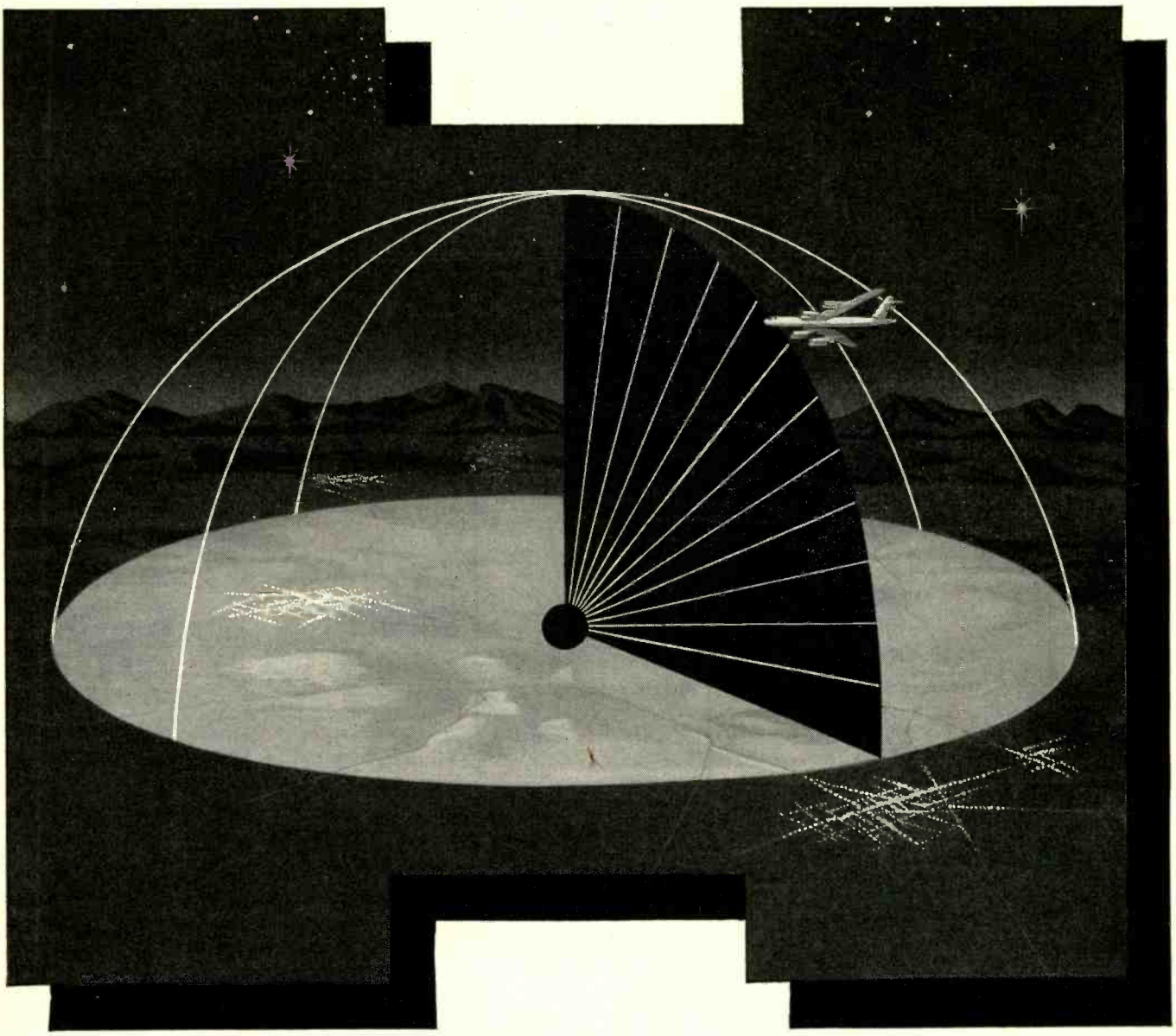


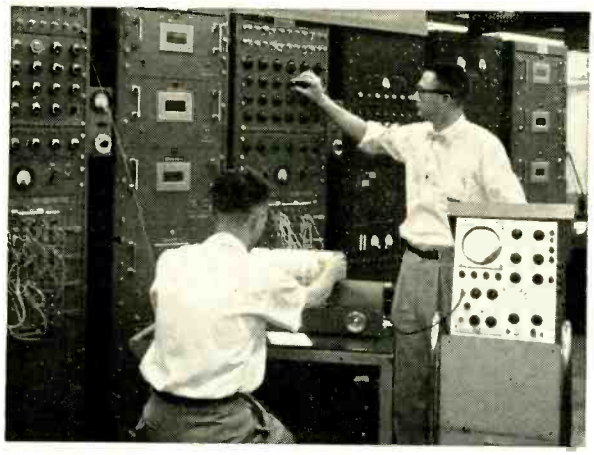
THAT NEVER LEAKS

To achieve umbrella-like radar protection Hughes engineers at Fullerton, California, have developed systems which position radar beams in space by electronic rather than mechanical means. These unique three-dimensional radar systems are digitally programmed to instantaneously detect high-speed enemy aircraft, even at low altitude.

Other defense systems under development at Hughes in Fullerton are Data Processors which monitor the movement of hundreds of aircraft, store the information and assign defense weapons; radars with beams capable of detecting and tracking missiles; and new radar systems for installation on surface and subsurface naval vessels.

Other Hughes activities are delving into similarly advanced areas of electronics. Engineers at Hughes Research & Development Laboratories are probing into the effects of nuclear radiation on electronic equipment, studying advanced microwave theory and applications, and examining communication on a spatial scale. Applying this advanced type of creative engineering to commercial projects is the task of engineers at the Hughes Products activity.

The highly advanced and diversified nature of Hughes projects offers creative engineers and physicists the opportunity to build a rewarding career in a progressive and expanding environment.



Research & Development Engineers use REAC computing equipment as an aid in such complex problems as systems simulation.

Reliability of the advanced Hughes Electronic Armament systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.

An immediate need now exists for engineers in the following areas:

Electron Tubes	Radar
Industrial Systems	Communications
Semiconductors	Circuit Design
Field Engineering	Microwaves
Computer Engineering	Systems Analysis

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-G-1, Culver City, California.

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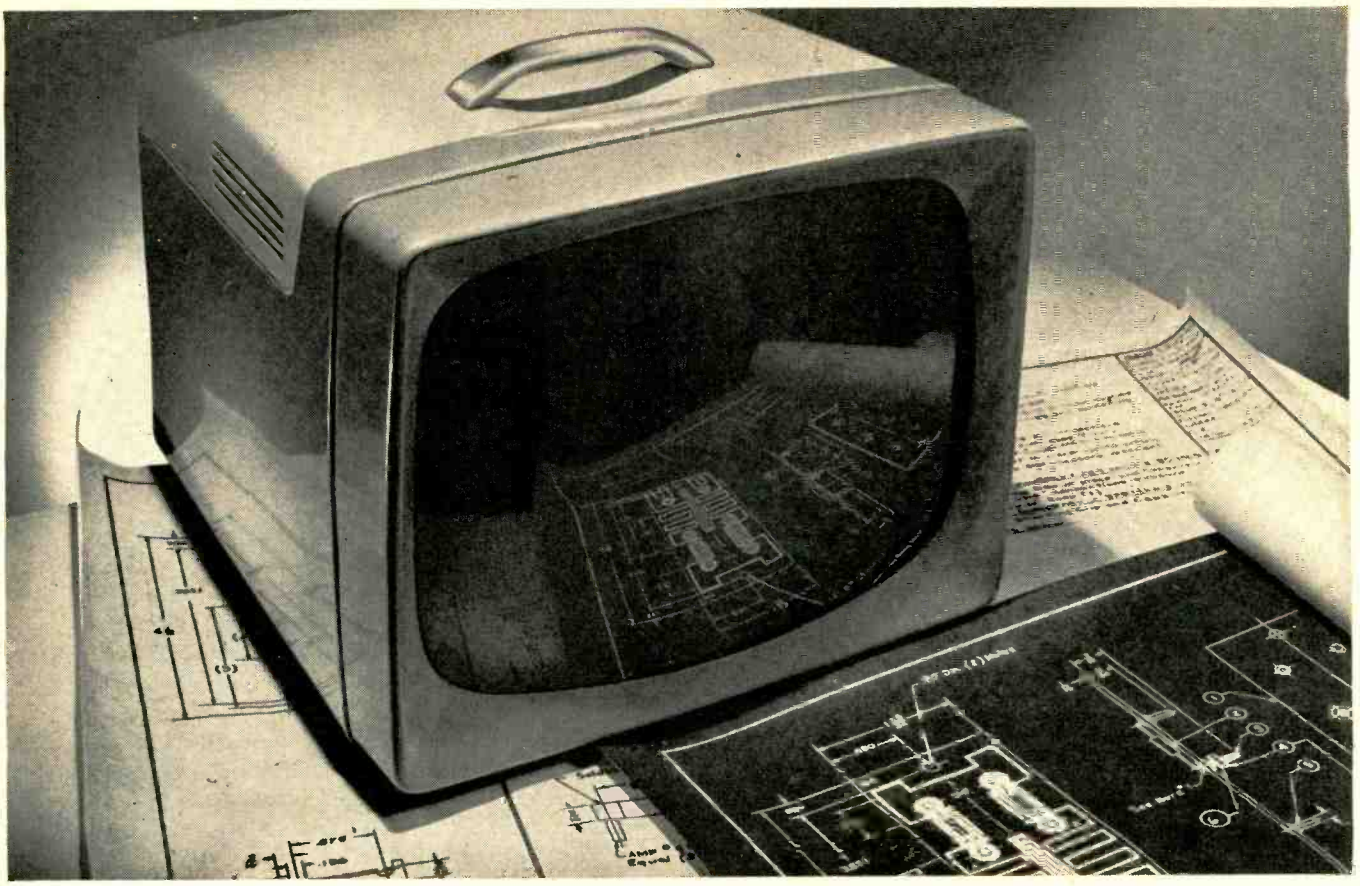


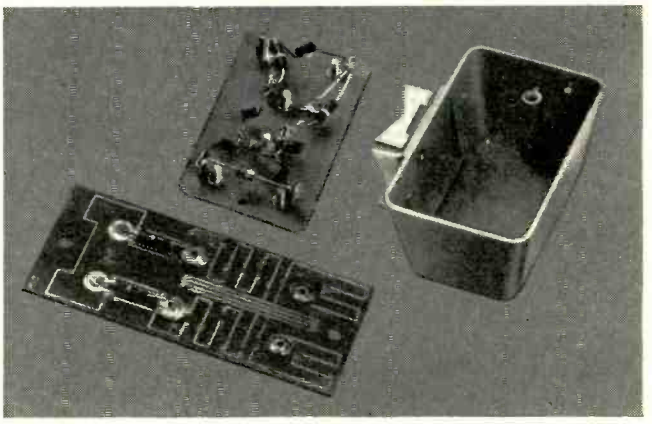
Taylor copper-clad laminate printed circuits reduce cost of TV crossover network by 66%

Also eliminate subsequent installation costs and improve reliability of part

Hugh H. Eby Company, Philadelphia, Pa., has reduced the cost of producing crossover networks for VHF-UHF television sets approximately two-thirds by changing production methods and switching to circuits printed on Taylor copper-clad laminate. It has also eliminated subsequent installation of the part on antenna masts, thereby greatly improving part reliability.

Taylor copper-clad laminate was selected for two reasons: dimensionally stable after hot punching, it assures uniform hole size and good registration; its rolled-copper surface, free of pinholes, pits and lead inclusions, provides consistently good etched circuits.

You, too, may have applications where Taylor copper-clad laminates will cut costs and improve reliability. Our application engineers will be glad to discuss them with you. Both the Norristown, Pa., and La Verne, Calif., plants are equipped for prompt supply of basic materials or fabricated parts. Write us for details. TAYLOR FIBRE CO., Norristown 40, Pa.



Above (right) is shown the old-style crossover network with its housing. Below it is the new printed-circuit network. The small, compact network costs one-third as much to produce and is assembled in the television set instead of on the antenna mast.

Taylor

LAMINATED PLASTICS ■ VULCANIZED FIBRE

SILICON RECTIFIERS

designed and manufactured to meet

THE NEW JAN SPECIFICATIONS

For AXIAL LEAD TYPES

JAN 1N538 (MIL-E-1/1084A)	JAN 1N540 (MIL-E-1/1085A)	JAN 1N547 (MIL-E-1/1083A)

now from AUTOMATIC

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers designed to meet the new JAN MIL-E-1 Specification

Type No.	Peak Reverse Voltage (VDC)	DC Output Current @ 25° C. Ambient (MA)	DC Output Current @ 150° C. Ambient (MA)	Maximum Reverse Current* (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
JAN 1N538	200	750	250	0.350	Axial lead	1084A
JAN 1N540	400	750	250	0.350	Axial lead	1085A
JAN 1N547	600	750	250	0.350	Axial lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

PRODUCTION QUANTITIES OF ALL TYPES AVAILABLE FOR FAST DELIVERY

Naturally, you can get these new axial lead JAN types direct from AUTOMATIC, and from authorized distributors throughout the country — and at prices that reflect General Instrument's years of volume production experience.

Together with the earlier JAN type stud mount group, AUTOMATIC now covers the entire medium power silicon rectifier field for the requirements of every military application.

More information? A complete set of data sheets is yours for the asking. Please write us today.

GENERAL INSTRUMENT SEMICONDUCTORS

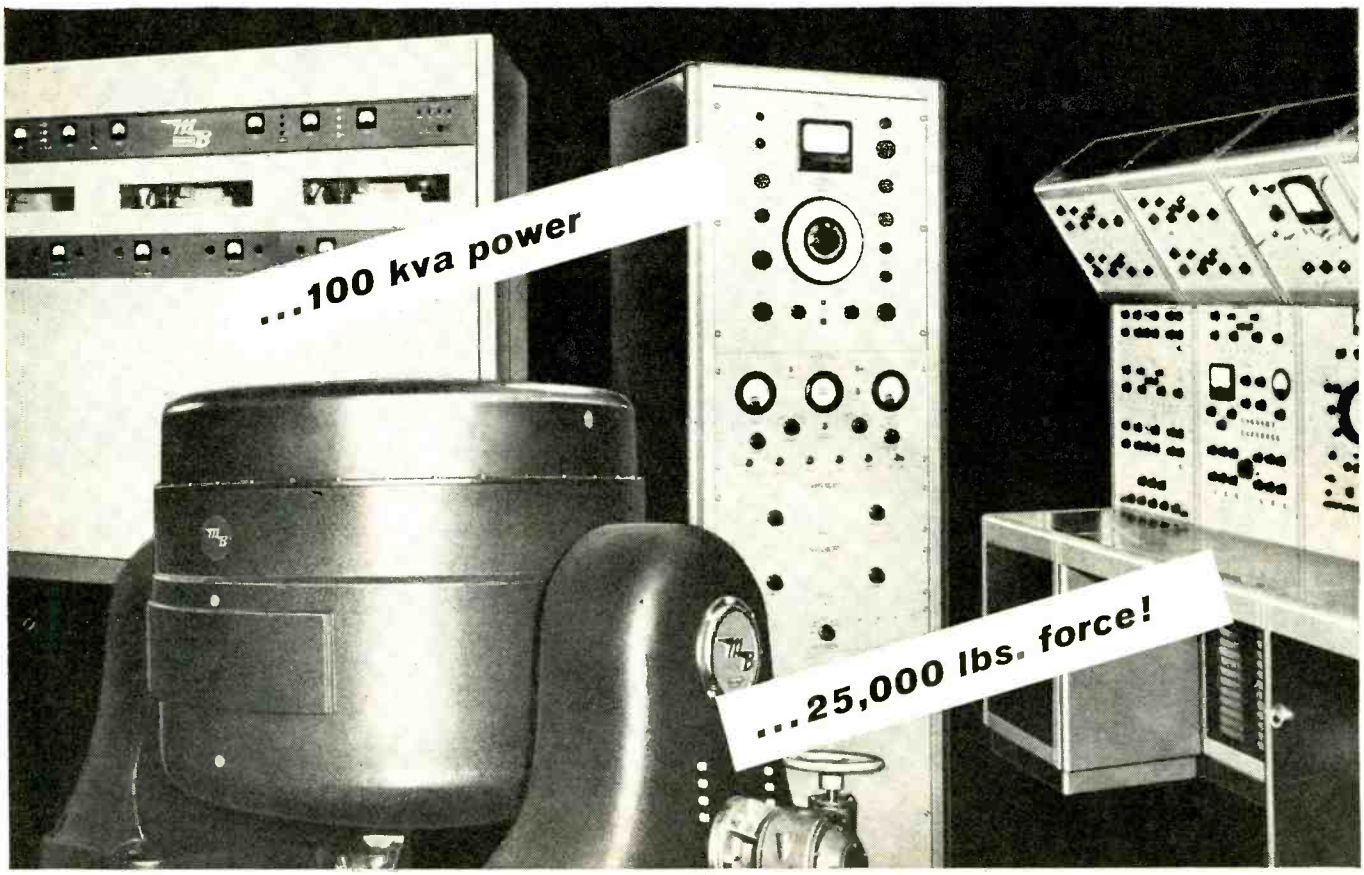
General Instrument Corporation also includes F. W. Sickles Division, Radio Receptor Co., Inc., and Micamold Electronics Manufacturing Corporation (Subsidiaries)

AUTOMATIC MANUFACTURING

MASS PRODUCERS OF ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR STREET, NEWARK 4, N. J.

MB develops largest vibration system!



THIS NEW, complete MB vibration test system is the largest in existence. It represents the most advanced equipment for high force, high frequency, high performance shake testing.

CONTINUOUS DUTY SHAKER: Featuring unique magnetic design, the MB C200 electrodynamic exciter delivers almost twice the force of its predecessor with but little increase in size. So efficient is this design, it reduces stray magnetic field at the table to under 20 gauss *without degaussing coil!* Unimode suspension (pat. pend.) of moving element permits full 1-inch linear table travel.

HIGH POWER AMPLIFIER: Rated at 100 kva continuous output, the MB-built T999 amplifier drives the shaker over its entire range under the most adverse reactive load conditions which are characteristic of electrodynamic exciters. It is designed by MB for optimum performance in both sine wave and complex motion testing, abounds with design advances and operating conveniences.

MATCHED CONTROLS: As part of the matched integrated MB system, the T68MC sine wave automatic cycling unit provides for remote control of amplifier, and contains all controls for running the shaker. The T88 complex motion console rounds out the system for the most exacting and advanced random motion testing.

UNDIVIDED RELIABILITY: Working with MB, you avail yourself of the longest experience in the field . . . the widest scope of test systems . . . the operational benefits of matched elements . . . the undivided responsibility for performance and service of the complete system . . . and the largest field service organization.

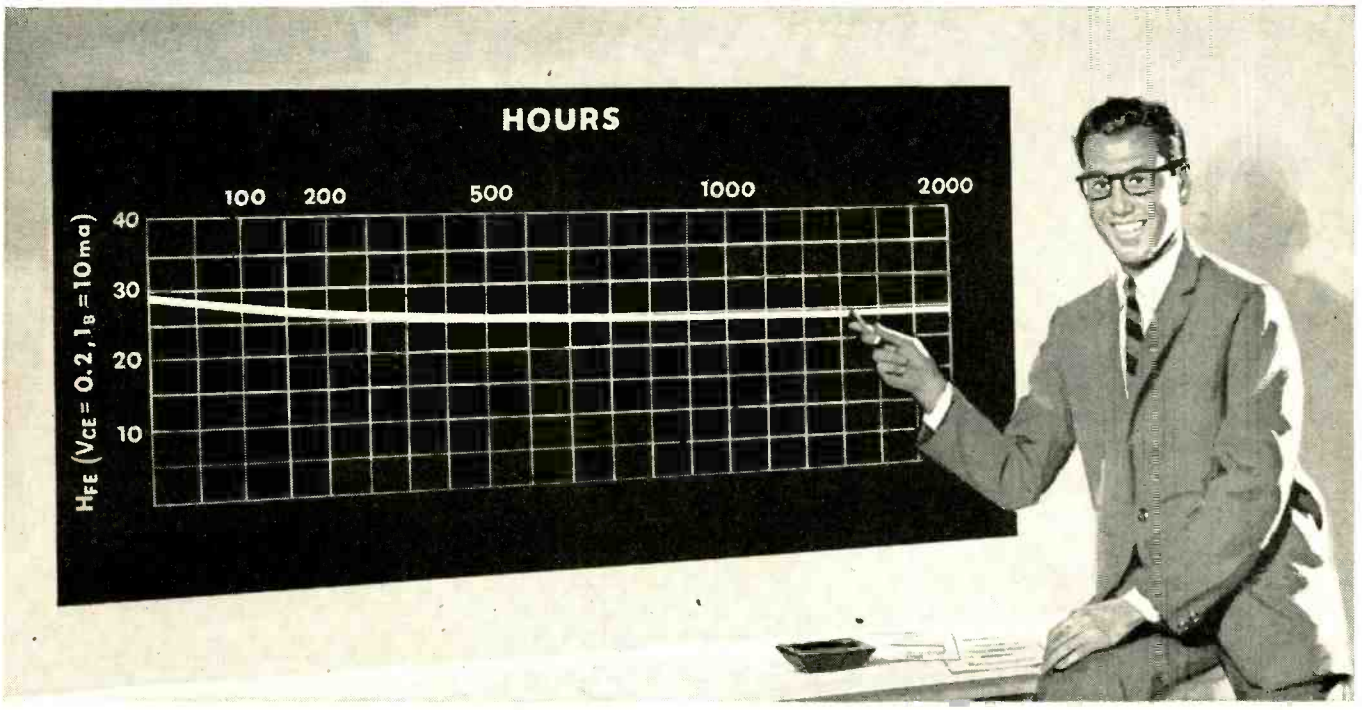
Send for Bulletin 470 which gives data on MB systems from 7000 to 25,000 pounds force. If you need less capacity, ask for Bulletin 435 (1750 to 5000 pounds force) or Bulletin 425 (1000 to 2500 pounds force).

largest producer of complete systems for vibration testing

MB manufacturing company 1075 State Street New Haven 11, Conn.

A Division of Textron Inc.

SYLVANIA–NPN SWITCHING TRANSISTORS

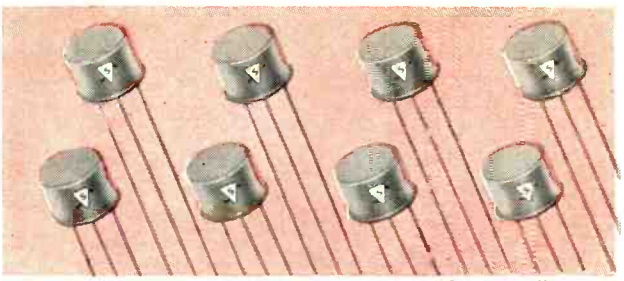


...still holding the line at 2000 hours

Eight new high stability NPN switching transistors designed for wide application in low and medium power switching circuits, are now available from Sylvania. They increase to 15, the total number of NPN switching types in the Sylvania line. Most of the units now have passed 2,000-hour evaluations and are continuing to maintain the high Beta stability and fast rise time so important in switching applications.

The fifteen NPN germanium transistors include both *base-on-the-can* types with *150 mw and 200 mw dissipation* and *base-off-the-can* types with *100 mw dissipation.*

Each of the types features the Sylvania welded hermetic seal for full protection against humidity and other environmental conditions and meets JETEC TO-5 and TO-8 dimensions. For further particulars on the entire line, contact your Sylvania representative or write Sylvania direct.



Type	Max. Dissipation at 25° Ambient	Max. Junction Temp. (°C)	Max. I_c (ma)	Current Gain h_{FE}	Max. Rise Time, t_r
2N439	100 Mw	85	100	40	2.5 usec
2N556	100 Mw	85	200	50	3.5
2N557	100 Mw	85	200	30	6.5
2N558	100 Mw	75	200	75	3.5
2N576*	200 Mw	100	400	40	2.0
2N576A*	200 Mw	100	400	60	2.0
2N587*	150 Mw	85	200	30	2.0
2N679*	150 Mw	85	100	20	3.0
2N312	100 Mw	185	200	20	1.5
2N356	100 Mw	85	500	30	2.0
2N357	100 Mw	85	500	30	1.2
2N358	100 Mw	85	500	30	0.8
2N377*	150 Mw	100	200	40	2.5
2N385*	150 Mw	100	200	70	–
2N388*	150 Mw	100	200	110	1.0

*Base internally connected to the case

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., P. O. Box 1190, Station "O," Montreal 9

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

CLEVITE 'BRUSH'

High Resolution Magnetic Heads

WITH GAPS AS NARROW AS **20** MICROINCHES

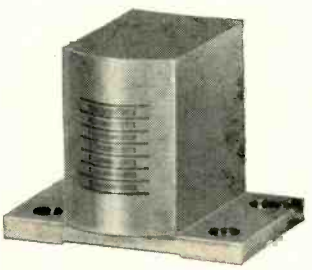
Clevite "Brush" high resolution magnetic heads permit major improvements in tape recording systems:

Greater packing density and/or higher frequency recording at your present tape or drum velocity. *Less volume of tape required.*

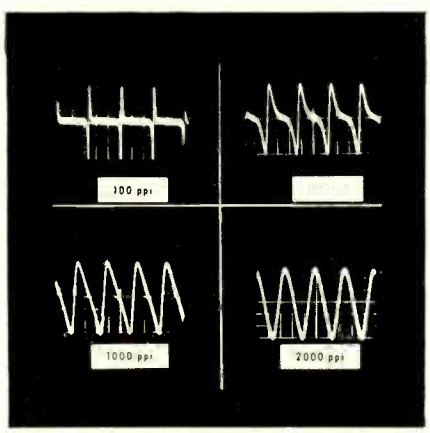
Up to 10 to 1 reduction in tape or drum velocity at your present frequencies or pulse repetition rate. *More recording time on the same length of tape.*

Reduced playback pulse width, allowing extended pulse width modulation (pwm) recording; for example, 10 microsecond pulse width at 120 inches per second tape velocity.

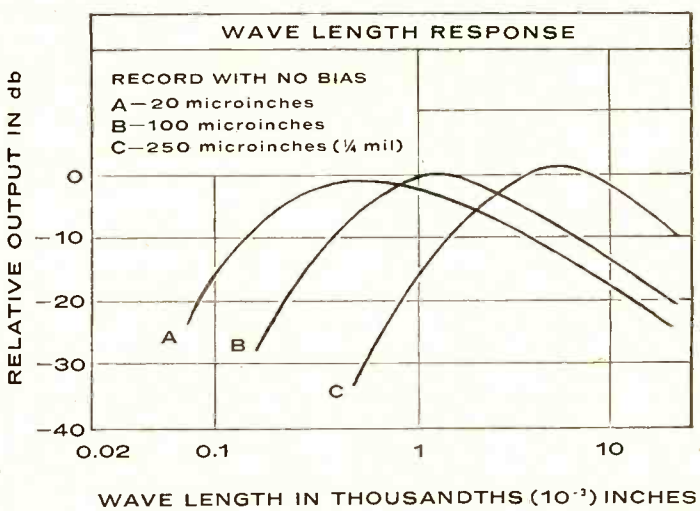
Special high resolution heads were developed by Clevite to meet specific customer applications. They are now commercially available in 2 to 32 channel form in a variety of mechanical configurations. These heads, slightly modified, may fit your present design requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.



Typical Clevite narrow gap multi-channel head records more data on an equal length of tape.



Oscilloscope photos of pulse recordings on Clevite high resolution head. Pulse duration, 1 microsecond; tape speed, 60 inches/sec.

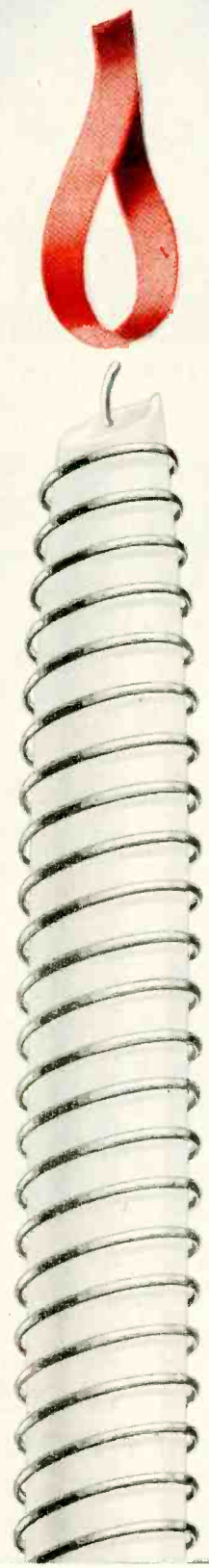


Clevite 'Brush' High Resolution Heads for radar recording • high density tape recording • high density drum recording • video recording • VHF instrumentation for missile telemetering

CLEVITE ELECTRONIC COMPONENTS

DIVISION OF CLEVITE CORPORATION

MAGNETIC HEADS
TRANSDUCERS
PIEZOELECTRIC CRYSTALS, CERAMICS AND ELEMENTS



FOR 50 YEARS

the time-tested world standard in resistance alloys

Nichrome*

made only by Driver-Harris

On August 11, 1908, the trademark NICHROME for Resistance Wire was registered in the United States Patent Office.

Today, after a half century of world wide recognition and use, Nichrome is still the accepted standard of quality in electrical resistance alloys.

Of the 132 special purpose alloys now produced by Driver-Harris for the Electrical, Electronic and Heat Treating Industries, Nichrome is the most famous . . . and it is made only by Driver-Harris.

* T.M. Registered U.S. Pat. Office

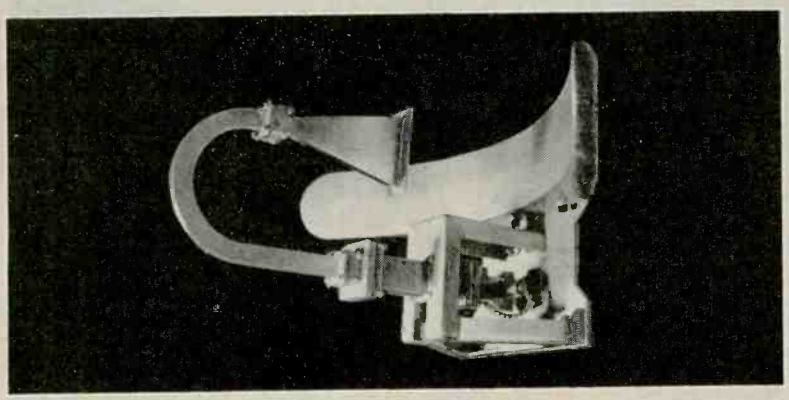
DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

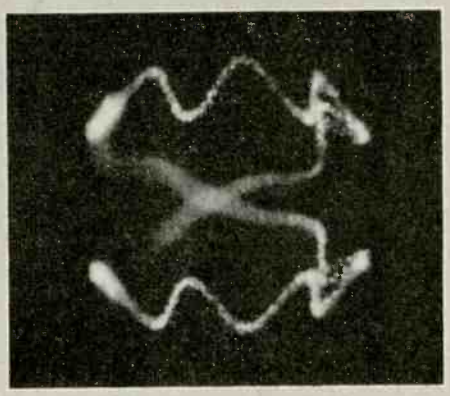
Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

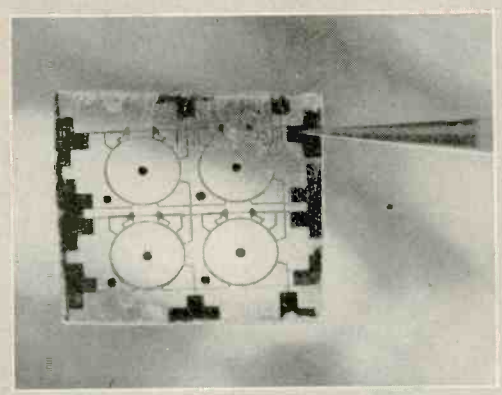
SPECIAL PURPOSE ALLOYS SINCE 1899 — D/H — TRADE MARK REG. U.S. PAT. OFF.



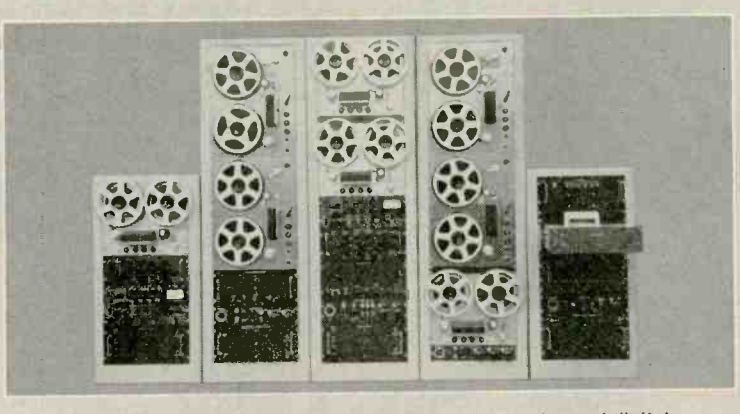
Horn fed parabolic reflector antenna for airborne applications.



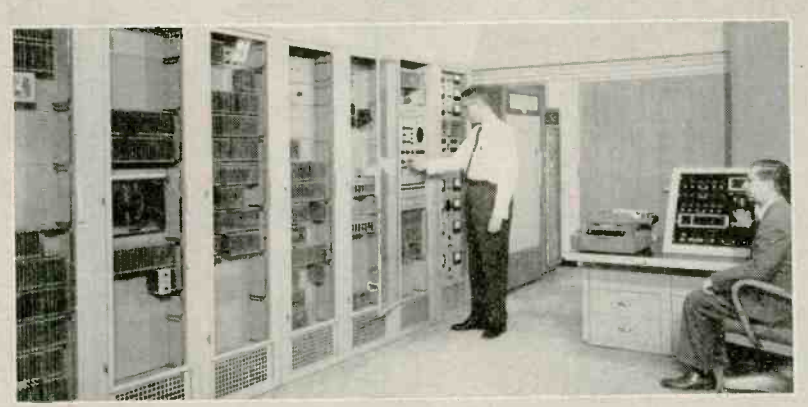
Charged aluminum particle suspended and controlled in a vacuum chamber by an oscillating electric field.



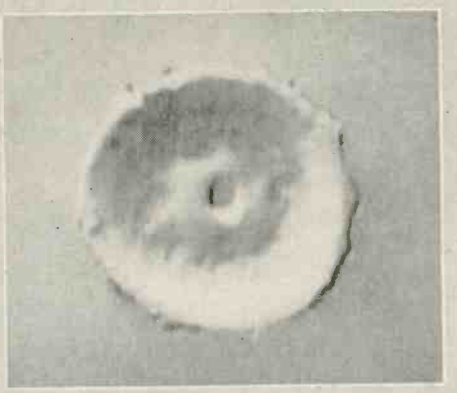
The Persistor gives promise of cryogenic computer memories with a capacity of 1,000,000 bits per cubic foot and access times of 1/30 microsecond.



Ground based data handling equipment for processing analog and digital reconnaissance information.



Data conversion system for digitizing and processing telemetered missile test data.



Electron micrograph of impact produced on aluminum coated glass by a 1 micron diameter particle traveling at 7,000 feet per second.

Pictorial **PROGRESS REPORT**

The photographs above illustrate some of the recent research, development, and manufacturing activities at Ramo-Wooldridge. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields:

- Digital Computers and Control Systems
- Communications and Navigation Systems
- Guided Missile Research and Development
- Infrared Systems
- Electronic Countermeasures
- Electronic Instrumentation and Test Equipment
- Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

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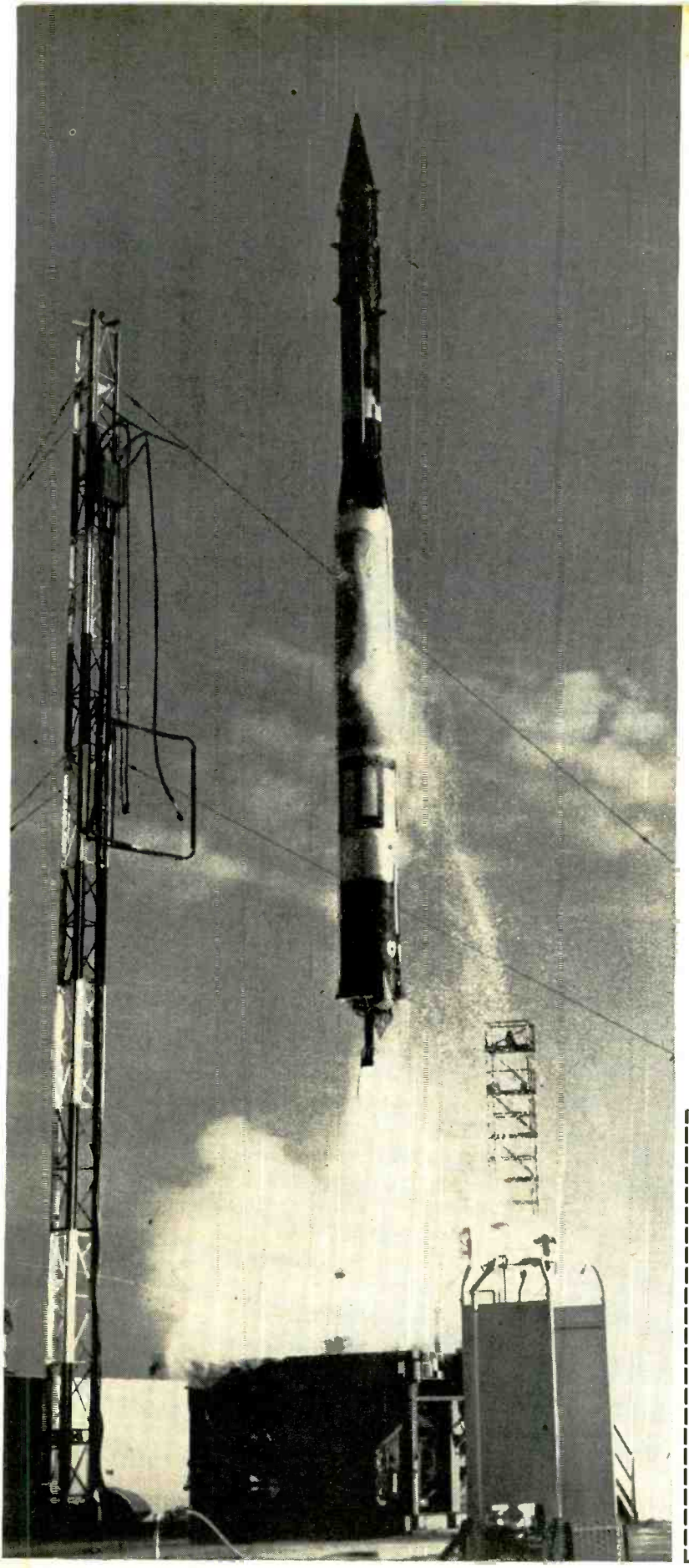


Successful Vanguard equipped with Union miniature relays

March 17, 1958—Union Switch & Signal 6 PDT miniature relays functioned perfectly in the separation controls between the first and second and second and third stages . . . in the first stage propulsion unit . . . and in the third stage spin control assembly of the satellite-bearing Vanguard.

The Martin Company, builders of the Vanguard, chose these outstanding relays for their reliability . . . for their simple, rotary design . . . and for the expert quality control associated with the established leader in electrical relay design—Union Switch & Signal.

The 6 PDT relay used in the Vanguard is just one of a complete line of *dependable* relays designed by Union Switch & Signal—"Pioneers in Push-Button Science." Send the coupon for complete technical information.

COMPLETE FACTS

Union Switch & Signal, Adv. Dept.
Pittsburgh 18, Pennsylvania

Please send information on the following:

- ☐ New 4PDT relay which meets every requirement of MIL-R-25018.
- ☐ Catalog of other miniature dc and ac relays.
- ☐ Digital and Alpha-Numerical Indicators for data display.

Name_____ **Position**_____

Firm_____

Address_____

City_____ **Zone**____ **State**_____

"Pioneers in Push-Button Science"

UNION SWITCH & SIGNAL

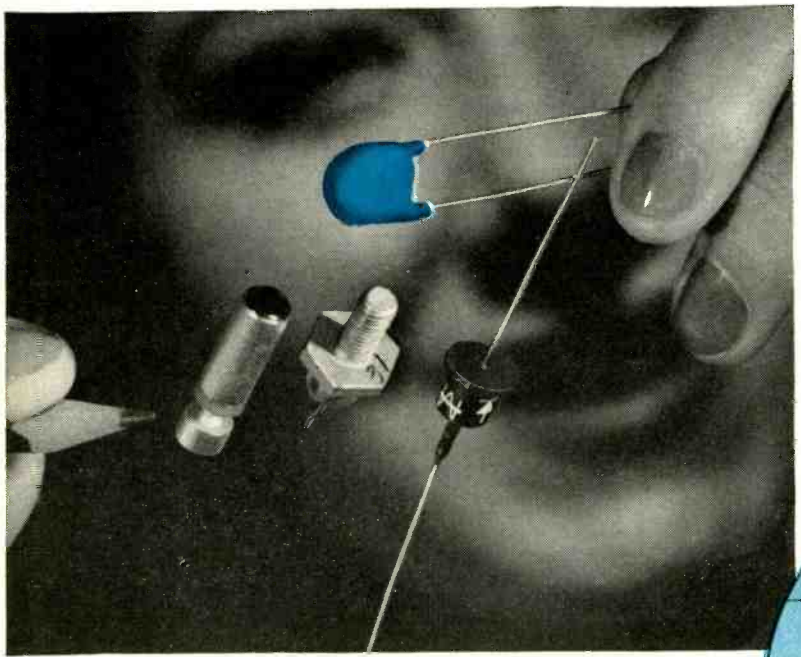
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

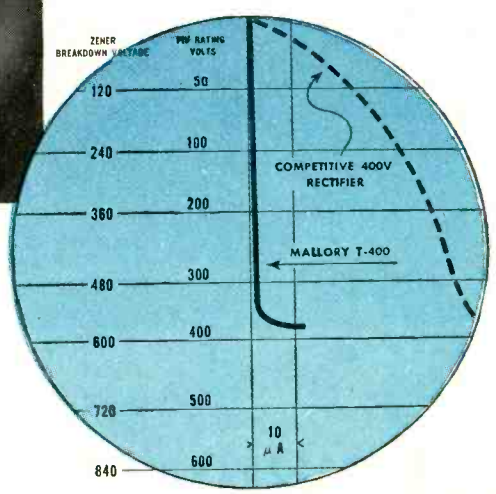
For the First Time in Silicon Rectifiers— High Quality and Dependability at *New Low Prices*

Mallory announces a major break-through in semi-conductor technology which gives high quality and reliability at a price even lower than present commercial units. This new Mallory Type T encapsulated diffused junction silicon rectifier offers radio and TV set manufacturers a practical, low-cost silicon rectifier for saving space, weight and costs in new set models. These are some of the highlights:

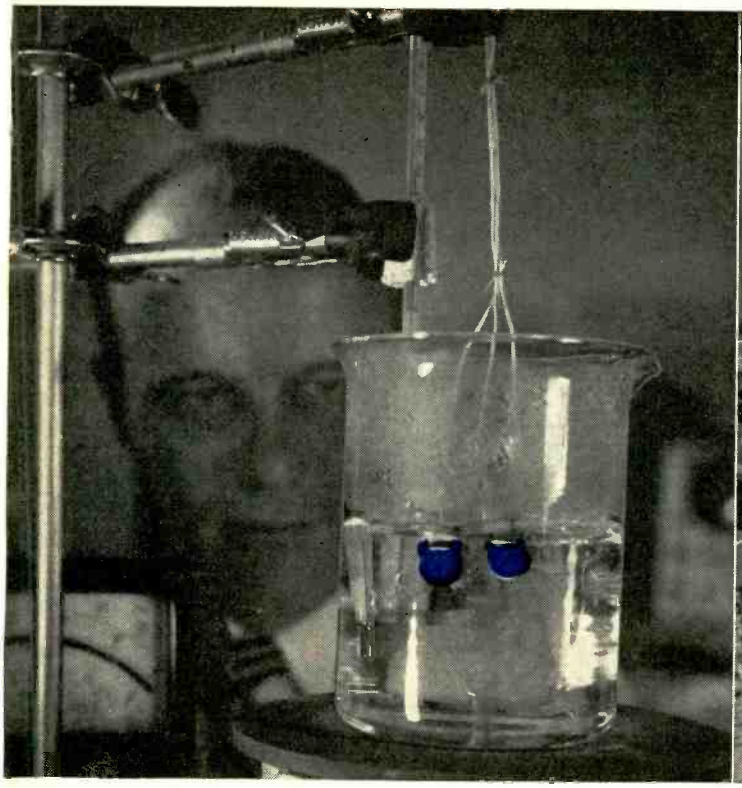
- **Premature Failures Eliminated**—Unique silicon wafer production methods overcome short life problems . . . assure long service of *all* rectifiers.
- **Low Reverse Leakage Current**—less than 250 microamperes at 85°C. ambient temperature and 0.5 amperes forward current.
- **Low Forward Voltage Drop**—less than 0.5 volt full cycle average at 85°C. ambient temperature and 0.5 amperes forward current.
- **High Temperature Rating**—to 85°C.



In addition to Type T Mallo-Seal encapsulated diffused junction silicon rectifier, Mallory offers a new line of military and industrial grade silicon rectifiers.



Extremely sharp Zener breakdown characteristic, as indicated in diagram at right, means longer, more reliable operation. 100% inspection by automatic equipment checks surge current, Zener breakdown voltage, and reverse leakage of every Mallory Type T.



Two Mallory Type T silicon rectifiers, encapsulated in Mallo-Seal, are shown operating while completely submerged in boiling distilled water.

Mallory-designed and built automatic classification equipment is used for 100% testing of silicon rectifier production—insuring high quality and reliability at low cost.

- **High Resistance to Humidity**—exceeds military humidity cycle test requirements of MIL-202A—made possible by new Mallo-Seal* compound available only from Mallory. Unaffected by 250 hours immersion in water.
- **Mallo-Seal** is an exclusive development of Radio Materials Company, a division of P. R. Mallory & Co. Inc. Encapsulation of the rectifier in this new compound gives unusually high stability under severe operating conditions.
- **Lowest Prices**—substantially less than commercial silicon rectifiers.

SPECIFICATIONS FOR TYPE T

	T50	T100	T200	T300	T400	T500	
Max. Allowable PIV	50	100	200	300	400	500	V
Max. Allowable RMS Voltage	35	70	140	210	280	350	V
Max. Allowable DC Output (at 85°C ambient)	500	500	500	500	500	500	Ma
(at 50°C ambient)	750	750	750	750	750	750	Ma
Max. Full-Load Forward Drop (Full Cycle Average at 85°C)	.5	.5	.5	.5	.5	.5	V
Max. Leakage Current (Full Cycle Average at 85°C)	.25	.25	.25	.25	.25	.25	Ma

Mallory offers a range of ratings for all standard rectifier circuits. Mallory applications engineers have developed extensive design data on the use of silicon rectifiers. Write for specifications and application information, and for consultation on your exact requirements.

Mallory also manufactures and offers a complete range of "top-hat", stud mounting, and plug-in type silicon rectifiers for military and industrial applications. Specifications and application information available on request.

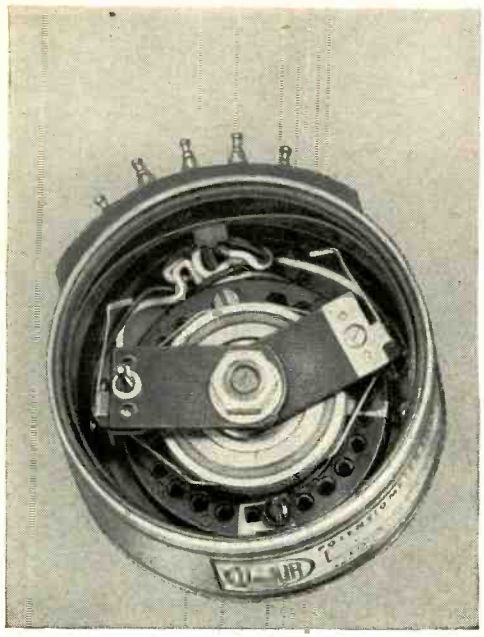
*Trademark of P. R. Mallory & Co. Inc.

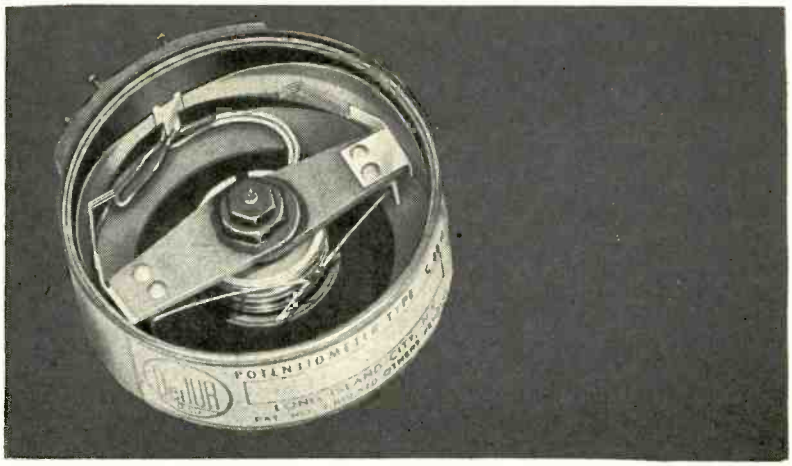
Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

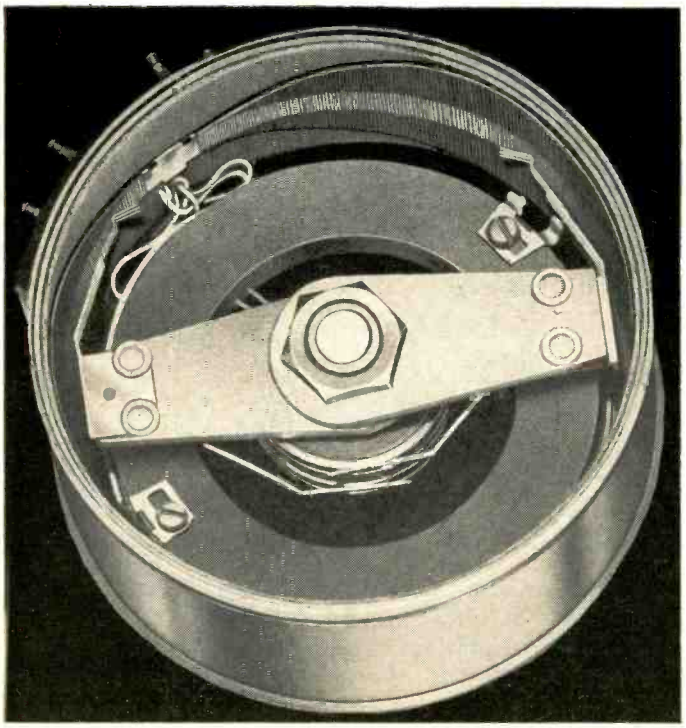
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA





NEW DeJUR SINE-COSINE POTENTIOMETERS

achieve exceptional functional conformity



Unique design and production techniques make it possible for DeJUR to offer sine-cosine function accuracies previously unknown in wire-wound potentiometers.

The new line includes 1⅞" and 2" diameter units with standard function accuracies of 0.5% peak-to-peak. BOTH ARE AVAILABLE WITH 0.25% ACCURACIES ON SPECIAL ORDER. Also available is a 3" diameter unit in the same group with standard peak-to-peak conformity of 1%; or 0.5% on special order.

All DeJUR Sine-Cosine Potentiometers are fully enclosed, self-contained units with independent brush contacts 90° apart and mounted on a common shaft, to produce accurate sine-cosine voltages. Any practical number of ganged units are available with individual sections in simultaneous function or other conformity.

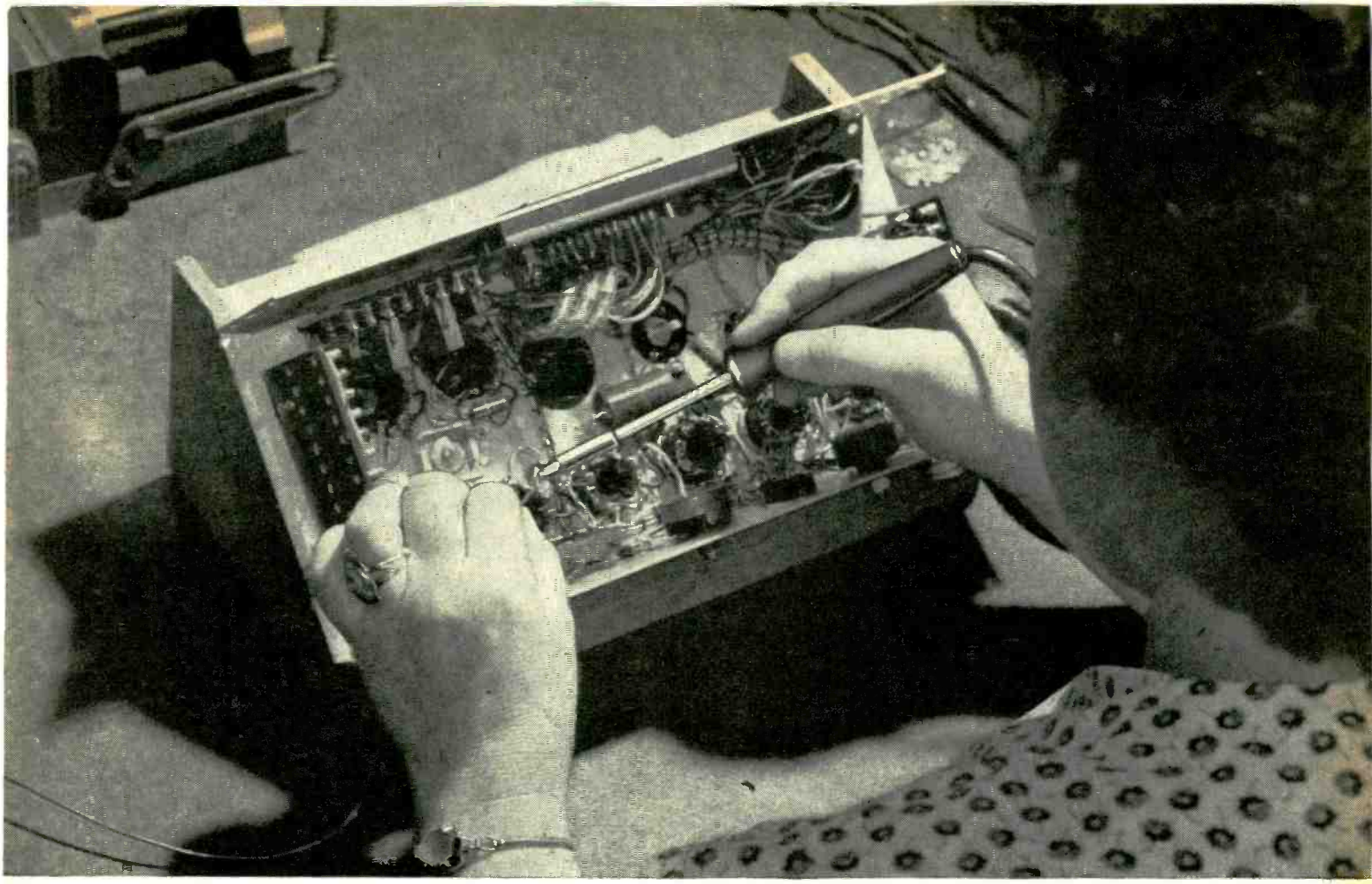
For complete details on DeJUR potentiometers write today to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, New York.

You're always sure with

DeJUR

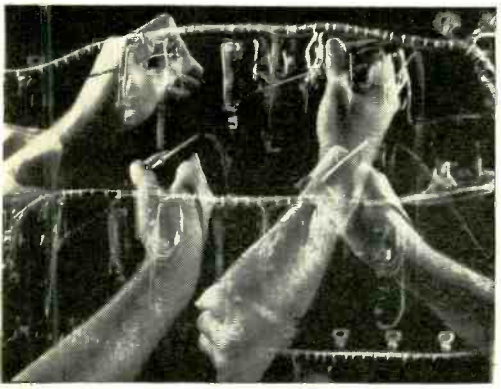
ELECTRONIC COMPONENTS

Manufacturers of precision potentiometers for over thirty years



HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less than 3 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and tinning time daily, per operator station.

Sanborn speeds assembly 13% with G-E Midget iron, a small soldering iron with big-iron efficiency



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-9, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE 65 READERS SERVICE CARD


ENGINEERS . . .
with Creative Imagination
probe physical universe
at Cubic Corporation
Cubic Engineers, endowed with creative imagination, successfully developed a single system for the simultaneous tracking or guiding of five or more anti-bomber or anti-ICBM missiles.
At Cubic Corporation creative imagination is continuing to broaden the scope and realization of such versatile systems as MOPTAR, which is completely mobile and capable of operating in the most stringent missile environments.
YOU, who enjoy the creative challenge of scientific and technical developments which probe the very nature of the physical universe, should talk to Cubic!
Cubic Corporation RIGHT NOW affords Engineers and Scientists the opportunity to grow and gain added prestige in such advanced fields as:
Advanced Mathematics
RF-UHF-VHF
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At Cubic Corporation in beautiful, equable-climated San Diego you will be associating with a company in which creativity is required, recognized, rewarded.
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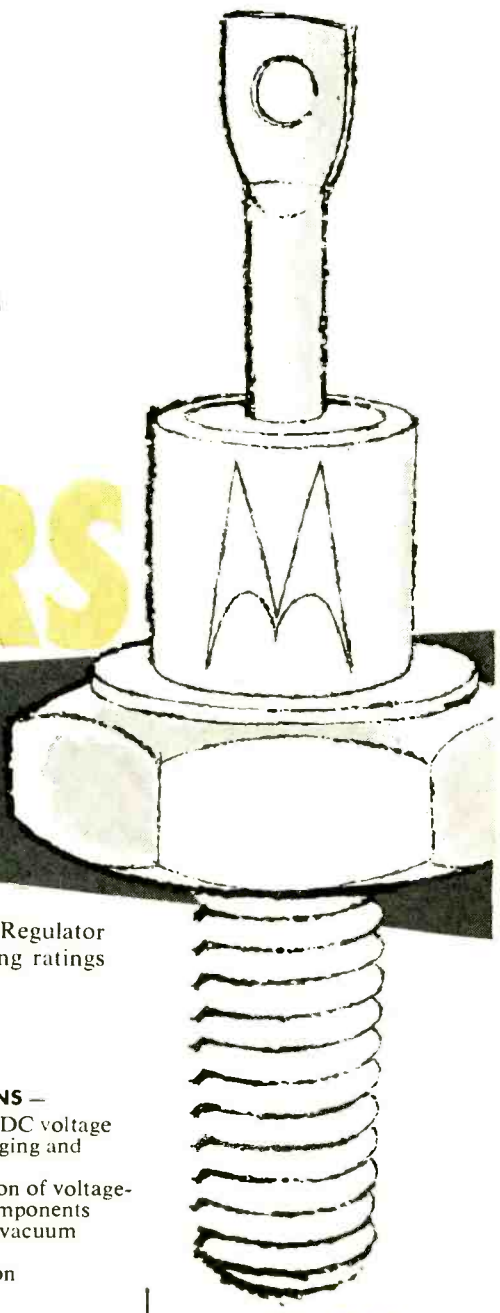
NEW MOTOROLA ZENER REGULATORS

10 and 50 WATT types up to 200 VOLTS



Here's an entirely new Motorola product line . . . silicon junction Zener Regulator diodes produced under Motorola's extreme quality standards and offering ratings and characteristics not previously obtainable.

- Very high power ratings — both 10 and 50 watt types available.
- Wide voltage range — up to 200 volts in both 10 and 50 watt types.
- Very low Zener impedance limits.
- "Soft" or unstable Zener knees eliminated — by impedance limits at 5 mA for 50 watt type . . . at 1 mA for 10 watt types.
- Forward characteristics controlled — for applications requiring conduction in both directions.
- Available with either anode or cathode connected to case.
- Conservatively rated — excellent long-time stability.
- Designed for military usage — Operating and storage temperature range −65°C to +175°C.
- Standard packages —

  10 WATT TYPES welded, hermetically sealed, metal to glass, Jetec package.

  50 WATT TYPES plug-in or solder-in TO-3 package with series interlock construction for protection against overvoltage on load.

TYPICAL APPLICATIONS –

Regulation of DC voltage
DC level changing and coupling
Surge protection of voltage-sensitive components
Regulation of vacuum tube heaters
Arc suppression

10MZ SERIES
10 watts @ 55°C

50MZ SERIES
50 watts @ 55°C

FOR COMPLETE TECHNICAL INFORMATION

concerning these new Zener Regulators, contact the nearest Motorola regional office or

MOTOROLA, INC.,
5005 East McDowell Road, Phoenix, Ariz.
BRidge 5-4411. Teletype Px 80.

"DEPENDABLE QUALITY – IN QUANTITY"

MOTOROLA SEMICONDUCTORS

MOTOROLA, INC.
5005 E. McDOWELL
PHOENIX, ARIZONA

Regional Offices

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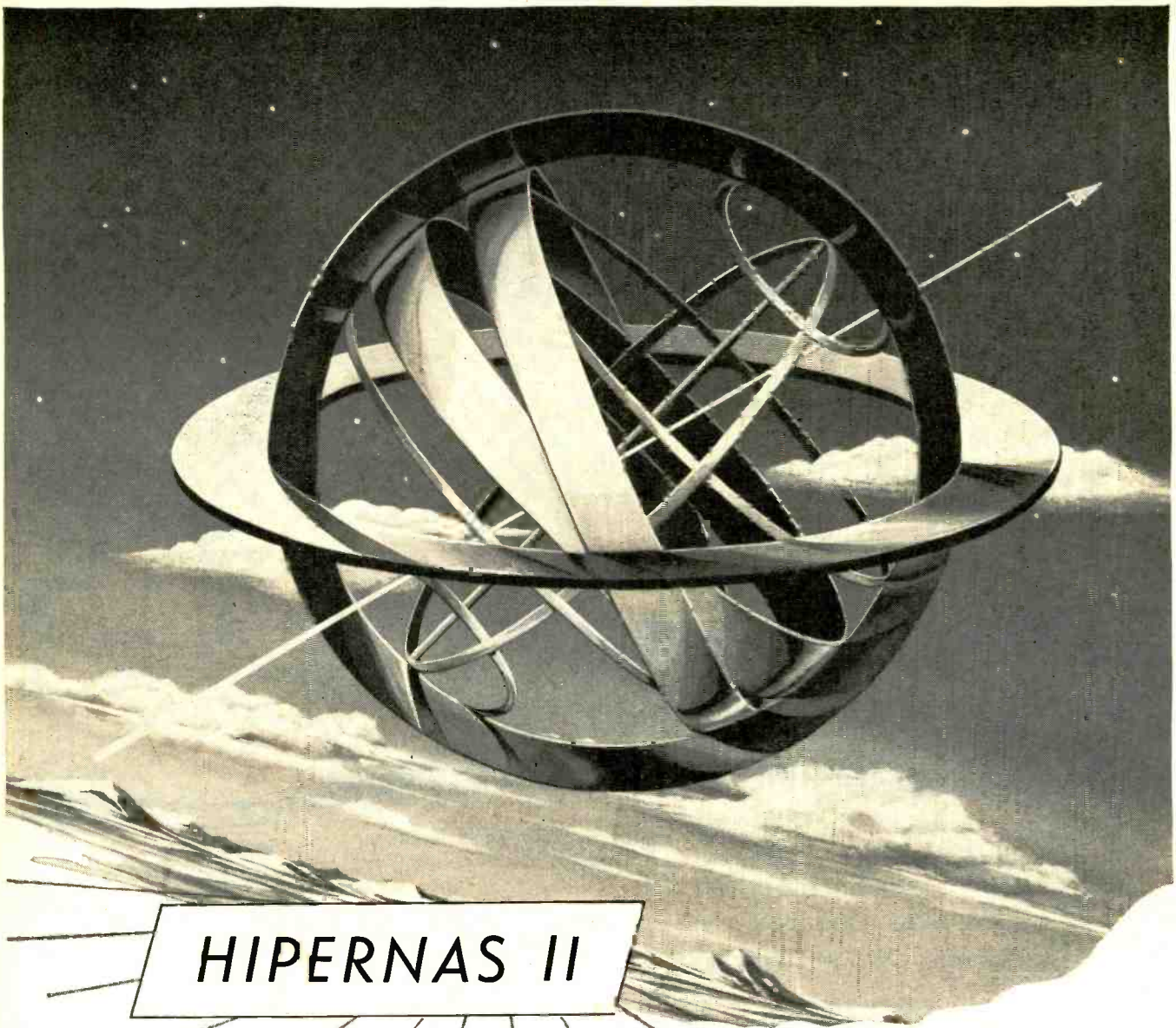
WHitney 5-7500

CHICAGO 44, ILLINOIS
4900 West Flournoy Street
ESterbrook 9-5200

HOLLYWOOD 28, CALIFORNIA
6555 Sunset Boulevard
HOllywood 5-3250



HIPERNAS II

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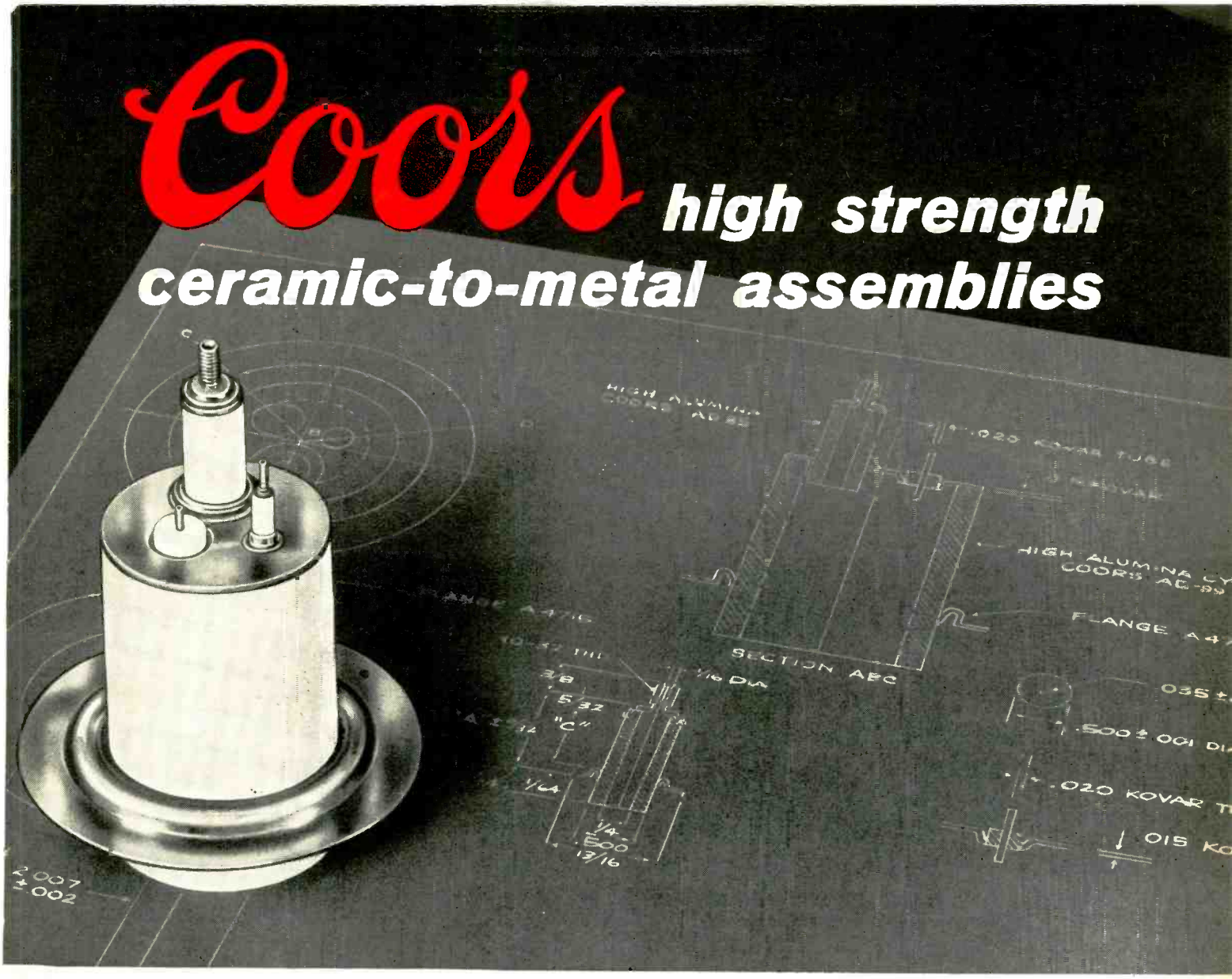

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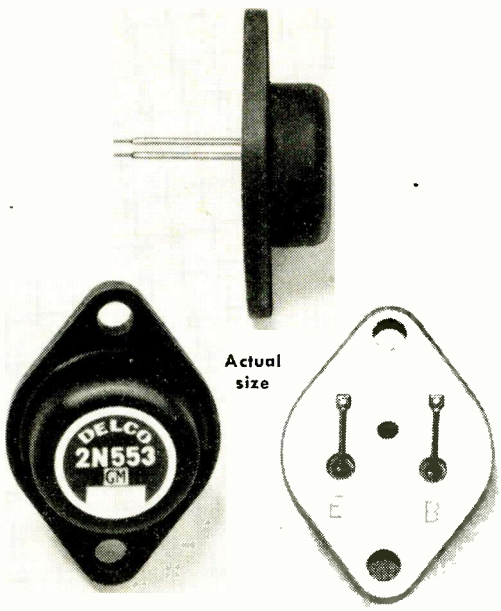

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Collector current	4 amps. maximum
Base Current	1 amp. maximum
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Minimum junction temperature	−65°C
Collector diode current I_{CO} (V_{CB} = 2 volts)	12 μa
Collector diode current I_{CO} (V_{CB} = −60 volts)	0.5 ma
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Current gain (V_{CE} = −2 volts, I_C = 0.5 amp.)	55
Current gain (V_{CE} = 2 volts, I_C = 2 amps.)	25
Saturation voltage V_{EC} (I_B = 220 ma, I_C = 3 amps.)	0.3
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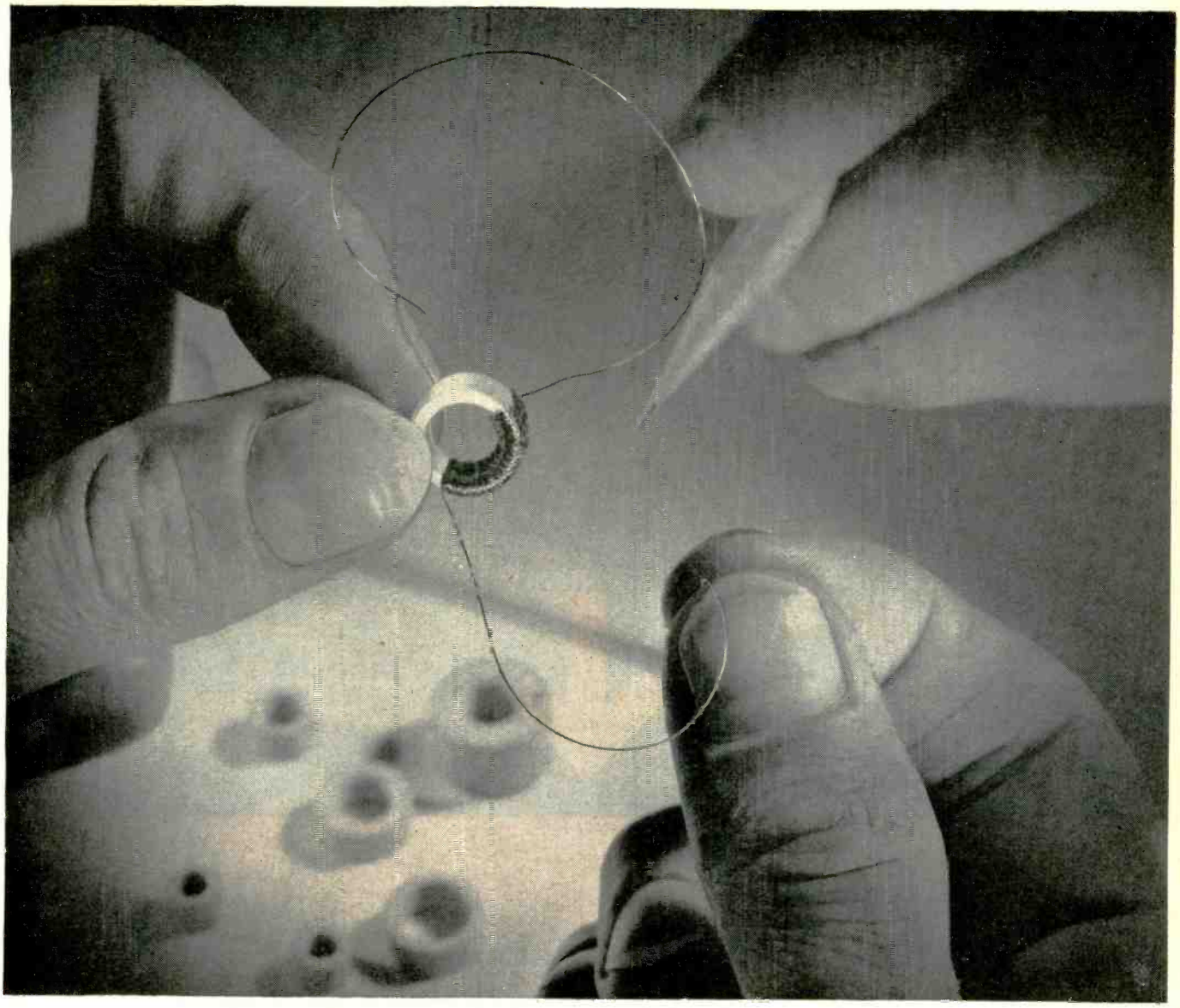

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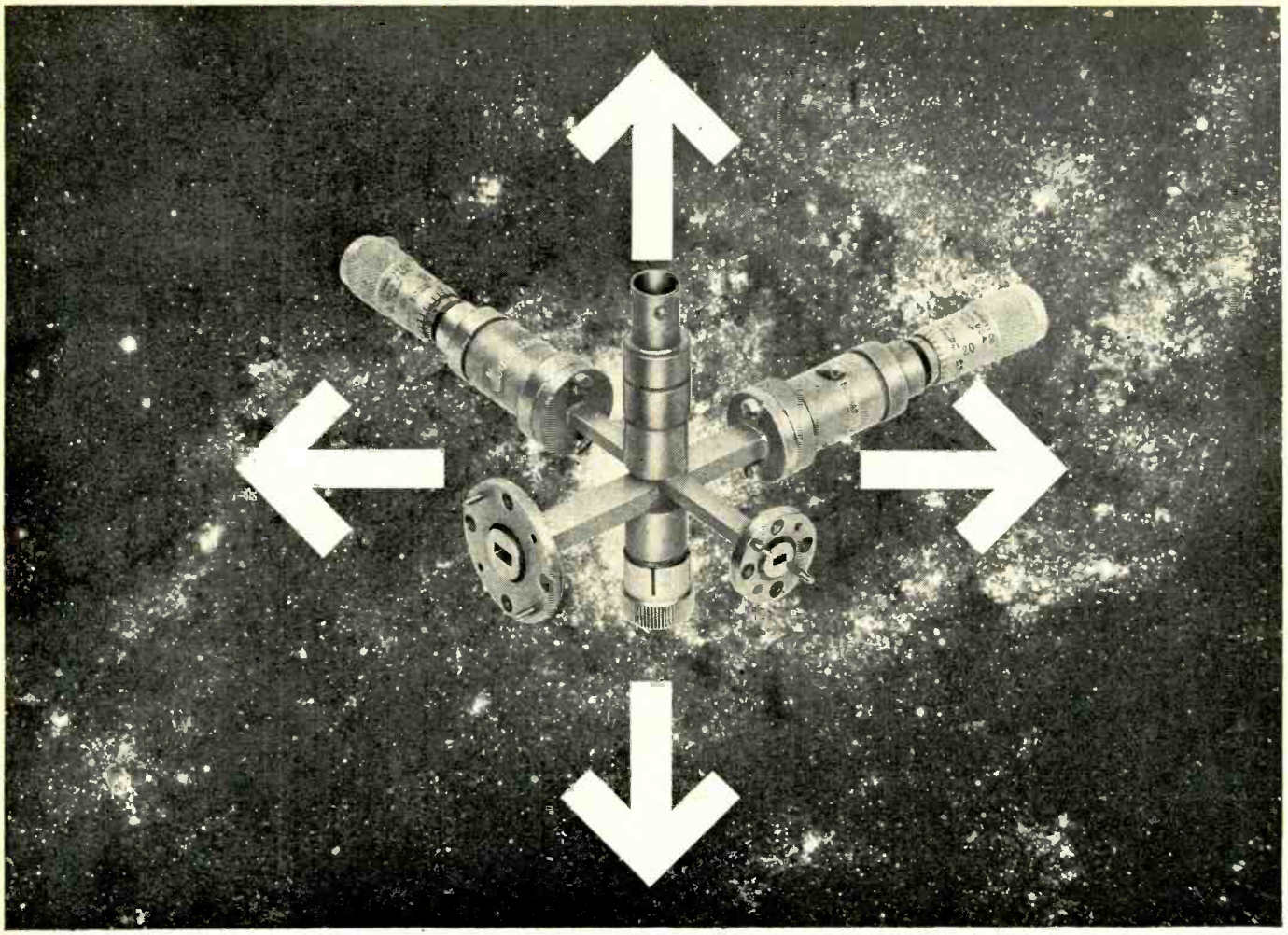

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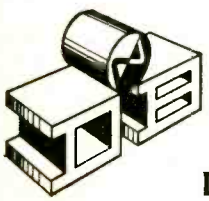

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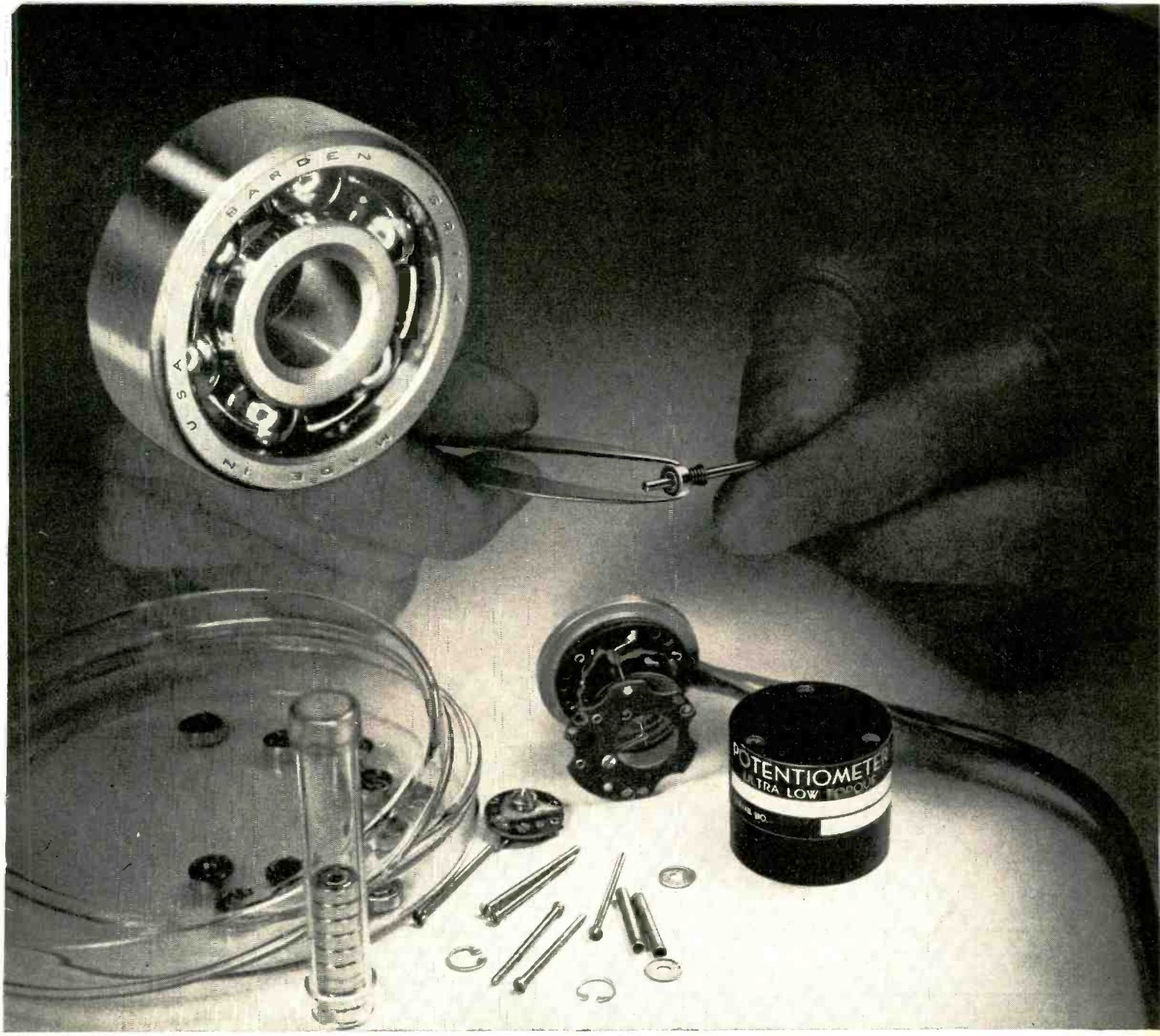

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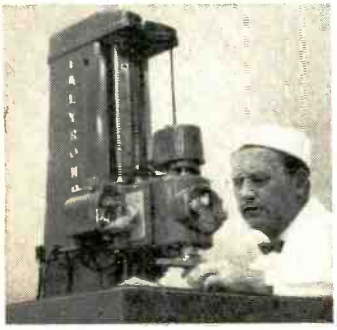

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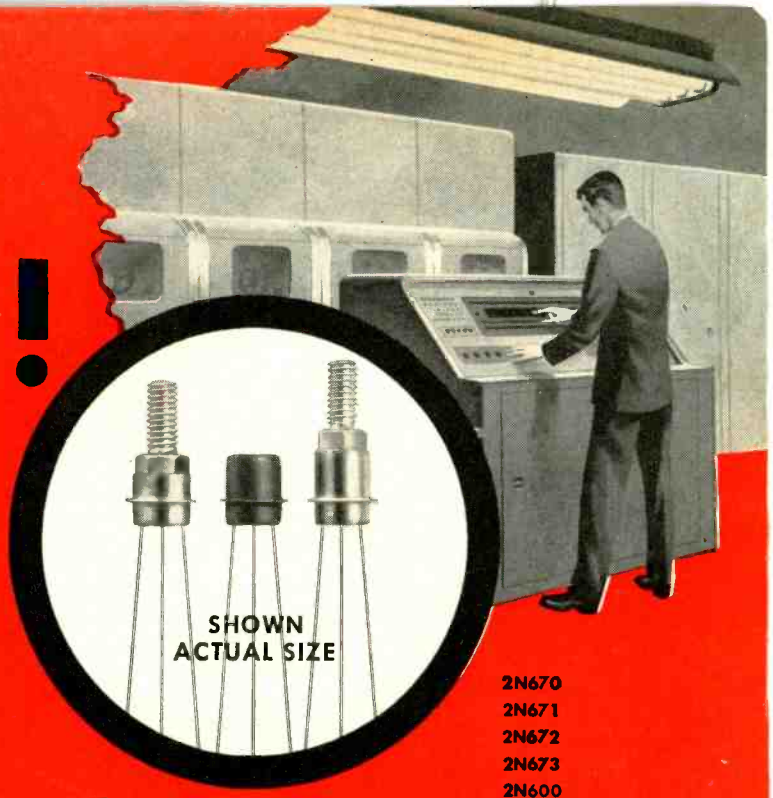

2N670
2N671
2N672
2N673
2N600
2N601

TYPE	$V_{CE\ MAX}$ (Volts)	$I_{C\ MAX}$ (Amps)	P_{MAX} (Watts)	$f_{\alpha b}$ (mc)
2N670	40	2	0.3	0.65
2N671	40	2	1	0.65
2N672	25	2	0.3	1
2N673	20	2	1	1
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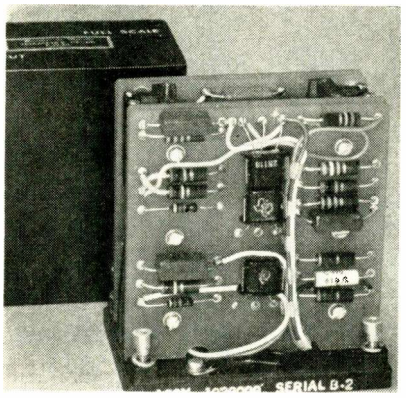

Keyer construction allows circuit boards to be folded down for repair as shown. At right is closeup of construction details

Transistors Ruggedize Airborne Telemetry Keyer

High linearity, low crosstalk and jitter and high effective input impedance are provided by a transistor pulse-duration-modulation keyer. Circuit includes bistable flip-flop, linear ramp generator and voltage comparator. Output pulse widths vary as the signal amplitude

By D. A. WILLIAMS, Jr., Bendix Aviation Corp., Pacific Division, North Hollywood, California

AIRBORNE PULSE-duration-modulation telemetry systems are ideally suited to transistor circuits. A pdm keyer can be designed to exploit fully the switching properties of transistors. For this reason, development of a transistor keyer to meet military pdm specifications was undertaken. The primary objectives: high linearity, low crosstalk and jitter, and a high effective input impedance.

A bistable flip-flop, linear ramp generator and voltage comparator are used in a circuit which produces output pulses with widths proportional to signal voltages. Signals are sampled at the rate of 900/sec by either mechanical or electronic commutation. Use of printed circuits and silicon transistors insures reliability and long life over the extreme environmental range encountered in flight test of guided missiles and high performance aircraft.

Input Impedance

In a system such as the one described, a mechanical or electronic multiplexer samples various input sources which may have impedances ranging from near zero to 100,000 ohms. For overall system accuracy and ease of calibration, the keyer must have a high effective input impedance. This can be achieved with cascaded common-collector stages but internal noise or temperature problems appear almost insurmountable.

One way to gain high effective impedance is to compare the signal with a sawtooth waveform and look at the input signal only at the exact moment of coincidence. When coincidence occurs, the input impedance might drop to a lower value, but the pulse width information has already been obtained. With the pulse width thus independent of source impedance, it is possible to avoid independent calibration for each signal channel. In practice, zero and full-scale signals are introduced into two input channels and later used for overall automatic system calibration.[1]

Description of Operation

Figure 1 is a block diagram of the transistor keyer. The principle of operation is that of comparing the signal input voltage to a linearly rising sawtooth which is generated within the keyer. An output pulse begins when the ramp voltage starts increasing and terminates when the ramp and signal voltages are equal. Pulse width is directly proportional to the input signal.

About 100 μsec after the signal

has been applied to the voltage comparator, the trigger delay circuit triggers the flip-flop to the on state. This delay feature is incorporated to allow the comparator input circuitry to stabilize. The flip-flop opens a transistor switch, allowing the ramp generator to begin generating a linearly rising voltage. This ramp voltage is also applied to the voltage comparator, as can be seen in Fig. 1.

A sharp pulse is generated by the comparator when the two inputs are equal, or as they do in practice, differ by a small fixed amount. This coincidence pulse triggers the flip-flop to its original off or rest state. The flip-flop in turn resets the ramp generator and the keyer is ready for the next signal and trigger. The keyer operates at a nominal rate of 900 samples/sec. The input voltage range is 0 to +5 v d-c. A two-section commutator is used, one section supplying commutated signals and the other generating triggers for the timing system. If desired, the keyer output can be used to modulate a 40- or 70-kc subcarrier oscillator instead of the f-m transmitter directly. Electronic commutators may be utilized by a slight modification of the trigger delay circuit.

Flip-Flop

The bistable flip-flop consisting of Q_3, Q_4 and Q_5 of Fig. 2 is used to drive the ramp generator switch as well as to provide the duration-modulated output pulses. The common-collector cross-coupling transistor Q_4 reduces the capacitive loading on the collector of Q_5 allowing a fast rise-time. This fast switching is a primary reason for the extremely low keyer jitter. The low-impedance waveform at the emitter of Q_4 is coupled through a potentiometer R_1 to the pdm output terminal. The off and on triggers are diode-gated into the flip-flop to avoid any ambiguity in flip-flop states.

Ramp Generator

The linearity of the Miller integrator and the bootstrap integrator are related to the β and α transistor current gains respectively. The Miller circuit approaches perfect linearity as its

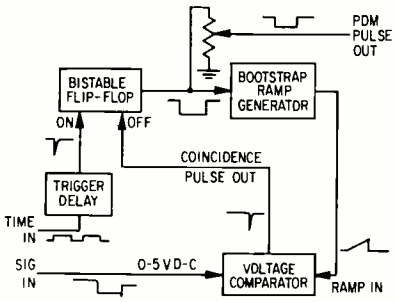

FIG. 1—Block diagram of the transistorized pdm keyer. Timing pulses are provided by the commutator

gain approaches infinity, while the bootstrap approaches perfect linearity as its gain approaches unity.[3] Because the direct-coupled transistor operational amplifier would be difficult to stabilize with temperature, the simple transistor bootstrap was selected for the ramp generator.

Figure 3A is a schematic of a conventional transistor bootstrap. When switch S is opened, capacitor C begins charging through R. Assuming the bootstrap transistor has unity voltage gain, and that C_d is large enough so that its voltage does not change appreciably during the cycle, the current through R is constant. Current I_C does not equal I_R but is less by the amount I_b. As the ramp is generated the voltage across R_e increases. The required base current thus increases with time, decreasing the charging current to C. This produces a ramp which has a constantly decreasing slope.

Two ways to approach a constant slope are to increase the direct current gain and to increase the value of R_e so that a smaller base current change occurs.

As the value of R_e approaches infinity, the output approaches perfect linearity. If the value of R_e is made large, however, the time required to replace the charge lost by C_d during the ramp generation becomes excessive. This results directly in crosstalk since the starting point of each sweep is now influenced by the pulse width of the preceding channel.

Linear Circuit

These difficulties are overcome in the circuit of Fig. 3B. The switch is placed in the emitter circuit and R_e, during ramp generation, is essentially infinite. A constant-current condition now exists and the voltage gain of Q_8 approaches one (see also Fig. 2). When the switch S is closed, C_1 is discharged through the base and emitter of Q_8. To prevent excessive collector current from flowing during this discharge and during standby, R_2 is of such a value that the collector of Q_8 is saturated except when the ramp is being generated. This circuit has high linearity and allows a

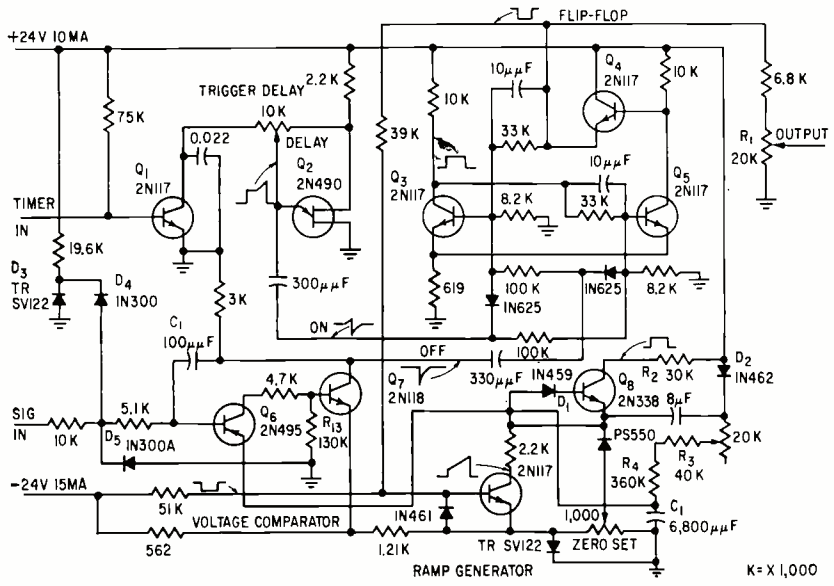

FIG. 2—Overall schematic diagram of the pdm keyer. With this configuration, α linearity of 0.2 percent maximum deviation from a straight line between end points is maintained from —40 C to +85 C

high variable duty cycle (low crosstalk) without depending upon a high transistor current gain. Linearities as high as 0.03 percent maximum deviation from a straight line between end points have been obtained for the ramp generator because of its excellent characteristics at low collector current and its low I_{co}.

An interesting feature of this circuit is the appearance of a positive-going square wave on the collector of Q_8 during the time the ramp is being generated. If this waveform is coupled through a nonphase-inverting switch to the emitter of Q_8, a self-gating action similar to that of the vacuum tube phantastron circuit occurs. This could eliminate the need for a flip-flop.

This self-gating configuration is not used in the present keyer design because of the excessively long trigger pulse required. The slope of the bootstrap is approximately proportional to α which increases with temperature, increasing the slope of the ramp.[3] This is compensated for by using a positive temperature coefficient resistor R_2 in series with the main ramp resistor R_4 (Fig. 2).

Voltage Comparator

Referring to Fig. 2, the voltage comparator is derived from a Schmitt trigger except that, as a result of the requirement for high input resistance, the feedback loop is coupled through capacitor C_1.[4] This circuit is an extension of the hook connection.[5] It also resembles some of the newly developed *pnp-npn* flip-flops except that Q_7 is always actively biased.

During standby, both junctions of Q_6 are reverse biased and the only current that flows in the input is I_{co} and I_{co}. The ramp increases the emitter voltage of Q_6 until its emitter becomes forward-biased and transistor action occurs. Regeneration results, producing a 10-v negative off trigger pulse with a fast rise time.

The comparator tends to produce longer pdm pulses as the signal impedance is increased because of two factors: the base-to-emitter capacitance C_{bc} of Q_6 tends to couple the ramp input to the signal causing a small current to flow which is equal to C_{bc} times ramp slope. This offset current seems to be small compared to the other effect, which is the time delay between actual coincidence and the beginning of full regeneration. During this short period a small surge current must be supplied by the signal source. In no case does this effect cause more than 0.2-percent error.

The circuit becomes more sensitive as temperature is increased. For this reason a series diode D_1 is used in the ramp generator so that the ramp is reset to a lower voltage with increasing temperature. It also protects Q_8 from excessive reverse bias when +24v is applied.

From a system point of view it is desirable to provide some sort of input limiting to avoid ambiguity in the output pulses caused by off-scale input signals. One method is to provide diode clamps at the input.

By proper choice of diodes D_4 and D_5, the input capacitance is increased only about 10 $\mu\mu$f. Since the diodes are in series, their leakage currents tend to cancel. To provide low-impedance limiting, Zener diode D_3 is used for a 5-v reference.

When the keyer design was initiated, it was felt that no trigger amplifier would be required. However, consideration was given to the possibility of commutator noise and bounce under severe environmental conditions, which could cause false keying. Therefore, a combination trigger amplifier-integrator was deemed necessary.

When the commutator time contacts close, Q_1 ceases conduction and the emitter voltage of the unijunction transistor Q_2 rises exponentially. At a voltage determined partly by the physical characteristics of Q_2, its emitter goes into negative resistance and the emitter voltage drops very suddenly to near zero.[6] This sudden voltage drop is differentiated and is the on trigger. Noise cannot cause false triggering because the unijunction transistor has a thyratron-like action and either is in full conduction or cut off. The voltage appearing across the commutator trigger contacts does not interfere with high-impedance signal channels.

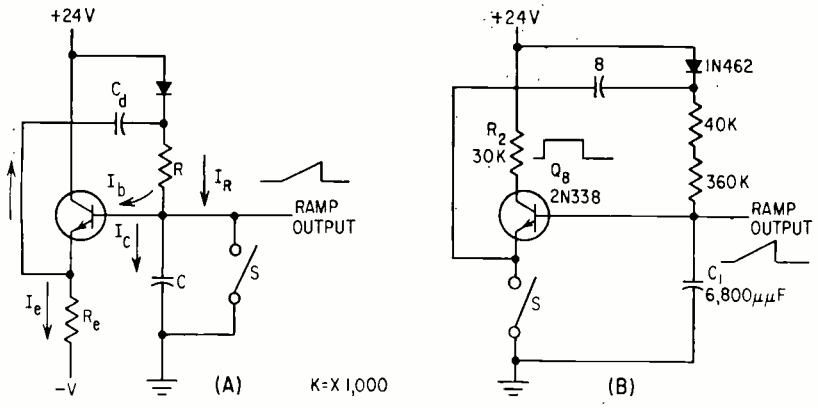

FIG. 3—Conventional bootstrap circuit (A) has poor linearity as base current increases with time. In (B) charging current of C_1 is kept constant resulting in high linearity

Performance

The specified nonlinearity of the keyer is 0.2 percent maximum deviation from a straight line between end points from −40 C to +85 C.

Jitter is nominally 0.1 μsec. This low figure is achieved primarily because of the use of a fast flip-flop and the use of a clamping diode to determine ramp zero level.

The keyer output pulse has a 14-v amplitude and a rise time of 3 μsec.

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Solid-State Panel

Only a simple power supply is needed to initiate X-ray amplification by a thin panel containing photoconductive and electroluminescent phosphor materials. High contrast aids perception of details. Long persistence permits close-range viewing with X-rays off

By B. KAZAN,* Radio Corp. of America, RCA Laboratories, Princeton, N. J.

IMAGE INTENSIFICATION for X-ray analysis is approached in a new manner with a panel amplifier using solid-state techniques. The amplifier is in the form of a thin plate similar in outward appearance to the conventional fluoroscope screen. Since the amplification occurs entirely within the panel itself, no complex and bulky amplifying equipment is required external to the panel. Size of the panel is arbitrary and only a simple power supply is required for operation.

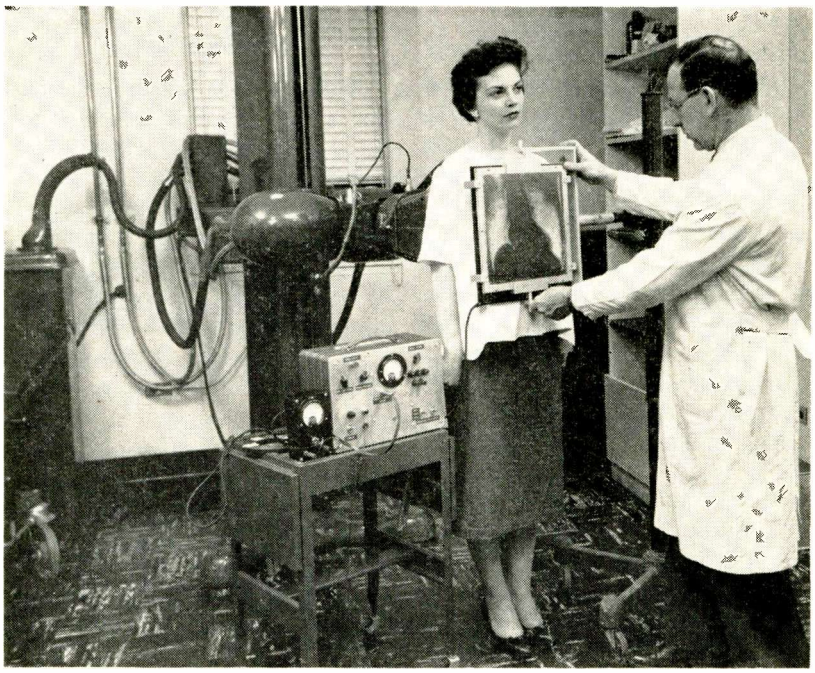
Principle of Operation

Figure 1 shows an amplifying panel in its simplest form. Adjacent layers of photoconductive and electroluminescent phosphor materials are used. Electrodes are provided on the outer surfaces across which alternating voltage is applied. In the absence of X-rays, the thicker, high-impedance layer of photoconductor limits the flow of current through the phosphor to a low level. But if X-rays excite a local area of the photoconductor, its conductivity is increased and current flows through the corresponding area of the phosphor with the emission of light.

To prevent output light from feeding back and exciting the photoconductor, a thin insulating opaque layer is placed between the photoconductor and phosphor layers. For viewing, the electrode in contact with the phosphor is made transparent. To permit X-rays to penetrate to the photoconductor, the opposite electrode is made of a thin material consisting, for example, of silver paint.

Photoconductor and phosphor layers have a total thickness of about 10 mils. Consequently, a pattern of X-rays can produce a pattern of output light with little loss in resolution due to spreading of the currents. In effect, the photoconductor is a distributed valve, controlling the flow of alternating currents into the phosphor layer at each point. With sensitive photoconductors and efficient phosphors, an output light can be produced whose energy is many times greater than the energy of the incident X-rays.

The phosphor layer, consisting of a powder bonded with plastic, can be fabricated readily into uniform, large-area layers one- to two-mils thick by conventional techniques such as spraying. Although many photoconductive materials are known, they are usually either in the form of small crystals of the order of millimeters in size or thin evaporated or sintered layers. For an amplifying panel, a large-area photoconductive layer is required about 10 mils thick. This requirement is met by use of a recently developed CdS powder photoconductor[1] which can be bonded with plastic and fabricated easily into large-area uniform layers. In addition, this powder has high sensitivity and low dark current; conditions



The Front Cover—Actual use of 12-in. amplifier containing within its back cover the auxiliary phosphor layer. Connected to amplifier is its 400-cps supply and also shown is meter for measuring current flow through the photoconductor

* Now with Hughes Research Laboratories, Culver City, Calif.

Amplifies X-Rays

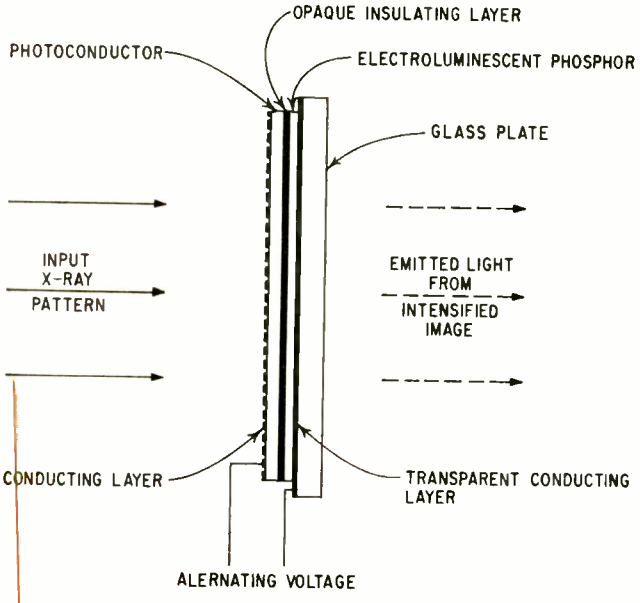


FIG. 1—Simple form of amplifying panel

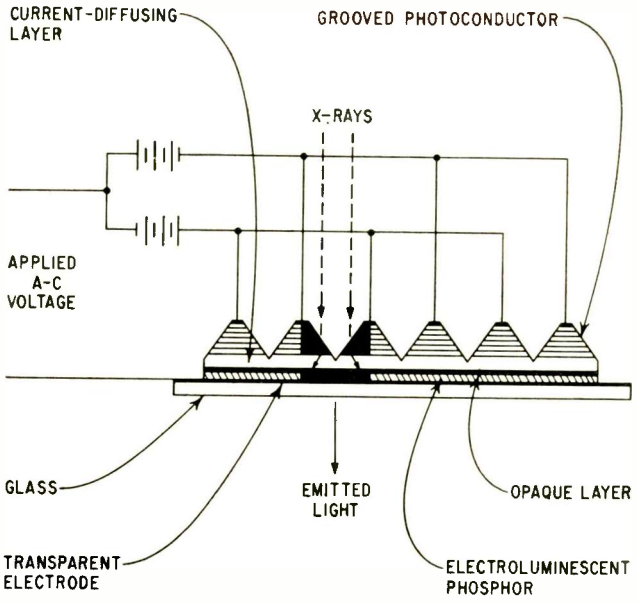


FIG. 2—Cross-section of amplifying fluoroscope screen

required by the amplifier. Capacitive impedance of the photoconductive layer is much higher than that of the phosphor layer.

High-Gain Panel Design

Much higher sensitivity can be obtained from the photoconductor by passing d-c through it instead of a-c. To accomplish this and provide the necessary a-c for the phosphor layer at the same time, a circuit developed earlier for panel light amplifiers is used.[2] A cross-section exaggerated in thickness is shown in Fig. 2. The darkened areas represent a single picture element excited by the X-rays. As indicated, each phosphor element is excited by two photoconductive elements.

Operation of the high-gain panel is explained in Fig. 3. By inserting d-c supplies of opposite polarity in series with the photoconductors, unidirectional voltages are applied as shown to the right. Since the photoconductive material has a nonlinear voltage-current relationship, most of the current flow occurs in the neighborhood of the voltage maxima. Resulting charging and discharging of the phosphor element through the respective photoconductors each half cycle provides alternating current required for exciting the phosphor.

The partially conducting current-diffusing layer shown in Fig. 2 provides d-c conductivity between adjacent ridges of the photoconductor which are slightly separated at their bases. This conductivity was chosen to limit the current spread to about one groove width. In present amplifiers, photoconductive grooves are spaced 25 mils on centers. This allows the separation of picture details down to about this size.

Input-Output Characteristic

Because of the build-up properties of the photoconductor, an output image does not appear immediately when the panel is excited with X-rays. At the low X-ray levels used in medical fluoroscopy, build-up time is in the order of seconds.

Figure 4 shows a curve of panel light output as a function of incident X-ray level with a 10-sec excitation time. By comparison, light output of a conventional fluoroscope screen is also shown. In medical work, X-ray levels on the screen below 200 milliroentgens/min are common. At these input levels, the panel amplifier produces images whose output light is as much as 100 times greater than the fluoroscope screen. In addition, as shown by the high slope of the amplifier characteristic, output light is roughly proportional to the third power of the input X-ray level. Compared to the conventional screen, whose characteristic is linear, the amplifier output image has a much higher contrast. High contrast is desirable for detecting small differences in density or thickness of the body.

Figure 5 shows a reproduction of an output image produced on a 12-by 12-in. amplifier panel. To simulate absorption and scattering of X-rays in the human body, about five in. of Presdwood sheets were used between which were placed a variety of objects. At the center is a human femur or thigh bone with a nail through it as would be used to repair the bone in a hip-pinning operation. Also shown are a variety of metallic objects and an additional piece of bone which extends above the amplifier where a section of a conventional fluoroscope screen is located. Because of the low output light, no image is recorded from the conventional screen.

A roughly reciprocal relationship exists between input X-ray level and exposure time required to produce a given output light. For ex-

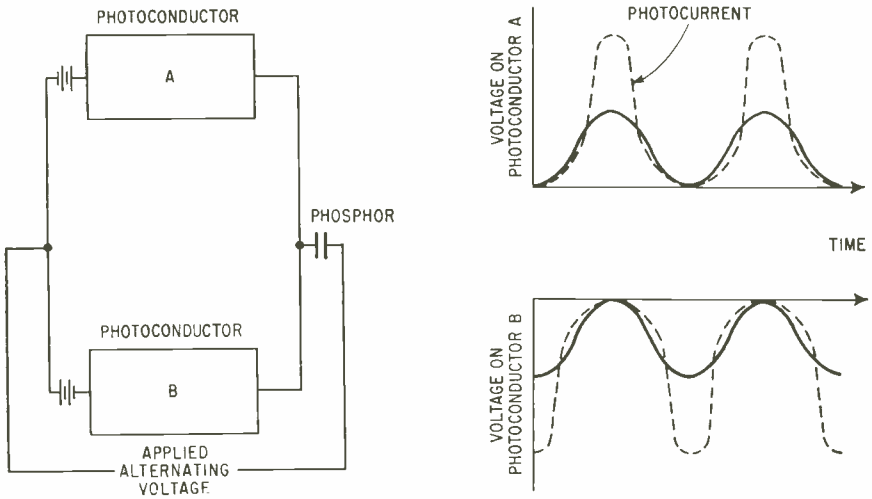


FIG. 3—Amplifier element with biased a-c operation. D-c supplies of opposite polarity inserted in series with photoconductors, apply unidirectional voltages as shown at right. Most of current flow occurs in the neighborhood of the voltage maxima

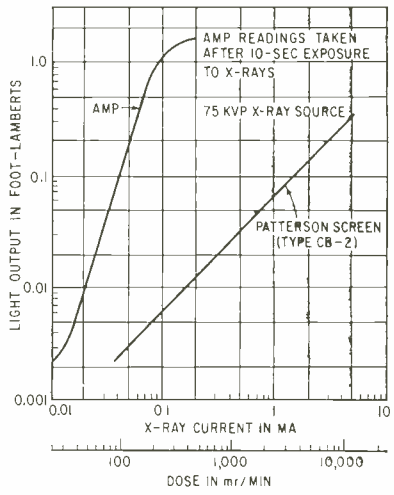


FIG. 4—Input-output characteristic of amplifier compared to conventional fluoroscope screen

ample, if exposure time is doubled to 20 sec, X-ray level can be cut in half and gains up to 200 times over the conventional screen can be obtained. Reciprocity exists for excitation times up to about 30 sec and below 0.01 sec.

Decay Properties

In addition to its build-up property, the panel has a long decay time after the X-rays are cut off caused by the characteristics of the photoconductor. In practice, the gradually decaying image can be viewed for as long as 30 sec with the X-rays off. Figure 6 shows a set of decay curves obtained by exciting the amplifier for one sec with different input levels. These curves are approximately straight lines, with a decay characteristic of the type $L = Ke^{-0.3t}$ where L is output light and t is time. This indicates the output to fall to $1/e$ in roughly three sec.

In extended viewing of a stationary X-ray image, the long persistence of the amplifier allows a saving in dosage to the patient since the image can be studied with the X-rays off. When higher X-ray voltages are used such as in X-ray therapy and industrial applications where shielding is difficult, viewing of a bright image can be done in complete safety with the X-rays off. If it is desired to photograph the screen, the much higher light output and long decay of the amplifying panel is of potential advantage. It enables either a reduction in X-ray exposure or use of lower-aperture, less-expensive optics.

In practical applications, ability to view a new image is sometimes desired without waiting for the previous image to decay gradually. This can be accomplished by making use of a special property of the

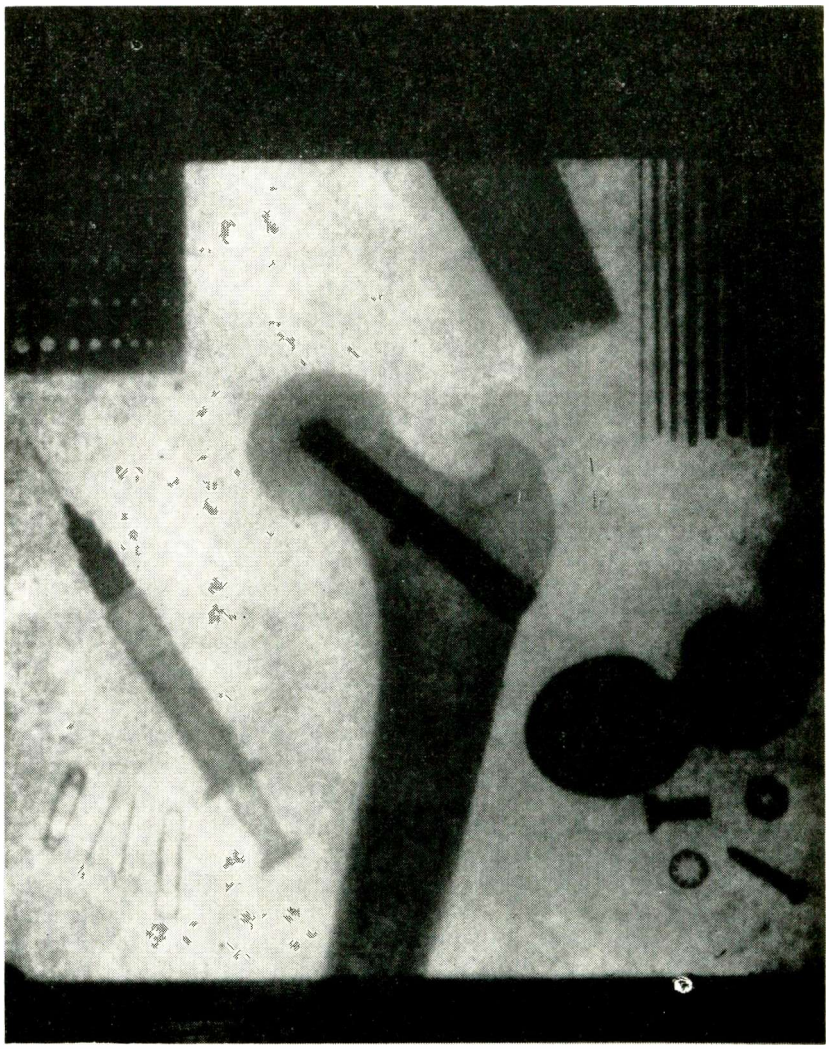


FIG. 5—Amplifier output. See text for detailed explanation

photoconductive material. After an image is built up, polarity of the d-c supplies is reversed. Conductivity of the photoconductive powder in the reversed direction is suddenly reduced to a low level and output of the panel is cut off. Since reverse conductivity is determined somewhat by current flow in the initial direction, it is preferable to flood the entire amplifier with radiation before reversing the voltages.

The complete arrangement for erasing is indicated in Fig. 7 with thickness of the layers again exaggerated. In addition to the reversing switch, an auxiliary electroluminescent phosphor layer is placed adjacent to the amplifier. Since the grooved photoconductor is sensitive to visible light as well as X-rays, it is more convenient to flood it with light from the auxiliary phosphor layer. By making the phosphor layer thin, about one-mil thick, and supporting it on a five-mil Mylar sheet, X-ray absorption

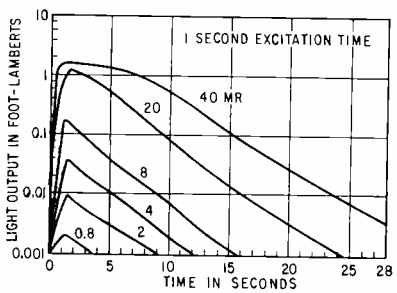


FIG. 6—Amplifier decay following excitation with different X-ray inputs

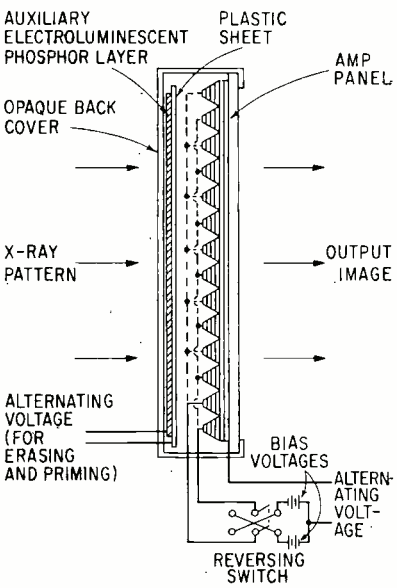


FIG. 7—Cross-section of complete amplifier with erasing means

caused by the introduction of these layers is negligible. To provide a transparent electrode, surface of the Mylar in contact with the phosphor is coated with an evaporated aluminum layer of about 40-percent light transmission.

In operation, after an output image has been excited by the X-rays, the slowly decaying image can be viewed for an arbitrary time. When erasure is desired, the auxiliary phosphor layer is switched on for one sec or less to flood the entire panel followed by a reversal of the bias voltage. Following the erasing, the entire amplifier is dark and can be excited with a new image as soon as desired.

Bias light provided by the auxiliary phosphor layer is also useful in priming the amplifier prior to exciting it with an X-ray image. In some cases, as a result of the erasing action or if the amplifier has been unexcited for a long period, current through the photoconductor may be below the threshold level required to produce any light output on the amplifier. To reduce X-ray exposure on the amplifier to a minimum when building up an image, it is desirable to prime it initially with the auxiliary light until the threshold output light is reached. To prevent exciting the amplifier by ambient room light, the back side of the panel with the auxiliary phosphor layer indicated in Fig. 7 is enclosed in a light-tight plastic cover which is X-ray transparent.

Control Circuits

To avoid the need for d-c supplies, the control circuit of Fig. 8 is incorporated. This circuit uses oppositely polarized rectifiers to provide d-c to the two sets of photoconductive ridges. As with biased a-c, current flow through adjacent photoconductive ridges occurs at alternate half cycles. For equal peak voltages applied to the amplifier, gain with diodes is almost as high as with biased a-c. Difference in gain is caused by the change in wave shape of the applied voltage. The auxiliary phosphor layer, having a capacity of about 0.1 μf is also excited from the 400-cps source. To control the output light and lower the voltage, appropriate dropping resistors are used.

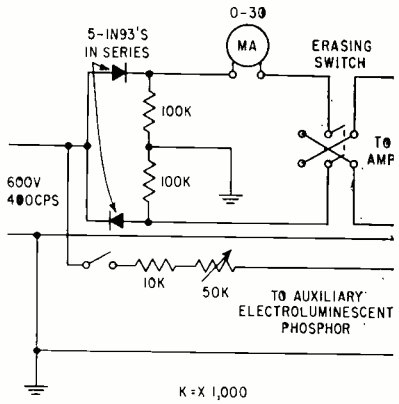


FIG. 8—Control circuit of the portable supply

For the 12-in. amplifier, current of about 30 ma is required. Since current flow through the photoconductor is a measure of output light, it is convenient to monitor this current with a d-c meter in series with one set of diodes. In cases where the panel is observed during the decay period with the X-rays off, the current meter, remotely positioned, can be used to indicate when the panel has reached full brightness. In place of the meter, or in series with the second set of diodes, it is convenient to use a relay set to automatically shut off the X-ray source when the image has reached full brightness.

Applications

The present amplifying panel with its build-up and decay properties is potentially useful for the viewing of nonmoving parts of the body. In these applications, its bright image permits working in a moderately lit room without dark adaptation. By increasing the contrast of the X-ray image, it aids in the perception of details. Because of its amplifying action, relatively low X-ray dosages are required. At high X-ray voltages, where shielding is a problem, its long persistence image can be viewed at close range with the X-rays off. Since output light is relatively high, it can also be conveniently used with an industrial tv system employing a vidicon pickup tube where remote viewing is desired.

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(1) S. M. Thomsen and R. H. Bube, High-Sensitivity Photoconductor Layers, *Rev Sci Inst*, 26, p. 664, 1955.

(2) B. Kazan, An Improved High-Gain Panel Light Amplifier, *Proc IRE*, 45, p 1358, 1957.

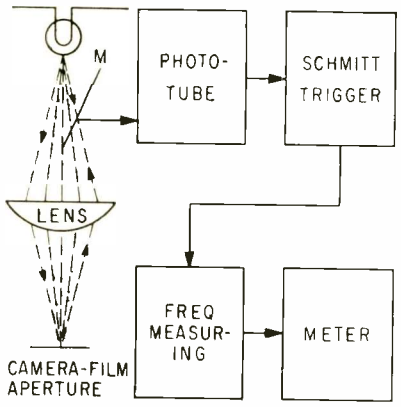


FIG. 1—Frame-rate checker has optical system that includes phototube and light source for cameras and projectors

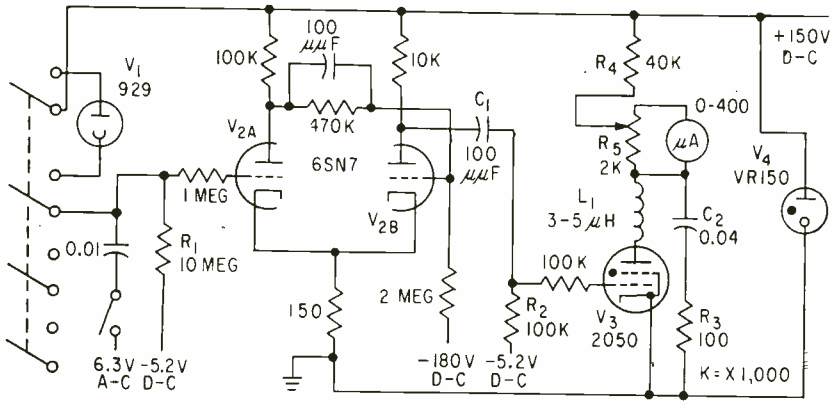


FIG. 2—Separate light and second phototube that use lower portion of switch at left must be added to accommodate fixed-lens cameras. Increased photocurrent raises potential of V_{2A} that starts circuit action

By **CHESTER OWLETT,** Senior Design Engineer, Eastman Kodak Company, Rochester, N. Y.

Frame-Rate Checker for

Light beam, projected through front panel into motion-picture camera or projector, reflects back from pressure plate in film gate if shutter is open. Reflected beam feeds into checker optical system and is deflected onto cathode of phototube. Current increase gates Schmitt trigger each time shutter opens. Differentiated output triggers thyratron in circuit of meter readings of which are proportional to trigger-pulse frequency

CHECKING FRAME RATES in movie cameras and projectors has long been a ticklish problem in the camera industry. Most mechanical tachometers take too much power from the spring driven systems, and revolution counters provide only an average rate during the entire run-down cycle.

Two systems, the stroboscopic disk and the photoelectric counting method, provide a speed check at every instant while drawing little power from the mechanism. Although the strobe disk gives frame rate only within certain present limits, the photoelectric method to be described provides the exact frame rate at every instant.

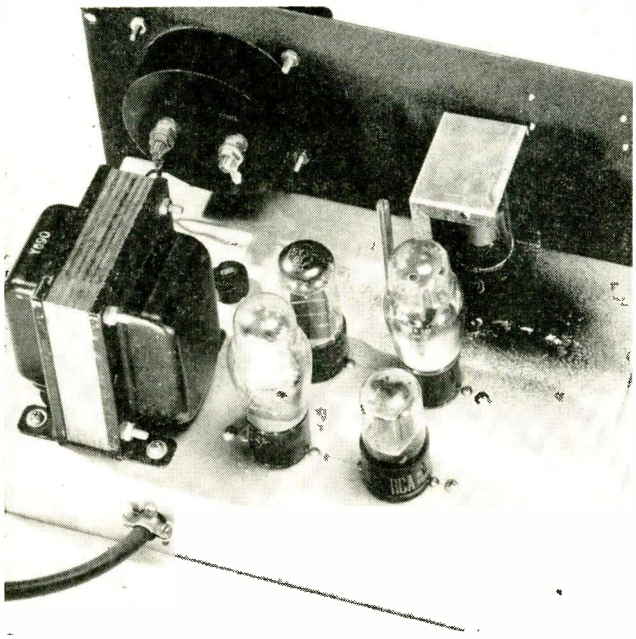
The frame rate checker has simple, accurate circuits and can be used with many types of movie cameras and projectors. The system block diagram is shown in Fig. 1.

Checker System

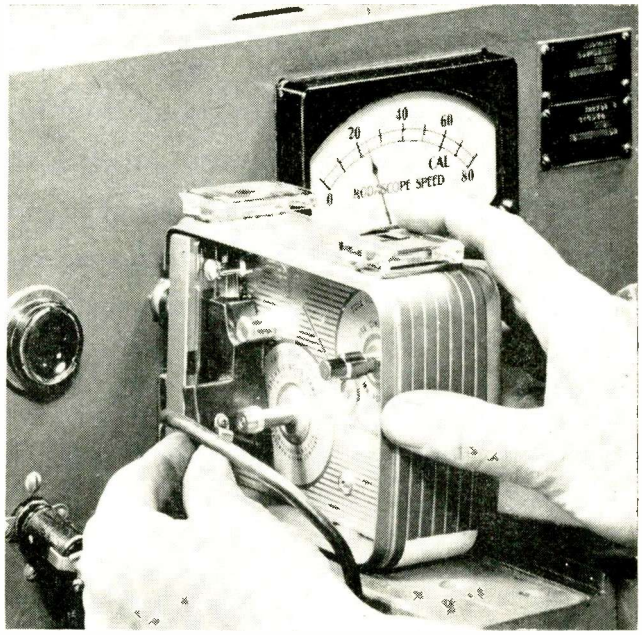
For use with removable-lens cameras, the instrument is equipped with an optical system that projects a beam of light through the front panel into the camera. After passing through the shutter, the beam is reflected by the polished surface of the pressure plate in the film gate. If the shutter is open, the reflected beam travels back into the optical system of the checker where it is deflected by a beam splitter onto the cathode of a phototube. Circuit details for the complete unit are shown in Fig. 2.

Pulses, with frequency a function of shutter speed, pass from phototube V_1 into Schmitt trigger V_2. The circuit triggers in one direction when the input potential at the grid of V_{2A} is raised to a critical value and triggers in the reverse direction when the input is reduced to another critical level. With the phototube dark, V_{2A} is practically cut off.

When light falls on the phototube, the current through R_1 raises the grid potential of V_{2A}. A consequent drop in plate potential of V_{2A} couples to the grid of V_{2B} which is normally clamped at cathode potential. The plate current in V_{2B} decreases, thus the cathode potential drops and the grid potential of V_{2A} increases. The action is regenerative and V_{2B} rapidly cuts off.



Open view of chassis of frame-rate checker



Operator reads shutter speed on specially damped meter

Motion-Picture Cameras

The output of V_{2B}, a rectangular wave of constant amplitude, is fed to differentiating network C_1R_2. Thus, the voltage across R_2 is a series of uniform positive spikes that occur each time the phototube is illuminated and negative spikes each time the light is cutoff.

Metering

Positive spikes across R_2 are fed to the grid of thyratron V_3 in the frequency-meter circuit and the tube fires. Capacitor C_2, which is normally charged to 150 v and regulated by V_4, rapidly discharges.

Resistor R_3 limits the thyratron current to a safe value. Inductor L_1 in the plate circuit tends to drive the plate negative and helps deionize the tube after the conducting period. Capacitor C_2 recharges through the plate load resistor R_4 and the 400-μa meter.

The charging time constant is short compared to the shortest time between trigger pulses so the capacitor always recharges to 150 v. Because each pulse removes a fixed charge from C_2, the average charging current through the special highly damped meter is directly proportional to the frequency of the trigger pulses. Potentiometer R_5 is a ring shunt for varying meter sensitivity without disturbing the damping.

Instrument Calibration

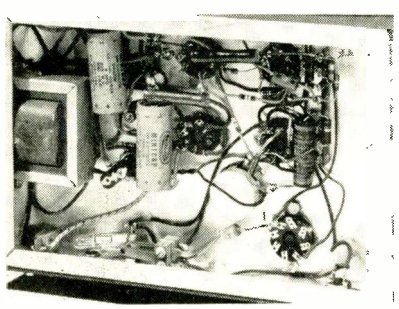
The 60-cps power-line frequency is a standard for calibrating the instrument. A pushbutton switch on the panel applies the 6 v from the heater winding of the power transformer to the trigger circuit, and the ring shunt on the meter is adjusted for a meter reading of 60.

Performance

The checker reads speeds of five frames/sec with no appreciable wobble in the indicator needle. Speeds above the 64 frames per sec of slow motion are easily handled as there is a tolerance of approximately six R_4C_2 time constants between pulses at 60 frames per sec.

The unit can check all types of cameras and projectors with an accuracy limited only by the line frequency and the accuracy of the meter.

A plot of checker accuracy as a function of frame rate is shown in Fig. 3.



Under-chassis view of frame-rate checker shows relative simplicity of component layout

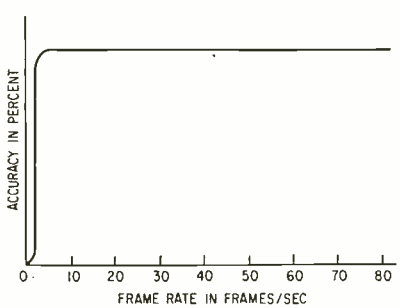


FIG. 3—Accuracy of frame-rate checker approximates 100 percent in the range from 16 to 64 frames/sec

Survey of circuit problems effected by peculiarities in electron tubes covers sleeping sickness, blackout, d-c shift, stray emission, mica charge, spook interference, snivet interference and other phenomena not ordinarily described in literature on tubes and circuits. Causes, effects and solutions are covered for each of these unusual phenomena

By W. E. BABCOCK

Electron Tube Division, Radio Corporation of America, Harrison, New Jersey

Unusual Tube Effects

SOME TIME or other, circuit designers experience the feeling that electron tubes are part gremlin. This feeling is caused by some of the peculiar effects noted with certain tubes in certain circuits. These effects usually are not mentioned in the data supplied by tube manufacturers nor are they described in any textbook on tubes or circuits.

Sleeping Sickness

Most attention, on the part of tube manufacturers and circuit designers in the last few years, has been given to an effect which has been termed sleeping sickness. This effect has been most serious in computer circuits where a tube may operate for long periods of time with its plate current cut off. When a problem is put to the computer which requires the tube to pass a pulse of current, the tube will often not conduct.

The sleeping-sickness effect is caused by the formation of a cathode-interface resistance layer between the cathode base metal and the cathode coating. This thin resistance layer acts as a dielectric for a capacitor of the order of 0.01 μf in which the cathode base metal is one plate and the cathode coating is the other.

The effect of the cathode interface layer is shown in Fig. 1. When a rectangular pulse is applied to the tube, interface capacitance C_i acts as a direct short across interface resistance R_i for an instant. The initial plate current of the tube is determined solely by the magnitude of the applied pulse and by the perveance of the tube. During the flat portion of the pulse the capacitor charges and the current begins to decay exponentially toward a value determined by the interface resistance.

Although the interface resistance is normally close to zero in a new tube, it can increase to several-hundred or even a few-thousand ohms after many hours of life with plate current cut off.

Magnitude of the interface resistance can be determined with calibrated variable resistor R_2 in series with the pulse supply. First, the height, H_1, of the output pulse trailing edge is measured with R_2 set at zero; R_2 is then increased until the leading edge, H_2, of the output pulse has the same amplitude that the trailing edge had when R_2 was at zero. This value of R_2 is equal to the interface resistance.

Cathode-Interface Cause

Formation of cathode interface is the direct result of the efforts of tube manufacturers to make tubes having a high value of emission at

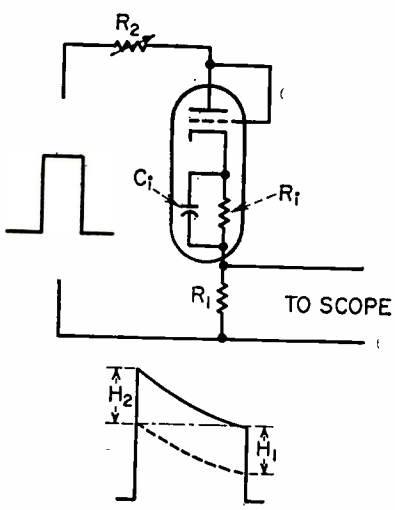


FIG. 1—Cathode interface layer effects plate current as shown here

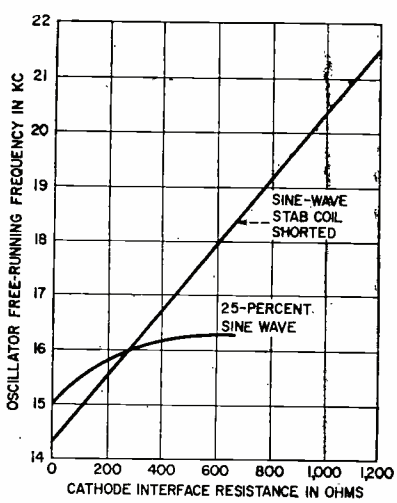


FIG. 2—Free-running frequency against interface resistance for oscillator

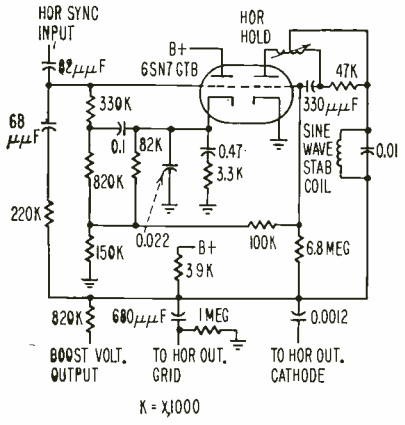


FIG. 3—Sine-wave stabilization coil improves oscillator frequency stability

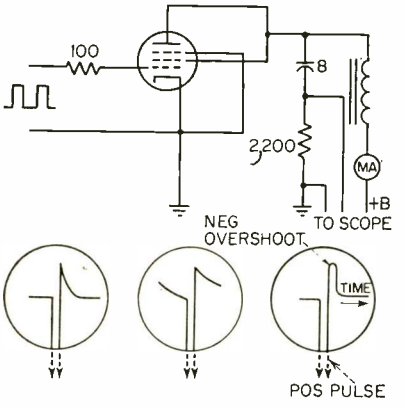


FIG. 4—Blackout test shows output for poor (left, center) and good (right) tubes

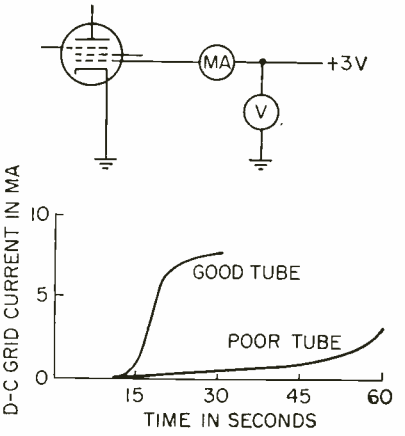


FIG. 5—Direct-current test method for blackout and resultant curves

Cause Circuit Troubles

a reasonable cost to consumers.

While the tubes are being evacuated during manufacture, the carbonate mixture which forms the cathode coating is broken down into oxides. Subsequently, during aging the oxides are broken down to form a surface layer of pure barium.

A reducing agent is required at this step to assure that the oxides produce pure barium without liberating oxygen. This reducing agent consists of minute impurities, less than 1 percent, added to the cathode base metal. In tubes designed especially for applications where heater-only or plate-current cutoff operation will be used, cathode material having an extremely low silicon impurity content limits formation of an interface layer. These tubes can operate for thousands of hours with negligible interface development.

If practical, it is recommended that some small amount of plate current be maintained at all times.

In many cases, it has also been found desirable to use low-silicon cathode material in receiving tubes designed for home-entertainment applications. For example, low-silicon cathodes are used in the 6SN7GTB twin triode, which is used as a horizontal deflection oscillator in many television receivers. Most horizontal oscillator circuits tend to exhibit frequency drift and thus loss of sync, if the oscillator tube develops cathode interface.

Figure 2 shows the free-running frequency as a function of the interface resistance for the Synchroguide type of oscillator circuit used in many television receivers. A similar curve can be obtained with the stabilized multivibrator type of horizontal oscillator. The upper curve, with the sine-wave stabilization coil shorted, shows the frequency drift when there is no compensation for tube variations.

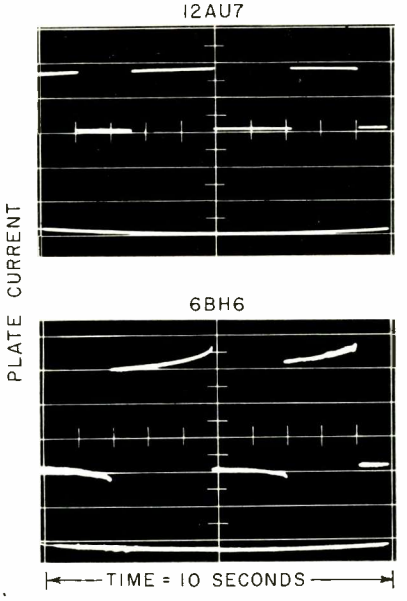


FIG. 6—Output of good tube (top) and one with d-c shift (below)

The second curve indicates the improvement in frequency stability achieved with the circuit compensation shown in Fig. 3. The sine-wave stabilization or ringing coil pulls the oscillator frequency back to its proper value when changes in the tube or other components tend to change the frequency.

Although the use of sine-wave stabilization reduced the frequency drift considerably, performance was still not considered satisfactory. Therefore, the cathode base metal of the 6SN7GTB oscillator was modified to a lower silicon content. With this change, field troubles in this circuit resulting from cathode interface have been nonexistent, even after several thousand hours of operation.

Blackout

Another effect, which in many respects is related to cathode interface, has been called blackout. This effect was first noted during the early days of World War II, when the transmitted pulse of a radar would get back into its receiver and cause it to go dead.

Blackout shows up only when a tube's control grid is driven positive. At some stage during the manufacture of a tube a semi-insulating layer is deposited on the surface of the control-grid wires. This layer acts as the dielectric of a capacitor in which one plate is the

grid wire and the other is the layer of electrons collected on the semi-insulating surface when the grid is driven positive. The tube then develops its own bias internally, as in the familiar grid-leak or grid-resistor method of biasing an oscillator or class-C amplifier.

Figures 4 and 5 show two methods for determining whether a tube has blackout. In the pulse method, shown in Fig. 4, the plate voltage of the tube under test is first adjusted for some given level of plate current and a positive pulse of sufficient magnitude to drive the grid into appreciable grid current is then applied to the control grid.

If the tube has no blackout effect, the plate current will probably rise slightly. However, if blackout is present, plate current will drop sharply as observed on an oscilloscope or a d-c milliammeter. Oscilloscope displays obtained with a tube having no blackout and with two tubes having different degrees of blackout are illustrated in Fig. 4.

D-C Method

In the d-c method of testing for this effect, shown in Fig. 5, normal voltage is applied to the heater and simultaneously a small positive bias is applied to the control grid. If the tube under test has no blackout, grid current will start to flow in about 10 to 15 sec and rise rapidly to a maximum.

If the tube displays blackout, however, the grid current will rise slowly and may take as long as several minutes to reach a maximum value. The grid current increases slowly, because the resistance layer on the control-grid surface has a negative temperature coefficient. The effect usually disappears completely in 5 to 10 min.

The negative temperature characteristics of the resistance can produce some annoying effects. For example, in the multivibrator type of horizontal oscillator circuit, it

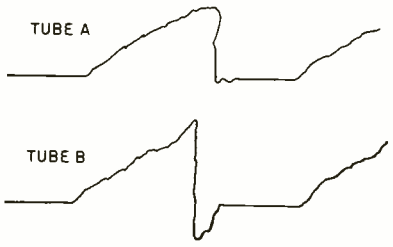


FIG. 7—Screen-grid current waveforms of good horizontal deflection amplifier tube (A) and one having screen-grid emission (B). Curve (B) reduces deflection

may be impossible to hold the oscillator in sync for several minutes after the television set is turned on. Because the magnitude of the resistance varies as the tube heats up, the horizontal frequency also varies and the picture drifts in the horizontal direction for several minutes every time the set is turned on.

Tube manufacturers have not yet developed a process for preventing the development of this effect, nor for eliminating it once it has developed. Fortunately, normal processing techniques produce tubes which are generally free from this effect and most applications do not drive the control grid positive.

D-C Shift

Another effect, which in many respects appears to be similar to cathode interface and blackout, is known as d-c shift. In amplifiers using tubes having d-c shift, the amplifier gain is less for d-c signals than for a-c signals. In oscilloscope amplifiers, therefore, the usual a-c calibration signal is not reliable if the oscilloscope is to be used for d-c measurements.

The d-c shift effect can be demonstrated dramatically by the use of a low-frequency square-wave signal, as shown in Fig. 6. If the tube has no d-c shift effect, plate current remains at a constant level during the flat portion of the pulse. If the tube has d-c shift, the plate current drifts about 5 to 10 percent over a period of about 2 sec.

The d-c shift problem has been attributed by Nergaard of RCA Princeton to the Sproull effect, which is caused by the formation of a donor depletion layer near the emitting surface of the cathode. That is, d-c shift is caused by the resistance of the cathode coating.

This resistance has a time constant of the order of 1 or 2 sec, while cathode interface has a time constant of just a few μsec.

This shift effect is inherent in tubes having close spacings and can only be eliminated by the develop-

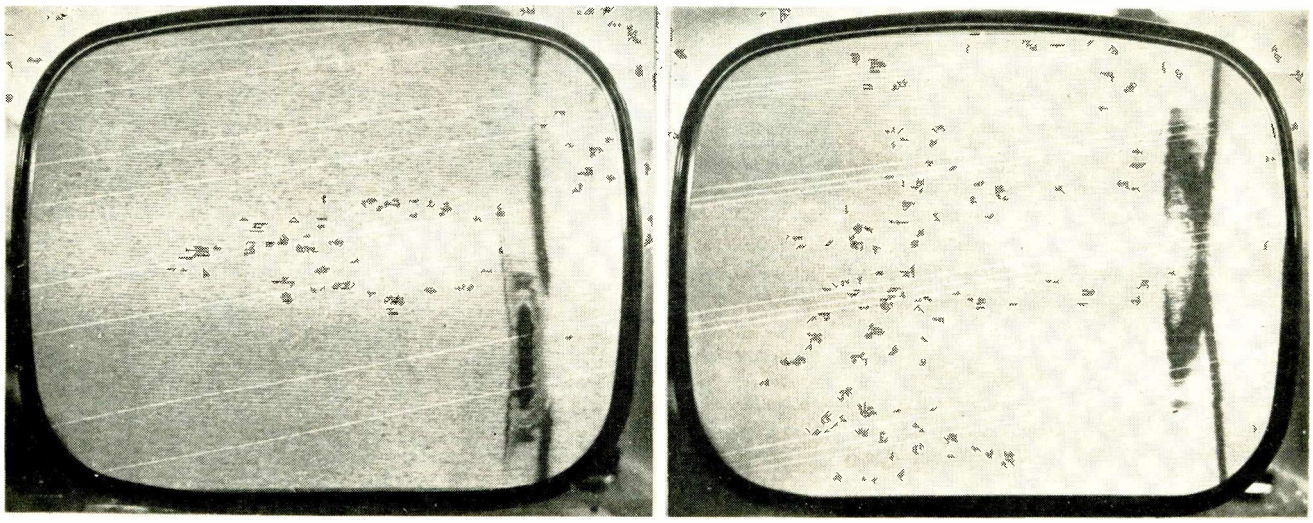


FIG. 8—Typical snivet as caused by nonlinear operation, during plate current fall, in receivers' horizontal-deflection circuits

ment of a new cathode material.

Stray emission in electron tubes can also cause some peculiar effects. The most familiar of these effects is probably that due to control-grid emission when an excessively large grid resistor is used; the tube runs away and usually destroys itself if a protective fuse is not used.

Stray emission from the screen grid in horizontal-deflection amplifier tubes is often responsible for loss of scan. In recent years, tube manufacturers have reduced screen-grid emission in such tubes to satisfy complaints of shrinking picture width, especially when the television receiver is operated at higher

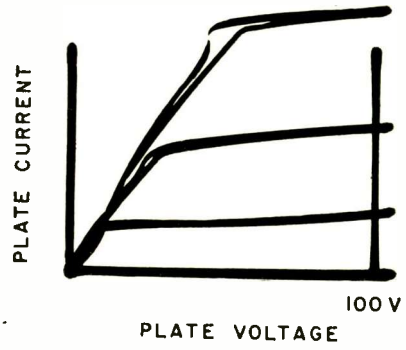


FIG. 9—Horizontal deflection tube plate characteristic at zero bias

than normal line voltage.

The screen-grid current wave forms of two horizontal deflection amplifier tubes are shown in Fig. 7. The emission current from the screen grid of tube *B* consumes power which would normally be used for deflection. As a result, insufficient power is produced for full deflection and the picture width is reduced.

Similarly, emission from the plate of the horizontal deflection amplifier tube causes a power drain from the deflection system and a reduction in picture width. Although tube manufacturers have improved deflection tubes considerably and reduced the tendency toward screen-grid and plate emission, operation of tubes outside of ratings will seriously aggravate this problem.

Bulb or Mica Charge

Deflection circuits of television sets produce many peculiar effects. Some of the most mysterious effects are caused by bulb or mica charge, which produces jitter of portions of the picture. In horizontal-deflection tubes, such charge may produce streaks or jitter of the entire raster. In extreme cases, the effect is called cogwheel or pie crust.

In vertical circuits, mica charge produces an effect known as white line or bright line. It can also produce a black line.

Troubles due to mica charge are minimized by mica designs incorporating slots which interrupt leakage paths and by the use of a high-resistance material such as alundum on mica surfaces. Equipment designers can help to reduce problems caused by bulb or mica charge by designing deflection circuits with peak voltages on the tubes well within ratings.

Spook Interference

Spook interference is another peculiar effect associated with horizontal-deflection circuits.

The interference appears as a vertical line or band at the extreme left edge of the raster. In some cases, it may not be visible at all, because of overscan of the raster or because it is in the blanked region. Sometimes the interference is picked up from a neighboring receiver and may go flitting mysteriously back and forth across the screen; service technicians have referred to this behavior as windshield-wiper effect.

Spook interference is generated by the plate current of the damper tube rising from zero to several-hundred milliamperes in about 0.1 μsec. This rapidly increasing waveform produces many higher-order harmonics of the horizontal scanning frequency which lie within the television frequency band. In addition to producing the vertical line at the left edge of the raster, these harmonics often get into the sync circuits and cause picture instability.

It is impossible to eliminate the harmonics produced by the rise of current in the damper tube. However, if r-f chokes are placed in the damper leads at the tube socket, interference is limited to the amount radiated by the tube itself.

A familiar interference from

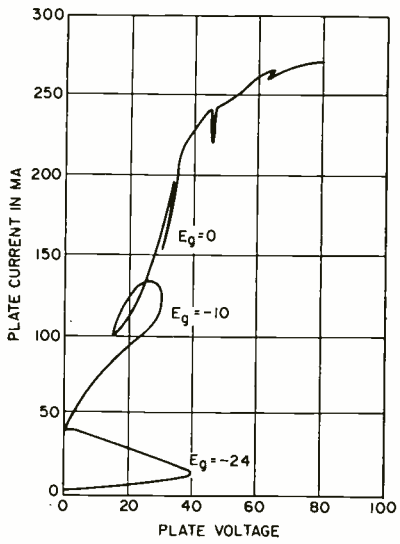


FIG. 10—Load line of a 25CD6G horizontal deflection tube in a receiver that exhibits strong snivets

horizontal-deflection circuits is the snivet type, shown in Fig. 8. One possible cause of this form of interference is illustrated in Fig. 9, which shows the plate-current, plate-voltage characteristic of a deflection tube at zero bias. When the plate current rises from zero to high values, it follows a smooth curve. However, when it decreases from high values toward zero, there is a discontinuity in the curve. This sudden change in plate current produces harmonics which can be picked up by the r-f amplifier and produce interference.

Another theory holds that snivets interference is caused by a form of Barkhausen oscillation, because the plate voltage swings appreciably below the screen-grid voltage in many receivers. This condition is especially severe in modern flyback transformer designs which drive the plate voltage as far into the knee region as possible.

An examination of the load line of a horizontal deflection tube illustrates this phenomenon quite well. The most familiar load line to most engineers is the straight line for R-C amplifiers. If the load is reactive, the load line becomes an ellipse.

In contrast to these conventional load lines, Fig. 10 shows the load line of a typical deflection tube (25CD6G) in a television receiver which exhibited strong snivets.

Modified Transceivers

Two communications transceivers operating on a common frequency form a responder-interrogator combination between an aircraft and a ground station. By measurement of the time lapse between interrogator and responder pulses, distance can be measured between stations to within 0.1 mi accuracy. Precisely measured time delays at both ends of the system allow turn-around time for the transceivers

By **HARRY VANTINE, JR.,** Supt., Radio Division, **and EINAR C. JOHNSON,** Asst. Supt., Radio Div., U. S. Naval Air Development Center, Johnsville, Pa

ABILITY TO MEASURE distance using communication transceivers thus increasing their utility has been developed at the U.S. Naval Air Development Center. For evaluation, the distance-measuring technique was applied successfully to an airborne uhf radio set, AN/ARC-27, an equipment which is standard in most present-day service aircraft. The AN/ARC-27 communications transceiver with a special antenna system, AN/ARA-25, already supplies azimuth information so that the addition of the range determining feature provides a more complete navigation system.

Turn-Around Time

The system to be described is similar to radar beacon operation in that a signal is sent out by an interrogator station, received by the transponder station, and a reply is initiated by the transponder. The NADC range system differs from this fundamental operation in one important detail. That is, when using transceivers operating on a common frequency for both responder and interrogator functions, it is necessary to provide a precisely measured time delay at both ends of the system to permit turn-around time for the transceivers. Turn-around time is the time taken by the communications transceiver to change its function from transmit to receive.

Referring to Fig. 1, the interrogator transmits an interrogation pulse at time A and begins its changeover to receive mode. The responder, which is normally in the receive mode, receives the interrogating pulse at a time AB later, equal to the propagation time of the signal between the two transceivers. The responder, upon receipt of the signal changes mode from receive to transmit and sends a reply pulse. However, since it takes time to change modes, a precise time delay equal to BC is introduced between receipt of a pulse and transmission of a reply pulse. The responder pulse is received by the interrogator after a delay CD, also equal to the propagation time between the two transceivers.

If the known period of time represented by BC is subtracted from AD at the interrogator, the remaining time $AB + CD$ equals twice the propagation time between the two stations. An indicator measures this propagation time in nautical miles.

Delay Unit

The heart of the system is the long delay unit which provides approximately 100 millisec of delay with a time jitter of less than $\frac{1}{2}$ μsec.

The precise value of this delay (later referred to as the long delay) is of little interest but must be long enough to permit ample turn-around time for the communications transceiver. Delay jitter must be held to appreciably less than the resolution of the range system. It was found that a jitter of less than 0.1 μsec in 100 millisec is readily achieved.

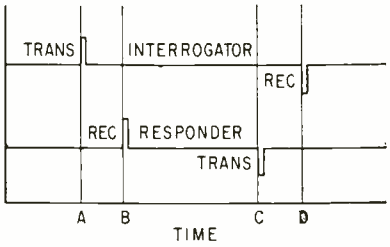


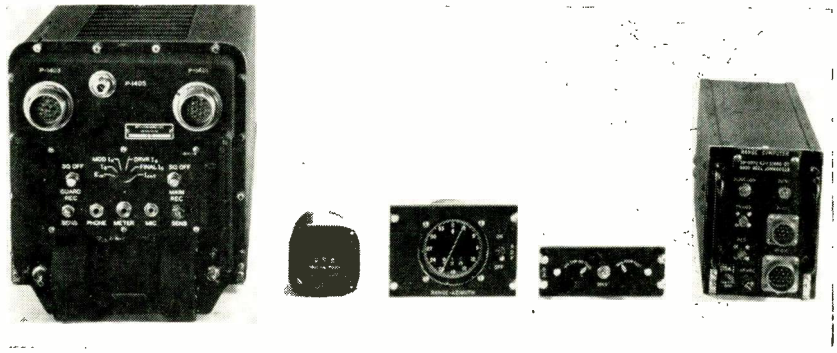
FIG. 1—Sequence of operation in range computer is explained in text

The ranging technique is capable of operating with any transmitter-receiver combination and long delays greatly in excess of 200 millisec are readily obtained so that long turn-around times can be accommodated.

The system consists of an interrogating station and a responding station. Both stations may be physically identical but are arranged by the operators to perform electrically in different modes. The interrogator station initiates the action and reads the range or intervening distance between the interrogator and the responder stations. The responder station operates like a beacon. Any station may operate as an interrogator or as a responder at the operator's will. The range function may be switched off by the operator thus reestablishing the normal communication functions of the transceiver. Figure 2 is a

Compute Distance

Range computer system is checked before takeoff for flight test



Complete system includes, left to right, transceiver, range indicator, optional range-azimuth indicator, control box, and range computer unit

block diagram of the system and Fig. 3 is a chart of the significant time-sequence waveforms.

Interrogate Operation

With the equipment in the INTERROGATE position a trigger is initiated by the AUTOMATIC/MANUAL trigger generator. It operates the transmit-receive (t/r) multivibrator energizing a plate circuit relay coil. This places the transceiver in TRANSMIT for 100 millisec at which time the multivibrator is turned off by a stop trigger from the long delay unit.

The trigger generator output is fed also to the long delay gate pulse generator, a multivibrator which generates a 200-millisec pulse and is turned off at the end of this interval by a stop pulse.

The output from the long delay gate pulse generator is applied to the long delay gate along with pulses from the clock unit. The clock unit, as shown in Fig. 4, consists of a crystal-controlled oscillator V_{1A} and shaping circuit V_{1B} producing pulses with a repetition rate equal to the frequency of the crystal oscillator. The crystal clock pulse period T is determined by the relation $T = 12.359N$ where N is the resolution of the system in nautical mi. For example, if the intended resolution is to be 0.1 nautical mile, then a pulse spacing of 1.2359 μsec or a crystal frequency of 809.11 kc would be used. For 1-mi resolution the frequency of the crystal clock is 80.911 kc.

Delay Gate

The gate pulse from the long delay gate generator enables the long delay gate to pass pulses from the crystal clock unit to the long

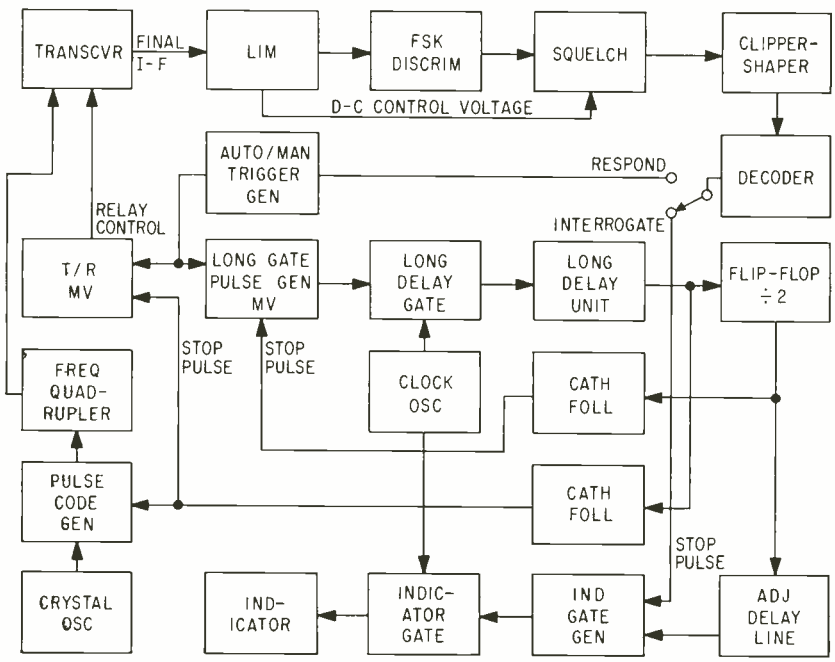


FIG. 2—Block diagram of range computer used in conjunction with a voice communications transceiver. Both stations may be physically identical, but operate in different modes according to which station is set up to initiate action

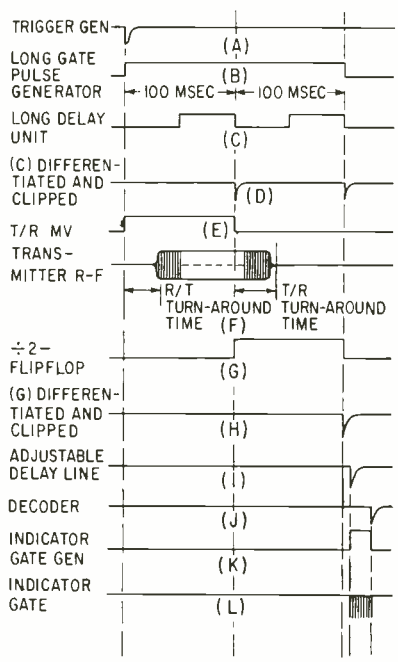


FIG. 3—Pulses at output of indicator gate (L) are counted and displayed as range in miles

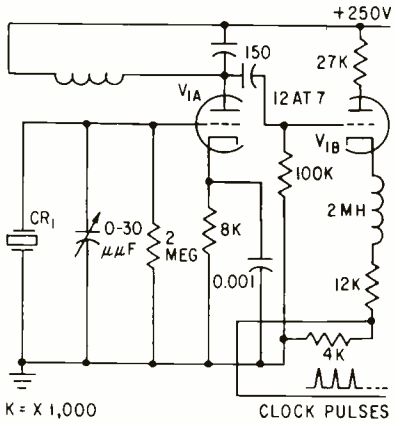


FIG. 4—Schematic of clock oscillator and shaping tube

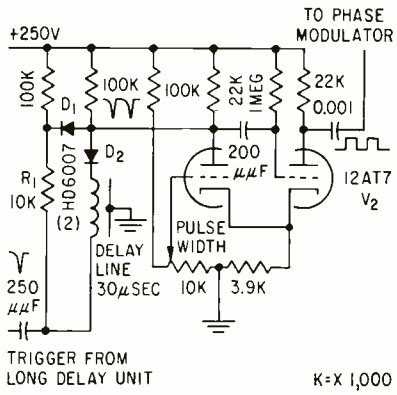


FIG. 5—Schematic of pulse code generator. Pulse spacing is controlled by the 30-μsec delay line

delay unit. It consists of a series of flip-flops arranged to count pulses arriving through the long gate from the crystal clock. A count sufficient to provide an output pulse after a delay of approximately 100 millisec is provided. With clock pulses having a repetition rate of 809.11 kc a count of 80,000 will provide an output pulse after a delay of 98.872 millisec. This count can be obtained using four decimal and three binary counters. This output pulse is applied through a cathode follower to the t/r multivibrator as a stopping pulse and at the same time energizes the pulse-code generator.

Pulse-Code Generator

Figure 5 shows the pulse-code generator used in the range computer. A pulse width of 15 μsec and a pulse spacing (controlled by a delay line) of 30 μsec are used. A double pulse represents the simplest pulse code that will give a reasonable degree of immunity from noise; at the same time the decoder becomes simply a coincidence gate. The operation of the pulse code generator is as follows: a negative trigger is applied to the second grid of a monostable multivibrator V_2 through two paths; one through an amplitude-controlling resistor R_1 and steering diode D_1 and one through a delay line and diode D_2 introducing a delay of 30 μsec. Thus the monostable multivibrator receives two triggers spaced 30 μsec apart. The circuit is arranged to produce a 15-μsec pulse for each trigger received and consequently the output is a double pulse.

Modulator

The pulse code is fed to the modulator unit consisting of an integrating network, a crystal-controlled oscillator and a phase modulator. Figure 6 shows the schematic of the crystal oscillator-phase modulator-multiplier chain. In this circuit, the pulse code is integrated by R_2-C_1 before being applied to the grid of the phase modulator V_{3B}. The phase modulator feeds some

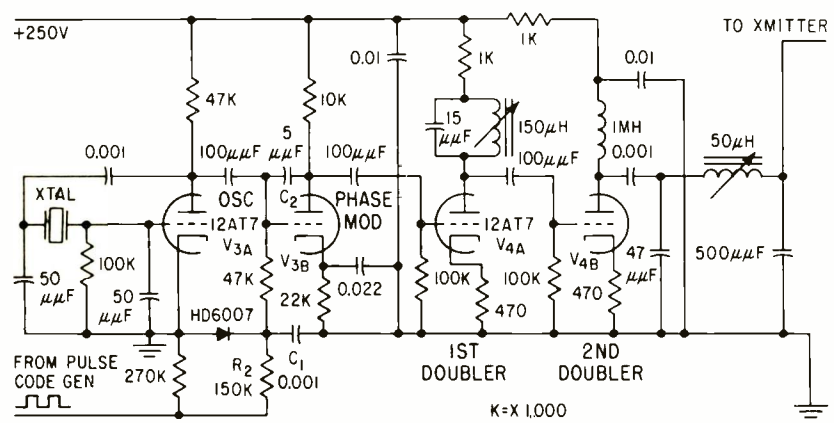


FIG. 6—Circuit diagram of the oscillator—phase-modulator—multiplier chain

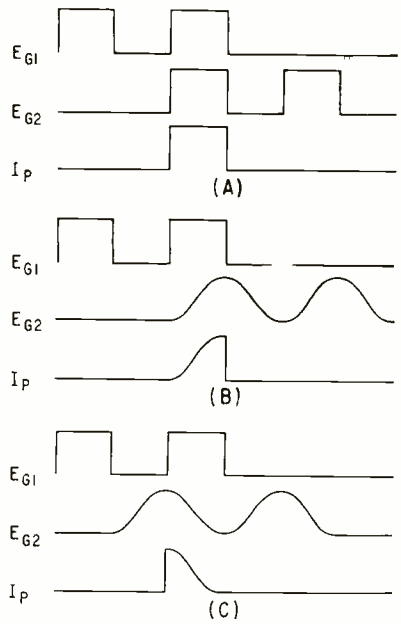


FIG. 7—Waveforms illustrate operation of decoder. Proper time delay in (C) yields sharp rise-time of I_P despite poor pulse shape of E_{G2}

of the plate circuit voltage back to the grid through C_2. Thus the signal applied to the grid of this tube is composed of two phasor voltages, the applied or reference phasor and another voltage phasor displaced almost 180 deg from the reference. The output of this stage is then the phasor sum of these two components and varies in both phase and amplitude with the transconductance of the modulator tube.

The transconductance is varied by the integrated pulse code so that the time rate of change of phase will be linear for flat-topped code pulses. Since the amount of frequency shift is directly proportional to the time rate of change of phase, a frequency shift keyed pulse is produced for each pulse in the code. The phase modulator produces approximately 5 to 10 kc of equivalent frequency shift so that two frequency doublers V_{4A} and V_{4B} are used to increase the shift.

The pulse code takes 45 μsec so that the fsk code is applied to the transmitted carrier before the stop pulse has time to operate the relays of the transceiver.

The modulator output frequency is chosen to be compatible with the normal crystal-controlled oscillator of the transceiver. In the AN/ARC-27 transceiver, this frequency is 3.45 mc.

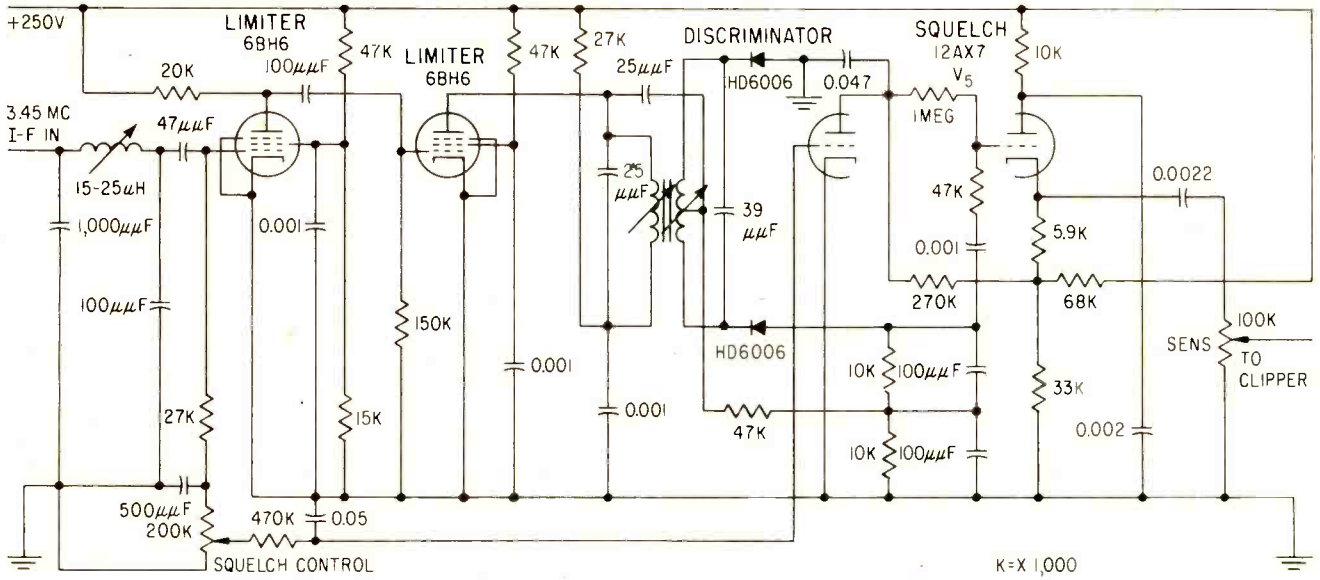


FIG. 8—Limiter-discriminator and squelch circuitry. The squelch tube circuitry has a time constant adjusted so that a sustained carrier of 35 millisec opens the squelch to normal reception of frequency-shift-keyed signals

The output of the long delay unit is applied also to an additional divider flip-flop. An output pulse from this stage occurs when the second pulse from the long delay unit is received indicating another count of 80,000 clock pulses. Hence the output of the binary stage occurs after a delay of 197.744 millisec. This binary output pulse is applied through a cathode follower to the long gate multivibrator as a stop pulse and simultaneously to the adjustable pulse code error delay line.

The latter introduces a fixed small delay to eliminate the error introduced by the finite time it takes to send and recognize the code plus any delays inherent in the transceivers. The output of the pulse code error delay line is applied as a trigger to the indicator gate multivibrator. This is a standard monostable multivibrator that produces a rectangular output pulse beginning with the trigger from the pulse code error delay line and ending with a trigger from the decoder.

Decoder

The decoder consists of a coincidence gate circuit with a delay line between two grids. However, the action is modified from the usual circuit in the amount of delay employed. The standard coincidence gate employs a double-pulse signal in which the first pulse is delayed until it is in time coincidence with the second signal pulse. The undelayed signal is applied to one grid of a dual grid tube, and the delayed signal is applied to a second grid. If the pulse spacing is correct, a plate current pulse is obtained during coincidence of the undelayed second pulse and the delayed first pulse.

The situation is shown in Fig. 7*A*. However, with delays on the order of 30 μsec, it is difficult to preserve the pulse shape through an L-C delay line. Consequently, the situation is more precisely portrayed by Fig. 7*B*. The resulting plate current now has a poor rise time and a sharp fall. A sharp rise in the plate current is desired for use as a trigger. Consequently a delay of half the pulse spacing is employed, and a sharp rise in pulse current is obtained as shown in Fig. 7*C*.

Limiter-Discriminator

The military transceivers employed are a-m equipments, hence a limiter and discriminator in the range computer is provided followed by a squelch tube controlled by limiter grid current. This circuit, shown in Fig. 8, has a time constant such that a c-w carrier of approximately 35 millisec duration is required to open the squelch tube V_5 and allow normal reception of fsk signals. A clipper stage is used to shape the pulses from the discriminator. Considerable noise immunity is obtained with this circuitry. The limiter is fed a signal from the last i-f stage of the receiver through a coaxial lead.

It was mentioned earlier that the indicator gate multivibrator was started by a trigger from the pulse code error delay unit and stopped upon receipt of a trigger from the decoder. The length of the pulse generated by this multivibrator then is proportional to the distance separating the interrogator and the responder. Accurate measurement of the length of pulse produced by this multivibrator must now be made and the results converted into equivalent nautical miles of range and displayed to the operator.

The clipper and decoder circuitry are shown in Fig. 9 with typical waveforms. The decoder delay line is composed of ten L-C stages of conventional design.

Indicator Gate

The manner of measuring the length of the indicator gate multivibrator pulse is to feed this pulse to the indicator gate with pulses from the crystal clock. The output of the indicator gate is fed to a counter capable of counting up to the greatest range anticipated. Four decade counters are used for 0.1-mi resolution, three for 1-mi

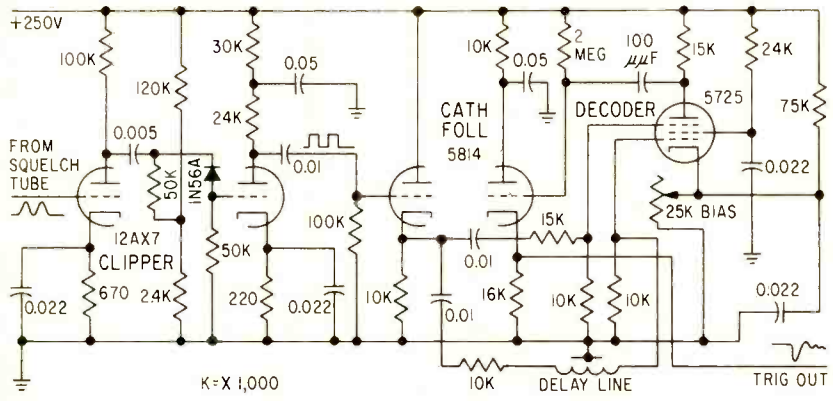


FIG. 9—Clipper and decoder circuit diagram. The double pulse code permits use of a conventional coincidence gate as decoder

resolution, and so forth.

Thus the number of clock pulses that pass the indicator gate can be made numerically equal to the range in whatever units are desired. For example, with 0.1-mi resolution, the clock will produce 809.11-kc pulses one of which passes through the indicator gate for every 0.1 nautical mi of range.

When the pilot desires to read the accumulated count, a seeking switch searches each of the decimal counters to determine the count situation following each interrogation. The seeking switches, driven through fast operating clutches by a motor, are arranged to disengage their respective clutches when the voltage they seek is found. The switches are mechanically connected to synchro transmitters which drive one or more standard 3-in. aircraft indicators. These indicators display the range on drum dials in a conventional manner. The count remains displayed until a new interrogation trigger is initiated by the operator or the automatic trigger generator. Old data is released after a predetermined period.

Automatic Trigger

The automatic trigger generator is a simple gas-tube relaxation oscillator providing either of two interrogation rates. For aircraft, these are one trigger every 5 sec for ranges greater than 10 mi or one trigger/sec for close-in navigation. A manual position permits single interrogation.

The long delay unit counters are cleared automatically before being called upon to serve as the indicator counter. To remove the stored mileage reading, a counter reset pulse is generated automatically in the trigger generator each time an interrogation is initiated.

In the RESPOND mode, the communication transceiver is in receive position. Upon receipt of a sustained carrier of over 35 millisec duration the squelch circuit operates to permit signals from the limiter-discriminator to be passed to the clipper stage. The desired signal consists of a sustained carrier of 100 millisec minus the r/t turn-around time of the communication transceiver, with a double pulse fsk code near the end. The magnitude of the frequency shift has been arranged to be approximately 20 kc in one direction from carrier frequency. This permits some selectivity in calling by arranging the responders to accept either a positive or a negative shift fsk signal.

A sustained 35 millisec carrier is sufficient to stabilize the avc circuits in the transceiver. Control bias for the squelch stage is obtained from the rectified grid current of the first limiter through a delay circuit arranged so that the squelch tube opens a few millisec prior to the arrival of the fsk code signal.

The detected pulse code is shaped in the clipper unit and passed to the decoder. The proper pulse code causes the decoder to produce a trigger which is directed by the switch (now in RESPOND position) to the t/r multivibrator and to the long-delay multivibrator.

The t/r multivibrator places the transceiver in transmit position for 100 millisec as previously described and causes the proper fsk code to be placed on the carrier just prior to cutoff. The circuitry following the 100-millisec delay unit is not used in the RESPOND mode.

Modifications

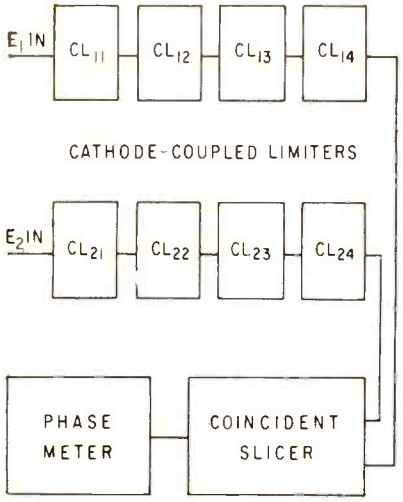
The required changes of a typical military type transceiver are minor. A signal is taken from the primary of the last i-f transformer at a low level so as not to interfere with the communication function of this equipment. A 3.45-mc signal is fed into the crystal socket after removing the crystal. The required 3.45-mc signal is obtained from the output of the crystal oscillator-phase modulator-multiplier chain.

Bandwidth

The ranging system can be used with any transmitter-receiver combination at any frequency as long as sufficient bandwidth is provided for the resolution desired. To determine the bandwidth, consider the rise-time t_r in μsec possible in a system of bandwidth Δf. This is estimated by the expression $t_r = 0.7/\Delta f$ where Δf is in mc. Assuming that jitter t_j amounts to 5 percent of the rise time, t_j in μsec is then $0.035/\Delta f$. So that t_j remains reasonable below the resolution N of the system, the jitter must not exceed $12.36N/2$ or $6.18N$. Here 12.36 is the time in μsec for a radio signal to make a round trip of 1 nautical mi. Setting this limit into the expression for t_j, and solving for Δf, it turns out that $\Delta f = 5.7/N$ kc. Thus, for a resolution of 0.1 mi the minimum required bandwidth is 57 kc. In practice, bandwidths 15 percent greater are used.

Flight tests indicate that the maximum distance over which the ranging system will operate is limited only by the range of the transceivers used.

Voice communication is possible during the time that the ranging function is in use but the ranging operation is interrupted during the time that voice communication is in progress. A control box has been developed which permits easy pilot selection of either the ranging function or communications. When the ranging function is not in operation, the communications transceiver operates normally.



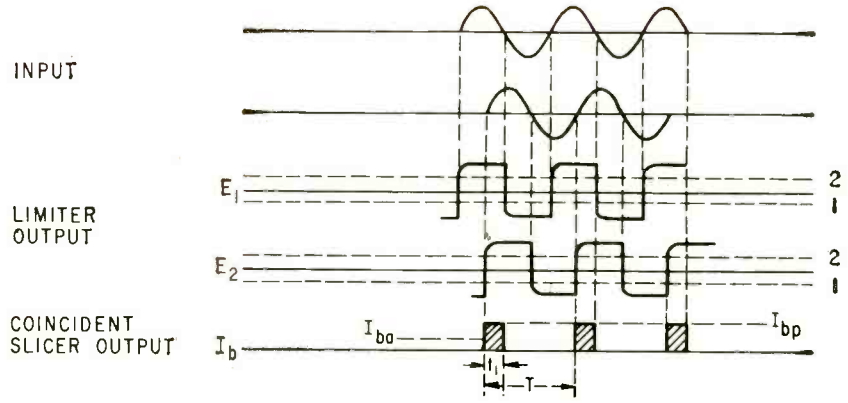


FIG. 1 (left)—Cathode-coupled limiters convert input signals to square waves and feed them to coincident slicer. FIG. 2 (above)—Waveforms of the input, limiter output and coincident slicer output

Coincident Slicer Measures Phase Directly

Self-adjustment of the cathode-coupled limiters and use of a coincident slicer to drive a direct reading phase meter gives good accuracy and stability. Coincident slicer permits fluctuations in input-signal amplitude from 0.3 v to 70 v and fluctuations in supply voltage from 95 v to 135 v

By Y. P. Yu, President and Chief Engineer, Ad-Yu Electronics Lab Inc., Passaic, N. J.

PHASE ANGLE between two voltages is read directly from a meter with an absolute accuracy of one degree and a relative accuracy of 0.25 degree. A cathode-coupled limiter with plate-to-grid d-c degeneration and a simple method for adjusting bias voltage give this accuracy.

A coincident slicer circuit, used to measure phase angle, makes the output meter independent of variations in signal amplitudes from 0.3 v to 70 v and supply voltages from 95 v to 135 v. Amplitude or frequency adjustments are not necessary after the starting full scale and zero adjustments have been made. Stability of the instrument permits phase measurements of a fraction of a degree without ambiguity over a frequency range from 1 cps to 500 kc.

A block diagram of this phase meter is shown in Fig. 1. Input signals E_1 and E_2 are applied to the four-stage cathode-coupled limiter, CL_{11} to CL_{14} and CL_{21} to CL_{24}. The cathode-coupled limiters produce a square wave with zero-axis-intersecting points identical to those of the input signals. Both input signals are then fed into a coincident slicer circuit, which activates the panel meter.

Waveforms at various points of the instrument are shown in Fig. 2 to illustrate how the phase angle is read directly from the current meter. Voltages E_1 and E_2 are output signals of the two four-stage cathode-coupled limiters and I_b is the plate-current waveform of the coincident slicer. Time T is the period of the applied signals; t_1 is the duration of the plate current and θ is the relative phase angle. The average plate current I_{ba} can therefore be expressed as:

$$I_{ba} = I_{bp}\, t_1/T = k\,\theta$$

where I_{bp} is the peak plate current of the coincident slicer and k is a constant. Since meter deflection is proportional to average current, the output meter can be calibrated to read the phase angle between E_1 and E_2 directly in degrees.

Cathode-Coupled Limiter

A schematic diagram of a cathode-coupled limiter is shown in Fig. 3. The grids of V_1 and V_2 are biased with positive potentials E_{c1} and E_{c2}. When the input signal increases above zero, plate current of V_1 increases, raising the cathode potential of both V_1 and V_2. Since the bias voltage E_{c2} of V_2 is held constant, the grid-to-cathode potential decreases, reducing the plate current of V_2 and raising its plate po-

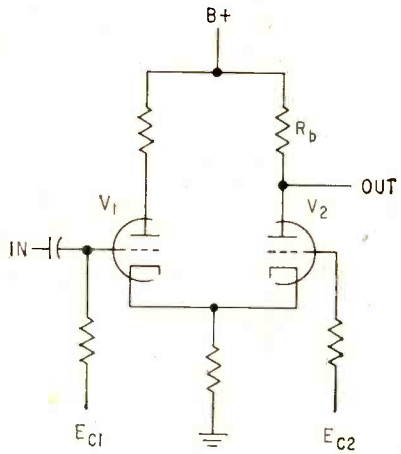


FIG. 3—Conventional cathode-coupled limiter

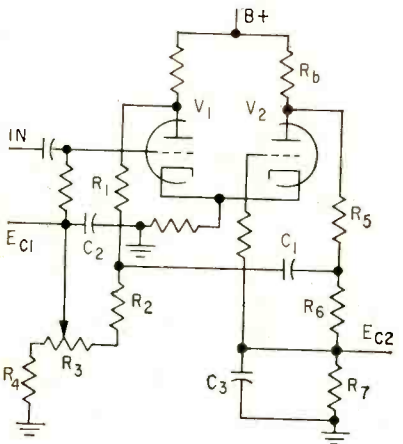


FIG. 4—Cathode-coupled limiter stabilized by plate-to-grid d-c degeneration

tential, or output. This action continues until V_2 is driven to cutoff and the output can no longer follow the input but remains at the plate-supply voltage level. The output remains flat until the input to V_1 comes up to a level which will permit plate current to flow again in V_1.

Before limiting action occurs, the gain of a cathode-coupled limiter is approximately equal to $\mu R_b/2(R_b + R_p)$, where R_b is load resistance at the plate of V_2, R_p is plate resistance of the tube, and μ is the amplification factor of the tube. Using conventional duotriodes, an overall gain of 10,000 is obtained with four stages of cathode-coupled limiters. This high amplification, combined with limiting action, removes more and more of the curved portion of the input waveform until the resultant waveform at the output of the last stage is a square wave with practically vertical sides.

A simple method for adjusting bias voltages is based on the principle of zero average current for a perfectly symmetrical square wave. The adjustment is made using the d-c microammeter of the instrument (properly shunted) in series with R_b. A pure sine wave applied to the input terminal results in a meter reading of I_1. With the input signal removed, bias voltage E_{c1} is adjusted until the meter, which is now measuring the quiescent plate current of V_2, is again reading I_1. These steps are repeated until the meter reading remains unchanged for variations in input signal amplitude from zero to maximum.

The adjustment gives an output square wave from V_2 with an average value of zero. Panel switches installed in the instrument enable the operator to adjust bias voltage at any one of the eight limiter stages. The ability to make adjustments insures proper operation of the limiter stages and increases instrument accuracy.

Plate-To-Grid Degeneration

Because characteristics of a vacuum tube vary with its age, cathode emission and supply voltages, it is difficult to predict how long the symmetrical square-wave output will remain unchanged after adjustment. To avoid the necessity of frequent bias voltage adjustment, d-c degeneration is used between the plate and grid without a-c feedback, Fig. 4. The d-c bias voltage for V_1 is obtained from the voltage dividers R_1, R_2, R_3, and R_4. And d-c bias voltage for V_2 is obtained from the voltage dividers R_5, R_6 and R_7. Potentiometer R_3 is adjusted to give a symmetrical square-wave output for a pure sine wave input.

Any variation of the tube characteristics from age, cathode emission or supply voltages is accompanied by a variation in quiescent value of the plate current.

Any increase of quiescent plate current causes d-c bias voltage to decrease, and conversely, the effect of tube characteristic and plate current changes is minimized by a corresponding variation in d-c bias voltage. Signal frequency components of the tube currents, however, do not affect the d-c grid bias voltages, because of the filtering action of C_1, C_2 and C_3.

A signal applied to the input terminal produces plate current components in V_1 and V_2 which are equal in magnitude and 180 deg out of phase. The time constants R_1C_1, R_5C_1, R_1C_2 and R_7C_3 are large compared to the period of the input signal. Signal components of both plate currents therefore are completely filtered by C_1, C_2 and C_3 before entering the grid circuits.

It is feasible for the limiter circuit of Fig. 4 to have high gain and no degeneration in signal component and at the same time, have a highly degenerative d-c component for stabilizing its characteristics. Degeneration is also developed by the cathode resistor to offset common mode variations between V_1 and V_2.

Coincident Slicer

A circuit diagram of the coincident slicer, which uses a gated-beam tube with two control grids, is shown in Fig. 5. Both G_1 and G_3 have a positive bias with respect to the cathode and both applied signals are negative. Plate current of the gated-beam tube cannot flow unless G_1 and G_3 are both above cutoff simultaneously. When both input signals are at their most negative values, plate current cannot flow.

Assume that dotted line No. 1 in Fig. 5 represents cutoff level and dotted line No. 2 represents saturation level for grids G_1 and G_3. When the potentials at G_1 and G_3 are increased from a value below cutoff, plate current will start to flow as soon as the voltages of G_1 and G_3 are both either equal to or above

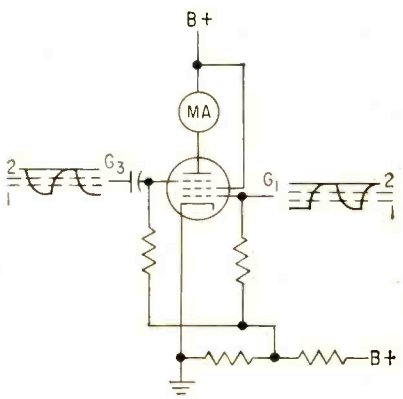


FIG. 5—Microammeter in the plate circuit of coincident slicer is calibrated to read phase angle directly

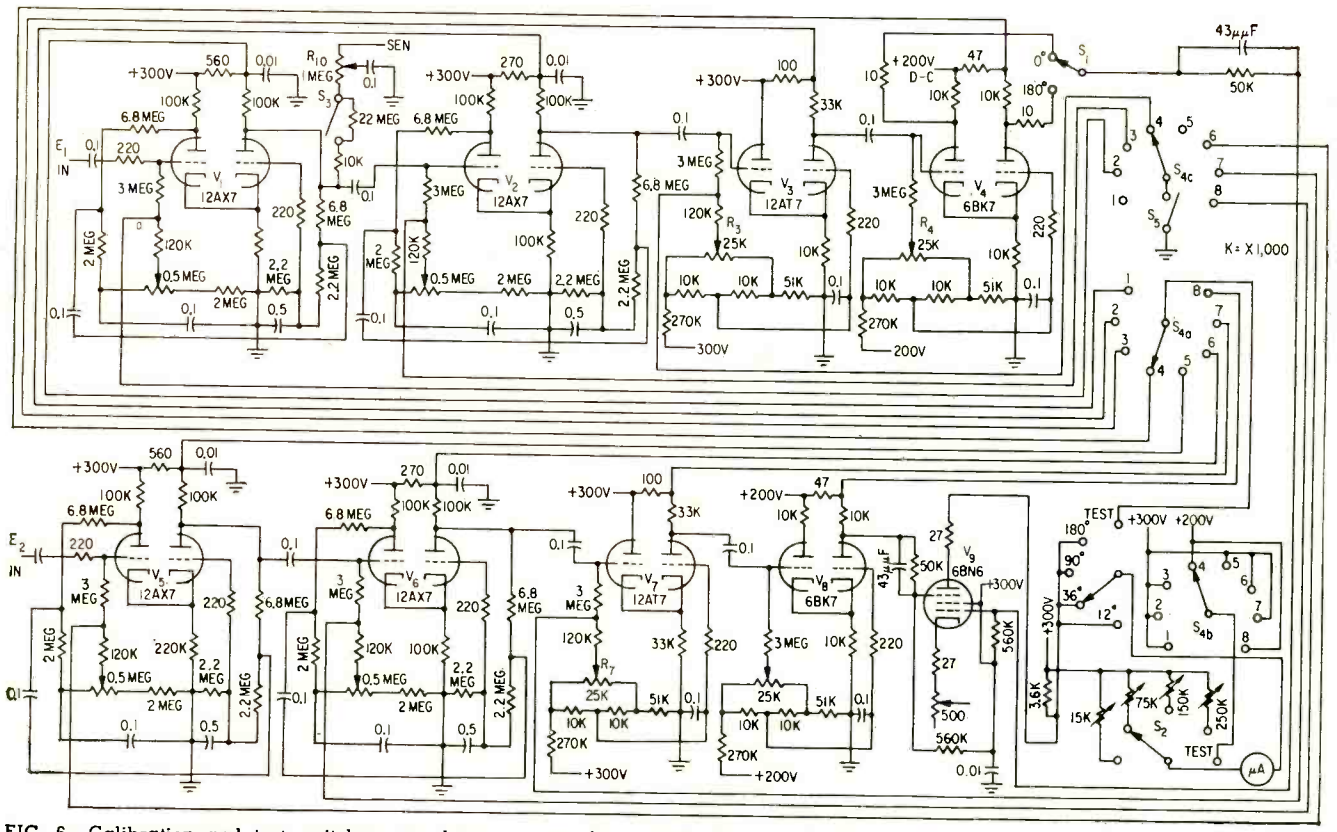


FIG. 6—Calibration and test switches are shown on complete circuit diagram of phase meter

dotted line No. 1. Plate current continues to increase as the potentials at G_1 and G_2 continue to increase. As soon as they reach dotted line No. 2, plate current reaches its maximum value and will no longer increase. If rounded corners and overshoots of both input signals are outside the dotted lines, plate current will not be affected by the irregularities.

Output signals E_1 and E_2 from two four-stage, cathode-coupled limiters, with exaggerated rounded corners for the low-frequency signals are shown in Fig. 2. Dotted line No. 1 and dotted line No. 2 are the cutoff and saturation levels, of the gated-beam tube used in the coincident slicer. Current I_b is the plate-current waveform of the coincident slicer.

Complete Circuit

Figure 6 is a complete circuit diagram of the instrument. Tubes V_1 to V_4 are connected as a four-stage cathode-coupled limiter for the E_1 channel and tubes V_5 to V_8 for the E_2 channel. A gated beam tube, V_9 is used for the coincident slicer. The panel meter is activated by the plate current of gated-beam tube V_9.

The first two limiting stages of both E_1 and E_2 channels use negative feedback to stabilize the limiting levels.

Bias voltage for V_1, V_2, V_5 and V_6 is controlled by the plate potential of each tube. Any variation in average value of the plate current, due to variations in tube characteristics or supply voltages causes a corresponding change in bias voltage. As a result variations are minimized and operating conditions remain stable.

When switch S_2 is in test position, the panel meter indicates plate current of the output section of any limiter stage, V_1, V_2, V_3, V_4, V_5, V_6, V_7 or V_8, depending on the position of S_{4a}. Bias voltage of any one of the eight limiter stages can be adjusted to maintain a constant plate current for grid variations from zero to the maximum permissible value. Plate current is equal to the quiescent value of the symmetrical signal applied to the grid. When the stage is adjusted, its square-wave output will be symmetrical, provided the amplitude of the input signal is never large enough to cause the tube to draw grid current.

The circuit shown in Fig. 6 has an absolute accuracy of 1 deg and relative accuracy of 0.25 deg for phase measurement from 8 cps to 100 kc. Meter readings are virtually independent of variations in output amplitude of the cathode-coupled limiters or tube-supply voltages. Accuracy of the instrument is unaffected by signal amplitude variations from 0.3 v to 70 v or supply line voltages from 95 v to 135 v. Each channel has a gain of about 10,000 through the limiters, permitting stable phase measurements of a fraction of 1 deg.

By changing the coupling capacitors from 0.1 μf to 0.5 μf, the grid-leak resistors from 3 megohms to 6.8 megohms and shunting the panel meter with a 2,000 μf capacitor, lower limit of the signal frequency can be extended down to 1 cps. By reducing the plate and cathode resistors of all cathode-coupled limiter stages, phase angles can be measured up to 500 kc.

The author acknowledges the contribution from the engineering staff of Ad-Yu Electronics Lab Inc. and particularly the effort of O. Santos.

Pulses of 0.25 μsec at 50 volts are produced by pulse generator to life test microwave triodes. Load changes from one to fifteen tubes are accommodated without appreciable change in pulse shape. Amplitude and pulse repetition rate are adjustable within limits, and the circuit can be easily modified for other frequencies and pulse characteristics. Design data for two pulse-forming networks to operate into different load ranges are included

By R. S. RINGLAND

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Pulse Modulator Works

FIFTY-VOLT PULSES were required to test fifteen microwave triode tubes in a life test rack. Pulse widths of 0.25 μsec were needed with rise time less than 0.025 μsec and fall time less than 0.05μsec. Pulse shape had to be substantially unchanged with a change in load from one to fifteen tubes.

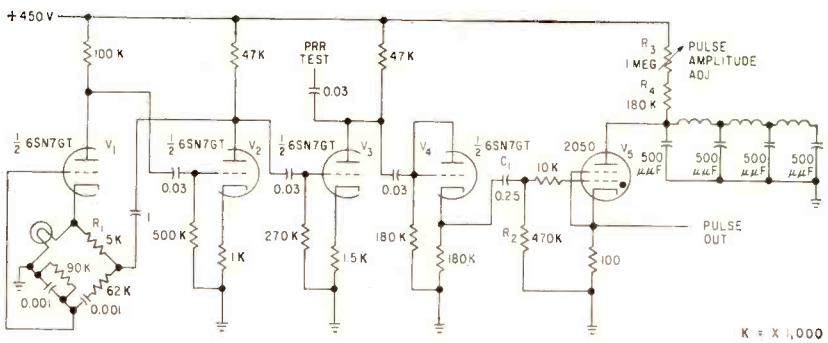


FIG. 1—Oscillator output is rectified after squaring and used to trigger thyratron. Pulses are taken from thyratron cathode

Circuit Description

The stable oscillator, shown in Fig. 1, was necessary to set the pulse repetition rate. A Wien-bridge type was selected, since it can be easily and compactly built around a 6SN7GT tube, and the circuit is known to be stable. Frequency is set by the values of the R-C combinations in the bridge circuit. Resistor R_1 is variable and is used to adjust frequency.

The 3-watt lamp in the cathode circuit acts to stabilize the oscillator. If the amplitude of oscillations increases, there is an increase in the lamp's filament temperature and its resistance increases correspondingly. The bridge unbalance produced by the increase in resistance reduces feedback to the grid, stabilizing the oscillator.

Tube V_3 acts as an overdriven amplifier. It squares the sine wave from the oscillator and also acts as a buffer amplifier, so that changes in load do not affect the oscillator. The test connector for oscillator frequency calibration is coupled to the plate circuit of this tube.

Tube V_4 has its grid and plate shorted. It acts as a diode rectifier to produce a positive square wave, which is used to trigger V_5, a type 2050 inert-gas thyratron.

The thyratron discharges the pulse-forming network. The grid-leak bias action of the R-C combination comprising C_1 and R_2 keeps a negative voltage on the thyratron grid between trigger pulses to prevent continuous conduction.

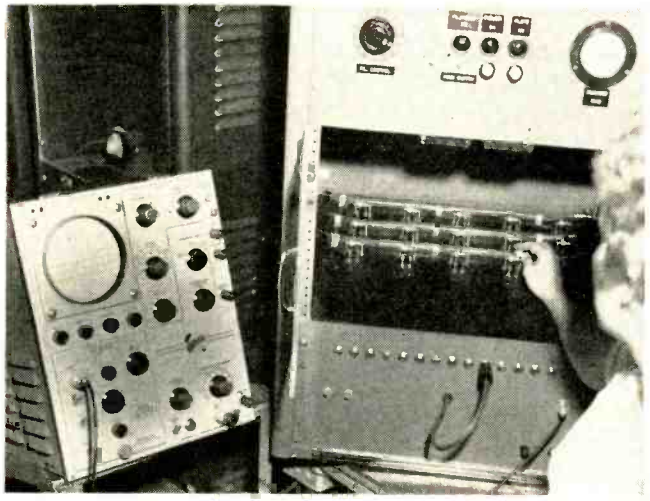
The thyratron is connected as a cathode follower with the positive output pulse taken from its cathode. No pulse transformer is necessary.

Pulse-Forming Network

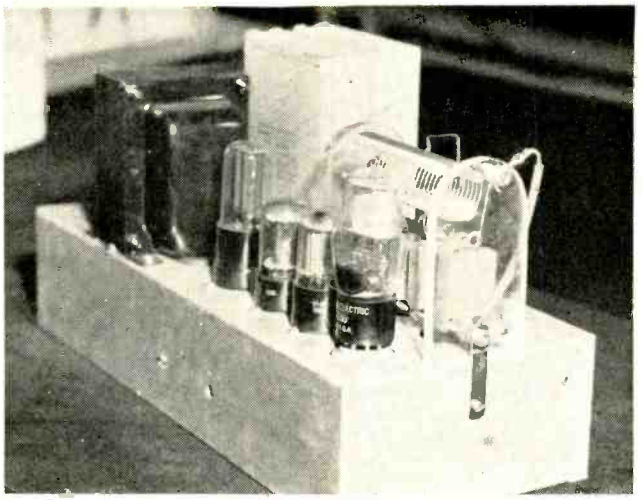
The pulse-forming network is charged directly from the power supply through a one-megohm linear-taper potentiometer, R_3, and through R_4. Potentiometer R_3 controls output pulse amplitude by limiting charging current to the pulse-forming network. Limiting the current flow determines the

Table I—Design Data for Pulse-Forming Network

Network Impedance (ohms)	Pulse Time (μsec)	Total Inductance (μh)	Total Capacitance (μf)	Coil Length (in.)	Coil Diam (in.)	Turns per Section		
						1	2	3
62.5	0.25	7.8	0.002	3	1	11.8	9.4	11.8
20	0.25	2.5	0.006	2	1	5.5	4.5	5.5



Up to 15 tubes can be tested simultaneously in life-test rack



Pulse-forming network is at right of pulse-generator chassis

into Variable Load

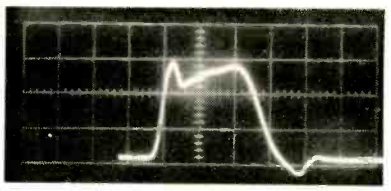
point on the charging curve reached by the network at the instant the thyratron is fired. Both R_1 and R_2 prevent the discharge current of the pulse-forming network from going through the power supply.

Pulse-forming network design is a Guillemin type-B voltage-fed network, designed for the equal-capacitance case. Network impedance selection involved several factors. Ideally, it should match the total load into which it discharges. In this application, load can vary from one to 15 tubes.

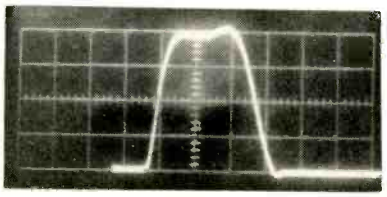
An unusual condition is presented to the thyratron, since the pulse duration is 0.25 μsec while the time for complete ionization of this tube is approximately 0.5 μsec. When the thryatron is triggered, ionization starts. Conduction of the 0.25-μsec pulse through the tube is complete before full ionization takes place.

The equivalent resistance of the pulse tube varies inversely with the pulse current through it. Actual measurement of the 0.25-μsec pulse across V_5 varied from 126 to 158 peak volts for peak current pulses ranging from 1.61 to 6.16 amperes. Equivalent resistance of V_5 to the pulse varies from 78 to 26 ohms.

As each tube on the aging rack draws a peak grid pulse current averaging 500 ma when subjected to the 50-volt pulse, tube load (1 to 15 tubes) varies between 100 and 6.66 ohms. Resistance shunting reduces this variation to a range from 30 to 5.75 ohms. The composite equivalent resistance into which the network discharges (tube load and switch tube) varies between 108 and approximately 30 ohms. As a result, 62.5 ohms was chosen as a good compromise for network impedance. The resulting pulse shape over the load range was good.



Fifty-volt, 0.25-μsec pulse across loaded life-test rack



Eighty-volt, 0.25-μsec pulse across 15-ohm load

Alternate Network

Improved manufacturing techniques increased the pulse emission level of the tubes for which the equipment was designed. The resulting lower impedance lowered the output voltage pulse below the specified level when pulsing fifteen tubes at 2,000 pps. There was insufficient energy in the 62.5-ohm network, even assuming it charges to the d-c power-supply level. Its minimum network-charging-line time constant was 360 μsec compared with a pulse interval of 500 μsec.

Accordingly, a new pulse network was designed. It has an impedance of 20 ohms. Line-charging resistor R_1 and potentiometer R_2 were changed to 100,000 and 50,000 ohms, respectively. The minimum network-charging-line time constant with this combination is 600 μsec, so the network is charged to only 330 volts when the pulse discharge takes place at 500 μsec pulse interval. Considerably more power could be obtained by reducing the value of charging resistor R_1 (and hence the time constant) to 60,000 ohms, which would allow the pulse network to charge to almost the full power-supply voltage. A value of 100,000 ohms was used to confine output amplitude to the range of values required by the application.

Design data for both networks is shown in Table I. Capacitance input was used to keep pulse rise time short. The capacitors are rated at 1,000 v working.

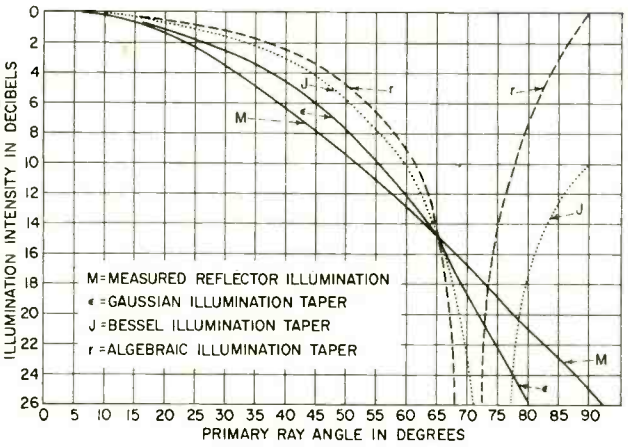


FIG. 1—Comparison of curves generated by three approximation methods with that plotted from actual measurement data

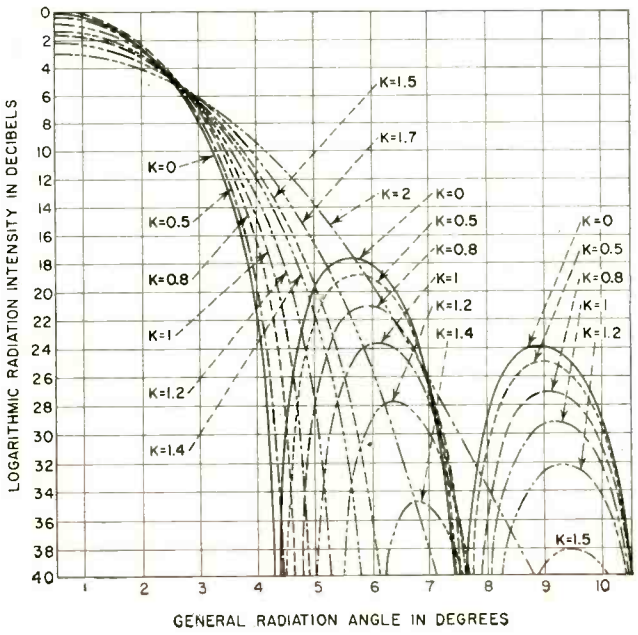


FIG. 2—Radiation patterns produced by Gaussian illumination taper

Radiation Charts for Paraboloidal Antennas

Diffraction from a plane-phase, circular apertured antenna having an axially symmetrical amplitude can be predicted from curves given here. Far-field secondary pattern is graphically determined from aperture illumination

By **LAWRENCE W. LECHTRECK,** McDonnell Aircraft Corp., Municipal Airport, St. Louis, Missouri

FREQUENTLY a small primary source is used to illuminate a paraboloidal reflector from a point near its focus. Such an antenna will produce a pencil beam secondary radiation whose gain, beamwidth, and side lobes are a function of the distribution of electromagnetic power over the antenna aperture.

The far-field radiation from a plane-phase, circular aperture having an axial symmetric amplitude taper and a finite edge illumination is given by [1]

$$E(u) = 2a^2\pi \int_0^1 F(r)\, r\, J_o(ur)\, dr$$

where u = the generalized radiation angle = $(a\pi/\lambda)\sin\theta$, a = the aperture edge radius; r = the aperture normalized radial coordinate; and $F(r)$ = the aperture field illumination. For the case of the paraboloidal reflector, the scalar integral gives the far-field secondary radiation which is however, subject to limitations.[2]

Aperture illumination is represented by the Gaussian function $F(r) = e^{-k^2r^2} = e^{-1.9r^2}$. Advantages of using this representation are that it accounts for the nonzero edge illumination of most circular aperture antennas and closely matches the actual illumination by a horn feed in front of a paraboloidal mirror.

Two other mathematical approximations of radiation are the Bessel illumination taper[3] and the algebraic illumination taper[4]. Results from these are expressed as a summation of Bessel functions.

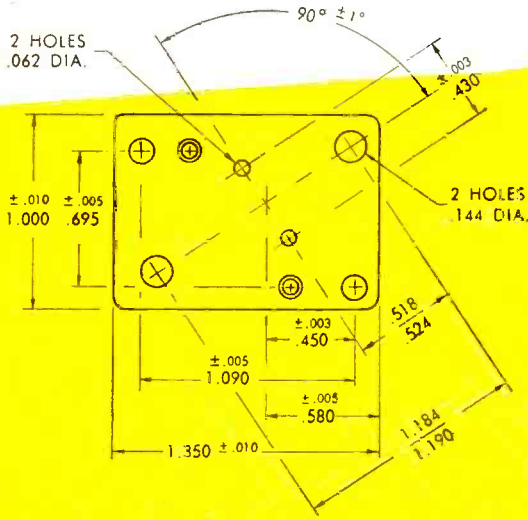
Curves plotted from these three approximation equations are shown in Fig. 1. Curve M is the actual measured reflector illumination produced by a typical waveguide horn and paraboloidal reflector.

The constant for each approximation was selected to produce the measured illumination at the aperture center and at the rim.

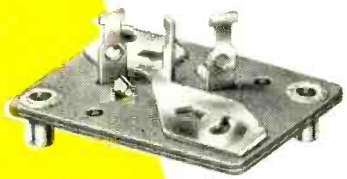
(continued on p 106)

NEW POWER TRANSISTOR SOCKETS BY CINCH

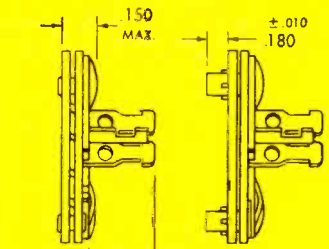
LAMINATED TYPES:



No. 24324



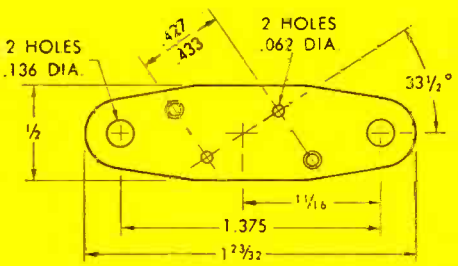
No. 24850
WITH INTEGRAL EYELETS



No. 24860 WITH INTEGRAL EYELETS

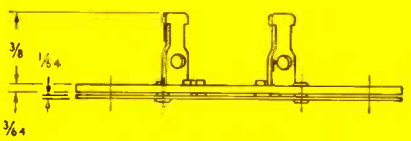
No. 24324

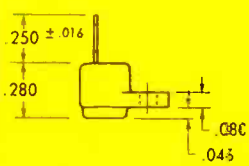
No. 22831



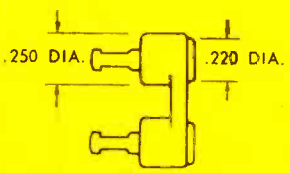
MOLDED TYPE

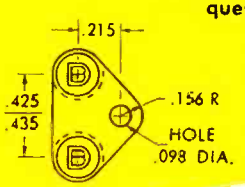
No. 24246
(SHOWN BELOW)





Military version of the above sockets are available. Information on request.





There are three laminated type sockets; 22831, 24324 and 24860. No. 22831 is elongated in shape, top plate is of 1/64" chocolate colored XP Bakelite, bottom plate is of 3/64" chocolate colored XP Bakelite; both vacuum wax impregnated. The contacts are of brass, cadmium plated.

No. 24324 is rectangular in shape. Top and bottom plates are of natural XP Bakelite, vacuum wax impregnated. Contacts are of brass, cadmium plated. Formed thread for 6-20 screw. .104/.110 dia. hole in C R steel plate. Provides easy attachment to a heat sink.

No. 24860 is identical with 24324 except it is equipped with integral eyelets for easy assembly to chassis.

No. 24246 is a molded socket with general purpose Bakelite casting. Contacts are phosphor bronze, cadmium plated.

Dimensions are shown at the left.

ALL SOCKETS FIT FOLLOWING TRANSISTORS:

Bendix	2N-235, 2N-235A
CBS Hytron	2N-155, 2N-554, 2N-555, 2N-556
Mallory	2N-230
Motorola	2N-176, 2N-178, 2N-179, 2N-350, 2N-351, 2N-375, 2N-618
Cleavite	2N-257, 2N-268, 2N-297
RCA	2N-301, 2N-301A
Sylvania	2N-242, 2N-296, 2N-307, 2N-325, 2N-326
Texas Instrument	2N-250, 2N-251

Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, La Puente, California and St. Louis, Missouri.

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CIRCLE 75 READERS SERVICE CARD

Radiation Charts (continued from p 104)

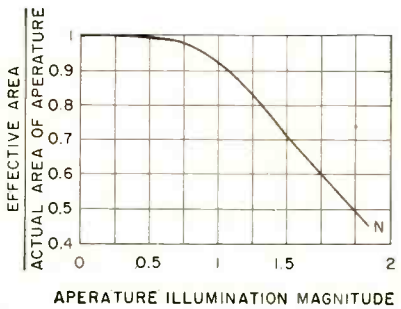

FIG. 3—Relationship of illumination taper magnitude and aperture effectiveness

Gaussian taper $= e^{-1.9r^2}$

Bessel illumination taper $= J_0\,(2.13\,r)$

Algebraic illumination taper $= 1 - 0.90r^2$

The Gaussian, or exponential function, is seen to fit the measured aperture illumination curve closely and has an edge illumination gradient that is nearly equal to the edge illumination gradient of typical reflector type antennas.

Gaussian Patterns

Radiation patterns produced by the Gaussian illumination taper are given in Fig. 2. Each of the curves represents a different amplitude taper and hence different edge illumination. It can be seen that when the illumination taper increases, the near-in side lobe intensity approaches zero as in an infinite aperture of Gaussian illumination, the beam broadens because of the weaker edge illumination and the aperture effectiveness decreases as the result of the smaller equivalent area of illumination.

All curves in Fig. 2 have been normalized for the constant net power illuminating the aperture. The on-axis intensities are, therefore, a measure of directivity relative to a uniformly illuminated aperture.

Dependence of aperture effectiveness and side lobe intensity on the magnitude of the aperture illumination taper K is shown in Figs. 3 and 4. The value of K can be estimated from knowledge of the primary feed pattern and reflector curvature.[2]

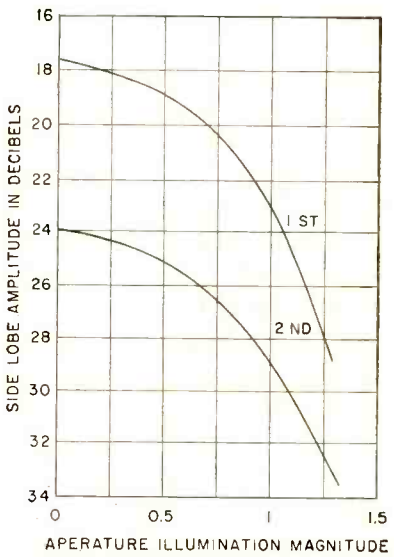

FIG. 4—Relationship of illumination taper magnitude and side lobe intensity

Typical exponential illumination tapers are shown in Fig. 4. By matching one of these functions to the known aperture illumination, the constant K can be determined. Far field diffraction patterns can then be found in Fig. 2.

In the case of the primary feed and paraboloidal reflector, the computed secondary patterns are those resulting from the backscattering of the reflected wave. For this reason, the effects of spillover on antenna pattern and gain are not included.

Assumptions made in the application of Fourier diffraction analysis to a particular paraboloidal radar antenna were: that the primary pattern had spherical wave fronts centered about the principal focus of the reflector, the primary pattern of the feed was symmetric about the axis of the reflector and the feed and waveguide presented negligible distortion in the aperture illumination.

These imperfections result in some aberration in the radiation pattern generated by exponentially tapered aperatures. Departure of the measured paraboloid antenna performance from the radiation characteristics shown in Fig. 2 is a direct measure of the effect of the aberrations and of spillover. After taking the feed shadow effects into account, the measured and computed radiation patterns have been found to agree closely.

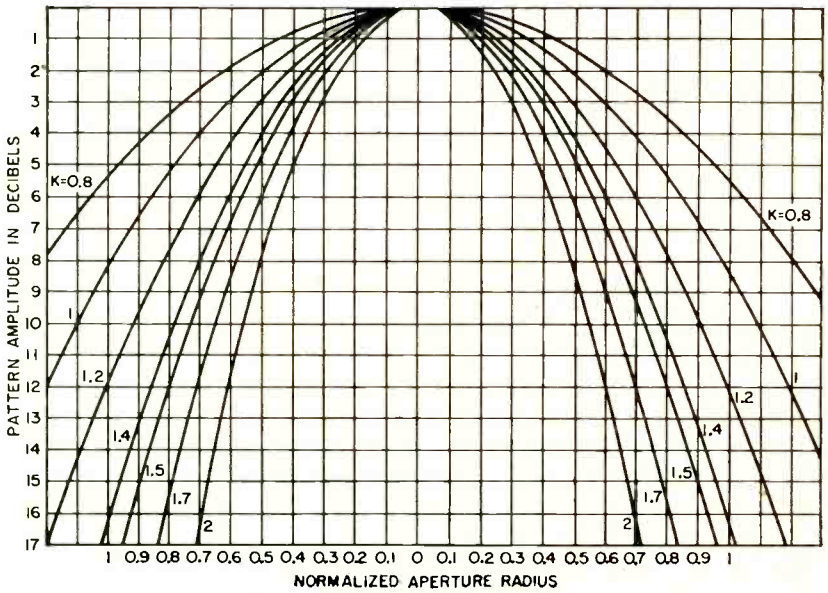

FIG. 5—Typical exponential illumination tapers

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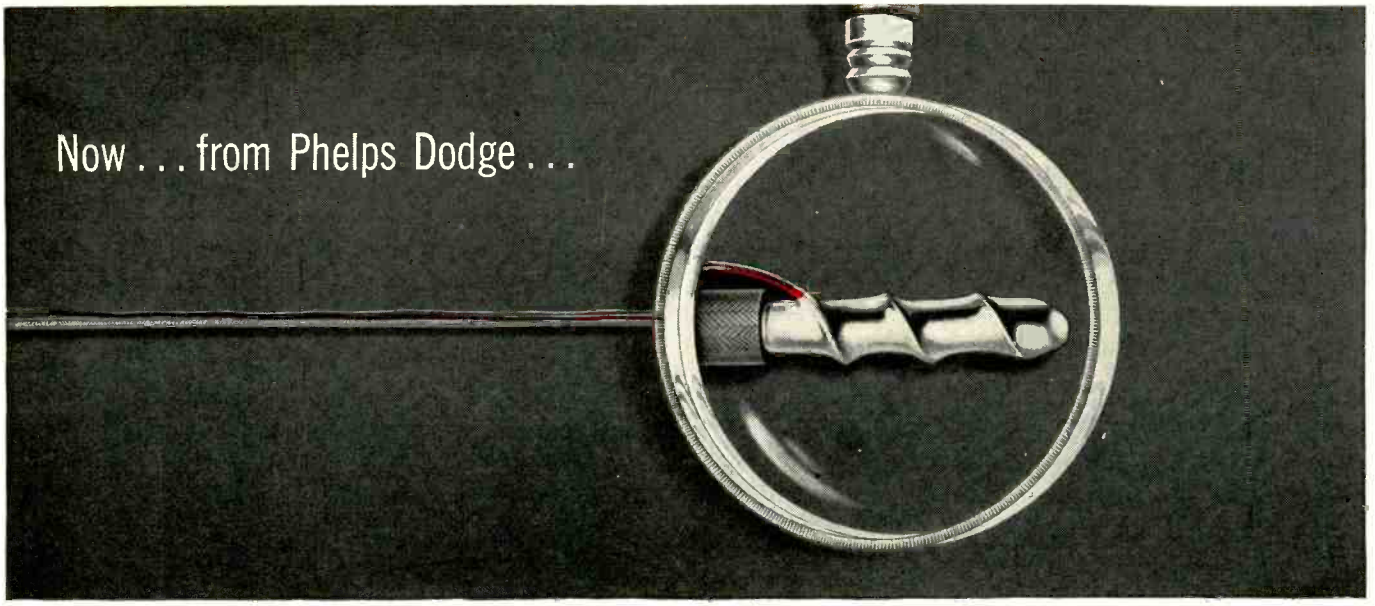
(1) S. Silver, "Microwave Antenna Theory and Design", **12**, p 193, *Rad Lab Series*, McGraw-Hill Book Co. Inc, New York, 1949.

(2) S. Silver, "Microwave Antenna Theory and Design", *Rad Lab Series*, McGraw-Hill Book Co. Inc, New York, 1949.

(3) L. J. Chu, Calculation of Radiation Properties of Hollow Pipes and Horns, *Jour App Phys*, p 603, Sept. 1940.

(4) L. J. Chu, Theory of Radiation from Paraboloidal Reflectors, Radiation Lab Report No. 114.



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FORT WAYNE, INDIANA

Feedback Oscillator Patent Is Granted

STABILITY is a prime feature of a feedback oscillator. One such oscillator requiring relatively few parts has proved to be stable against supply-voltage changes, component aging and temperature.

The circuit is shown in Fig. 1. Tube V_1 is connected as a cathode follower. Tube V_2 is a conventional amplifier coupled to the cathode follower by common cathode resistor R_1. Capacitor C_1 provides positive feedback between amplifier and cathode follower, causing oscillation at a frequency and amplitude at which loop gain is unity.

A twin T network is incorporated in the negative-feedback loop to maintain a pure sine wave free from harmonics of the desired frequency.

Tubes V_3 and V_4 are used in a variable-gain negative - feedback amplifier designed to stabilize frequency and amplitude at prescribed values. Components are chosen so that the amplifier operates near cutoff and within the nonlinear portion of the tube characteristic. The circuit is designed so that V_3 and V_4 are not driven beyond cutoff by possible changes in supply voltage, component values and temperature.

Small signals are amplified more than large signals, so that there is a smoothing effect. Output, taken from the plate of V_4, remains quite constant despite changes in input level.

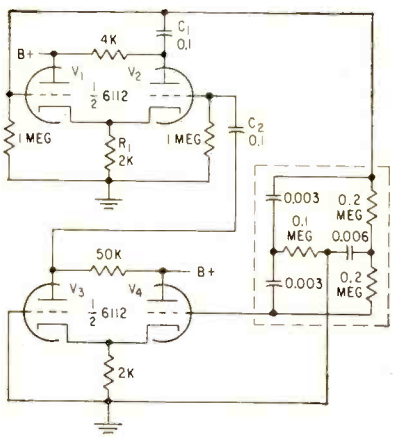

FIG. 1—Feedback amplifier is operated in nonlinear part of tube characteristic so that small signals are amplified more than large signals

Capacitor C_2 completes the negative-feedback loop by coupling the plate of V_1 to the grid of V_2. The stabilized output of the oscillator may be taken from the plate of V_2 by capacitive coupling.

Capacitor C_2 causes a high-frequency decaying transient superimposed on the signal envelope when sudden changes in plate voltage occur. The transient is not generated if capacitive coupling in the negative-feedback loop is replaced by direct coupling.

The circuit was tested during simultaneous variations in plate supply voltage from 100 to 200 volts, filament voltage from 5.7 to 7.8 volts and temperature from 70 to 205 F. Maximum variation in frequency measured at the plate of V_2 was less than 0.2 percent.

This material, abstracted from AEC patent 2,827,569, is available for licensing. The inventors are P. L. Jessen and H. J. Price.

Pi Network Nomograph

By **R. W. JOHNSON,** Consulting Engineer, 9372 Hill View Rd., Anaheim, Calif.

RELATIONSHIPS usually given for Pi matching networks are in terms of one arbitrary variable. This is because there are three network elements to be found, but only two related quantities to find them. These are input and output image impedances.

If one specifies bandwidth in addition to the image impedances, the third variable is no longer arbitrary. The general expression for input impedance of a Pi network as frequency is varied is cumbersome and primarily of academic interest. However, the Q of this impedance at resonance is useful. As with an ordinary resonant circuit, the Q should be 10 or more if adequate discrimination against harmonics is to be achieved.

Accordingly, let the first shunt reactance, $\mathbf{X}_a$, of the Pi network be specified by $X_a = R_1/Q$ at the design frequency. In this equation, R_1 is input image impedance and Q is a number chosen to be greater than 10.

Rearranging familiar expressions for X_b and X_c as given in several texts to a form useful for nomographs

$$X_c/R_o = \pm (Q^2 + 1 - t^2)^{-1/2} \quad (1)$$

and

$$\left(\frac{1+X_a/R_o}{1-X_a/R_o}\right)\left(\frac{1+X_c/R_o}{1-X_c/R_o}\right) = \left(\frac{1-X_b/R_o}{1+X_b/R_o}\right) \quad (2)$$

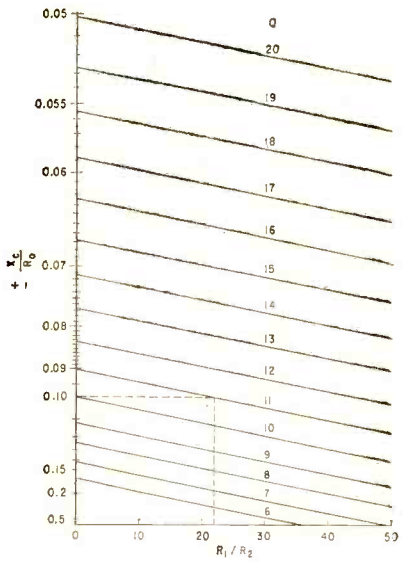

FIG. 1—With transformation ratio of a Pi network and an assumed value of Q, chart indicates ratio X_c/R_o

where $t = (R_1/R_2)^{1/2}$ and $R_o = (R_1R_2)^{1/2}$

Given the transformation ratio, R_1/R_2, and the assumed value of Q, one finds X_c/R_o from Eq. 1. Given any two reactances in a Pi network, the third can be found from Eq. 2. In the present case, $X_a = R_1/Q$ and $X_a/R_o = t/Q$. X_c can be computed from Eq. 1, and then X_b can be determined from Eq. 2.

Nomographs for these relationships are given in Fig. 1 and 2. To use these charts, assume a value for Q. Enter Fig. 1 at the desired transformation ratio, R_1/R_2, moving vertically to the assumed value of Q.

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Stall Torque .3 oz in min.
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MOTOR GENERATOR
Generator:
Input Voltage 10 v
Output Voltage 0.13 v /1000 rpm max.

DC MOTOR
Output Power 4.0 watts
No Load Speed 20,000 rpm
Input Voltage 28 v DC

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Linearity .5%
Null E at EZ .015 v
Phase Shift 15 deg. lead

TRANSMITTER
Accuracy 7′ error max.
Null 30 mv max.
Phase Shift 8.5 deg. lead

RECEIVER
Accuracy 30′ max. error spread
Torque Gradient 2200 mg-mm/deg.
Input Power .54 watts

CONTROL TRANSFORMER
Accuracy 7′ error max.
Null 30 mv max.
Phase Shift 8.5 deg. lead

DIFFERENTIAL
Accuracy 7′ error max.
Null 30 mv max.
Phase Shift 9 deg. lead

RESOLVER
Accuracy 7′ error max.
Null 30 mv max.
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Move horizontally to the X_c scale and read X_c/R_o.

Enter Fig. 2 at this value of X_c/R_o (which may be assumed either positive or negative, as desired—the signs come out automatically in Fig. 2). The value of X_a/R_o and its sign are then indicated.

As an example, let it be required to match $R_2 = 50$ ohms to $R_1 = 1{,}100$ ohms. $R_1/R_2 = 22$. $R_o = 234.5$ ohms. Assume $Q = 11$ arbitrarily. $X_a/R_o = \pm (22)^{1/2}/11 = 0.427$. From Fig. 1 (see dotted line), $X_c/R_o = 0.1$. Assuming X_a and X_c both negative, from Fig. 2 find $X_b/R_o = 0.505$. Multiplying each by R_o, we find $X_a = -100.4$ ohms, $X_b = 118.8$ ohms and $X_c = -23.45$ ohms.

Note from Fig. 1 that the commonly used value $X_c = R_o$ results in a very low Q except at very high transformation ratios; one would expect poor harmonic rejection in this symmetrical case, which is what is observed in practice.

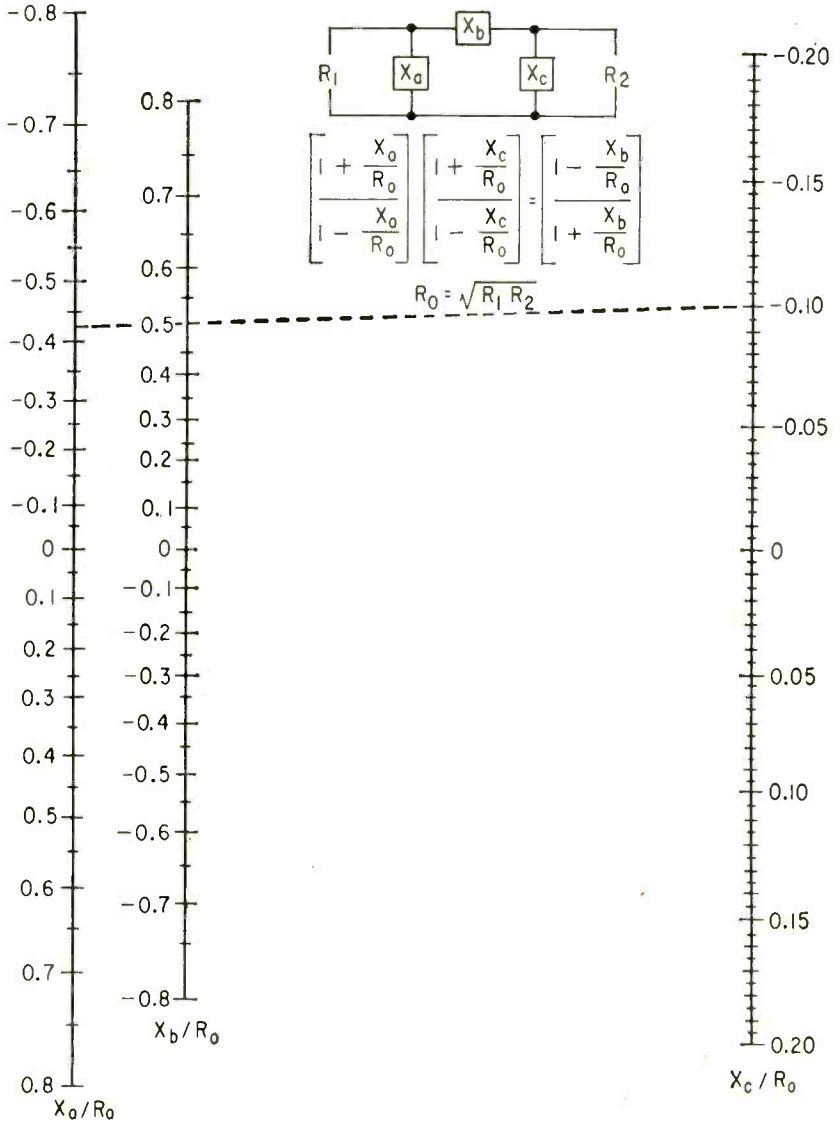

FIG. 2—Knowing the ratios of two reactances of a Pi network to R_o, nomograph indicates ratio of third reactance to R_o, from which reactance can be determined

Trailers House Military Gear

HIGHLY MOBILE military units require electronic equipment that can be moved easily and set up quickly. Complex electronic systems for both training and combat are being housed in trailers and vans to increase their flexibility.

Systems so large that they cannot be housed in a single trailer are often split up into a number of

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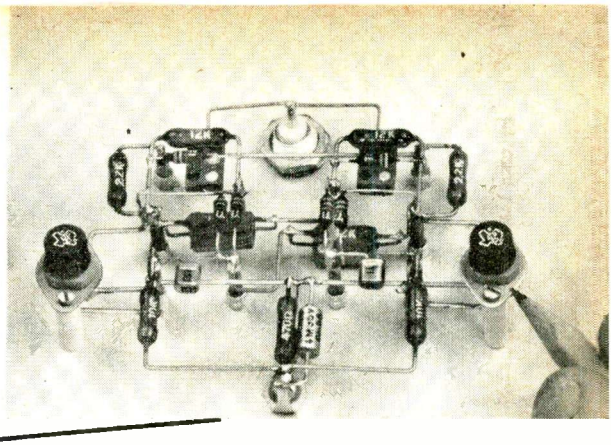

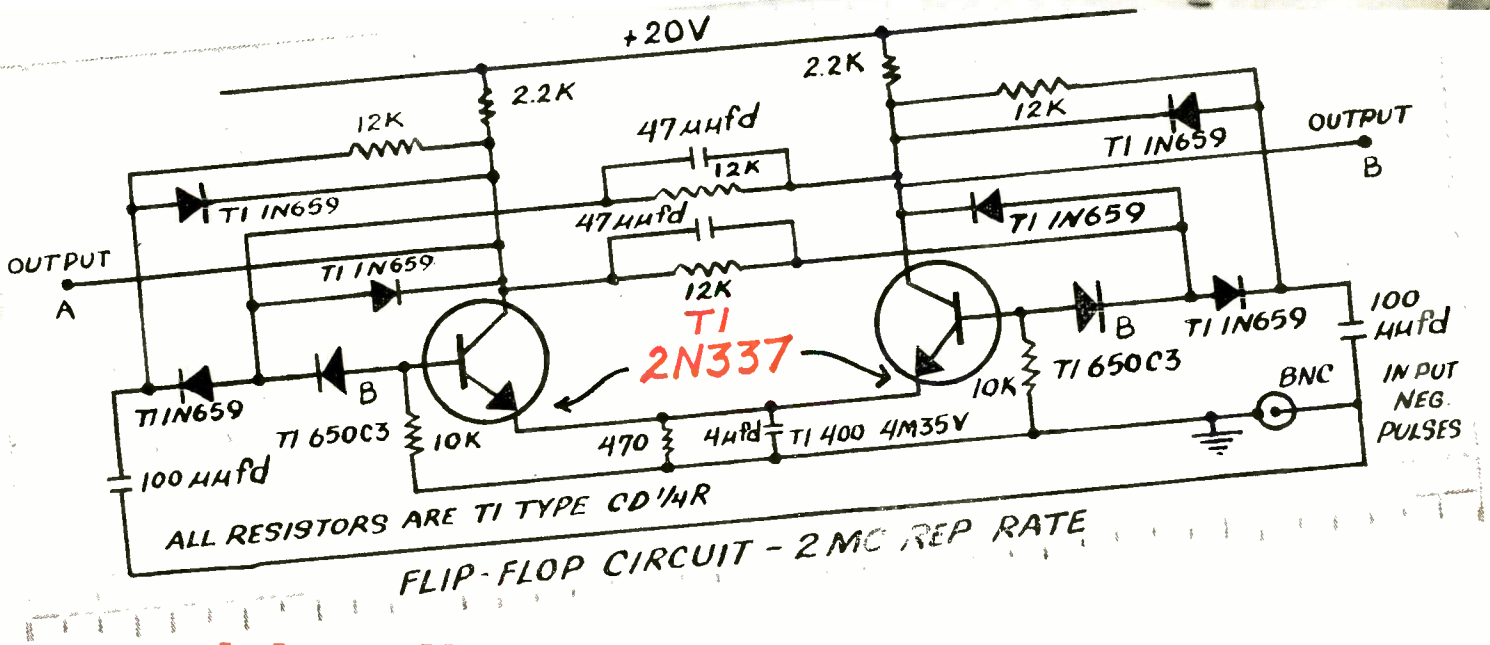

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NEW IMPROVED SPECIFICATIONS FOR 2N337 AND 2N338

	from	to
BV_{CBO}	40 V max	45 V max
R_{CS}	300 Ω max	150 Ω max
h_{ib}	90 Ω max	80 Ω max

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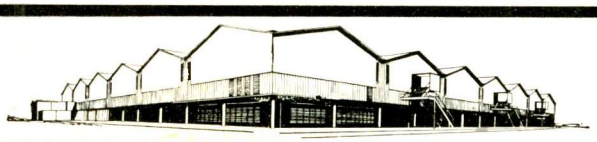
design characteristics at 25° C ambient (except where advanced temperatures are indicated)

		test conditions		2N337 min	2N337 design center	2N337 max	2N338 min	2N338 design center	2N338 max	unit
I_{CBO}	Collector Cutoff Current	V_{CB} = 20V	I_E = 0	—	—	1	—	—	1	μA
	at 150°C	V_{CB} = 20V	I_E = 0	—	—	100	—	—	100	μA
BV_{CBO}	Breakdown Voltage	I_{CB} = 50μA	I_E = 0	45	—	—	45	—	—	V
BV_{EBO}	Breakdown Voltage	I_{EB} = 50μA	I_C = 0	1	—	—	1	—	—	V
h_{ib}	Input Impedance	V_{CB} = 20V	I_E = −1mA	30	50	80	30	50	80	Ohm
h_{ob}	Output Admittance	V_{CB} = 20V	I_E = −1mA	—	0.2	1	—	0.2	1	μmho
h_{rb}	Feedback Voltage Ratio	V_{CB} = 20V	I_E = −1mA	—	200	2000	—	300	2000	X10⁻⁶
h_{fb}	Current Transfer Ratio	V_{CB} = 20V	I_E = −1mA	0.95	0.985	—	0.975	0.99	—	—
h_{FE}	DC Beta	V_{CE} = 5V	I_C = 10mA	20	35	55	45	80	150	—
$f_{\alpha b}$	Frequency Cutoff	V_{CB} = 20V	I_E = −1mA	10	20	—	20	30	—	mc
C_{ob}	Collector Capacitance*	V_{CB} = 20V	I_E = −1mA	—	1.2	3	—	1.2	3	μμf
R_{cs}	Saturation Resistance†	I_B ‡	I_C = 10mA	—	75	150	—	75	150	Ohm
h_{fe}	Current Transfer Ratio	V_{CB} = 20V	I_E = −1mA, f = 2.5mc	14	22	—	20	24	—	db
t_r	Rise time§			—	0.05	—	—	0.06	—	μsec
t_s	Storage Time			—	0.02	—	—	0.02	—	μsec
t_f	Fall time			—	0.08	—	—	0.14	—	μsec

* Measured at 1 mc † Common Emitter ‡ I_B = 1mA for 2N337, 0.5mA for 2N338 § Includes delay time (t_d)



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trailers forming caravans. Arrangements are made for quick interconnection of the trailers, and mobile motor generators supply power for the systems.

One such system is a mobile flight-operations center to control Army aircraft traffic in combat areas. It was developed by the U. S. Army Signal Research and Development Laboratory.

The flight-control system is for tactical use in battle zones. However, Army Signal Corps communications experts believe the system may provide new ideas for other military and civil aviation authorities working toward safer and faster flight control.

FOCs differ from familiar air control towers in that they clear a pilot's flight plan before takeoff and then provide him with in-flight assistance from origin to destination. They maintain contact with pilots in the air, compile information on identification of friendly and hostile aircraft and of enemy ground action. Close liaison with antiaircraft missile and gun batteries is a critical function.

A mobile computing system designed and constructed by Remington Rand Univac was recently accepted by the Air Force for the Air Research and Development Center.

The equipment consists of a high-speed special-purpose electronic computer with a display output consisting of a projected and numerical presentation. This system provides a technique for controlling electronic warfare devices.

The entire equipment is housed in two 35-foot semitrailers. A subdivision of the equipment allows the computer section to be housed in one of the semitrailers, while the projection display and its associated circuitry are housed in the other.

In the computer van, two cabinets contain the majority of the electronic data storage and processing equipment.

The numerical display and projection presentation are located in a single console in the display trailer. The projection display employs a projection kinescope and a Schmidt projector with circuitry provided for digital to analog conversion and position coordinate transformation. The numerical display of 19 electro-

mechanical registers presents decimal information correlating the information on the dynamic display.

The system is a fixed-program, internal-binary, serial machine that is programmed to identify, filter and process the incoming target data with precataloged data on the magnetic drum. The situation is then transferred to the visual displays for quick and easy assessment and decision.

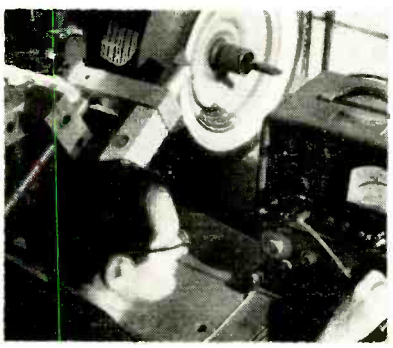
The Army Signal Corps' battlefield Mobidic, a mobile digital computer, is being designed and built by Sylvania Electric to fit into a standard 26-foot trailer.

The all-transistor Mobidic is a general purpose electronic computer. It is designed to solve a large variety of military problems ranging from battle strategy and tactics to logistics.

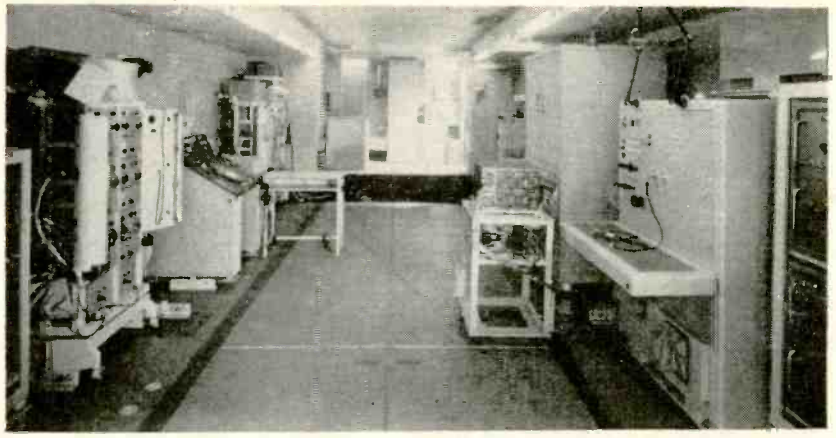
In the field of training, Emerson Radio & Phonograph, under contract to the Air Materiel Command of Wright Air Development Center, has developed a trailerized system for training crews who will man Airborne Early Warning equipment. With this system, it is possible to give effective training to large numbers of crews on the ground without the expense and risk involved in training them while in actual flight.

Each AEW trainer consists of two trailers. One simulates an aircraft compartment that houses all radar, radio and internal communications equipment found in opera-

Tire-Roundness Tester



Unpleasant tire thumping and uneven wear result when tires are not perfectly round. U.S. Rubber uses electronics to check for out-of-round tires. Variations in width of ribbon of light focused across tire are detected by photocell. Resulting voltage analogs are converted to thousandths of an inch



Simulator trailer for training Airborne Early Warning crews has expandable sides that can be moved together for transport to other training centers

tional aircraft. Actual flight conditions are duplicated, even the sound of the engines. The crew being instructed occupies this trailer.

The other trailer contains all simulated signal and monitoring equipment for supplying simulated echo signals to the first trailer. Instructors in the second trailer feed and check on problems presented to the crews being trained by manipulating the target-generating equipment, the intercom system and the simulated radio communications apparatus.

These generators provide several hundred simulated enemy targets and twelve friendly targets. All targets can be presented to simulate relative motion, and each trainee is required to obtain, plot and transmit information with respect to the numbers and types of enemy aircraft assigned to him. He must also determine their courses, speeds and altitudes.

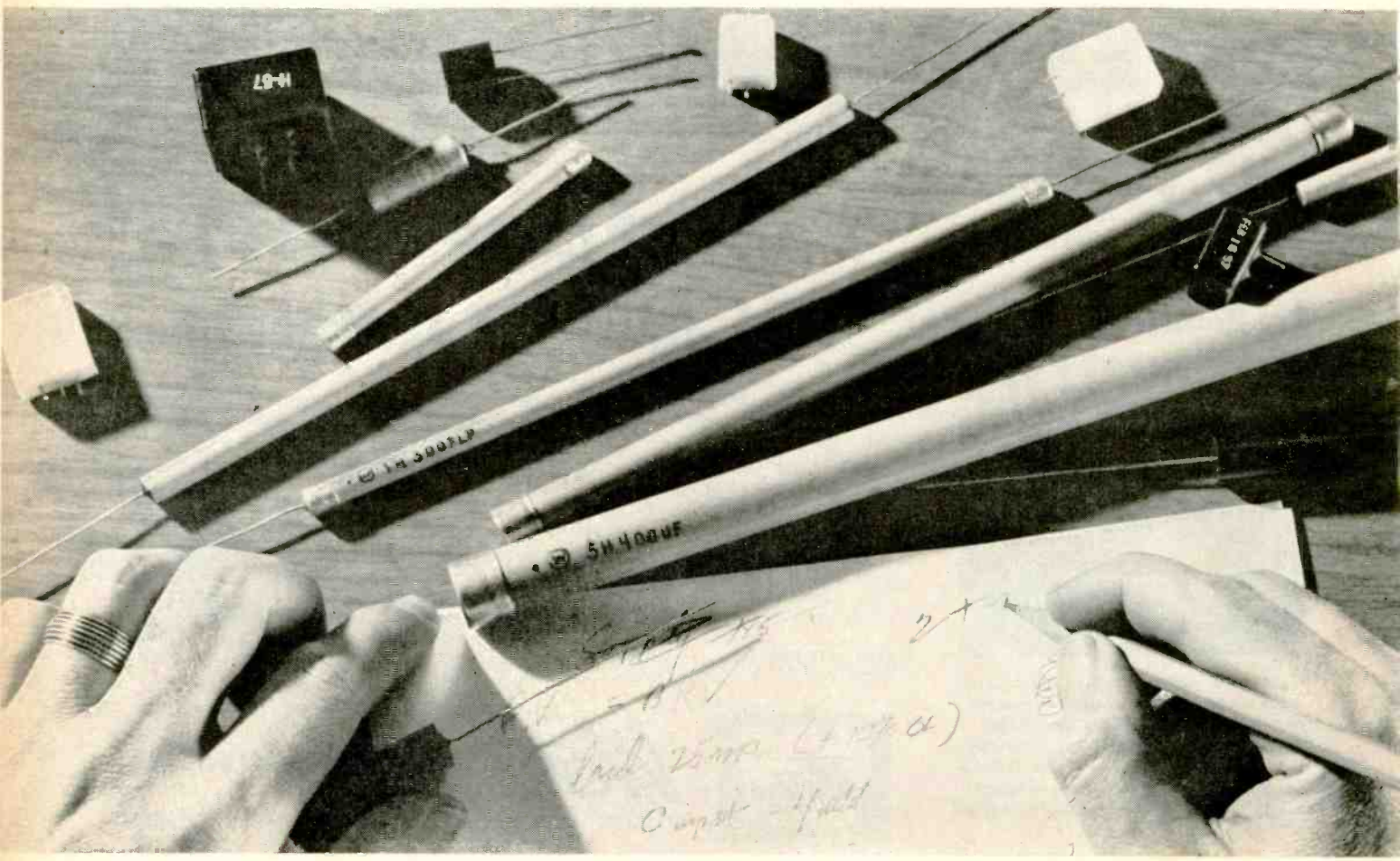
In actual practice, this data is transmitted to CIC (Combat Information Center), which assembles and interprets all information received from similar AEW aircraft.

In the course of a simulated mission over a prescribed area, trainees are required to actually plot on a large board all aircraft located in their area. Designated members of the crew operate the simulated radio equipment linking their plane and other planes or ground stations.

In an effort to achieve complete realism, noise and fading can be introduced into the simulated radio communications net as well as into the intercom in the plane.

Micromicroammeter for Satellites

MICROMICROAMMETERS for satellites must be light, stable and provide fast response. Such an instrument was designed by Keithley Instruments for use in the Vanguard and in an Air Force satellite scheduled



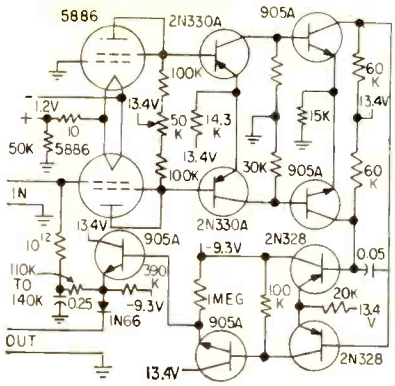


FIG. 1—Very high input impedance for micromicroammeter was obtained with tube input which was followed by transistor amplifiers

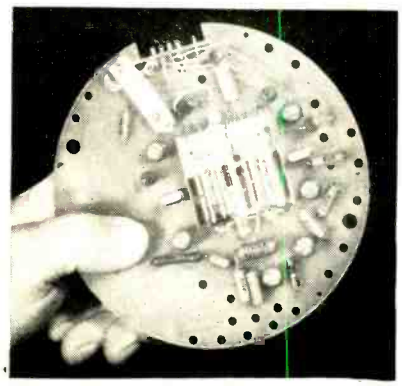
for launching in the spring of 1959.

The micromicroammeters operate in conjunction with an ion chamber for measuring soft X-rays from the sun.

The circuit, shown in Fig. 1, is a modification of micromicroammeters used in nuclear control instruments. Reduction in size and weight were prime requisites. In contrast to conventional instruments which weigh 20 lb, the satellite model weighs less than 5 oz.

The micromicroammeter was designed to withstand up to 100 g's vibration. It has a full-range sensitivity of 5 × 10^{-12} amperes and a frequency response from d-c to 30 cps. Drift rate is less than one percent of full scale per week. Power consumption is below 100 mw.

The high input impedance necessary could not be obtained with transistors. Therefore, it was necessary to use subminiature tubes in the input. These tubes impose little power penalty, since filament power consumption is only 30 mw. Plate potential need only be 10 volts.



Two tubes and eight transistors are used in miniature micromicroammeter for satellites

Output impedance of these tubes operated as triodes is 20,000 ohms. Thus they can reasonably drive the following transistor amplifier stages.

The circuit for the Air Force space vehicle is similar to the Vanguard unit except that it has a logarithmic scale. It is basically a micromicroammeter ionization gage. It is built in stacked modular form and has a rotary solenoid motor for checking calibration and selecting various input devices.

Circuit Generates Tape Stop Signal

By HAUS J. WILHELMY
Corp. De Radio De Chile, Santiago, Chile

PLAYBACK SYSTEMS that select portions of magnetic tape require a method for stopping the system at the end of the desired part. In one such system, a stop circuit was developed that generates and records a stop signal on the tape. The same circuit detects a recorded stop signal and shuts down the system.

The circuit is shown in Fig. 1. To

record the stop signal, a single pushbutton is pressed. This switches the EL 84 tube to its oscillating state. The tank in the plate circuit is tuned to 10 kc. This signal is supplied to the recording head and recorded on the tape.

During oscillation, a 60-uf capacitor is charged from B+ through a 47,000-ohm resistor. When the stop button is released, this capacitor is discharged through a relay coil, which stops the machine. The button must be pressed for approximately one second for the capacitor to be sufficiently charged to operate the relay.

When playing, the EL 84 tube is biased nearly to cutoff to limit the drain on the B+ supply. The recorded stop signal is applied through a high-pass coupled triode preamplifier to the EL 84. The signal in the tuned plate circuit of the EL-84 is transformer coupled to a crystal diode rectifier. The rectified voltage increases the positive bias on the EL 84 control grid, ultimately driving the tube to saturation. Cathode current energizes the relay, stopping the machine.

A switch has been incorporated in the cathode circuit to disable the entire stop circuit at will. Thus an entire tape can be played without stopping, even though stop signals have been recorded on the tape.

Recordings other than the stop signal do not trigger this circuit for three reasons: the high-pass preamplifier and the tuned plate circuit of the EL 84 are frequency sensitive; the bias of the diode circuit makes it amplitude sensitive; and the long time constant of the diode load circuit requires a continuous signal of nearly one second duration.

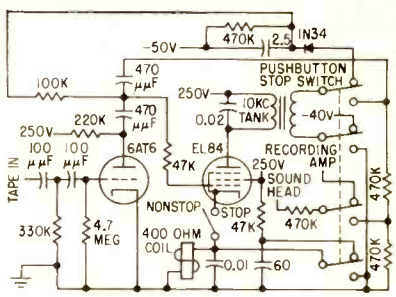


FIG. 1—Feedback arrangement in EL 84 circuit increases cathode current sufficiently to energize relay in response to stop signal

SHAFT POSITION TO DIGITAL ENCODERS AND READOUTS

10 bit/turn Shaft Encoder in true Binary... converts shaft position to non-ambiguous true binary data representing input shaft position to 1 part in 1024 for each revolution. Used as input-output devices for true binary digital computers. **No external logic required.**

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X-Y Decimal Keyboard... consists of a three-decimal bank for each axis with associated plus-minus keys.

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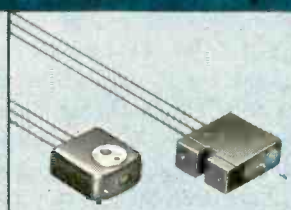
Magnetic Storage Drums... for medium storage applications; capacity 131, 072 non-volatile bits; several speeds; clock frequency 130 kc. Other models available.



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Load-Sharing Matrix Switch

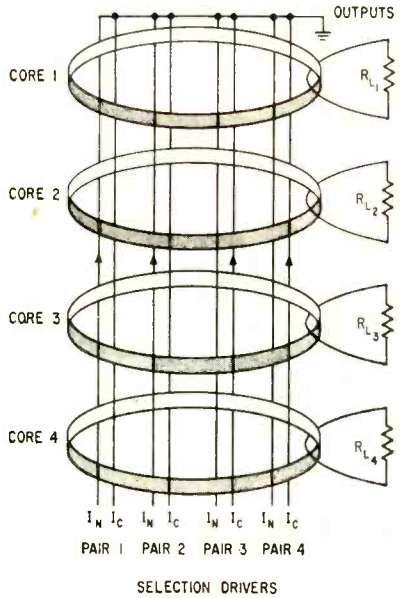
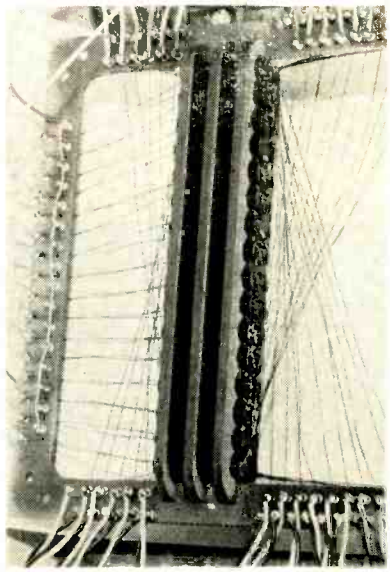


FIG. 1—Winding diagram for a four-output, load-sharing matrix switch



Sixteen-output matrix switch constructed as a unit

POWER FROM SEVERAL pulse generators can be combined into a single, high-powered output pulse to drive a computer core memory by a device known as a load-sharing matrix switch. Such a switch offers three important advantages. First, each pulse generator feeding the switch need supply only a fraction of the power delivered to the load. Second, relatively low-power transistor drivers can be used with the switch. Third, the switch has a minimum number of spurious outputs.

Switch Operation

Characteristics of the switch result from the pattern in which the input wires are wound on the cores and from the manner of pulsing the cores. If the pulse generators are operating properly, the pattern of winding the inputs through the switch cores ideally results in zero net ampere-turns of excitation on all cores except the selected one.

Windings for a four-output matrix switch are shown in Fig. 1. Pulse generators are shown as current sources and memory drive lines as resistor loads for the outputs. An output pulse is delivered to a resistor load by simultaneously pulsing one wire of each input pair. Pulse pattern for "normal N" or "complement C" wires determines which output will be selected to receive the pulse.

To select core 3 for example, input currents $1N$, $2N$, $3C$ and $4C$ are applied. Total input excitation on the core is four times the ampere-turns supplied from each winding because all currents pass through the core in the same direction. Core 3 acts as a transformer with a certain input excitation to deliver a READ pulse to the load R_{L3}. In a similar manner, currents $1C$, $2C$, $3N$ and $4N$ add in core 3. But since the excitation is in the opposite direction, a WRITE pulse is delivered to R_{L3}. Table I gives combinations of input currents required to select each core in the four-output switch.

With the winding arrangement shown in Fig. 1, each nonselected core has two inputs exciting it in the READ direction and two in the WRITE direction. To the extent that input currents are equal at each instant of time, each nonselected core will have zero input excitation.

A convenient way of describing the winding connections is as follows. Since each input winding has the same number of turns, the only unique property is the direction of core excitation. A winding which excites a core in the READ direction may be designated by R; in the WRITE direction by W. Table 2 gives directions of excitation caused by each winding.

The matrix switch may be expanded most easily by doubling its size. In this case, the number of inputs as well as the number of outputs is doubled. However, it can be expanded still further. The accompanying illustration, for example, shows a 16-output switch used in the application described in the remainder of this report.

Computer Application

A computer in the process of design will contain a two-μsec memory driven by transistors. The drive line for the memory requires a 585-ma, 100-v pulse. Peak power input to the drive line is 58.5 w.

The drive pulse can be obtained from a 16-output load-sharing

Table I—Selection Pattern for Four-Output Switch

Read output				
Core	Pair 1	Pair 2	Pair 3	Pair 4
1	N	N	N	N
2	N	C	N	C
3	N	N	C	C
4	N	C	C	N
Write output				
Core	Pair 1	Pair 2	Pair 3	Pair 4
1	C	C	C	C
2	C	N	C	N
3	C	C	N	N
4	C	N	N	C

Table II—Excitation Directions for Four-Output Switch

Normal windings				
Core	Pair 1	Pair 2	Pair 3	Pair 4
1	R	R	R	R
2	R	W	R	W
3	R	R	W	W
4	R	W	W	R
Complement windings				
Core	Pair 1	Pair 2	Pair 3	Pair 4
1	W	W	W	W
2	W	R	W	R
3	W	W	R	R
4	W	R	R	W

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RAPID, ERROR-FREE READINGS BECAUSE

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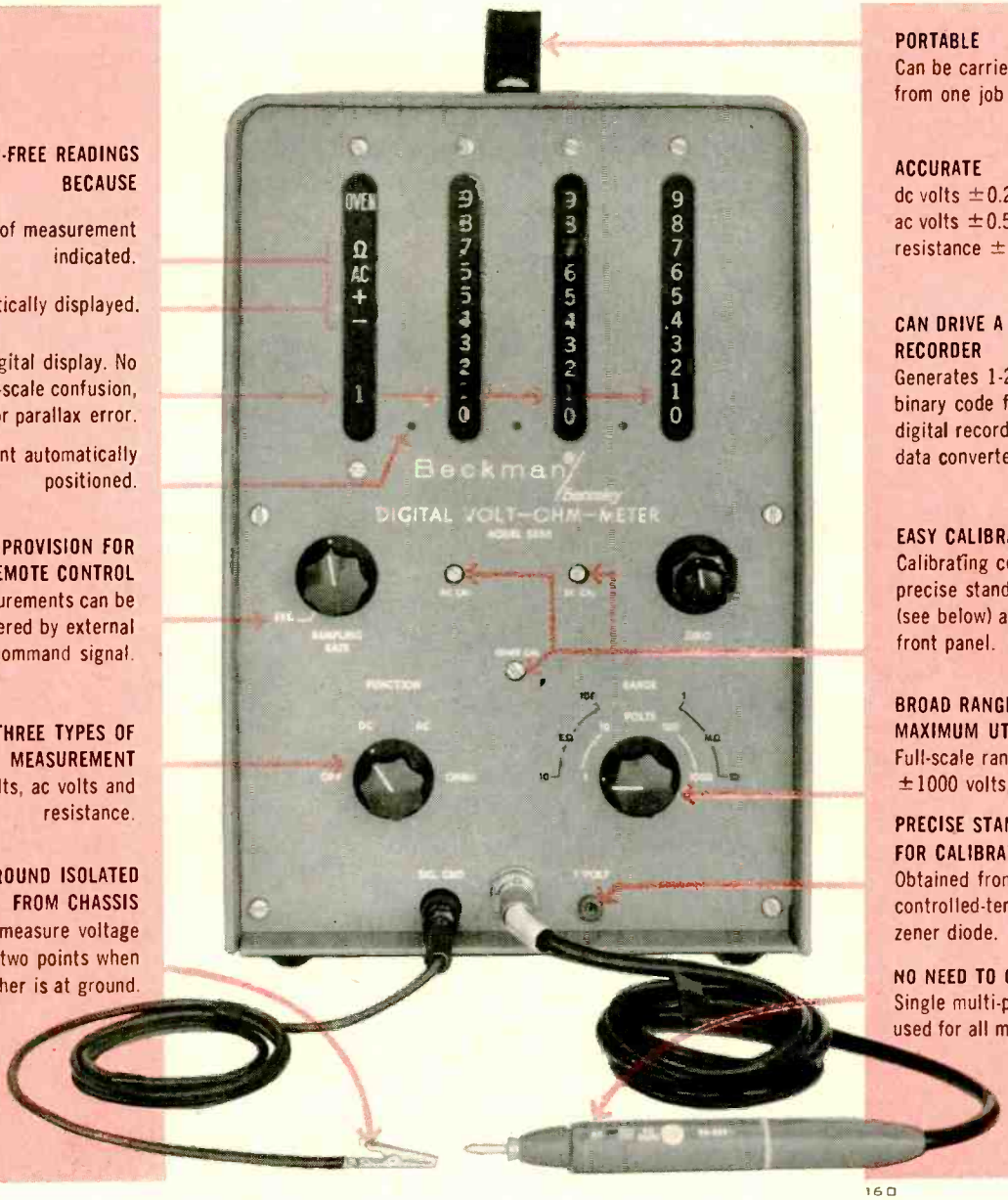

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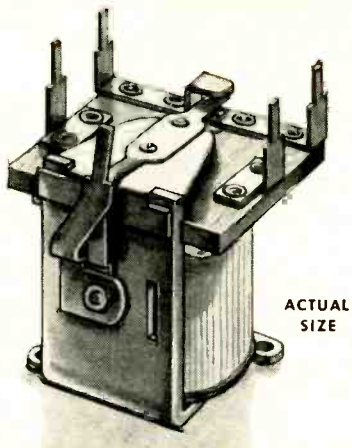

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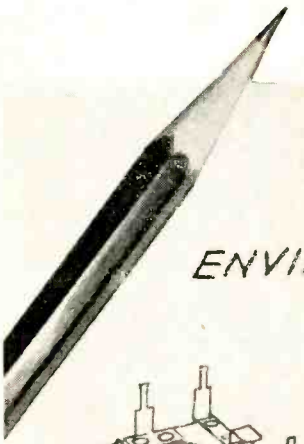

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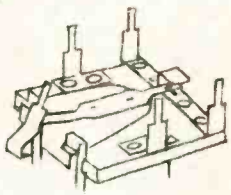
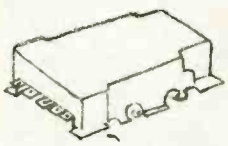
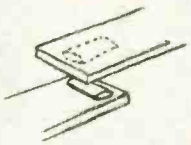


AVAILABLE WITH PRINTED CIRCUIT TERMINALS



ENCLOSED CONTACTS WHERE DESIRABLE



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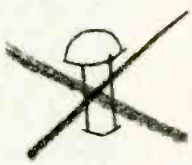
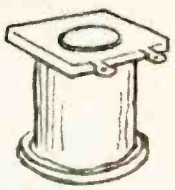


NO CURRENT-CARRYING RIVETS



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COIL RESISTANCE	TO 10,000 OHMS	TO 15,000 OHMS
MAX. COIL POWER	1 WATT	1.5 WATT
MIN. COIL POWER	.40 WATT (SINGLE POLE)	.025 WATT (SINGLE POLE)
CONTACT RATING	1 AMP. 28 V D.C. OR 115 V A.C. (NON-INDUCTIVE)	1 AMP. 28 V D.C. OR 115 V A.C. (NON-INDUCTIVE)

CONTACT FORMS

SINGLE POLE	COMMON MAKE
NO	3 NO & 1 DT
NC	5 NO
DT	

TERMINALS

(A) SOLDER TYPE - ALL VERSIONS

(B) PRINTED CIRCUIT TYPE (SINGLE POLE VERSIONS ONLY)

Consult your local RBM Product Application Engineer or write for Bulletin MS-3

RBM Controls Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

matrix switch. Total peak power input to the switch is about 65 w because switch efficiency is about 90 percent. Each of the 16 drivers operating during a pulse furnishes about 4.1 w peak. Fast transistors can be obtained to deliver 11-v pulses with a 0.1-μsec rise time. Each transistor furnishes a 370-ma, 0.5-μsec pulse.

Ferrite switch cores are 125 mils inner diam and 250 mils outer diam and 1.8-in. long. The core is made in 12 sections to simplify core fabrication and matrix switch winding. Each core is made of two adjacent stacks of six sections to reduce winding length.

This report is based on an article by G. Constantine, Jr., which appears in the July, 1958 issue of the *IBM Journal*.

Toroidal Core Winding Chart

By THOMAS J. MANEY, Member Technical Staff.
Space Technology Laboratories, The Ramo-Wooldridge Corp., Los Angeles, Calif.

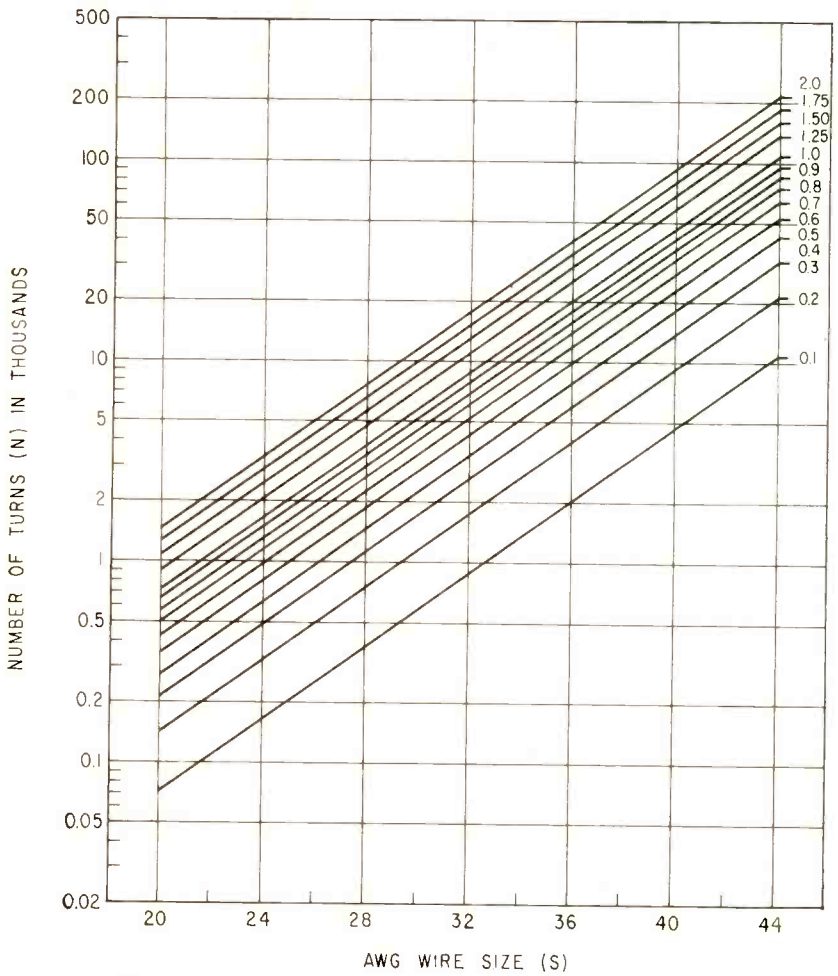
NUMBER OF TURNS that can be wound on a given toroidal core for various wire sizes can be determined from the chart below.

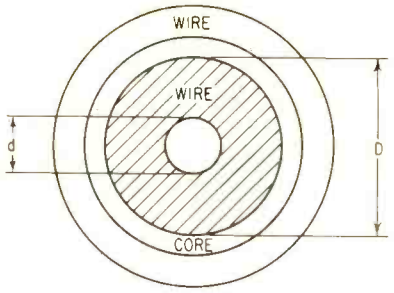
A wound toroidal core sectioned through the center of the plane of the torus is shown in Fig. 1. Region of interest is the shaded area occupied by wire inside the toroidal core. This area divided by the area per turn equals the total number of turns wound on the core. Cylindrical wire cannot fill the area completely. Neglecting the boundaries, however, hexagons circumscribed about each wire will fill the area. The ratio of a cylindrical wire to a circumscribed hexagon is

$$\pi\sqrt{3}/6.$$

This ratio is approximately 0.9.

Areas of various wire sizes, num-





d = Diam of hole after winding

D = Inside diam of toroidal core

FIG. 1—Cross-section of toroidal core through center of plane of the torus

ber of turns per sq in., and adjusted turns taking into account the 0.9 factor are given in Table I.

A general expression for the number of turns is

$$N = 10^{(S/10+1)} \qquad (1)$$

where N is turns per sq in. and S is AWG wire size number. Since a toroidal winding machine and/or the operator cannot lay all turns in the core hole uniformly, this equation must be modified.

From data on 130 cores wound with various wire sizes from AWG 20 to AWG 44 and wire-filled areas varying from 0.0620 to 1.443 in.^{2}, the ratio of actual number of turns compared to the equation was averaged. This ratio, as a function of wire size, is shown in Fig. 2.

From the plot of Fig. 2, the equation of the least squares straight line was determined and modifies Eq. 1 as follows

$$N = \frac{\pi}{4}(D^2 - d^2)\, 10^{(S/10+1)} \left[0.961 - 0.122\,(S/10)\right] \qquad (2)$$

where N is total number of turns, D is inside diam of toroidal core, d is diameter of hole remaining after winding, and S is AWG wire size number. This equation includes the effect of boundary losses from ideal

Table I—Areas and Turns for Different Wire Sizes

AWG wire size	Cross-sectional area in sq in. (double Formvar covered)	Turns per sq in.	Turns per sq in. with 0.9 packing factor
20	8.92×10^{-4}	$10^3/0.89$	10^3
30	9.23×10^{-5}	$10^4/0.92$	10^4
40	9.54×10^{-6}	$10^5/0.95$	10^5

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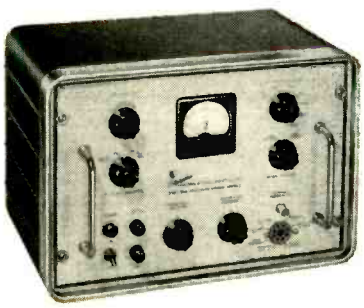

SPECIFICATIONS

OUTPUT		Type 812	Type 809
Beam	Volts, dc	200 to 3600	250 to 600
	Current, ma	0-125	0-65
	Ripple, mv rms	5 max.	5 max.
Reflector	Volts, dc	0 to —1000	0 to —900
	Current, μa	50 max.	50 max.
	Ripple, mv rms	1 max.	10 max.
Grid	Volts, positive	0 to 150	—
	negative	0 to 300	
	Current, ma positive grid	5 max.	
	Ripple, mv rms	3 max.	
MODULATION		**Type 812**	**Type 809**
Square Wave	Frequency, cps	500 to 5000	400 to 2000
	Volts*	0 to 150 (clamped)	0 to 90
Pulse	Frequency, cps	500 to 5000	
	Volts*	0 to 150 (clamped)	—
Sawtooth	Frequency, cps	40 to 120	60, fixed
	Volts*	0 to 200	0 to 125
Sine Wave	Frequency, cps	60, fixed	—
	Volts*	0 to 200	

**volts, peak to peak*

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For additional details, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-1.

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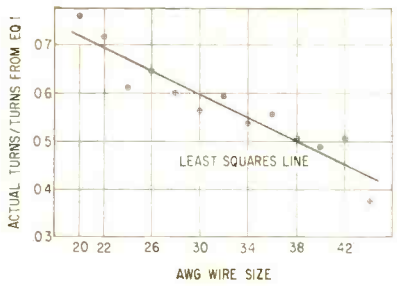


FIG. 2—Ratio of turns versus wire size gives least squares line

fill as well as imperfect winding.

Equation 2 will not plot as a straight line on semilog paper but the deviation from a straight line is small over the interval $20<S<44$. Variation between machines and operators does not warrant plotting Eq. 2. Therefore, a semilog straight line approximation over the interval $20<S<44$ is justified. This approximation is

$$N = \frac{\pi}{4}(D^2 - d^2)\ 10^{(S/11.033+1.0414)} \quad (3)$$

Families of Eq. 3 are plotted in the accompanying chart with

$$A = \frac{\pi}{4}(D^2 - d^2)$$

as the family parameter.

Use of Chart

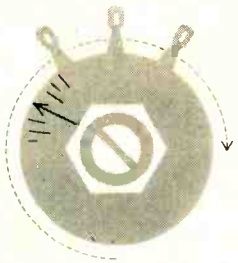
To use the chart, first determine A. Then read off from the appropriate curve the number of turns versus AWG wire size.

With well-adjusted winding machines and highly skilled operators, accuracy of the chart may be improved by a slight translation and rotation of the curves.

New Process Gives Low-Cost Rectifiers

NEW LOW-COST encapsulated silicon rectifiers of the diffused-junction type have been developed by P. R. Mallory and Co. Inc., Indianapolis, Ind. The type-T units feature low reverse leakage current (0.2 ma maximum) and low forward voltage drop (0.5 v maximum).

To obtain high uniformity and closely controlled operating characteristics of the finished rectifiers, a new crystal-growing technique was developed. Known as the floating-zone method, it produces crystals pure to two parts per billion.



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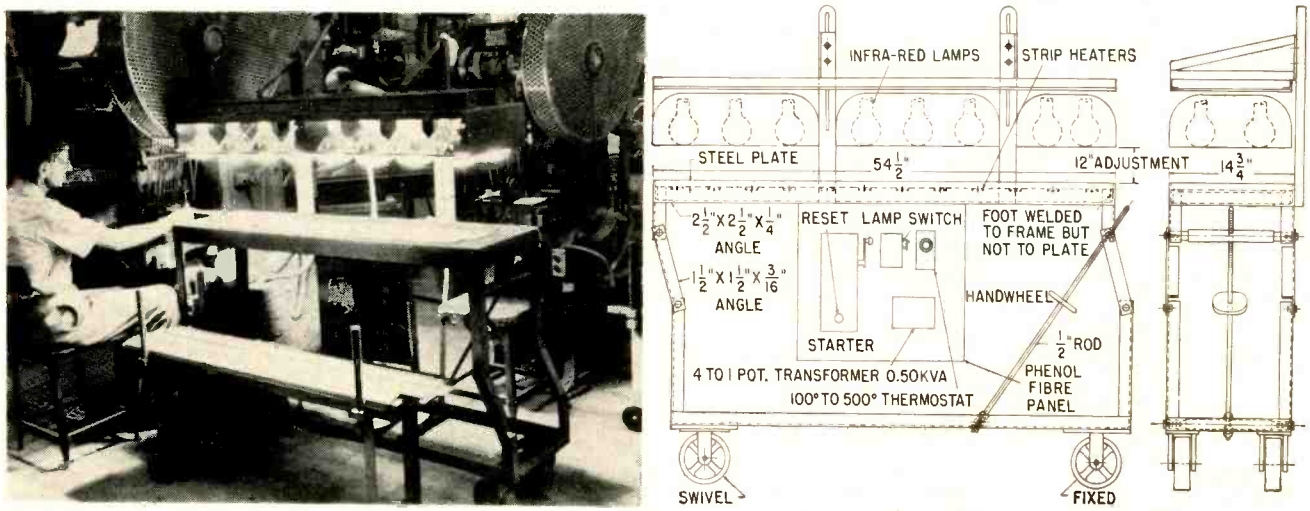


Laminate heating table combines conventional hotplate with backup heat from 2 banks of infrared lamps. Table height and temperature are adjustable

MANY DIFFICULTIES encountered in hot punching plastic laminates may be traced to improper heating. Preheating laminates simultaneously from above and below with separate heat sources is often a solution, saving time and reducing rejects.

Taylor Fibre Co., Norristown, Pa., has designed a roll-around heating table which can be easily adjusted for heat and operating height.

Strip to be punched is heated from below by a conventional hot plate on which it rests. The plate is ¾ inch HR steel, 54½ inches long. Spaced along its underside are 12 Chromolox strip heaters, No. S-1405-500w-230v. The hot plate is constructed by welding and is left free to lift out of the table.

Top heating is provided by 16 300 w, 230 v infrared lamps arranged in 2 banks of 8 lamps. The lamps are held in a phenol fibre lamp support panel. Distance between the lamps and the work can be adjusted by slots cut in the vertical lamp panel supports.

Adjustments in table height (or lamp distance) are made by a handwheel welded to a rod which is threaded into a cross member fixed to one pair of the table's jointed legs. Table height with legs straight is 35 inches.

Proper temperatures for hot punching will depend on material, thickness and hole specifications. Strip that is too cool will crack; holes will be off if it is too hot. Trial and error will determine correct temperature.

The hot plate, thermostatically controlled within 5 degrees over a 100 F to 500 F range, gives satisfactory heating for most work. For thicker material, or where tight specifications requires thorough through-heating, lights and hotplate may be used.

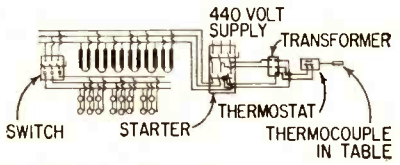


Table wiring diagram

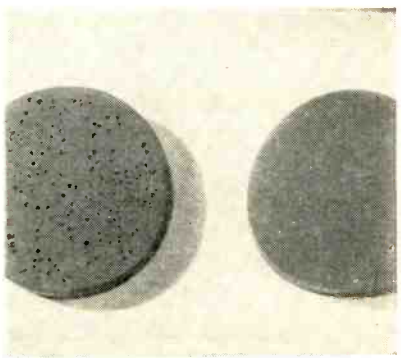
The lights may be used alone with thin stock, heating both stock and hot plate. One bank of lights adds about 100 F and both banks, 200 F. Taylor uses lights on 15 to 20 per cent of its jobs, mostly phenolics.

Mixer Degasses Potting Resin

POTTING COMPOUND is freed of air bubbles in a modified pressure paint pot at the Wichita plant of Boeing Airplane Co. The process prevents high altitude failures, due to expanding bubbles, of encapsulated aircraft plug contacts.

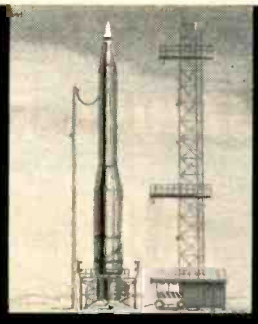
Compound base is prepared in a 2-gallon air-agitated pressure paint pot. The stirrer is a 4-blade propellor 5.5 inches in diameter. Stirring speed is regulated by air flow to the stirring mechanism. Best results are obtained with the compound used (manufactured by Coast Pro-Seal Co. in accordance with MIL-S-8516B-727) by stirring at 130 rpm.

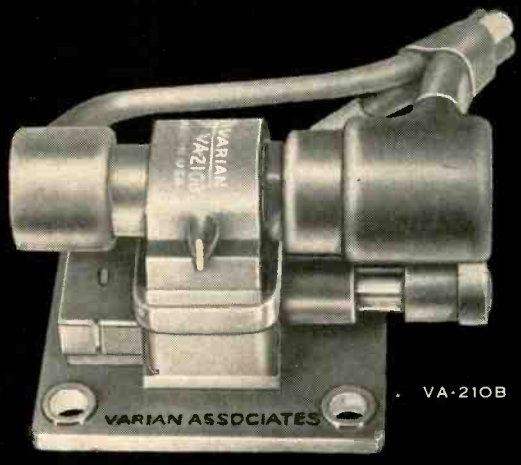
Induced vacuum removes air during stirring. About 3.5 hours of stirring will remove air from a 2-gallon container of the compound. Pump used is a Cenco Press-O-Vac 10 psi, which will pull approximately 29.9 inches. A ¼ hp, 725 rpm motor is used.



Vacuum-mixed potting compound at right is free of air bubbles

The paint pot is mounted on the





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VA-203B	8.5 to 9.6 kMc	90 mW
VA-203B	9.5 to 9.6 kMc	30 mW
VA-94	16.0 to 17.0 kMc	40 mW
VA-221H	5.25 to 5.56 kMc	40 mW

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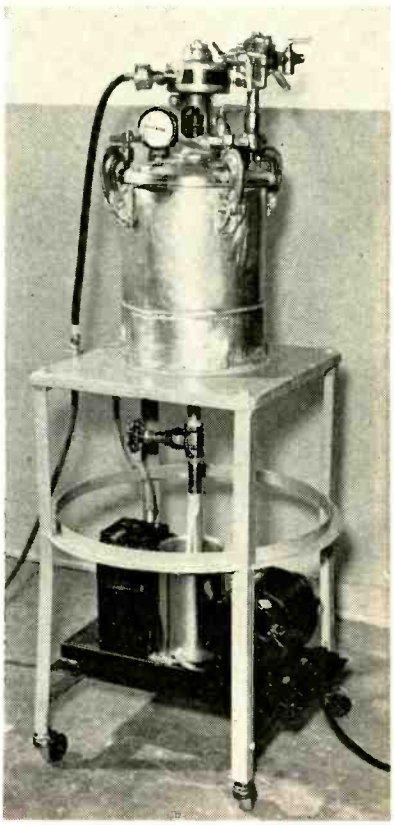
top plate of a roll-around cart. The pump and motor are mounted on the base, with space between them for a second mixing pot. Mixed compound base is drained from the top pot into the bottom pot through a pipe and plastic tubing.

As the bottom pot is filled, care must be taken to prevent the compound from folding or overlapping. This would entrap air in the compound again. When the bottom pot is filled, the proper amount of catalyst is added on top of the base.



Roll-around cart carries pressure paint pot on top and vacuum pump, motor and compound discharge tube in base

Catalyst has been withheld until this point to avoid premature curing and loss of solvent in the vacuum pot.

Catalyst and base are mixed on a Pyles Semco SP 1350 pressure mixer. Air pressure for the dasher assembly and ram is set at 45 psi. A total of 350 strokes is used at a rate of 20 to 25 strokes a minute. The compound is placed in polyethylene cartridges and stored at −40F until used. The compound may not be stored more than 10 days and

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Creative imagination, as Sir Arthur Eddington pointed out, is what takes knowledge and the knowledge of how we know it and projects further discoveries of the physical universe.

At National Company creative imagination has taken the known unvarying resonance of the Cesium atom and translated it into a frequency-producing instrument with a stability of frequency of 5 parts in 10^{10} throughout its entire operating life — This is the Atomichron, man's most accurate measurement of time.

The applications and adaptations of the basic Atomichron are many-fold and, as yet largely untouched.

Here is a known tool which properly applied can lead to tremendous further discovery and development.

You, who enjoy such creative challenges to scientific and technical development, should talk to *National*.

National Co. *right now* affords engineers and physicists the opportunity to grow and establish prestige in such advanced fields as multipath transmission, noise reduction and correlation techniques, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, signal processing, and long range microwave transmission.

At National Co. in the heart of New England electronics, you can associate with a company in which creativity is required, recognized and rewarded.

tuned to tomorrow *Write or phone*

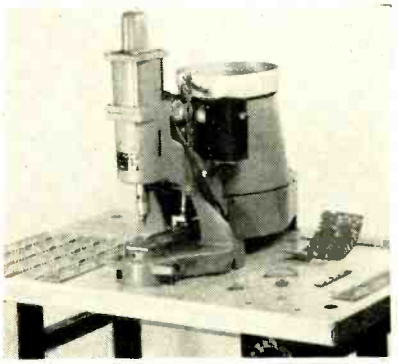
National ®

National Company, Inc., Malden, Mass.

BURTON BROWNE ADVERTISING

must be used within its pot life after thawing.

Machine Sets Turret, Bead Chain Terminals



Boards up to 10 inches wide are handled on standard model

MACHINE for setting turret and bead chain types of terminals in terminal boards has been developed by Black and Webster, Inc., Newton, Mass. It incorporates the firm's Electropunch and a vibratory feeder.

One feature is a light source under the punch head, which helps the operator find the exact location of a terminal hidden by the board. When the terminal hole is matched with the spot of light, the hole is centered directly over the nested terminal. This has been found especially useful with random hole distributions.

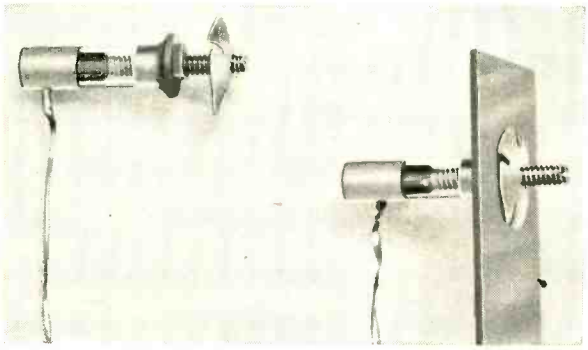
The feeder holds 2,000 terminals. Maximum feeding speed is 100 per minute. Production speed will depend on the operator's skill. Rates of 40 to 60 a minute are reported.

Terminals are fed through an orienting station, and a feed tube into an escapement where they are picked up by a feed bar. The bar carries the terminal to a staking nest. The operator places a board over the terminal.

Pressure on a knee or foot switch stakes the terminal and simultaneously causes another terminal to be advanced into the nest. The feed bar is driven by a crank and connecting rod. The crank, coupled to a constantly turning motor by a magnetic clutch, locks and unlocks the nest as the crank makes a 360 degree revolution.

The clutch will slip if a faulty terminal jams the mechanism. Feeding jam is prevented by a

Direct-Traverse, Expanding-Core
MINIATURE TRIMMING CAPACITOR



Illustrated same size — Patented

Designed for the coming space age, the ATLEE Variable Capacitor operates on new electro-mechanical principles to give a much greater range and higher stability with less space and weight than ever before.

Only $^{25}/_{32}$" long and $^{3}/_{16}$" in diameter, its capacitance range is 0.5 to 5.0 mmf. Has micrometer adjustment. Available in glass dielectric and brass for standard panel mounting or quartz and invar for special applications.

A rugged unit, it will maintain a set value under extreme vibration and shock *without undue stress!* Has excellent retrace characteristics. Full-floating piston assures positive mechanical alignment, eliminating run-out.

ATLAS E-E CORPORATION

47 Prospect Street • Woburn, Massachusetts
3757 Wilshire Blvd. • Los Angeles, California

CIRCLE 95 READERS SERVICE CARD

sending a bill?

It'll get there quicker if you give your postal delivery zone number with your address.

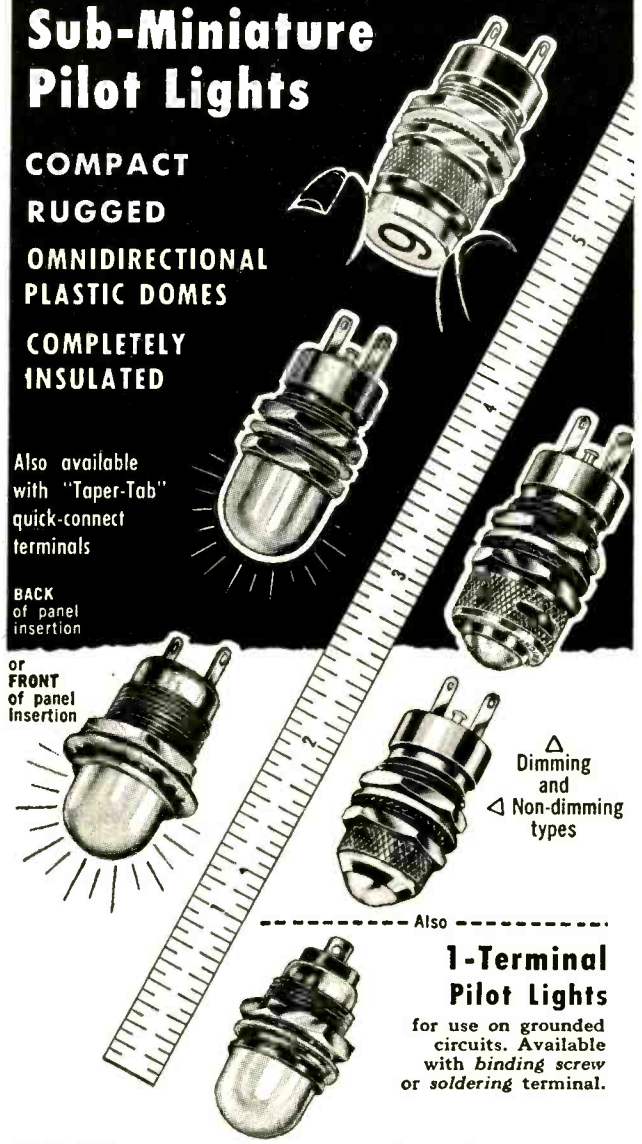
The Post Office has divided 106 cities into postal delivery zones to speed mail delivery. Be sure to include zone number when writing to these cities; be sure to include *your* zone number in *your* return address —after the city, before the state.

PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal

Sub-Miniature Pilot Lights

COMPACT
RUGGED
OMNIDIRECTIONAL PLASTIC DOMES
COMPLETELY INSULATED



Also

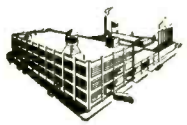
1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding screw* or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE



Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

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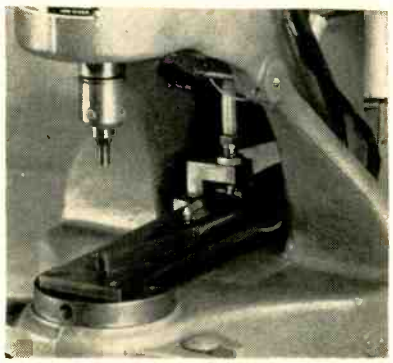
Address .....

CIRCLE 96 READERS SERVICE CARD



Feed bar carries terminals from escapement to staking nest

photoelectric cell which shuts off the vibratory feeder when the feed tube is ⅔ full. Feed speed is regulated by a variable resistor. Punch impact pressure may be varied by a variable transformer.

Flux-Solder Pastes Automate Assembly

RECENT developments in paste type solder alloys and brazing materials enable their use in production assembly operations. Key to their satisfactory use, according to Fusion Engineering, Cleveland, Ohio, is alloy and flux mixtures which will not separate or harden in automatic dispensers.

The paste may be applied to the parts automatically on production equipment or during mechanical assembly when that is required prior to assembly. The composition of the paste will depend on the job requirements. Dispensers will meter out as little as 0.001 ounce.

As an example, the firm cites pro-

Meter magnet assembly setup. Turntable moves counter-clockwise

the design engineers' dream becomes a reality—

AT LAST!

A CATHODE-RAY TUBE with

SPOT SIZE: .001" MAX.*

...no frills
...no gimmicks

the

DU MONT K1725

cathode-ray tube

Here's super resolution for flying spot scanners and photo-recording—a cathode-ray tube with a spot size of less than .001". And best of all, the Du Mont K1725 is no laboratory curiosity. It's a hard-working, practical, production component ready for the design engineer, requiring no super-size yokes and power supplies.

The K1725 cathode-ray tube is a five-inch, electromagnetically focused and deflected tube, utilizing the exclusive Du Mont Extra-Fine P-16 screen for high light output at fast writing rates.

- **.001" spot size over large range of currents.**
- **Uses standard-size yokes and power supply.**
- **A production component, ready for quantity delivery.**

**Measured by Shrinking Raster Method*

Another

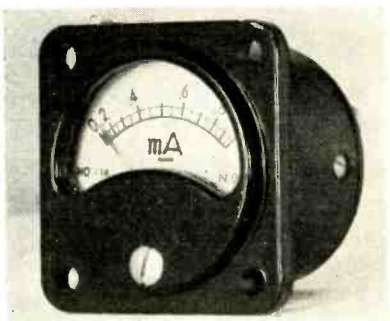
DU MONT® *AVAILABLE REALITY IN PRECISION PHOTOELECTRONICS*

INDUSTRIAL TUBE SALES, 750 BLOOMFIELD AVE., CLIFTON, NEW JERSEY, USA

115 v, 60 cps, single phase or a 26 v d-c power source. They are available in panel form for rack mounting or in equipment cases. Circle 304 on Reader Service Card.

Identifier for conductors

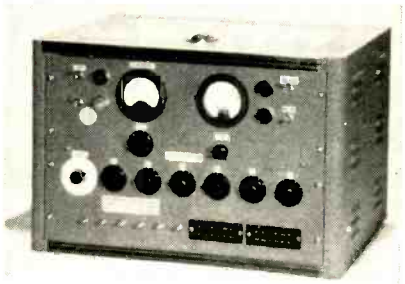
J. W. Dice Co., Englewood, N. J. A new instrument affords rapid and certain identification and separation of up to 4 unidentified conductors simultaneously. Code signalling transmitter is attached to one end of the unidentified conductors and a common lead attached to ground. Transmitter sends out repetitive identified coded signals on each of the conductors. Operator then attaches a code receiving device at the distant ends of the conductors, obtaining instant identification of each. Circle 305 on Reader Service Card.



Panel Meters miniaturized

Alco Electronics Mfg. Co., 3 Wolcott Ave., Lawrence, Mass. New miniature panel meters are currently available in 18 popular ranges and typically priced at $4.95 for a 0-1 ma movement. They feature a core magnet meter movement which makes it unnecessary to recalibrate for steel or aluminum

panels and a unique case design allowing optional mounting as a round or rectangular meter. They require only a 1-in. mounting hole and take nearly $\frac{1}{10}$ the panel space of a conventional $3\frac{1}{2}$-in. panel meter. Circle 306 on Reader Service Card.



Power Supply
automatic sequence

Research Industrial Laboratory of Electronics, Roslyn, Pa., announces an automatic sequence power supply for tube aging, processing, etc. Push of a button starts a sequence of various a-c and d-c voltages separably adjustable, each lasting a predetermined time period. Indicator lights show programming steps, shorts, and the like. The entire cycle is automatic, but can be manually tripped if desired. Circle 307 on Reader Service Card.

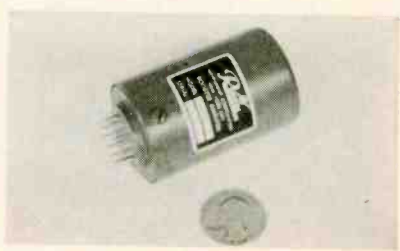
Transducers
frequency to voltage

Pioneer Magnetics Inc., 5858 Wilshire Blvd., Los Angeles 36, Calif. The MC line Magacycler converts pulse rate to a directly proportional d-c voltage or current. Static components give full range linearity of better than 0.5 percent with as low as 0.1 percent linearity upon request. Tempera-

less than 1 mv drift over a 24-hr period at constant temperature, and less than 0.001 percent per deg F change with temperature variations. A 10-percent change in line voltage will produce a change of less than 2 mv in output, while a 1-ampere change in load current will produce less than 1 mv change in output. Ripple is less than 1 mv peak to peak under all conditions of load. To protect the end instruments, the circuit design prevents failure voltages of greater than 20 v. Even a direct short will not damage the power supply itself. Circle 312 on Reader Service Card.

Ribbon Cable
multiple conductor

W. L. Gore & Associates, R.D. 2 Papermill Road, Newark, Del., announces multiple conductor cable insulated with tetrafluoroethylene resin. The ribbons are manufactured in wire sizes from Awg 12 to 34, with up to 100 conductors in a single ribbon, and the Teflon insulation can be put on in thicknesses from 0.003 in. to over 0.030 in. Circle 313 on Reader Service Card.



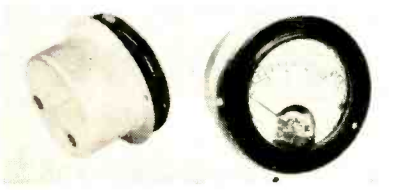
Booster Amplifier
miniaturized

Reeves Instrument Corp., Roosevelt Field, Garden City, N. Y. Highly miniaturized design, coupled with extreme accuracy and

reliability are features of a new booster amplifier for resolver systems. The unit consists of two fully transistorized amplifiers contained in a relay-type housing measuring 1½ in. in diameter by 2½ in. high. Each amplifier section is individually encapsulated for ease in servicing and replacement. Amplifier has an input impedance in excess of five megohms; and a feedback gain of 60 db minimum. **Circle 314 on Reader Service Card.**

Silicon Power Diode
70 to 250 amperes

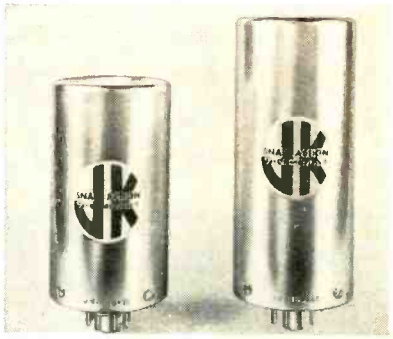
International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. High current silicon power rectifiers providing d-c forward currents up to 250 amperes with a maximum piv to 500 v are now available. They are designed for use at high temperatures and are capable of operation at a junction temperature of 200 C. These rectifiers use the latest techniques in hermetic sealing. **Circle 315 on Reader Service Card.**



Meter Shields
aid miniaturization

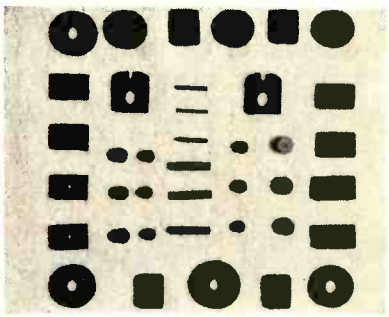
Magnetic Shields Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill., has developed a new line of Netic Co-

Netic magnetic shields which fit all meter shapes, aid miniaturization and increase meter reliability, permitting unrestricted use of meters in locations previously impossible for meters to function effectively. **Circle 316 on Reader Service Card.**



Component Ovens meet MIL specs

James Knights Co., Sandwich, Ill., announces a new series of crystal and component ovens featuring a disk type thermostat which provides snap-action opening and closing. The JKO 135 oven provides operating temperatures from 55C to 125C with a temperature stability of ±1.0 percent. The heater operates on 12-115 v. Other features are its fast warm-up, relatively low power consumption and ruggedness to withstand shock and vibration. **Circle 317 on Reader Service Card.**



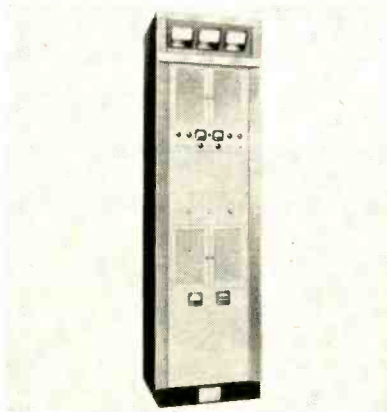
Permanent Magnets barium ferrite

D. M. Steward Mfg. Co., Chattanooga, Tenn., is manufacturing barium ferrite, a permanent magnet material having extremely high coercive force. The inexpensive material can be formed into intricate shapes to close tolerances with

no subsequent machining operations by conventional ceramic techniques. Circle 318 on Reader Service Card.

Transformers
chopper type

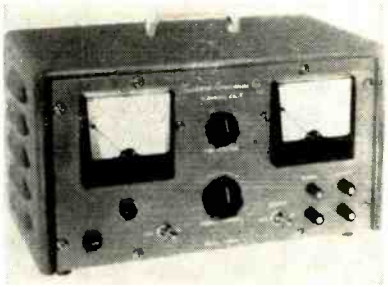
Microtran Co., Inc., 154 E. Mineola Ave., Valley Stream, N. Y. A line of low-level chopper input transformers efficiently transfer 30 to 500 cps transducer or thermocouple signals to instrument amplifiers. Signal level range is from 0.5 μv to 0.5v. They are resin impregnated to minimize mechanical vibration noise signal. Low hum pickup is assured by 3 mu-metal and 2 copper shields. Accurate center taps and external electrostatic shield connection improve low-level operation. Circle 319 on Reader Service Card.



VHF Tv Translator
150-w unit

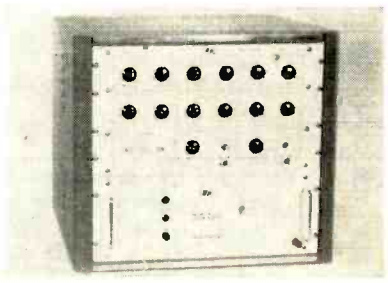
Adler Electronics, Inc., One Le-Fevre Lane, New Rochelle, N. Y. Designed for automatic, unattended operation, the type VSTT-150 tv translator receives signals from a vhf station and converts the information for rebroadcast on a different vhf channel. The standard unit has sufficient vhf head end equip-

ment to operate from a signal as low as 1,000 μv across a 75-ohm input. This 150-w translator can also be used for local tv program origination with the addition of an aural-visual driver unit. Circle 320 on Reader Service Card.



Lab Power Supplies transistorized

Transistor Applications Co., 859 E. Alosta Ave., Glendora, Calif., has a new line of completely transistorized, ultra-precision lab power supplies with transient response in the microsecond region. Illustrated is the model 0-50-2 designed for 115 v a-c, 60 cps input. Output voltage is 0 to 50 v d-c, continuously variable with fine resolution of 2 mv. Voltage regulation is better than 1 mv for input variations. Other models range from 300 ma to 20 amperes. All have constant current short protection and external sensing. Circle 321 on Reader Service Card.



Pulse Generator two outputs

Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif. Model 3460A megacycle double pulse generator provides two separate or mixed fast rise time outputs at variable repetition rates and separation, independently controllable in

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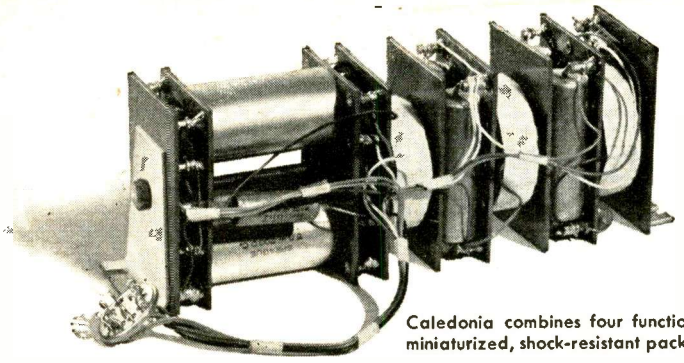

Caledonia combines four functions in miniaturized, shock-resistant package.

Electronics today is partly packaging

PROBLEM: Design a small (50 cubic in.) and light (3¾ lbs.) unit that contains:
1. a positive d.c. pulse selector
2. a negative d.c. pulse selector
3. a high level 60 cps band pass filter
4. a 400 cps detector circuit

(all with tight tolerances, naturally).

Design it to operate within the usual military environmental conditions, including high vibration and shock.

SOLUTION: We assembled the components shishkabob style. Then mounted the

kabob in a metal case filled with an epoxy foam compound to hold the parts in a firm cushion.

TIME ELAPSED: From original assignment, through design to volume production—two months.

If such quick, dependable assistance in design and production can make your work more effective, we'll be glad to hear from you. We offer experience, good production facilities, and a recognized quality record.

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NEW! RVG-8T 1/2" TRIMMER POT

Linearity ±3% and Power Rating 2w @ 85°C derated to 0 at 150° standard — 200°C intermittent operation available

RVG-8T Specifications

½" Trimmer Pot

Rating (watts)	2
Torque (oz.-in.) Max. special high torque available	1.
Weight (ounces)	⅓
Resistance Range ±5% 20Ω to 50K*	
Electrical Function Angle	320°
Voltage, Max. (insulation)	1000 DC
Linearity, Standard (%)	±3

*100K available
Notes: Shaft lock nut is supplied.

High Performance and Low Cost

Improve performance of your electrical and electronic circuitry with this new RVG-8T ½" Trimmer Potentiometer.

Excellent performance characteristics for its type and size. Windings are on cards or mandrels, usually with wire temperature coefficient of 20 ppm. Body is one-piece phosphor bronze, nickel plated; terminals are gold plated; stop pins and shaft are of stainless steel; precious metal contacts are used throughout. Insulation is designed to withstand 1000 volts DC.

Available now! RVG-8T is stocked in standard resistance ranges. 100 ohms to 50K ohms — up to 100K ohms available. Can be supplied with precision potentiometer tolerances, servo-mount, or for 200°C intermittent operation. Write for prices and catalog sheet today.

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Newton Upper Falls 64, Mass.

PRECISION POTENTIOMETER DIVISION

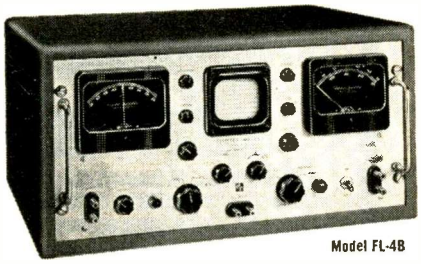
GAMEWELL

GA8-5

CIRCLE 212 READERS SERVICE CARD

SYNONYMOUS d&r LTD. FLUTTER METERS

For the most complete line of Flutter Meters, there is only one source — d & r LTD. From the meters used in simple maintenance test equipment to the most complex standardization and analysis equipment for missile flight systems and telemetering systems – we make them all.



Model FL-4B

WIDEBAND FLUTTER METERS

MODEL FL-3D FLUTTER AND WOW METER

Features
A convenient instrument of moderate cost for use in field maintenance of music-system tape recorders and reproducers, and phonograph turntables.

Specifications
Carrier frequency – 3000 cps, stabilized oscillator
Bandwidth – within 3 db to 250 cps modulation
Bandwidth Selection – 0.5 to 6 cps, 6 to 250 cps, 0.5 to 250 cps
Scale Ranges – 2% and 0.5% full scale rms

Price: $225.00

MODEL FL-4B WIDEBAND FLUTTER METER

Features
A very sensitive broadband instrument for laboratory use in the precise measurement of small amounts of flutter with components up to 5000 cps. Most frequently used in telemetering and data reduction systems.

Specifications
Carrier Frequncy – 14,500 cps, crystal controlled
Bandwidth – D-c to 5000 cps within 6 db
Bandwidth Selection – Full range above, 0.5 to 30 cps, 30 to 300 cps, 300 to 5000 cps.
Scale Ranges – 0.2%, 0.6% and 2.0% rms full scale
Drift Meter – ±2.0% frequency change d.c. to 4 cps
Display – 3-inch flat-face oscilloscope for flutter analysis

Price: $965.00 rack mounted, $1000.00 in cabinet

MODEL FL-5A LABORATORY STANDARD FLUTTER METER

Features
An extremely stable (temperature controlled discriminator) instrument with great sensitivity and extended bandwidth for laboratory work in connection with precision instrumentation data recorders. Galvanometer outputs provided.

Specifications
Carrier Frequencies – 40 kc. and 70 kc., crystal controlled
Bandwidth – D.c. to 10 kc. with 70-kc. carrier to 4 kc. with 40 kc. carrier
Indicating Instruments – Level Meter, and ±2% Drift Meter
Output Signals – Scope, two galvanometer outputs
Sensitivity – 0.05%, 0.2% and 2.0% selectable
Drift – On d-c galvo. output, less than 10 parts per million in ½ hour

Price: $3450.00 rack mounted

MODEL FL-6A BROADCAST FLUTTER METER

Features
An instrument designed for accurate measurement and analysis of flutter and wow in high-quality audio tape recorders.

Specifications
Carrier Frequncy – 8000 cps., stabilized oscillator
Bandwidth – D.c. to 1200 cps.
Bandwidth Selection – Full range, 0.5 to 30, 30 to 300, 300 to 1200 cps.
Scale Ranges – 0.2%, 0.6%, and 2.0% rms full scale
Display – 3-inch oscilloscope for waveform observation

Price: $845.00 rack mounted, $880.00 in cabinet

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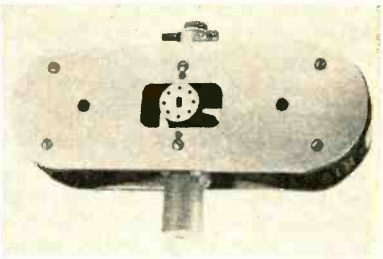
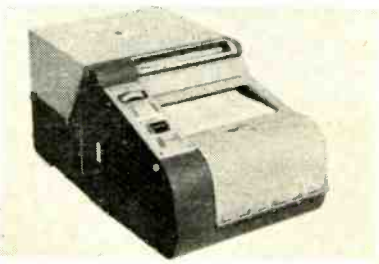
width, amplitude and polarity. Repetition rates are continuously variable in four decade ranges from 200 cps to 2 mc. Pulse width and separation are continuously variable from 0.1 to 100 μsec. Output from each channel is variable ± 35 v into 93 ohm load with 60 db attenuation provided. Circle 322 on Reader Service Card.



Tunable Magnetrons air-cooled

MICROWAVE ASSOCIATES, INC., Burlington, Mass., announces models MA-210A, B and C lightweight mechanically tunable ruggedized K_u band magnetrons. The tubes are air-cooled and use integral magnets. Three tubes tune 500 mc segments of a 1,500 mc range in the 34.2 to 35.5 kmc band. Because of their rugged construction and excellent r-f spectrum characteristics under severe vibration and shock conditions, the MA-210 series are recommended for airborne and mobile radar applications. Circle 323 on Reader Service Card.



Oscillograph 25-channel unit

MIDWESTERN INSTRUMENTS, Tulsa, Okla., has developed a 25-channel direct recording-direct readout oscillograph. Model D/R616 has a recording speed range of from ½ to 50 ips with writing speeds above 30,000 ips. Photographic records

of the galvanometer traces appear rapidly on the 7-in. paper and require no chemical development. A light beam interrupter type of trace identification has been incorporated into the instrument to provide identification of the galvanometer traces. **Circle 324 on Reader Service Card.**

KMC Generator
reference source

MANSON LABORATORIES, INC., 207 Greenwich Ave., Stamford, Conn. Model RD-170 generates both sinusoidal frequencies of 100 mc and 1,000 mc and harmonic signals covering a major portion of the microwave spectrum. Output frequency stability is governed solely by the stability of a 1 mc signal which it uses for a reference. The unit is intended for use as an ultra-precise source for reference, monitoring or calibrating purposes. Employing crystal synthesizer design techniques, the instrument essentially consists of a free running 100 mc oscillator, which is phase-locked to the 1 mc reference, and multiplier stages which raise the frequency to 1,000 mc. **Circle 325 on Reader Service Card.**

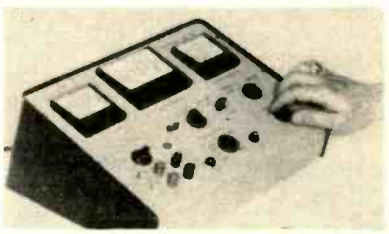
Teflon Terminals
pigtail extension

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. To eliminate a jumper on the extra soldering operation, the company offers its type FT-M-9 subminiature feed-

through with pin lug on top and extended or pigtail lead on bottom. The extended lead (1 in. long, standard) may be bent for point-to-point wiring. It is made integral with the pin lug on top. This feature is especially desirable in p-c boards, and is popular for computer assemblies. **Circle 326 on Reader Service Card.**

Pressure Transducer variable inductance

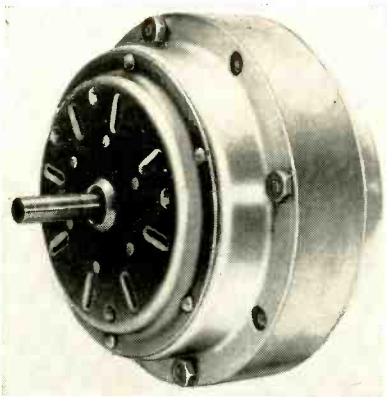
DATRAN ELECTRONICS, 1836 Rosecrans Ave., Manhattan Beach, Calif., has developed a new line of variable inductance pressure transducers to measure the pressures of conducting fluids such as salt water. It is now possible to obtain these transducers, which have their inner components and connections potted, in differential, gage or absolute ranges from 0 to 10 psi up to 0 to 3,500 psi. Electrical output from these transducers can be expressed as variable frequency, a-c or d-c voltage. **Circle 327 on Reader Service Card.**



Transistor Tester priced at $340

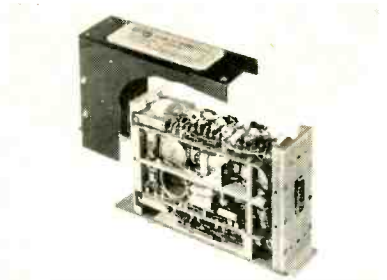
ARMOUR ELECTRONICS INC., 15002 Oxnard Blvd., Van Nuys, Calif. Model T-340 transistor test set is announced. Four basic parameters, Beta, I_{cbo}, I_{eo} and I_{co}, of both *pnp* and *npn* transistors are accurately measured with the transistor plugged into a common emitter circuit. A function selector establishes precisely controlled test con-

ditions with a minimum of individual adjustment. Results are read directly from a meter; no calculations are required. Binding post connectors and jumpers facilitate the installation of complete experimental circuits for design purposes. **Circle 328 on Reader Service Card.**



Hysteresis Motor
low heat rise

DALE PRODUCTS, INC., Box 136, Columbus, Nebraska. A new subfractional h-p hysteresis motor, although small in size, has a low heat rise of only 20C to 38C depending on h-p rating. Horsepower ratings are from 1/200th to 1/20th, with a running torque of 2.8 in. oz to 28 in. oz. Different rpm's can be selected by varying input frequency. The motor measures $4\frac{5}{8}$ in. in diameter by $3\frac{5}{8}$ in. thick and weighs $4\frac{1}{2}$ lb. **Circle 329 on Reader Service Card.**



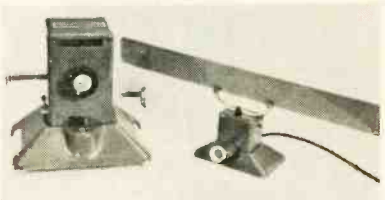
D-C Amplifier
for airborne use

SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Road, Houston 19, Texas. Model D-3B differential d-c amplifier is designed for airborne thermocouple

and strain gage telemetering applications. Chief features include dual-channel packaging, and true differential input (with both sides free from ground) to eliminate electrical noise pickup. Each of the two inputs is connected to a transformer primary through a full-wave chopper. Chopped d-c input is fed through a transistorized a-c amplifier circuit stabilized by negative feedback, to a silicon phase-sensitive detector. Circle 330 on Reader Service Card.

Motors subfractional h-p

Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass. Type R-29 subfractional hp motors are used as a power source in a wide variety of applications. The new motor is 2⅞ in. wide, 2⅞ in. high, comes both in 2 and 4 pole design and in three frame lengths. Included are induction, reluctance synchronous, and hysteresis synchronous permanent split capacitor motors built in ratings from 1/150 to 1/20 hp. Circle 331 on Reader Service Card.



X-Band Wattmeter simply calibrated

Wayne Kerr Instruments, P. O. Box 801, Philadelphia 5, Pa. Type U-182 X-band microwave watt-

meter is a standard, since its calibration depends only on measurements of length, mass and time. It is relatively independent of the vswr, and the electrical calibration is simplified and more accurate. Its design minimizes the effects of mismatch produced by small misalignment. The instrument makes possible rapid production checks on magnetrons, klystrons and has an in-line wattmeter for radar. Measurements can be made in the power range of 10 to 200 w, with an accuracy of 2 percent. **Circle 332 on Reader Service Card.**

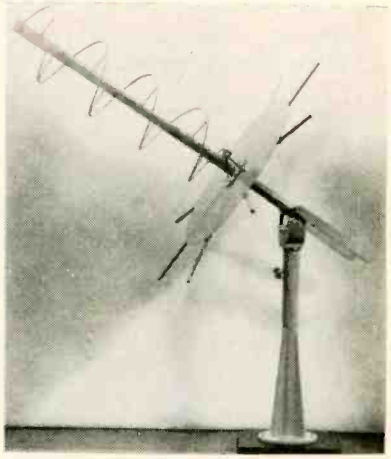
Panel Meter
high readability

MARION ELECTRICAL INSTRUMENT Co., Grenier Field, Manchester, N. H. The MM-5 occupies the panel space of conventional 4½ in. meters and the mounting space of ASA/MIL 3½ in. instruments, yet provides increased scale length and greater readability. A newly designed moving coil mechanism achieves a higher flux level and more symmetric flux distribution than either core or external magnet types. This rugged mechanism provides tracking that can be held to ½ percent of full scale, when plotted linearly or with a protractor reference for deflection angles up to and including 100 deg. **Circle 333 on Reader Service Card.**

D-C Voltmeter
multipurpose

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. The 412A is a multipurpose d-c voltmeter calibrated in current and resistance. It measures voltage within 1 percent of full scale and

has 12 ranges—1 mv full scale to 1,000 v full scale. It will also measure current directly from 1 μa to 1 ampere in 12 ranges. Resistance ranges from 1 ohm center scale to 100 megohms center scale in 9 ranges. The instrument has extremely low noise and drift, and is equipped with a recorder output of 1 v or 1 ma at full scale deflection. Circle 334 on Reader Service Card.



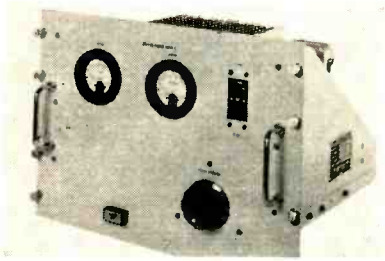
Telemetry Antenna helical beam

Nems-Clarke Co., 919 Jesup-Blair Drive, Silver Spring, Md. Model MAM-1000 is designed for applications where the antenna can be manually oriented to any position. It can also be supplied with a remote controlled motor-driven mount. Unit pictured is a four-turn helical beam antenna having an acceptance angle of approximately 50 deg and a gain of approximately 10 db over an isotropic source. Other designs are also available. Circle 335 on Reader Service Card.

Flutter Meter also measures wow

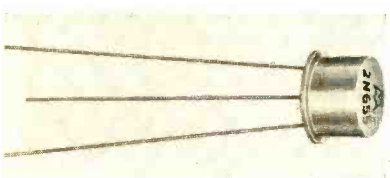
Kay Electric Co., Maple Ave., Pine Brook, N. J. The Fluttermeter permits the fine adjustment of re-

corder drives in the field or laboratory. To measure flutter (rapid drive-speed variations) or wow (relatively slow drive-speed variations), a pre-recorded nominal 1,000 cps signal is played on tape or disk through the recorder being tested. As the speed variations modulate the frequency of this signal, the Fluttermeter amplifies this band of frequencies; the output of a magnetic discriminator is metered as a percentage of variations of the 1,000 cps signal. **Circle 336 on Reader Service Card.**



Power Supply for missile test

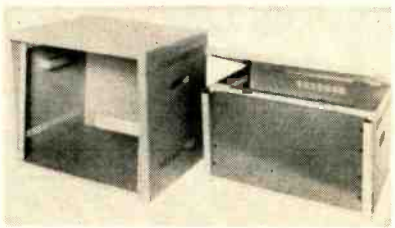
PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif. A completely militarized and ruggedized 0 to 32 v at 25 amperes d-c power supply is specially designed for missile test, checkout and launching applications. Model M-1071 tubeless, magnetic amplifier regulated d-c source operates from a 115 v, 1 phase, 60 cycle, a-c input and provides d-c output power over the range of 0 to 32 v up to 35 amperes with a continuous duty rating of 25 amperes. Output regulation accuracy is 1 percent and ripple is limited to 1 percent rms at 32 v and full load. Request catalog E-58A.



Transistors meet MIL-T-19500A

MOTOROLA, INC., 4545 W. Augusta Blvd., Chicago 51, Ill., announces a new family of germanium general

purpose audio (GPA) transistors. They are under EIA numbers 2N650 through 2N655. The new devices feature a maximum junction temperature of 100 C, collector dissipation ratings of 200 mw, and tightly controlled limits on other parameters. Circle 337 on Reader Service Card.



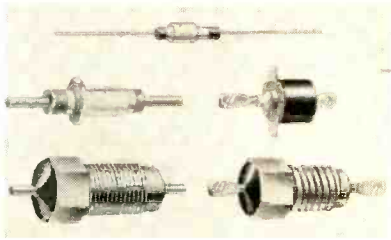
Electronic Housings steel fabricated

VAN NORMAN INDUSTRIES, INC., 186 Granite St., Manchester, N. H. A completely redesigned line of Insuline steel fabricated electronic housings has been introduced. The new line includes 19 in. heavy duty rack frames and cabinets, in accordance with military specifications. The cabinets feature provision for installation of an impeller fan and air filter, and have ganging flanges to permit units to be used in multiples. Circle 338 on Reader Service Card.

Substitution Box decade type

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has developed Zeniac, a diode substitution box offering a selection of eleven basic one watt silicon zener diodes covering the

range from 3.6 to 30 v. The decade-type substitution box is housed in a compact, easily portable unit which may be inserted into any breadboard circuit. A turn of Zeniac's selector switch rapidly determines the exact diode required. **Circle 339 on Reader Service Card.**



Low Pass Filters feed-through type

ALLEN-BRADLEY CO., Milwaukee, Wisc., has available a line of high-frequency low-pass feed-through filters. They are designed to provide radiation and feedback elimination in low power circuits in the frequency range from 50 mc to 5,000 mc. This includes the P, L, and S military bands. The new filter elements have effective capacitances up to 500,000 $\mu\mu$f. **Circle 340 on Reader Service Card.**

Commutator all-solid-state

WIANCKO ENGINEERING CO., 255 N. Halstead Ave., Pasadena, Calif., offers an all-solid-state airborne commutator which weighs less than 12 oz, occupies less than 35 cu in., and commutates 30 channels at rates up to 2,500 samples per sec or any IRIG commutation rate. It

Hycon

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For your laboratory, incoming inspection, or in-line test positions—or wherever *accurate* and *reliable* measurements must be made *quickly*—you need a HYCON Digital Volt-Ohmmeter.

READABLE ½" digits, in line, with illuminated decimal point and polarity indicator for fast (2 second average) readout without interpolation error.

RUGGED AND RELIABLE with no delicate components—designed for continuous operation, and to withstand shock and vibration without loss of accuracy.

Complete Data in Bulletin 645

Model 645AR 0.1% accurate, DC and Ohms..... **$875.00**

Model 615AR 0.5% accurate, DC and Ohms..... **$485.00**

Both instruments are 1% accurate on AC from 10 to 1000 volts; 2% accurate below 10 volts.

3 DIGITAL INSTRUMENTS IN 1

The HYCON reads DC volts in 4 decimal ranges from .001 V to 999 V...AC volts in 3 decimal ranges from 1.0 V to 999 V RMS...resistance in 5 decimal ranges from 1 ohm to 9.99 megohms.

High Impedance (vacuum tube) input. Size 5¼ x 19", 11" deep. Complete with probes.

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A SUBSIDIARY OF HYCON MFG. CO.

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EIGHT HOURS OF SHOCK

1100 jarring power shocks per minute...

Fastened to a pneumatic drill during an 8 hour working day, a HANDLEY *Wee Pot* TRIMMER Potentiometer conclusively proved its ability to maintain critical tolerances under the most severe conditions. When checked after this ordeal, there was NO CHANGE OF SETTING, and absolutely NO LOSS OF CONTINUITY.

ACTUAL SIZE

Designed especially for printed circuit use, the Wee Pot is a wire-wound miniature trimmer potentiometer with standard resistance ranges from one to 40K ohms, and a power rating of 1.5 watts at 40 degrees C.

Handley Electronics may have the answer to your problem. Write for our new brochure on the Wee Pot for a complete technical description and specifications.

HANDLEY ELECTRONICS, INC.

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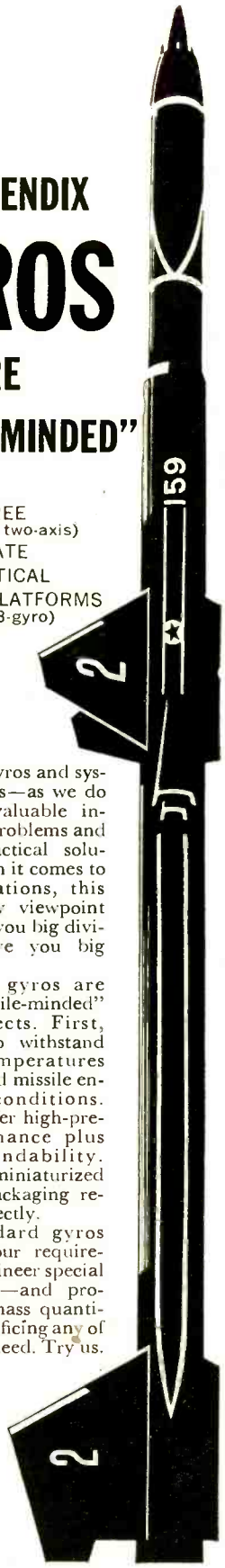
CIRCLE 231 READERS SERVICE CARD

WHY BENDIX GYROS ARE "MISSILE-MINDED"



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For Bendix gyros are definitely "missile-minded" in three respects. First, they're built to withstand high-range temperatures and other rugged missile environmental conditions. Second, they offer high-precision performance plus extreme dependability. Third, they're miniaturized to fit missile packaging requirements perfectly.

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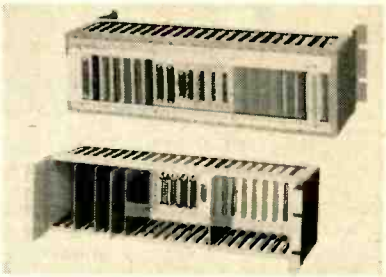
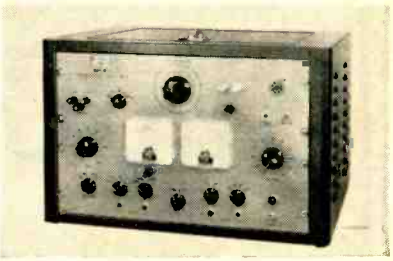
CIRCLE 232 READERS SERVICE CARD

operates at 40-g acceleration and temperatures from 0 to + 85 C. Circle 341 on Reader Service Card.



P-C Card Enclosure simply designed

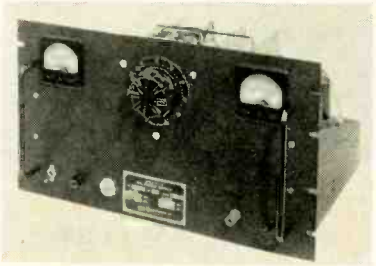
ELCO CORP., M St. below Erie Ave., Philadelphia 24, Pa. The Varipak enclosure is designed to be adapted to any packaging technique utilizing printed or etched circuitry. It holds boards and p-c connectors in alignment and saves much valuable soldering time. In a few minutes, as many as 78 parts may be firmly retained with only 8 screws. The Varipak is designed to fit any standard relay rack or standard electronic cabinet enclosure mounting: $4\frac{3}{8}$, $5\frac{1}{4}$, 7, $8\frac{3}{4}$, $10\frac{1}{2}$ in. panel sections. Circle 342 on Reader Service Card.



Transistor Tester general purpose

BAIRD-ATOMIC, INC., 33 University Rd., Cambridge 38, Mass. Model KP-2 is a versatile precision instrument for analyzing transistors at frequencies from 100 cps to 200 kc, valuable and dependable for both lab and production work. It offers a current range of from 100 μa to 1 ampere with two regulated semiconductor power supplies for bias voltages and currents. The direct measurement obtained is based on "h" parameters using basic simple and straightforward

circuitry for optimum dependability and reliability of test results. The test set is used with an external oscillator and vtvm. Circle 343 on Reader Service Card.



D-C Power Rectifier priced at $140

GATES ELECTRONIC CO., 2090 Barnes Ave., Bronx 62, N. Y., announces a new silicon d-c power rectifier. Input is 115 v, 1 phase, 60 cycles. Output is 30 v d-c, 0-10 amperes. Regulation is 5 percent; ripple, 0.1 percent rms. Meters have a 2 percent accuracy. Dimensions are 19 in. wide by 13 in. deep by 10½ in. high. Weight is 55 lb. Circle 344 on Reader Service Card.

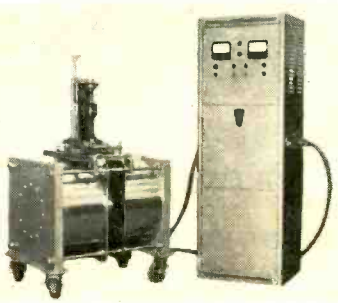
Rotary Switch subminiaturized

THE DAVEN CO., Livingston, N. J. The series G subminiature, sealed, rotary, circuit selector switch measures only ½ in. in diameter, weighs ⅓ oz and has been extensively tested under extremes of temperature, humidity, corrosion, vibration, acceleration, shock and immersion. It is specifically designed for limited-space applications. Ratings are: 100,000 cycle life; 125 C temperature; contacts, 1 ampere 250 v d-c resistive and 350 ma 100 v d-c

inductive; contact resistance, less than 0.008 ohm; dielectric strength, 1,000 v rms between terminals or to ground; low capacitance between all parts. **Circle 345 on Reader Service Card.**

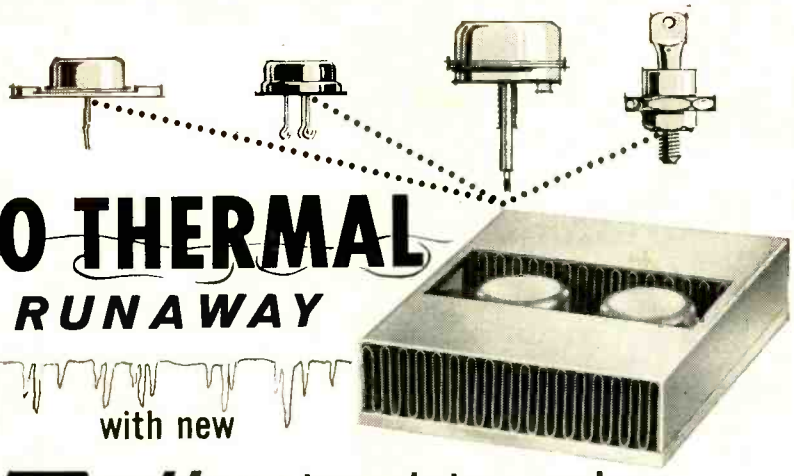
Focus Coil
higher power

SYNTRONIC INSTRUMENTS, INC., 100 Industrial Road, Addison, Ill. Type F20 electromagnetic focus coil is designed for photographic, flying spot, military and other special purpose 1½ in. neck diameter crt's requiring short focal length at high (up to 25 kv) accelerating potential without overheating. Minimum spot distortion is assured by machining coil case to close dimensional tolerances. Together with using top quality soft magnetic iron in the case, this results in a very uniform focusing field. Sharp focus for high beam currents is assured by the large i-d to focus gap ratio. Type F20 measures 1⅞ in. i-d, 3½ in. o-d, 1⅞ in. long and ⅝ in. front to gap center. **Circle 346 on Reader Service Card.**



Laboratory Magnet
with power supply

ADVANCE INDUSTRIES, INC., 640 Memorial Drive, Cambridge, Mass. Model AI-1101, a laboratory magnet and associated power supply that produces an accurately con-



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For full details on standard and custom-built Modine transistor coolers, plus Bulletin ID-158, write Electronic Cooling Dept., Modine Manufacturing Company, 1602 DeKoven Avenue, Racine, Wisconsin.

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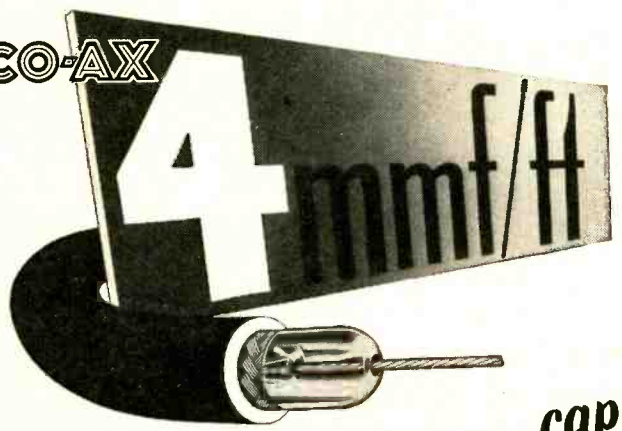
T-1374

CIRCLE 243 READERS SERVICE CARD

CO-AX



★ ULTRA LOW capacitance & attenuation

TYPE	μμ F/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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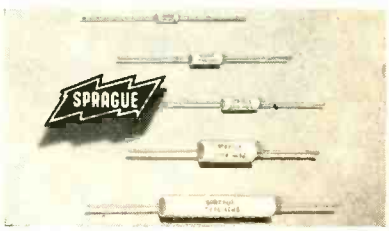
CIRCLE 245 READERS SERVICE CARD

trolled, adjustable magnetic field, is now being offered. It has an 11-in. pole diameter and features a precision control system which provides a selection of air gap flux densities up to a maximum of 20,000 gauss. Gap width may be continuously adjusted from zero to any specified value. Other features include replaceable energizing coil sections and cooling coils, built-in surge protection and a choice of accessories such as a positioning platform and a servo control field regulator. **Circle 347 on Reader Service Card.**

Power Supply
transistorized

ARD Corp., 2465 Lincoln Blvd., Venice, Calif. The Little Monster hermetically sealed, transistorized a-c to d-c power supply furnishes from ±7 to ±20 v d-c output as requested (±10 v d-c at 200 ma). Regulation is within 0.01 percent; ripple, less than 0.2 v rms; size, 6 1/2 in. by 3 1/8 in. by 2 7/8 in.; weight, 2 1/4 lb. **Circle 348 on Reader Service Card.**



Resistors
lower wattage

Sprague Electric Co., North Adams, Mass. The addition of new miniature 1/8 and 1/4 w ratings to the line of deposited-carbon Filmistors in hermetically-sealed ceramic cases has been announced. These resistors fully meet all requirements for Characteristic B resistors of specification MIL-R-10509B. **Circle 349 on Reader Service Card.**

Pulse Notes

Adjustable and Fixed Linear Inductors Introduced by Pulse

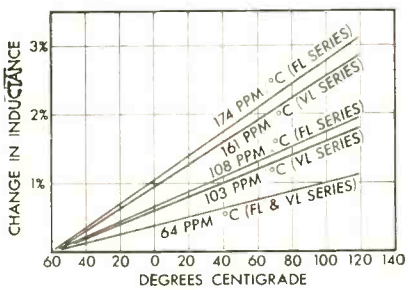
A new line of adjustable and fixed linear inductors is now available from Pulse Engineering. Pulse linear inductors are designed to replace toroids in wave filters, resonant circuits, impedance choke applications, and resonant transformer applications.

Pulse linear inductors provide a marked improvement over toroids in several respects. Variation of inductance is absolutely linear from −55° C to +125° C. Temperature coefficients of 55 parts per million to 161 parts per million are available. They are self-compensating with polystyrene foil capacitors in resonant meshes. They have a higher Q over a wider range, typically, 500 at 50 kc. Pulse linear inductors are more astatic than toroids and possess a lower external field.

Other advantages include low price, small size, Q variation of ±10% from −30° C to +85° C, inductance range of 100 μh to 2h. The adjustable inductor, VL Series, has a variable inductance of ±7% of center value.

By using these linear inductors, Pulse has been able to improve the frequency attenuation response of their filter networks, reduce the sizes and achieve an excellent stability of attenuation. (See graph)

CHANGE IN INDUCTANCE VS. TEMPERATURE



New Pulse linear inductors are available in quantity now. For complete technical information, prices, and delivery, call your nearest Pulse Engineering representative or write to Dept. E9

6

Literature of

MATERIALS

Epoxy Casting Compound. Isochem Resins Corp., 221 Oak St., Providence 9, R. I. Technical data bulletin DB-441-8127 fully describes Isocast 441, a two-part 100 percent solids epoxy resin casting and sealing compound which contains no reactive diluents or inert plasticizers. **Circle 350 on Reader Service Card.**

Metal Charts. Fansteel Metallurgical Corp., North Chicago, Ill., has published two new metal charts. One shows the melting points of the metals both in F and C scales. The other shows the densities of metals. Charts are available to those requesting them on company letterheads.

Plastic Laminates. New England Laminates Co., Inc., 481 Canal St., Stamford, Conn. A 4-page two-color booklet outlines the company's philosophy, facilities and products in the field of high-quality clad and unclad plastic laminates for the electrical and electronic industries. **Circle 351 on Reader Service Card.**

Strontium Salts. Hummel Chemical Co., 90 West St., New York 6, N. Y., has issued a product list describing their line of strontium salts which are used in the manufacture of fluxes and electronic tube coatings. **Circle 352 on Reader Service Card.**

Teflon Rods. Chemplast, Inc., 3 Central Ave., East Newark, N. J., announces a 4-page brochure on its line of Teflon rod stock. It gives sizes available, engineering data, tips on machining and typical uses. **Circle 353 on Reader Service Card.**

COMPONENTS

AN Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. An easily used wall-chart (22 in. by 28 in.) graphically provides a simple method for selecting the proper AN connector

the Week

for an application. **Circle 354 on Reader Service Card.**

Angular Accelerometer. Edcliff Instruments, 1711 South Mountain Ave., Monrovia, Calif. An illustrated engineering data sheet on model 6-9 angular accelerometer for controlling spin or rotation of missiles is now available. **Circle 355 on Reader Service Card.**

Crystal Filter Networks. Bliley Electric Co., Union Station Bldg., Erie, Pa. Crystal filter networks is the subject of bulletin 509. It contains reference data and curves on crystal filters for 5 mc, 10.7 mc and 13 mc. **Circle 356 on Reader Service Card.**

Decade Counter Tubes. Sylvania Electric Products, Inc., 1740 Broadway, New York 17, N. Y. A new technical booklet lists minimum and maximum ratings on a variety of bidirectional counter tubes. **Circle 357 on Reader Service Card.**

Distance Detector. Bently Scientific Co., 2811 Seventh St., Berkeley 10, Calif. Bulletin No. 15 describes the model D-15 distance detector, a precision electromechanical transducer which generates an output voltage as a function of distance. **Circle 358 on Reader Service Card.**

Microwave Components. Aircom Inc., 139 E. First Ave., Roselle, N. J., has released their new microwave components catalogs. The brochures offer both mechanical and electrical characteristics as well as Aircom part number. **Circle 359 on Reader Service Card.**

Pilot Lights. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. Form L-161 is a 16-page digest of condensed technical information on a wide range of Dialco pilot light assemblies and the appropriate lamp types housed therein. **Circle 360 on Reader Service Card.**

Relays. Kurman Electric Co., 191 Newel St., Brooklyn 22, N. Y. A

4-page colored brochure, No. 58-3, features complete illustrations, technical descriptions and prices of 132 relays that are stocked by distributors. **Circle 361 on Reader Service Card.**

Rectifiers. Bradley Laboratories, Inc., New Haven 11, Conn. A four-page folder contains information on a new line of diffused junction silicon rectifiers. It also describes and illustrates the basic types of Bradley vacuum processed selenium and copper oxide rectifiers. **Circle 362 on Reader Service Card.**

Transformers. Eisler Transformer Co., Inc., 16 N. Salem St., Dover, N. J., has issued a four-page brochure showing part of their new facilities and different types of transformers constructed by the company. **Circle 363 on Reader Service Card.**

Transistor Interchangeability Chart. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y., has available a revised up-to-date transistor interchangeability chart. It covers all EIA registered types comparable to GT types. **Circle 364 on Reader Service Card.**

Tube Clamps. The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif. New designs of heat reducing Kool Klamps are shown in 16-page catalog 5-KK. Types are listed for all subminiature and miniature tubes and many components, in both beryllium copper and 99½ percent pure heat treated silver. **Circle 365 on Reader Service Card.**

EQUIPMENT

Computer Design Techniques. Control Data Corp., 501 Park Ave., Minneapolis 4, Minn. New design techniques to accomplish substantial savings throughout engineering development programs for electronic digital computers are described in a recent booklet. **Circle 366 on Reader Service Card.**

Computer Method. Bendix Computer Division, 5630 Arbor

Vitae St., Los Angeles 45, Calif. A four-page bulletin describes the unusual features of a new programming method. The system described is designed for use with the Bendix G-15 general purpose digital computer and is a major simplification in the process of writing instructions to a computer. **Circle 367 on Reader Service Card.**

Data Link Receiver. Lear Astronics Division, 3171 S. Bundy Drive, Santa Monica, Calif. A single-sheet bulletin contains an illustrated description and engineering specifications for the model 5601 data link receiver, a command receiver designed to operate in missile environments. **Circle 368 on Reader Service Card.**

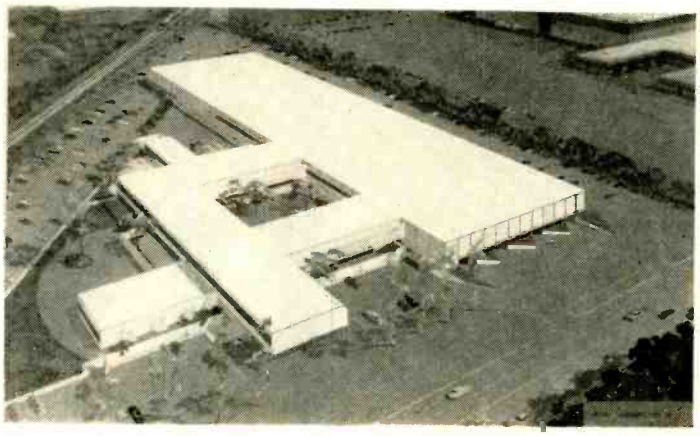
Magnetic D-C Amplifier. Calmag Division of California Magnetic Control Corp., 11922 Valerio St., N. Hollywood, Calif., has available an engineering bulletin completely describing the 100C3, an ultra-stable, linear, polarity sensitive, drift free magnetic d-c amplifier. **Circle 369 on Reader Service Card.**

Modular Oscilloscopes. Advanced Electronics Mfg. Corp., 2116 S. Sepulveda Blvd., Los Angeles 25, Calif. Complete specifications and prices of the model 200 series of modular oscilloscopes are contained in a new six-page short form catalog. **Circle 370 on Reader Service Card.**

FACILITIES

Analog Computer Application. Electronic Associates, Inc., Long Branch, N. J. Application Bulletin No. 5 is entitled "An Analog Computer Study of the Stability of a Molten Zone Refining Process used in the Production of Transistors". **Circle 371 on Reader Service Card.**

Standard Time Signals. General Radio Co., 275 Massachusetts Ave., Cambridge, Mass. Volume 32 No. 13 of the *Experimenter* contains an article on improving the accuracy of comparison between radio and local time standards. **Circle 372 on Reader Service Card.**



PSI Plans Mammoth Plant

AN ADVANCED engineering, production and administrative center (architect's concept, above) for the development and production of semiconductor devices will be built by Pacific Semiconductors, Inc., near the Los Angeles International Airport.

Ultimate investment in land and equipment was estimated at $10 million, with eventual employment at 3,000.

The announcement was made recently by Harper Q. North, president of the firm, which is engaged in research, development and manufacture of semiconductor devices in all fields of commercial and military activity, including computers, geophysical electronic systems, guided missiles and satellites.

North said the new PSI Center will be built in several increments. When fully developed it will comprise 300,000 sq ft. It will augment a present 43,000 sq ft facility in Culver City which the firm will continue to operate.

First increment, a 48,000 sq ft unit on an 18 acre site, represents an investment of $1 million, with equipment. Now under construction, it will be occupied early next year and will employ an additional 500 people.

The second increment, also 48,000 sq ft, is planned for 1959. With the present rate of company growth, North estimates the entire center will be required in the early 1960's and further expansion may be necessary by 1965.

Rapid changes in the state of the semiconductor art, which in turn require corresponding changes in production techniques, are anticipated in the building plans.

The entire manufacturing level will be subfloored. It will house all lines carrying utilities essential to production in networks that will make any utility readily available in any corner of the plant. Six gas lines will carry oxygen, nitrogen and other gases. Interior power lines will furnish 120, 240 and 480 volts and regulated voltage supplies.

Need for personal communication will be met through split-level floors and other design features.

Zenith Elects Engineering V-P

RECENTLY elected v-p in charge of engineering at Zenith Radio Corp., Chicago, Ill., is J. E. Brown (picture).

Brown has been Zenith's assistant v-p since 1943 and chief engineer since 1940. He joined the corporation in 1937.

Lenkurt Forms New Division

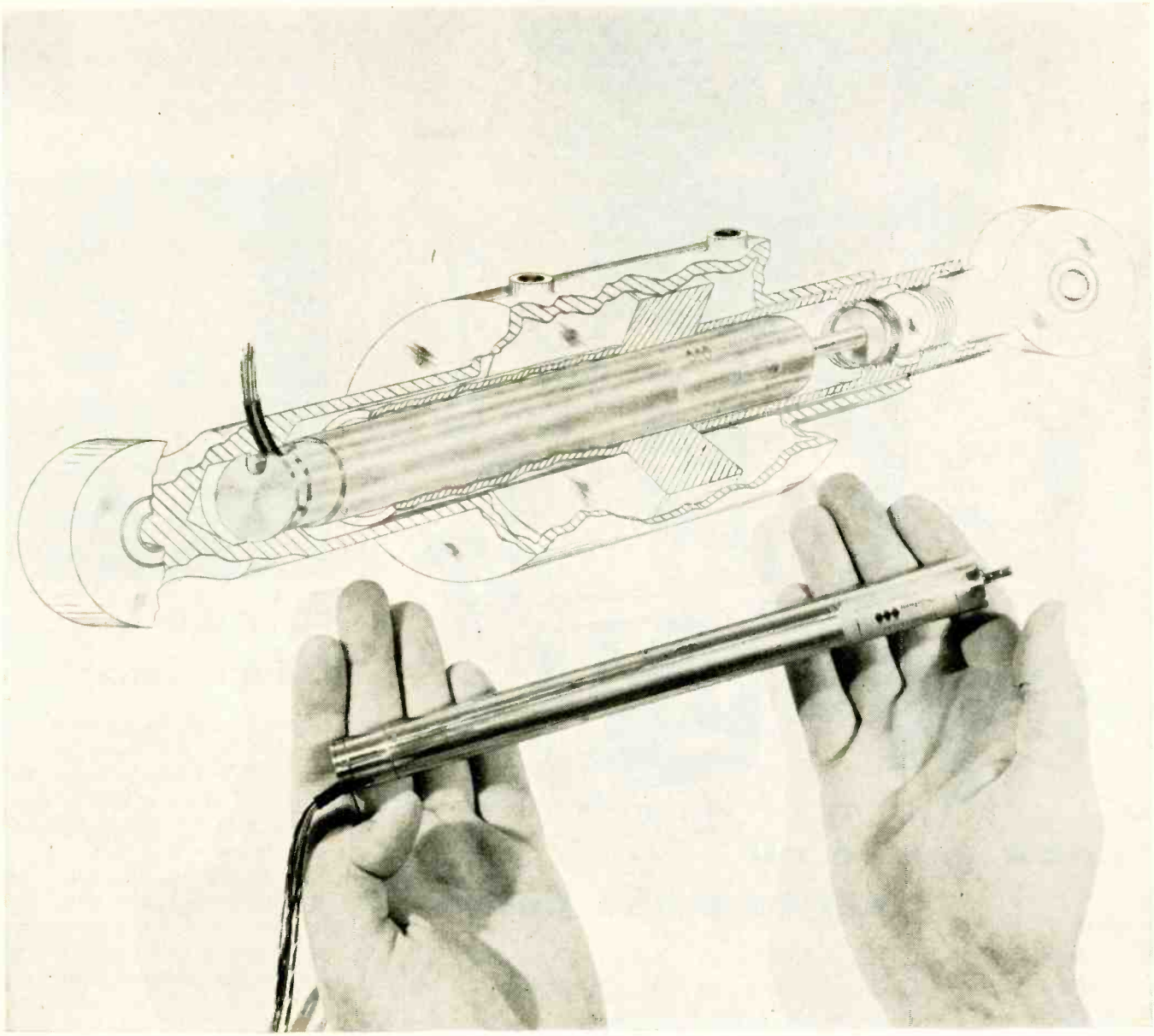
IN San Carlos, Calif., Lenkurt Electric Co. announces formation of a separate division to handle increased military business. The new unit will be responsible for future military production contracts as well as for research and development projects. Many of Lenkurt's key engineering and production people have been assigned to the military group to work independently of the firm's commercial operational structure.

Blakely Takes New Post

APPOINTMENT of Robert T. Blakely (picture) as corporate staff engineer, a new position in the executive engineering office, has been announced by Irven Travis, v-p of research and engineering, Burroughs Corp.

The position was established to assist Travis in planning the engineering program for the Series G electronic high speed printing and tabulating machine. Blakely's headquarters will be at Control Instrument Co., Brooklyn, N. Y., Burroughs subsidiary, where the Series G is being produced.

Blakely joined Burroughs at the



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For better performance in your servo systems, make a Humphrey potentiometer an integral part of the hydraulic actuator. You get most accurate feedback and zero backlash. You eliminate brackets and external mountings that take up space and permit mechanical deflection, introducing errors.

Humphrey makes a complete line of rectilinear and sector potentiometers for severe duty applications. Typical of the tough environmental conditions they are meeting in current missile applications are vibration 25 G, 10 to 2,000 cps, and shock of 100 G while operating.

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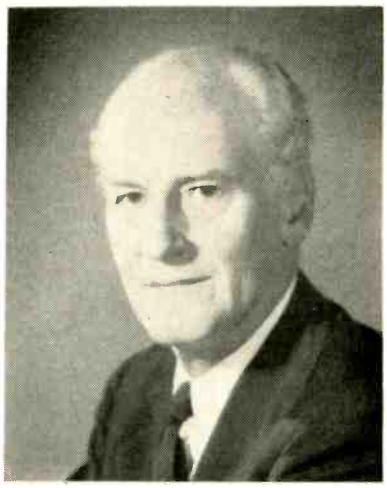
CIRCLE 255 READERS SERVICE CARD

Research Center in Paoli, Pa., in 1956, after having been associated with IBM Corp. for 20 years.



Elect V-P At Clevite Corp.

NEWLY elected vice president of Clevite Corp., Cleveland, Ohio, is A. L. W. Williams (picture). Also a Clevite director, he had until now been in charge of the corporation's research center.

Operations at the center will now be directed by Hans Jaffe, who becomes director of electronics research, and by Arthur D. Schwope, who becomes director of mechanical research.

GPE Subsidiary Shows Growth

EXPANSION of the products and services of a major subsidiary of General Precision Equipment Corp. and a name change to reflect the expansion were recently announced. GPE Controls, Inc. is the new name of the former Askania Regulator Co.

GPE Controls will offer a broader line of engineering services and products for automatic process control to industry through expansion of its own products and services and by integration with certain products and technical services of three other GPE subsidiaries. Companies in this group are Librascope, Inc. of Glendale, Calif., Link Aviation, Inc., Binghamton, N.Y., and

- Kearfott Co., Inc., Little Falls, N.J.

Executive offices of GPE Controls are in Chicago, Ill. Eastern and western regional sales headquarters are in the home offices of Kearfott and Librascope. Headquarters of the national service organization will be at Link Aviation.

Hynes Joins Hollenbeck

JAMES A. HYNES, former director of commercial development for Chrysler Corp., has been named to direct the midwest operations of Hollenbeck and Co., New York management consulting firm specializing in sales, distribution, marketing and product diversification.

Western Design Hires Manager

GEORGE S. BROWN, JR. (picture) has been named manager of engineering and manufacture for the Santa Barbara Division of Western Design & Mfg. Corp., Santa Barbara, Calif. He was formerly director of engineering and manufacturing at A.M.I. Inc., Grand Rapids, Mich.

Cannon Electric Advances Bowen

ROGER BOWEN was recently appointed to the central staff of Cannon Electric Co., Los Angeles, Calif., as director of engineering. In

this post he will direct and control the overall engineering activities of the company. He had previously been general manager of the company's Salem (Mass.) division.

IRC Promotes Stein

WITH the company since 1949, Sidney J. Stein (picture) was recently appointed director of engineering and research at International Resistance Co., Philadelphia, Pa. He has held the position of senior research chemist, assistant director, and director of research.

Florida Firm Names Officers

Two new officers were recently named at Instrument Corp. of Florida, Melbourne, Fla.

John H. Reber, formerly executive engineer, becomes vice-president of Electronics Division. A. K. Schiefner moves from director of optics to vice-president of Optics Division.

Carad Names V-P

LESTER L. Libby was recently named vice president of Carad Corp., Redwood City, Calif., designers and manufacturers of pulse transformers and associated pulse components. He joined Carad in 1957 as chief engineer and will continue in that capacity also.

Previous to his affiliation with the company, he was technical di-

rector of Sierra Electronic Corp., president and chief engineer of Alto Scientific Co., chief engineer of Kay Electric Co., section head at Federal Telecommunication Laboratories, tube design engineer at Tung Sol Electric, Inc., and receiving tube design engineer at RCA Radiotron Co.

Tresco Hires Jensen

NEW director of engineering of Tresco, Inc., Philadelphia, Pa., is Dwayne W. Jensen. He was chief engineer for Airdesign, Inc. for a number of years and previously was on the staff of the Research Division of Burroughs Corp., Paoli, Pa.

Tresco, Inc. is engaged in custom manufacturing of transformers and allied electromagnetic components.

Malter Joins Varian

APPOINTMENT of Louis Malter (picture) as director of central research for Varian Associates has been announced. He leaves RCA where he was chief engineer of the semiconductor and materials division, to join the Palo Alto electronics firm.

Allied Control Gets New Plant

OPENING of a new 30,000-sq ft plant in Plantsville, Conn., is announced by Allied Control Co.,

Inc., New York City.

The new plant is the second built by Allied in three years. The company also operates a second plant at Plantsville, and one at Glendale, Calif., besides pilot production facilities in New York.

Story Fills New Post

JAMES K. Story (picture) has been named to fill the newly created post of sales manager of transducers and systems for Donner Scientific Co., Concord, Calif.

He was formerly an applications engineer in the transducer and inertial systems division of Donner. Prior to his association with the company, Story was sales engineer with Statham Instruments, Inc.

Huskey Heads Bendix Group

AN ASSOCIATE professor in electrical engineering and mathematics at the U. of C. at Berkeley, Harry

D. Huskey (picture), is coordinating the activities of a newly formed Advanced Programming Development Group for the Bendix Computer Division.

A pioneer in the field of electronic computers, Huskey has served as consultant to Bendix since 1953. The group is currently engaged in developing compilers for the G-15D general purpose computer system.

Zenith Promotes N. W. Aram

NEWLY ELECTED assistant vice president and chief engineer of Zenith Radio Corp., Chicago, Ill., is Nathan W. Aram. In his new capacity he reports to J. E. Brown, vice president in charge of engineering.

Aram has been a member of Zenith's electrical engineering staff since he joined the company in 1939. Since 1946, two years before Zenith began the commercial manufacture of tv receivers, he has been the electrical engineering supervisor of tv receiver design.

Elect Packard To SRI Board

DAVID Packard (picture), president of the Hewlett-Packard Co., Palo Alto electronics firm, was recently elected to the board of directors of Stanford Research Institute, Menlo Park, Calif. He will also serve on the executive

committee of the board.

Before the formation of the Hewlett-Packard Co. in 1939, Packard was associated with the General Electric Co. He holds several patents in the field of electronics and measurements.

Varian Shifts Hiestand

NEWLY appointed manager, product development of Varian Associates' Instrument Division, Palo Alto, Calif., is Norman Hiestand (picture). Since 1955 he has been manager, power tube applications department in Varian's Tube Division.

Data-Control Names Willey

IN Danbury, Conn., Data-Control Systems, Inc., appoints Frank G Willey (picture) as manager of

data processing field services and marketing. Willey was previously with General Electric Co., Fairchild Camera and Instrument Co. and Servo Corp. of America.

Among the principal products of Data-Control Systems are high precision telemetry systems for airborne and ground use. The company's research and development interests include measuring techniques, instruments and automatic control systems.

News of Reps

Smith & Purdy Associates have been appointed exclusive New England representatives for Acoustica Associates, Inc., Mineola, N. Y.

Boston's Epsco, Inc. appoints **SSEC—Scientific Sales Engineering Co.**—as its rep in Florida, Georgia, Alabama, North Carolina, Tennessee and Mississippi.

North Atlantic Industries, Inc., Westbury, N. Y., announces two more technical sales reps for its phase angle voltmeter and other instrumentation:

Fred F. Bartlett & Co. will cover Pennsylvania, Maryland, southern New Jersey, Virginia, Delaware and Washington, D.C. **Gerald B. Miller Co.** will serve in Oregon, California, Washington, Nevada and Idaho.

Resistor lines of Chicago Telephone Supply Corp., Elkhart, Ind., will be handled by **Richard Legg Co.** in Oregon, Washington, Idaho, Montana and Alaska.

Phalo Plastics Corp., Worcester, Mass., manufacturer of plastic insulated wire and cable and allied products, names **Frank Lebell** as a sales rep to cover northern California, northern Nevada and Hawaii.

Wild and Associates will sell digital plotters, visual recorders, primary buffers and skip readers for Tally Register Corp., Seattle, Wash., in Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut and the District of Columbia.

THE CLIMATE'S RIGHT AT LINK-PALO ALTO

Engineers have several types of climate to consider... the *mental* climate at work, and the *physical* climate or atmosphere in which they live.

At Link Aviation, pioneer of flight simulation, both kinds of climate are right. Link's facilities, attitude, and forward-looking management—all provide a congenial setting for growth. Aside from the career opportunities at Link-Palo Alto, the mild, temperate climate inspires California living at its finest.

The climate of learning is at Link-Palo Alto, too. As a participant in the Stanford University Honors Cooperative Program, the dedicated engineer can advance his education by attending regular classes with time and tuition provided by Link.

Good pay, ample vacations, and hospital, health and retirement benefits are commensurate with today's most enlightened practices.

There are openings at all levels for engineers qualified in the following fields: Digital computers, analogue computers, radar simulators, automatic check-out equipment, complex electronic simulators, optical systems and electronic packaging.

If the climate's right for you, write at once to:

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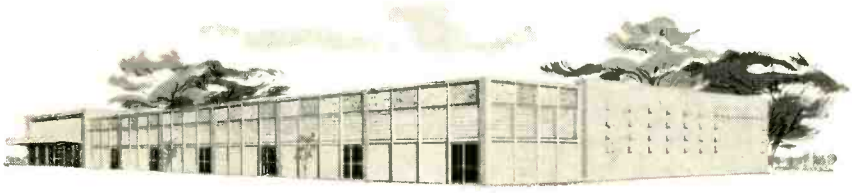


Other openings also exist at our main plant in Binghamton, New York. Information forwarded upon request

LINK AVIATION, INC.

NEW BOOKS

Principles of Noise

By J. J. FREEMAN.

John Wiley and Sons, Inc., New York, 1958, 298 p, $9.25.

DURING World War II and in the years since a great need has arisen for radars and communication systems of increasing sensitivity. This need has led to an intensive study of noise and related random phenomena which limit sensitivity, culminating in the classic papers of Rice and others. More recently, the filtering and prediction theory of Wiener and the communication theory of Shannon have set forth the limiting performance that is possible for specified kinds and amounts of noise.

Contents—The present book attempts to discuss noise theory in terms understandable to the engineer. To that extent it is concerned more with the application of this theory, actual or potential, rather than with its rigorous development. The book brings together in one place diverse material on stationary random processes, physical sources of noise, equivalent noise generators, noise factors, measurement of direct voltage, detection of alternating waveforms, and target noise. The material on the measurement of a direct voltage and the detection of alternating waveforms particularly should prove useful, since these subjects are concerned with limits on the reliability of measurement and, so far as this reviewer is aware, is otherwise unavailable in text book form.

Background Necessary—In considering the effectiveness of the book, one is inevitably drawn into the controversial question of whether it is better to assume that the reader has the necessary mathematical preparation or whether, as the author has done, to assume that certain necessary mathematical tools should be presented. The danger in the latter case is that of inadequate coverage and there is some question of that here. For example, in the chapter on probability, failure to discuss the Law of Independent Trials is a shortcoming, because this law gives excellent insight into the nature of chance events and leads quite

naturally to the Poisson distribution and the Gaussian Normal Law from the point of view of discrete rather than continuous events, a fact of importance to students because they find the discrete point of view easier to understand.

One might question the author's method of deriving necessary mathematical tools such as the Poisson distribution within the context of a specific application such as the temperature-limited diode. While the method has the advantage of directly relating the theory to the application, it creates the impression that the theory is applicable to the specific application only, whereas it is in fact applicable to a broad class of similar applications.

Because of the great importance of correlation theory to equipment operation in noise, it seems desirable to give more emphasis to the correlation function than has been done in this book, particularly with respect to the question of extracting weak signals from a noisy background.

Finally, noise in diodes seems to be over discussed. It would be better if there were less material on diodes and instead something on noise in transistors, a subject which is now of very great interest.

In spite of the reservations just cited this book is, for the engineer, a very good introduction to the subject of noise. The treatment is complete enough to satisfy the needs of instructors teaching first-year graduate students in engineering schools. There seem to be an adequate number of practical examples and problems for the student and although noise is not treated from an advanced point of view, the book might be of value to the theoretically inclined in showing them which areas are now of practical interest.—L. S. Schwartz, *New York University, New York, N. Y.*

Microwave Measurements

By EDWARD GINZTON. *McGraw-Hill Book Co., New York, 1957, 515 p, $12.00.*

The well-written text, the comprehensive coverage of the basic tech

niques and instruments, and the numerous references to recent papers make this book a valuable reference for anyone actively engaged in microwave research and design. Students entering the microwave field should find it an excellent introduction to the basic measurements and to the theory underlying the techniques and instruments which are indigenous to this region of the spectrum.

The book is well organized, reads easily and is well illustrated with graphs and diagrams. The author has taken care not to tire the reader by appropriately using footnotes and references to the literature for many of the details and specialized applications. The book does not make extensive use of electromagnetic theory but the reader should definitely have a good understanding of microwave transmission lines, on the level of "Fields and Waves in Modern Radio" by Ramo and Whinnery.

Although the selection of topics is good, this reviewer feels that too much of the book is taken up by a discussion of the methods for the generation of microwave energy, at the expense of other important aspects of microwave technology which could have been profitably included. Such topics could be the measurement of antenna characteristics or the measurement of material constants.

The discussion of energy sources is concerned mostly with the theory, operation, and use of reflex and two-cavity klystrons. The mathematics are kept to a minimum; the emphasis properly being placed on the physical phenomena which are involved. The principles of operation of traveling wave tubes are also explained in a heuristic manner.

Detectors—There is a very useful exposition of the behavior and physical principles of microwave detectors. The properties of crystal detectors, such as the response law, the figure of merit, sensitivity and noise figure, are treated adequately for the purposes of the book. The uses of crystals for detection and frequency conversion are discussed and illustrated by curves and data for typical modern

microwave crystals. There is also a good resume of the bolometric techniques for the absolute measurement of power. There are qualitative descriptions of the properties and limitations of the barreter and thermistor elements which are commonly used as power sensing elements in bolometers. The author discusses at length the errors involved in making measurements with crystals and bolometers.

In an introduction to impedance concepts at microwave frequencies, the author establishes the analogy between the fields of a mode in a uniform waveguide and the voltage and current parameters of the telegrapher's equation. It is made plausible that the transverse electric and magnetic fields of a waveguide mode can be related by a characteristic impedance and that these fields can be expressed to introduce voltage and current coefficients.

Standing waves are discussed in terms of the voltage coefficients and the characteristic impedance of the transmission line, leading to the introduction of the concepts of the voltage standing wave ratio and the reflection coefficient.

The construction and salient features of the rectangular impedance chart and the Smith Chart are described. The advantages and disadvantages of these two graphical representations are compared and typical uses for these charts are discussed.

Slotted Lines—The book includes an extensive up-to-date summary of the principal instruments and techniques used for the measurement of impedance. As one would expect, most of the discussion deals with the techniques associated with slotted-line standing wave indicators. These include the nodal shift method, the cavity method and the Chipman method. Typical designs of slotted lines are described and there is a detailed description of the errors introduced by these instruments. In addition to the various standing wave methods, the author also discusses the principal bridge methods of impedance measurement as well as the simpler methods such as the reflectometer technique and the

four-fixed-probes method, which require no moving parts.

In a chapter which is probably much too condensed to suit the purposes of a text book, the author discusses the principal methods for the evaluation of the six circuit constants necessary for the complete description of an arbitrary two-port network. These are: the representation by an equivalent T or π network, the scattering coefficient representation, the transformer method and the representation by an equivalent Canonical network. These methods are explained but not illustrated. There is a summary of the mathematical relations which interconnect the more important forms.

There is a good discussion of the methods for the measurement of frequency. Most of the material describes the requirements, design and principles of operation of tunable resonant cavities suitable for the measurement of frequency in microwave circuits. The various methods of coupling cavities to microwave circuits are compared and the effects upon the cavity of loading due to the external circuits are discussed. There is also a description of the design and uses of primary and secondary frequency standards. The standards which are described include the Bureau of Standards primary standards, the ammonia absorption line generator, the ammonia MASER, as well as cavity resonators as secondary standards.

Two of the chapters are a detailed introduction to the methods for the measurement of the parameters necessary and sufficient for the complete description of an arbitrary cavity operating in a given mode. The various selectivity factors, the shunt resistance, and the coupling coefficient are defined in terms of equivalent circuits. Experimental techniques for the measurement of these parameters are described. The necessary mathematical relationships are derived and attention is drawn to the necessary details for the achievement of accurate results. A number of graphical techniques are described for the rapid analysis of experimental data.

Two-Port Networks—The book

ends with a short summary of the principal methods for the measurement of the insertion loss of two-port networks. The author defines and discusses in terms of the scattering coefficients the significance of insertion loss, loss due to reflection, loss due to dissipation, transmission efficiency and intrinsic loss. The standard techniques of measurement of these quantities are described briefly.

As is understandable for a book of this scope, the discussions of the theory and techniques of the various measurements is rather sparing at times. The text, however, is supplemented with very extensive references to more specialized sources for additional details. Enough information is presented to enable the reader to use intelligently the techniques and instruments which are described.—NICHOLAS G. SAKIOTIS, *Naval Research Laboratory, Washington, D. C.*

Transistor Electronics

By DAVID DEWITT AND ARTHUR L. ROSSOFF.
McGraw-Hill Book Co., Inc., New York, 1957, 381 p, $8.00.

THE primary emphasis of this book is the application of the transistor as a circuit element. It should find widespread appeal with circuit designers who are finding the demands for transistorization steadily increasing.

As the authors readily state, this book makes no basic contribution to transistor theory. The material covered is not new. Those who have diligently covered the existing transistor literature will gain little from reading this work. The chief value of this book is the logical presentation of material starting with a somewhat simplified consideration of semiconductor theory, through a discussion of some of the most popular current transistor applications.

Fundamentals—The first quarter of the book develops the fundamentals of the transistor. Starting with the Bohr atom and going through elementary quantum mechanical considerations, the prop-

erties of semiconductors, the behavior of charge carriers within a crystal, the authors develop the theory of the *p-n* junction and finally the junction transistor. The chapter on the *p-n* junctions is particularly complete with its discussions of the fundamental conduction relationships, reverse saturation current and the consideration of both the abrupt *p-n* junction, as approached by the alloyed junction, and the graded junction, typified by the grown junction.

The second quarter of the book develops the small-signal low-frequency characteristics of the planar junction transistor. The fundamentals of transistor operation are derived.

After establishing the various equivalent transistor elements, an equivalent T circuit is developed from which the various basic configurations are analysed. The widely used matrix parameters are introduced together with a discussion of their measurement.

A chapter on transistor statics completes the first half of the book. A complete, readily understandable answer to the transistor designers' first practical problem—setting the operating point, and stabilizing it for large ambient temperature changes.

Applications—The second half of the book is devoted to the practical applications of transistors. There are separate chapters on amplifier circuits, audio power amplifiers, small-signal high-frequency performance, large-signal high-frequency mixers and demodulators, transient switching conditions and switching circuits and radio receiver circuits.

Because of the broad area covered, some of the material is exceedingly sketchy. For example, the discussion of transistor switching circuits mentions little more than one-shot multivibrators, logic circuits, relaxation oscillators and the extremely popular d-c to a-c inverters. The next to the last chapter covers some of the nonuniform junction devices. Discussed are the intrinsic-barrier, drift, field-effect, double-base tetrode, hook, photo, and point contact transistors. In this chapter the drift transistor is extensively discussed, the others

receiving considerably reduced attention.

Noise—The final chapter deals with the causes and computation of transistor noise. Shot noise, 1-f noise and thermal noise are explained. An equivalent transistor noise generator circuit is developed and noise computations for various frequency ranges are derived.

The book contains no general mathamatical tables. A simple appendix contains the physical properties of germanium and silicon, a few general physical constants and two useful tables of matrix and determinant interrelations. There is a section containing problems based on the material of each chapter making the book suitable for a text in a basic transistor course. The book also contains an excellent reference bibliography.

The mathematical treatment in the book is on an undergraduate senior level, but sufficiently clear text is available to make the book of value to the advanced technician as well. The book is a worthwhile addition to any library on basic transistor theory and application. —Paul Todd, *Universal Transistor Products, Westbury, L. I., N. Y.*

THUMBNAIL REVIEWS

Television Interference Its Causes and Cures. By P. Rand, Nelson Pub. Co., Box 36, Redding Ridge, Conn., 1958, 56 p, $1.75. This handbook is intended to enable the radio amateur, tv serviceman or set owner to diagnose and cure television interference. Nomographs are presented to simplify the design and construction of high or low-pass filters. The appendix includes a bibliography, list of FCC tvi committees, frequencies of amateur band harmonics and other frequency and channel data.

Mathematical Excursions. By H. Merrill, Dover Publications, Inc., New York, 1957, 145 p, $1.00. This reprint of the 1933 original covers odd and unusual aspects of mathematics including magic squares, puzzles, etc. Answers are supplied for the puzzles.

COMMENT

". . . All Those Magazines"

I have been a subscriber to ELECTRONICS since August, 1940. The better half gave me the ultimatum recently: "You just have to do something about all those magazines! So I decided to try rebinding them.

I have found that I can go through one year's supply in about two evenings and end up with three neatly bound volumes entitled ELECTRONICS, Electrons at Work, and Production Techniques. Since I also enjoy New Books and Backtalk (now called Comment), I usually place them in whatever volume happens to be the smallest.

The most convenient method I have found for binding the magazines is to use homemade staples, made out of straightened paper clips bent into the form of a staple, good for about 1½-in. thicknesses if necessary. For inserting the staples, I drill holes for three staples per volume, using one of the wife's heavy sewing needles in a ¼-in. drill. This makes for quite a substantial binding. The covers and the backing can be made according to the desires of the individual, using conventional bookbinding techniques.

I really appreciate the fact that your main articles are not interspersed with the advertising.

FRANK ERZNOZNIK JR.
HAWTHORNE, CALIF.

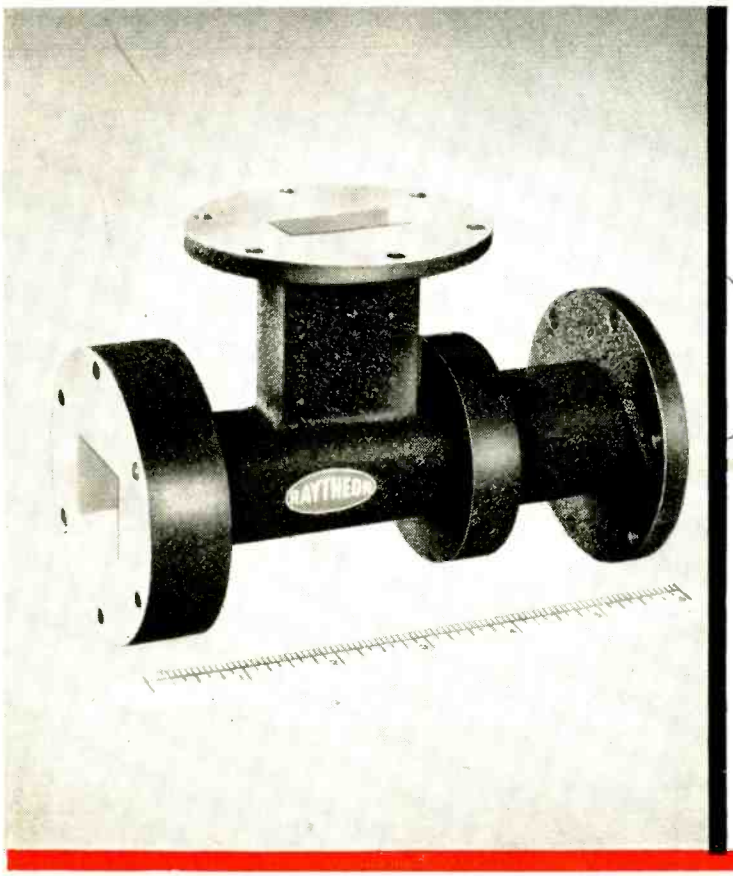
Voltage Spikes

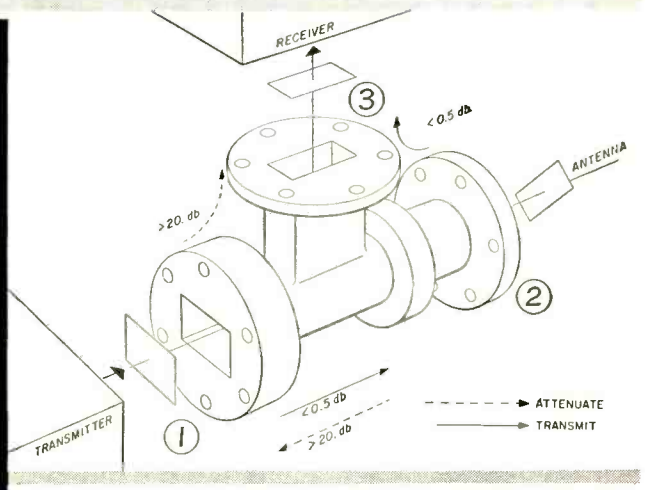
We have read with interest the article "Magnetic Inverter Uses Tubes or Transistors" (Mar. 14, p 158), by C. H. R. Campling. A method is described of eliminating transient voltage spikes by using clipping diodes, but no adequate explanation is given of the fundamental reason why the spikes appear.

As a result of experience gained in the design of inverters, we offer a qualitative reasoning, which we have substantiated. . . . Voltage spikes can be reduced to negligible proportions without using additional components by attacking the problem at its source.

The magnitude of voltage spikes

Recent Raytheon achievements in Microwave





THE MICROWAVE CIRCULATOR. Typical of recent Raytheon developments in advanced microwave equipment and components is the microwave ferrite circulator recently developed by Raytheon's Special Microwave Device Group. **HOW IT WORKS:** in the diagram above, transmitted signals enter arm (1) vertically polarized. They are then rotated 45° from the vertical in a ferrite Faraday rotator with a longitudinal field applied by a small cylindrical permanent magnet. They flow out of the circulator at the antenna arm (2) which is set at the same 45° angle. Received signals fed into the antenna arm are rotated an additional 45° by the ferrite Faraday rotator and can only leave through the receiver arm (3).

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Army Hawk (ground-to-air)

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is a function of the coupling between windings on the transformer core and the total load reflected into the collector winding. When a transformer core saturates, its permeability is greatly reduced and much of the magnetic coupling between windings is destroyed. The shunt inductance of a collector winding falls rapidly as the core approaches saturation, and a large current is established through the conducting transistor. When cumulative switch-off occurs (as the circuit changes state), the current source becomes high resistance, and the magnetic field produced by the winding current decays very rapidly due to the very small damping imposed upon the winding. A reverse voltage spike therefore occurs at the collector of the cut-off transistor, the magnitude of which may be several times the supply voltage and can be dangerous to the transistors.

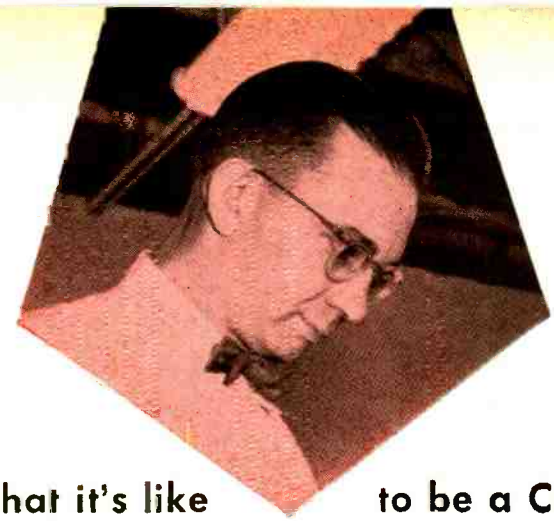
If coupling between windings is made as tight as possible, leakage inductance is kept to a minimum and the reflected load from other windings increases the damping on the collector winding and slows down the decay of magnetic flux. . . .

Optimum coupling is obtained by making collector and base windings of twisted-pair enamelled conductor, and these together with an output winding are layered one upon another over a small portion of tape-wound toroidal core of nickel-iron alloy. Loose coupling is achieved by spacing windings around the core. . . .

By observing the requirement for tight coupling of windings, designers may extensively reduce transient voltage spikes without recourse to using other components.

B. D. Simmons and
R. J. Todd
Siemens Edison Swan Ltd.
London S.E. 3, England

The qualitative reasoning of Readers Simmons and Todd was substantiated with oscillograms of waveforms in tightly and loosely coupled circuits. The spike is considerably reduced even with no external load connected to their circuit; with a load resistor, the spike is, as nearly as we can make it out, all but entirely gone.



INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

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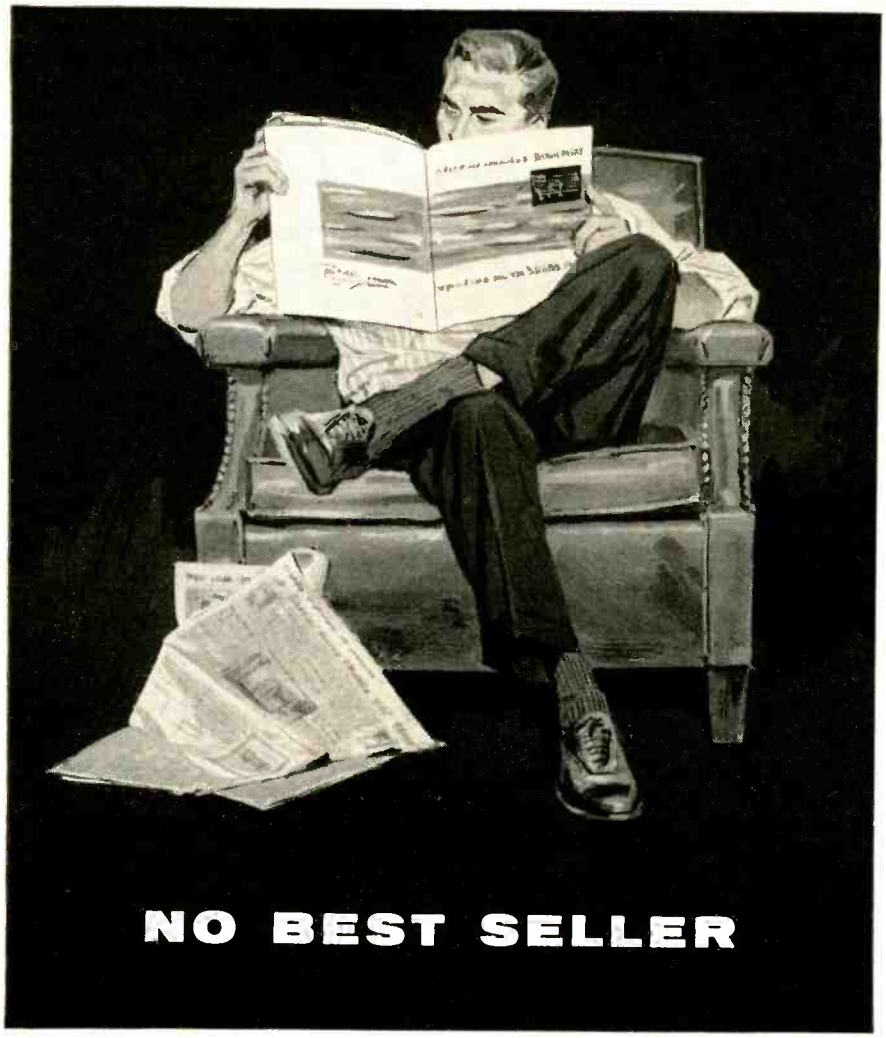

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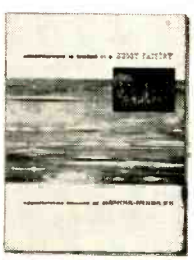

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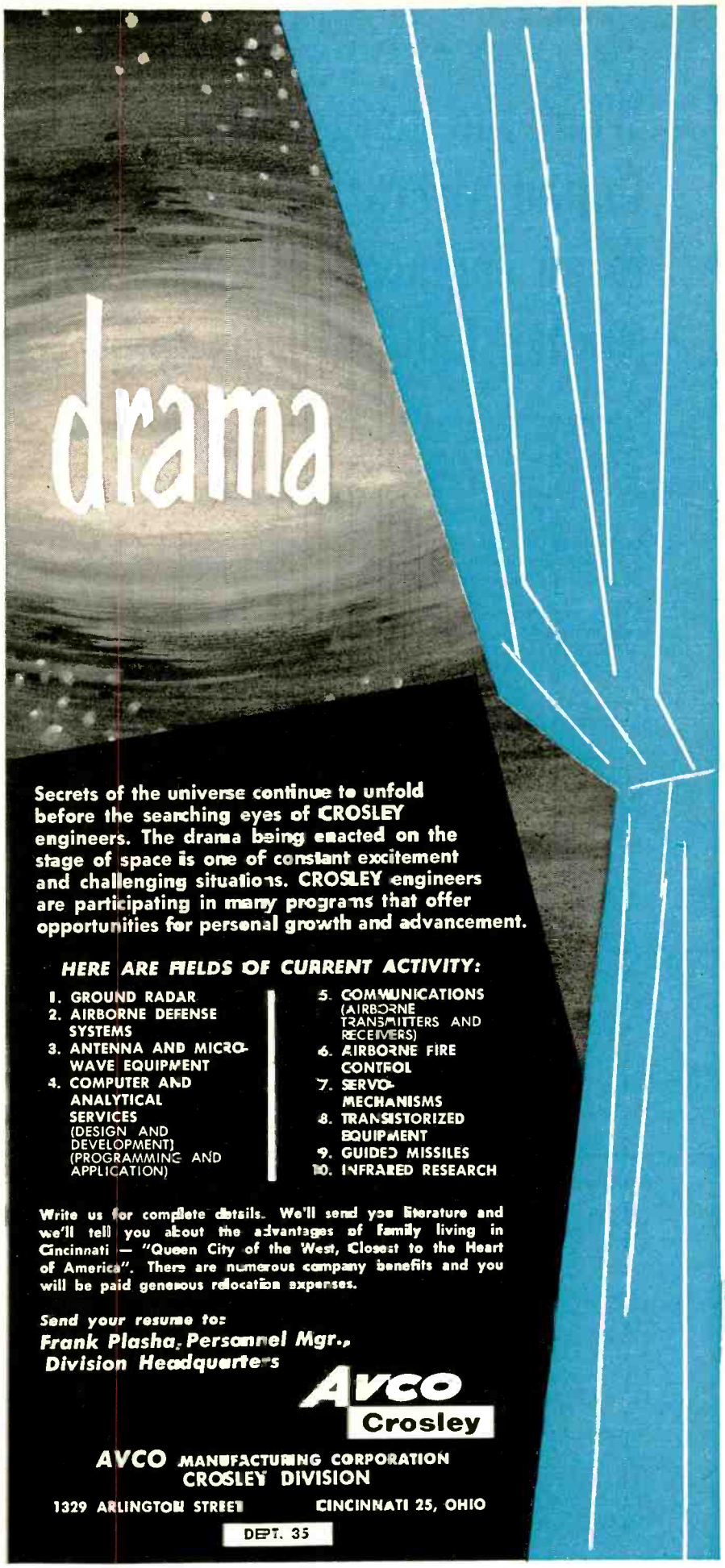

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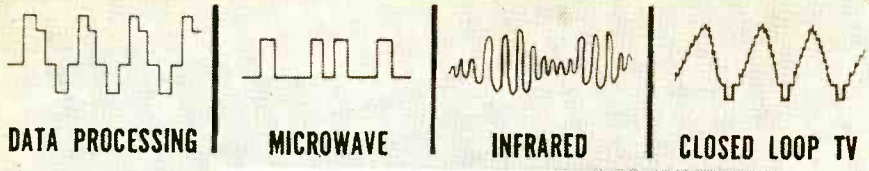

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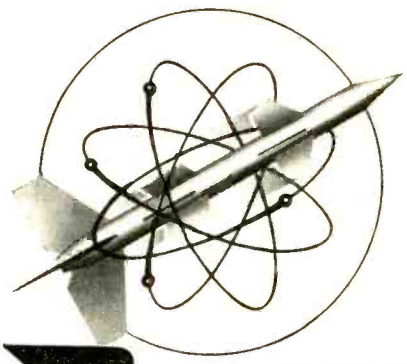

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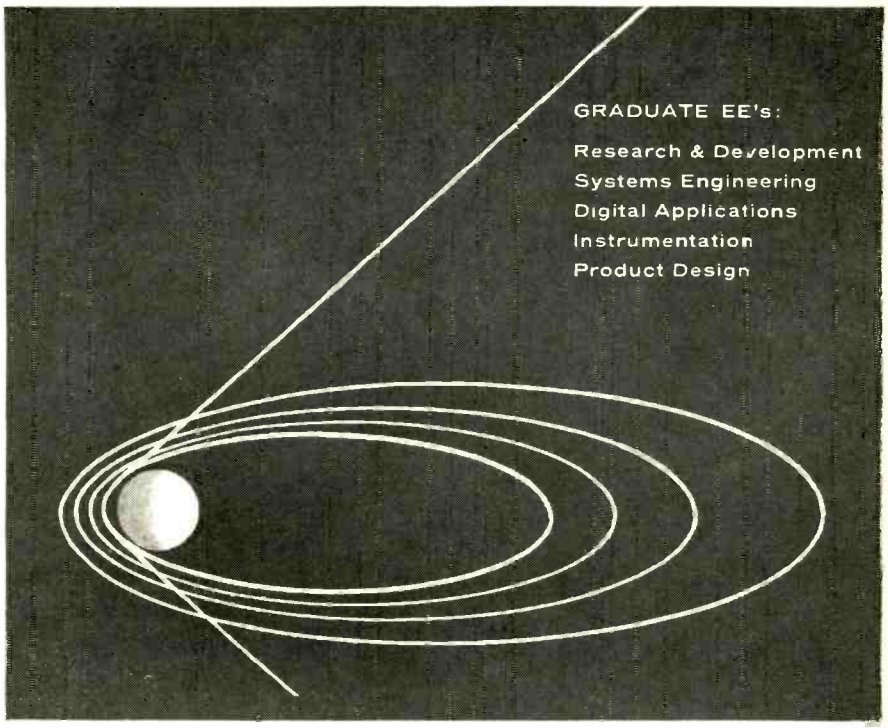

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Sonar: MS in Physics or engineering, background of applied math, classical physics and acoustics. To do research in both air and water-borne sound.

Infra-red: MS in Physics with background in applied math, classical physics, optics and electromagnetic radiation.

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- Infra-Red
- Detection
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- Antennas
- Radar
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- Radomes
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			500	.050	
DA-3A	28	10	300	.260	3.50
			150	.010	
			14.5	5.	
PE 73	28	19	1000	.350	10.50
BD 69	14	2.8	220	.08	8.95
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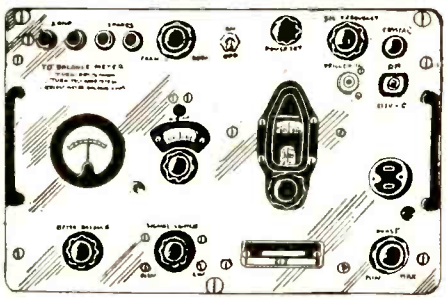

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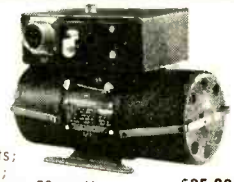

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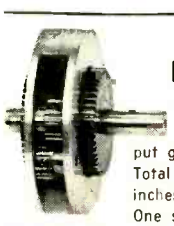
Size 2 1/16" long, 1 1/16" dia. 1-1 reverse ratio. 1/4" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23.32" dia. 53 teeth. Stock No. 150 **$3.50** ea.

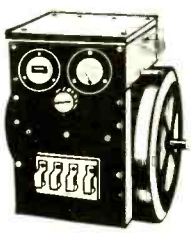
SIMPLE DIFFERENTIAL



1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is 1/4 inch. One shaft is 9/16" long; other shaft is 3/16" long. **$5.00**

Stock No. 151

400 CYCLE, 3 PHASE GENERATOR
BY MASTER ELECTRIC



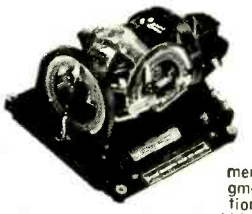
Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95. Star connected 120/208 3 phase 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".

Price **$395.00** each

SELSYNS-SYNCHROS

1CT cont. Trans 90/55V 60 cy.	$34.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	37.50
1HDG	37.50
1HCT	37.50
1HG	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7 50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
50DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	37.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
60G Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78410 Repeater 115V 60 cy.	20.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00

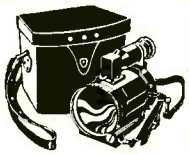
HONEYWELL VERTICAL GYRO MODEL JG7003A-1



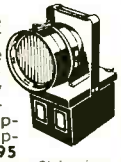
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll Potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to 1/2°. Weight 5.5 lbs.

Price **$35.00** each

HIGH-QUALITY OPTICAL PARTS



5" Schmidt Ultra Hi-Speed Objective Lens System



Eastman Kodak infra-red receiver, formerly known as U.S. Navy Metascope, Type B, 7" long with 5" SCHMIDT ultra-high speed Objective Lens (approx. f 0.5). Elaborate optical system, many coated lenses. Uses 2 penlight batteries. Govt. cost approx. $300. Factory-new. Shipping wt. 9 lbs. Price **$19.95**

Waterproof Carrying Case, extra. Shipping wt. 3 lbs. Price **$3.00**

Dual purpose U.S.N. floodlight throws strong beam of invisible infra-red rays. With infra-red lens, spare sealed beam lamp, batteries. Shipping wt. 23 lbs. Price **$14.95**

MICROFLEX RESET TIMER TYPE HXS141

A synchronous motor-driven device which trips its contacts closed or open after an adjustable time interval. Starting and resetting electrically controlled. Contacts: 15 amps., 12 volt D.C. Max. Cycles: 60 sec., Min: 0.1 sec.

Clutch Coil: 12 VDC—Motor: 110V, 60 cy. Mfg. Eagle Signal Corp. Price **$15.00** each

GENERAL ELECTRIC AUTO PILOT DIRECTIONAL GYRO INDICATOR and CONTROL UNIT

Mod. 8K63AC. 115 volts, 400 cps, 3 phase, 40 watts. Has settable induction pick-off.

Price **$10.00**

VARIABLE SPEED BALL DISC INTEGRATORS

No. 145

Forward & Reverse 2 1/4-0-2 1/4. Input shaft spline gear 12 teeth 9/32" dia. 3/8" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x 3/8" long. Cast aluminum construction. Approx. size 3" x 3" x 2 3/4".

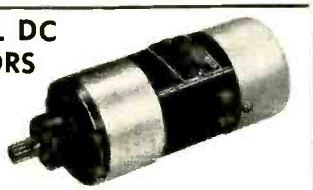
No. 146

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x 3/4" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4 1/2" x 4 1/2" x 4".

$17.50 ea.

(All Shafts Ball Bearing Supported)

SMALL DC MOTORS



(approx. size overall 3 3/4" x 1 1/4" dia.:)

5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
58A10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 rpm reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1 5/8" x 3 1/2"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-25 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1 1/4" in dia., 2" long overall	4.00

-CAPACITORS-

32 mfd.—600 V. . . . $2.98
4 individual 8 mfd sections. Dim. 4¾x3¾x3¼. Top Quality Brand.

16 mfd.—600 V. . . . $1.89
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

Case of 84. . . . . Each $1.49

Mfd	Volts	Price
.001	50KV	24.95
.005	25KV	21.95
.01	1500	.55
.012	25KV	10.95
.015	16KV	12.95
.02	8000	4.50
.02	10KV	5.25
.02	20KV	8.25
.025	15KV	7.25
.025	50KV	32.95
.03	7500	4.25
.04	17KV	6.50
.05	2500	.65
.05	7500	4.50
.05	16KV	7.95
.05-.05	12KV	8.95
.05-.05	40KV	60.00
.1	1500	.25
.1	2000	.65
.1	2500	.69
.1	3000	.50
.1	3000	1.19
.1	4000	1.29
.1	5000	1.30
.1	5000	3.25
.1	7500	.89
.1	7500	3.95
.1	12KV	6.95
.1	15KV	8.95
.1	20KV	9.95
.1	25KV	24.95
.125	27.5	21.95
.125	100KV	PUR
.1-.1	7000	1.35
.2	10KV	8.50
.2	13KV	9.50
.2	15KV	10.75
.2	50KV	69.50
.25	2000	.89
.25	3000	1.25
.25	4000	1.75
.25	6000	.89
.25	15KV	15.95
.25	20KV	19.95
.25	25KV	49.50
.25	50KV	69.50
.3	2000	.25
.4	10KV	10.95
.4-.4	7500	3.75
.5	440VAC	.49
.5	600	.45
.5	1500	.59
.5	2000	1.19
.5	2500	1.21
.5	3000	1.25
.5	4000	3.25
.5	5000	3.05
.5	7500	4.95
.5	25KV	38.50
.5-.5	9000	5.95
.5-.1	2000	.32
1-115	VAC	
1	600	.44
1	1000	.69
1	1500	.99
1	2000	1.55
1	3000	2.55
1	3600	2.75
1	4000	4.95
1	5000	6.25
1	6000	8.95
1	7500	7.50
1	7500	14.75
1	10KV	22.95
1	12.5KV	32.95
1	15KV	38.50
1	16KV	37.50
1	20KV	49.95
1	25KV	59.50
1	25KV	69.50
1.25	330VAC	.49
1.5	15KV	45.00
1.5	25KV	PUR
2	600	.55
2	1000	.79
2	1000TLA	1.29
2	1500	1.15
2	2000	2.75
2	2500	3.25
2	3000	4.95
2	4000	7.75
2	5000	11.50
2	6000	21.95
2	7500	23.50
2	10KV	55.00
2	12.5	53.50
3	1000	.98
3	2000	1.95
3	4000	8.50
3	8000	30.50
4	500	.65
4	600	.75
4	600TLA	.89
4	330VAC	1.25
4	1000	1.10
4	1000	1.60
4	1500	2.65
4	2000	3.75
4	3000	4.95
4	3000	6.99
4	4000	18.50
4	5000	19.95
4	7500	59.50
4	10KV	74.50
4	15KV	PUR
5	220VAC	.98
5	330VAC	1.19
5	600	.95
5	1000	1.69
5-5	400	.89
6	330VAC	1.29
6	600	1.29
6	1000	1.95
6	1500	2.95
7	600	1.15
7	800	1.25
8	330VAC	1.50
8	600	1.29
8	660VAC	2.40
8	1000	2.15
8	1500	3.65
8	2000	6.95
8-8	600	1.89
3x8	600	2.25
4x8	600	2.98
9	10KV	PUR
10	400	.65
10	600	1.10
10	600	1.49
10	1000	3.45
10	1400	2.25
10	1500	4.35
10	2000	6.50
10	2500	10.95
10	2500*	6.25
10	4000	20.95
10	5000	PUR
10	6000	52.50
12	660VAC	4.25
12	1000	2.95
12	2000	7.75
13.5	4000	21.25
14	660VAC	4.25
15	440VAC	3.25
15	600	2.95
15	1000	4.10
15	1500	6.35
15	5000	PUR
20	330VAC	3.25
20	4000V	35.25
25	600	4.25
25	2500*	10.95
28	1000	5.50
30	2500	13.50
32	600	2.98
32	9500*	51.50
40	600	5.85
50	100	4.10
50	330VAC	6.50
60	1000	39.50
100	4000	49.50
120	3000	49.25

* Photo Flash

TRANS. MICA CONDENSERS

Mfd	Wvdc	Price
.00001	600	.20
.000024	2500	.35
.000025	1200	.29
.00003	600	.24
.00003	1200	.28
.00003	2000	1.25
.00003	2500	.35
.000047	2500	.30
.00005	600	.23
.00005	1200	.29
.00005	2500	.33
.00005	3000	1.25
.000051	5000	1.75
.00007	2500	.26
.000075	5000	1.45
.0001	600	.24
.0001	1200	.27
.0001	2500	.36
.0001	5000	1.95
.00015	600	.23
.00015	2500	.33
.00015	5000	1.95
.0002	600	.23
.0002	1200	.29
.0002	2500	.34
.0002	5000	1.95
.00025	600	
.00025	1200	.19
.00025	2500	.35
.00025	5000	1.95
.00027	1200	.27
.00027	2500	.36
.0003	600	.23
.0003	2500	.36
.0004	600	.23
.0004	1200	.29
.0004	2500	.29
.0004	5000	1.95
.00047	2500	.40
.0005	600	.23
.0005	1200	.29
.0005	2500	.39
.005	3000	1.25
.0005	5000	2.45
.005	7500	2.95
.0062	3000	1.25
.00068	2500	.28
.00089	1200	.28
.001	600	.23
.001	1200	.32
.001	2500	.49
.001	4500	1.65
.001	5000	2.25
.001	8000	3.98
.0015	600	.23
.0015	2500	.53
.0015	5000	2.25
.002	600	.27
.002	1200	.39
.002	2500	.63
.002	5000	2.25
.002	6000	2.40
.0024	5000	2.25
.0025	600	.28
.0025	1200	.43
.0025	2500	.65
.003	600	.31
.003	1200	.52
.003	2500	.73
.003	3000	1.65
.003	5000	2.25
.004	600	.29
.004	1200	.49
.004	2500	.91
.005	600	.35
.005	1200	.45
.005	2500	.98
.005	3000	1.65
.006	600	.36
.006	1200	.55
.006	3500	1.65
.0062	2500	.94
.0075	3000	1.75
.008	600	.35
.008	1200	.57
.01	600	.48
.01	1000	.50
.01	1200	.69
.01	1250	.69
.01	2500	.94
.01	800	6.95
.012	1200	.64
.014	600	.45
.014	1200	.64
.015	600	.55
.015	2000	1.75
.02	600	.21
.02	1200	.99
.025	600V	.55
.02	2000	.98
.024	2500	1.10
.03	2000	1.50
.03	600	.65
.03	1200	1.18
.03	2000	1.50
.039	600	.67
.25	250	1.95
.05	1500	1.95
.4	600	3.25
2x.1	250	1.98
.115	2000	4.65

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VJ-12" Upright
VK-12" Upright
VL-12" Upright R.H.I. IND.

All indicators are 110v 60 cyc.

AN/APR-4 38-4000 MC RECEIVER

This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30 mc I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR

SCR-536 HANDI-TALKIE

3-6 MC Hand Held Trans-Rec. with range of approx. 1 mile. This set is comp. self contained. Inc. Batteries. We can supply these sets in large quantities tested.

EE-94-95
CODE PRACTICE EQUIPMENT

This is 20 and 40 man code practice set. This equipment is a complete setup for a school to teach Morse Code up to 400 WPM. The set consists of a recorder, turntable, switchboard. TG-34 keyers, code keys, headsets, clock, timer, wire record set, oscillator, etc. We can supply this set from a current production contract. Write.

SCR-291A DIRECTION FINDER

Automatic ground direction finder covering 1.5mc-30 mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

AN/PRC-6
47-55 MC HANDI-TALKIE

This is the Standard MIL. F.M. Handi-Talkie With a Range of About 1 Mile. The Set Operates From Batteries With an Output of .25 Watts, the Set is Self Contained With Its Own Antenna. Weight is Approx. 6 lbs. The Set is Crystal Controlled and Will operate with PRC, SCR 508, 608 SCR-300 Etc. Quantities Avail.

SCR-682 A RADAR

10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225KW.

AN/GSQ-1 NAVY TYPE PF
SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambld. Complete equipment available. 24 VDC input. Spare parts avail.

SCR-399 GRC-26

Semiportable high power radio set. Freq. 2-18 MC. Power out 350 watts. GRC-26 uses teletype operation. Complete sets ready to ship immed. Power plant PE-95 also in stock.

AN/TRC-1-3-4
100 MC RADIO-RELAY EQUIPMENT

The AN-TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10 50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cyc.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector heads, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline angus recorder disturbance in the earth's magnetic field. An indicator is provided that gives a bearing on a magnetic disturance. Input is 28v DC. Weight about 130 lbs.

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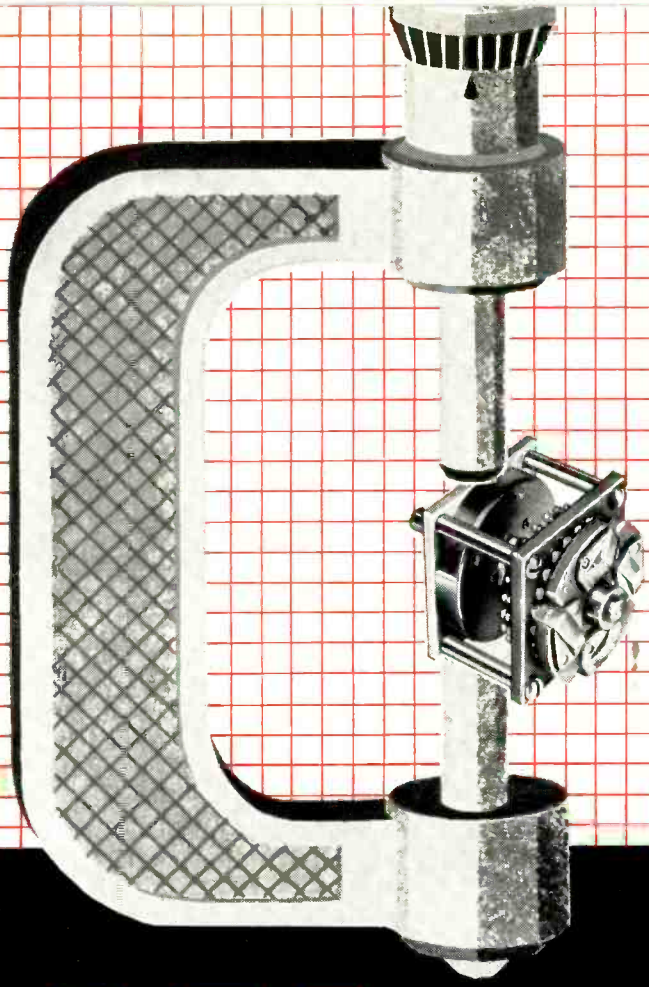
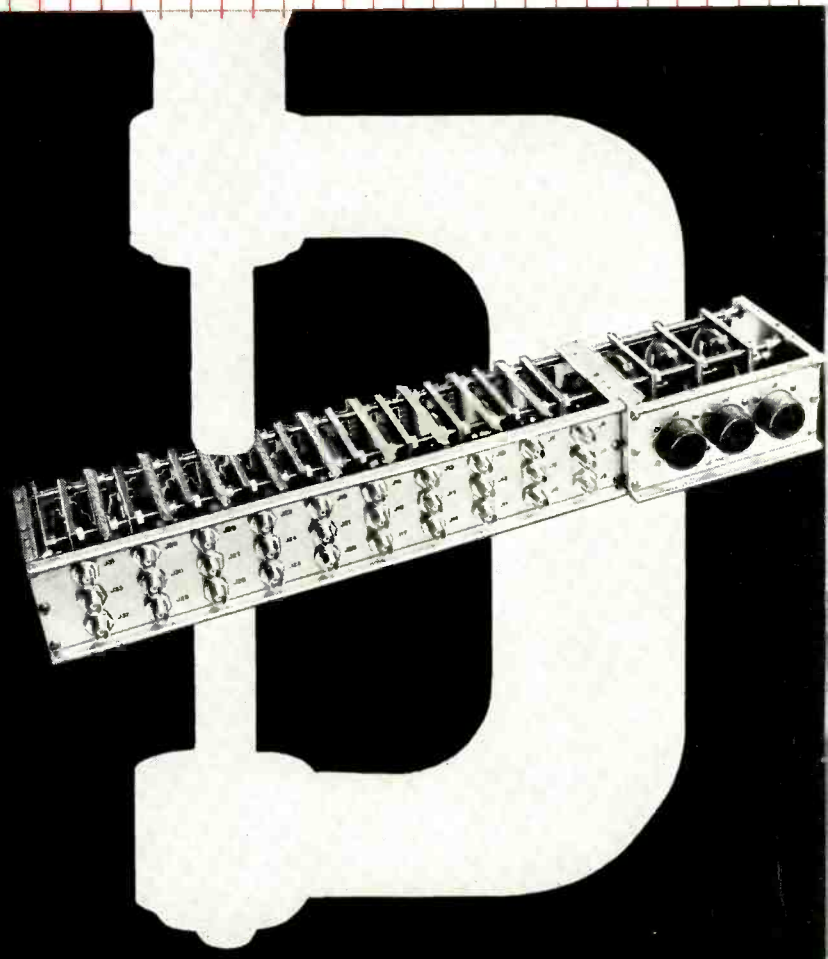


Everyone knows DAVEN makes switches like these...



We also make unusual switches like these...

"You name it . . . DAVEN either makes it, or can make it." This has been proven time and time again . . . and in the process DAVEN has produced some of the most complex switches and switching devices ever made. Switches with any number of positions—any number of poles—available in almost any type of material: ceramic, phenolic, glass base epoxy (GSG), melamine, mica . . . available as hand-operated units—or low or high speed switches. Life in the millions of operations when necessary.

DAVEN also produces switch assemblies—solenoid operated—and completely wired or cabled with components assembled to the unit where required. And, only DAVEN has the patented, Tamper-Proof Knee Action Rotor.

Aside from these distinctive and unusual units, DAVEN has over 3000 standard switches which are shown in the DAVEN Switch Catalog.

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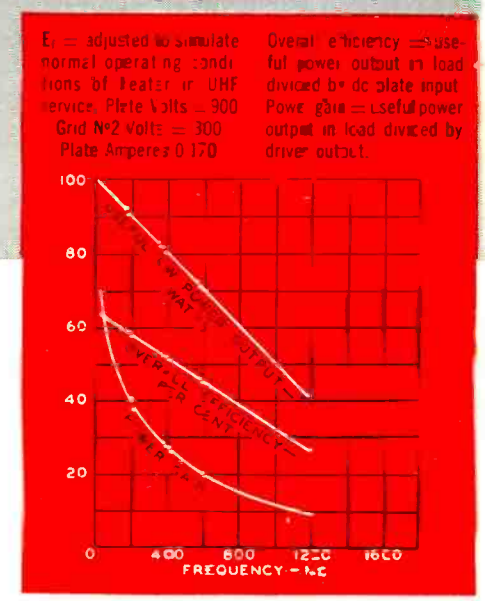
THE DAVEN CO.

LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN Ⓓ STANDS FOR DEPENDABILITY!

RCA-6884 is shown actual size



Typical Performance Characteristics of RCA-6884 & -6816 in Class C Telegraphy or Class C FM Telephony Amplifier Service.

This is a "look in" at the Collins 17L-7—the new airborne VHF transmitter that delivers 25 watts of power throughout the frequency range of 118 to 151.95 Mc. Note the compact arrangement of the power amplifier. See how the RCA-6884 Ceramic-Metal Beam Power Tube lends itself to efficient and compact circuit layout.

Here are major features we think you ought to know about this beam power tube design: First, it can deliver up to 40 watts of power at 1200 Mc—at a dc plate voltage of only 900 volts and a driver-stage output of 5 watts (see curves for higher power output at the lower frequencies); Second, it takes less than 3 cubic inches of space; Third, it utilizes a 26.5 volt, 0.52-ampere heater; Fourth, it features low-inductance rf electrode terminals insulated from each other by low-loss, high-strength ceramic bushings—a vital factor in any compact VHF and UHF equipment design.

Your RCA Field Representative will be glad to discuss application of the RCA-6884 and its counterpart—the RCA-6816 with 6.3 volt, 2.1-ampere heater—to your transmitter designs. For a technical bulletin on these types, write RCA Commercial Engineering, Section 1-19-Q2, Harrison, N. J.

RCA DISTRICT OFFICES

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TYPICAL CCS OPERATION OF RCA-6884 AND -6816
RF Power Amplifier, Oscillator—Class C Telegraphy
and
RF Power Amplifier—Class C FM Telegraphy

	at 400 Mc		at 1200 Mc
DC Plate Voltage	400	900	900 volts
DC Grid-No. 2 Voltage	200	300	300 volts
DC Grid-No. 1 Voltage	—35	—30	—22 volts
DC Plate Current	150	170	170 ma.
DC Grid-No. 2 Current	5	1	1 ma.
DC Grid-No. 1 Current	3	10	4 ma.
Driver Power Output*	3	3	5 watts
Useful Power Output*	23	80	40 watts

*approximate

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. Y.*