

High Accuracy Servo System . . . p 24

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SEPTEMBER 1, 1957

FREED

offers for Immediate Delivery

MAGNETIC AMPLIFIERS AND SATURABLE TRANSFORMERS

**FAST RESPONSE
MAGNETIC AMPLIFIERS**
2 \sim response Phase reversible

Cat. No.	Supply Freq. in C.P.S.	Power Out. Watts	Volt. Out. V. AC	AC or DC signal voltage req'd for full output.
MAF-1	60	13	110	1.0
MAF-6	400	5	57.5	1.2
	400	10	57.5	1.6
MAF-7	400	15	57.5	2.5

SINGLE ENDED MAGNETIC AMPLIFIERS

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Sig. req'd for full outp. MA-DC	Total res. Contr. wdg. K Ω	Lead res. ohms
MAO-1	60	4.5	3.0	1.2	3800
MAO-2	60	20	1.8	1.3	700
MAO-4	60	400	9.0	10.0	25
MAO-5	60	575	6.0	10.0	25

PUSH-PULL MAGNETIC AMPLIFIERS

Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. K Ω
MAP-1	60	5	—	1.2	1.2
MAP-2	60	15	115	1.6	2.4
MAP-3	60	50	115	2.0	0.5
MAP-1-A	60	50	115	7.0	2.9
MAP-4	60	175	115	8.0	6.0
MAP-7	400	15	115	0.6	2.8
MAP-8	400	50	110	1.75	0.6

SATURABLE TRANSFORMERS

Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. K Ω
MAS-1	60	15	115	6.0	27
MAS-2	400	6	115	4.0	10
MAS-5	400	2.7	26	4.0	3.2
MAS-6	400	30	115	4.0	8.0
MAS-7	400	40	115	5.5	8.0

All units designed for 115V-AC operation

VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620



The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, condensers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor. Resistance — 0.1 megohms to 4,000,000 megohms.

Voltage — variable, 50-1000 volts.
Accurate — plus or minus 5% on all ranges.
Simple — for use by unskilled operators.
Safe — high voltage relay controlled.
Self contained — AC operated.

OTHER MEGOHMMETERS AVAILABLE

Type 1620C Megohmmeter — a type 1620 with additional circuitry for testing capacitors.
Type 1020B Megohmmeter — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
Type 2030 Portable Megohmmeter — battery operated, 500 volt test potential. Range 1 megohm to 10 million megohms

FOR PRECISION LABORATORY OR PRODUCTION TESTING



1110-AB INCREMENTAL INDUCTANCE BRIDGE AND ACCESSORIES

Accurate inductance measurement with or without superimposed D.C., for all types of iron core components.

Inductance: 1 Millihenry to 1000 Henry
Frequency: 20 to 10,000 Cycles
Accuracy: 1% to 1000 Cycle, 2% to 10KC
Conductance: 1 Micromho to 1 MHO
"Q": 0.5 to 100
Superimposed D.C.: Up to 1 Ampere
Direct Reading: For use by unskilled operators.

ACCESSORIES AVAILABLE:

1140-A Null Detector
1210-A Null Detector — V.T.V.M.
1170 D.C. Supply and 1180 A.C. Supply

MIL-T-27A POWER, FILAMENT, PULSE & AUDIO TRANSFORMERS

POWER TRANSFORMERS-STANDARD

All primaries 105/115/125 v, 60 c.p.s.

Cat. No.	Hi Volt Sec.	et	DC Volts	DC Amps	Filament #1		Filament #2		MIL Case Size
					Volt	Amp.	Volt	Amp.	
MGP1	400/200	✓	185	.070	6.3/5	2	6.3	3	HA
MGP2	650	✓	260	.070	6.3/5	2	6.3	4	JB
MGP3	650	✓	245	.150	6.3	5	5.0	3	KB
MGP4	800	✓	318	.175	5.0	3	6.3	8	LB
MGP5	900	✓	345	.250	5.0	3	6.3	8	MB
MGP6	700	✓	255	.250					KB
MGP7	1100	✓	419	.250					LB
MGP8	1600	✓	640	.250					NB

FILAMENT TRANSFORMERS-STANDARD

All primaries 105/115/125 v., 60 c.p.s.

Cat. No.	Secondary		Test VRMS	MIL Case
	Volt	Amp		
MGF1	2.5	3.0	2,500	EB
MGF2	2.5	10.0	2,500	GB
MGF3	5.0	3.0	2,500	FB
MGF4	5.0	10.0	2,500	HB
MGF5	6.3	2.0	2,500	FB
MGF6	6.3	5.0	2,500	GB
MGF7	6.3	10.0	2,500	JB
MGF8	6.3	20.0	2,500	KB
MGF9	2.5	10.0	10,000	JB
MGF10	5.0	10.0	10,000	KB

PULSE TRANSFORMERS

Cat. No.	Block. Dic.	Int. Coupl'g	Low. Per. Out.	Pulse Voltage Kilovolts		Pulse Rise in Microseconds	Duty Ratio	No. of Wdg.	Test Volt. KV RMS	Char. Imp. Ohms
				0.25/0.25	0.25					
MPT1	✓	✓	✓	0.25/0.25	0.25	0.2-1.0	.004	3	0.7	250
MPT2	✓	✓	✓	0.25/0.25	0.25	0.2-1.0	.004	2	0.7	250
MPT3	✓	✓	✓	0.5/0.5/0.5	0.5	0.2-1.5	.002	3	1.0	250
MPT4	✓	✓	✓	0.5/0.5	0.5	0.2-1.5	.002	2	1.0	250
MPT5	✓	✓	✓	0.5/0.5/0.5	0.5	0.5-2.0	.002	3	1.0	500
MPT6	✓	✓	✓	0.5/0.5	0.5	0.5-2.0	.002	2	1.0	500
MPT7	✓	✓	✓	0.7/0.7/0.7	0.7	0.5-1.8	.002	3	1.5	200
MPT8	✓	✓	✓	0.7/0.7	0.7	0.5-1.5	.002	2	1.5	200
MPT9	✓	✓	✓	1.0/1.0/1.0	1.0	0.7-3.5	.002	3	2.0	200
MPT10	✓	✓	✓	1.0/1.0	1.0	0.7-3.5	.002	2	2.0	200
MPT11	✓	✓	✓	1.0/1.0/1.0	1.0	1.0-5.0	.002	3	2.0	500
MPT12	✓	✓	✓	0.15/0.15/0.3/0.3	0.3	0.2-1.0	.004	4	0.7	700

AUDIO TRANSFORMERS

Catalog No.	Application	Impedance				DC Current			
		Prim. Ohms	Et	Sec. Ohms	Et	Prim. P. Size MA	Max. Imp. MA	Max. Level DBM	
MGA1	Single or P.P. Plates to Single or P.P. Grids	15K	✓	90K Split	✓	10	10	+15	
MGA2	Line to Voice Coil	600 Split	✓	4, 8, 16	✓	0	0	+33	
MGA3	Line to Single or P.P. Grids	400 Split	✓	135K	✓	0	0	+15	
MGA4	Line to Line	400 Split	✓	600 Split	✓	0	0	+15	
MGA5	Single Plate to Line	7.6K 4.8T	✓	600 Split	✓	40	40	+33	
MGA6	Single Plate to Voice Coil	7.0K 4.8T	✓	4, 8, 16	✓	40	40	+33	
MGA7	Single or P.P. Plates to Line	15K	✓	600 Split	✓	10	10	+33	
MGA8	P.P. Plates to Line	24K	✓	600 Split	✓	10	1	+30	
MGA9	P.P. Plates to Line	60K	✓	600 Split	✓	10	1	+27	

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ELECTRONIC DESIGN

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EPA

NBP

Potter Model 905 Digital Magnetic Tape Handler

*(75 inches per
second with 3 msec
starts and stops)*



Meets all requirements for speed and convenience in processing large quantities of digital data

The Potter Model 905 is the result of the most extensive study of data-processing requirements. It combines high speed with complete reliability and easy accessibility to all wiring and parts. The Potter machined bronze head with precisely aligned gaps provides dimensional stability and minimizes digital drop-outs caused by oxide pickup.

Tape widths:

A - ¼" (2 or 3 channels)
B - ½" (6 or 7 channels)
C - ¾" (up to 8 channels)
D - 1" (up to 10 channels)
E - 1½" (up to 13 channels)
F - 2" (up to 15 channels)

Speed combinations:

J - 30 and 7.5 inches per second
K - 60 and 15 inches per second
L - 75 and 18.75 inches per second
X - Special (speeds up to 75 inches per second in ratios of 2 to 1, 3 to 1 and 6 to 1 are available on special order. Other speed combinations can be accommodated.)

Start time: 3 milliseconds
Stop time: 3 milliseconds
Reel sizes: 8" or 10½" standard NAB reels. Adaptors for other types can be provided.

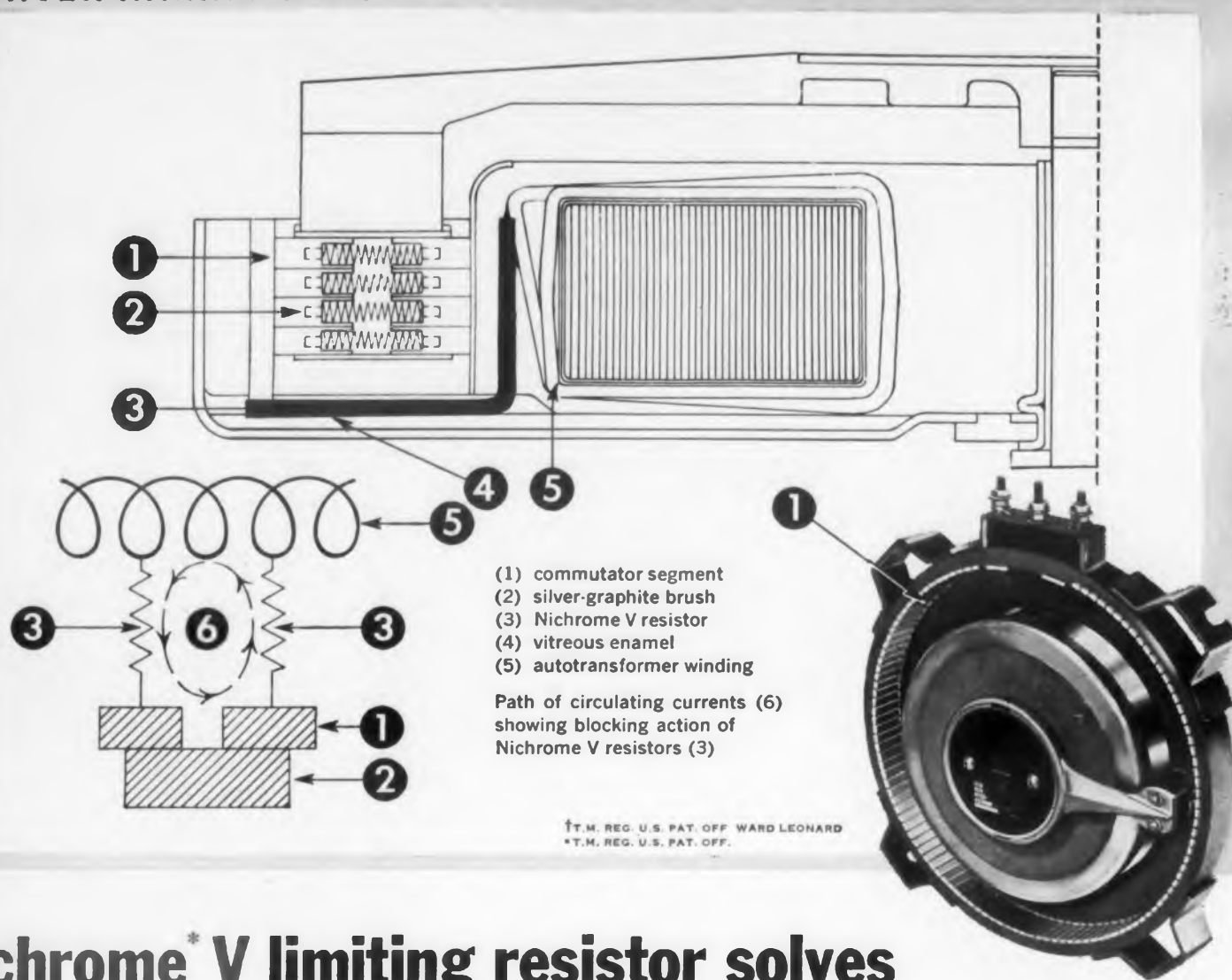
Control: Front panel pushbuttons or remote control contact closure and pulses.

Weight: 100 pounds
Dimensions: Panel, width . . . 19"; height . . . 24½"
Depth behind panel . . . 13½"
Depth in front of panel . . . 3½"

Power Requirements: 110 to 120 volts, 60 cps, 400 watts.

For more information, write, wire or phone your Potter representative or the factory.

Potter **POTTER INSTRUMENT COMPANY, INC.**
115 Cutter Mill Road
Great Neck, L. I. N. Y.



Nichrome^{*} V limiting resistor solves age old brush problem in Ward Leonard Dimmers

This Ward Leonard 6.6 KW Radiastat[†] Dimmer is essentially a specially designed core type autotransformer whose output voltage is linear, furnishing smooth, stepless control from maximum to zero. Other notable features are: Highest rating in smallest size and longer, maintenance-free life.

Nearly all adjustable autotransformers depend upon carbon brushes to limit the short-circuiting current which occurs whenever the brush straddles two segments. However, in the Radiastat Dimmer, circulating currents are kept to a minimum in a unique way, permitting use of self-cleaning, self-lubricating, low resistance silver-graphite brushes.

In the Radiastat, each segment is electrically connected to its respective turn of the winding through a Nichrome V current limiting resistor. During commutation, the main winding is protected against burnout from high short-circuiting currents, thereby eliminating external resistors or high resistance brushes.

These all important resistors (one for each segment) connect to the segments beneath the vitreous enamel and run out and up to connect with the winding. They protect every step of the Radiastat, regardless of the contact arm position—drop a penny or a nail across adjacent segments—there's no puff! no burnout! The Nichrome V circulating current resistors completely safeguard the unit.

Nichrome V is used because it supplies a specified ohmage in a #10 wire $3\frac{3}{16}$ " long; bonds well with the vitreous enamel; is highly resistant to heat and corrosion, and easily withstands severe current surges.

Driver-Harris now produces 132 different high nickel alloys in many different forms and in hundreds of sizes for almost every kind of industrial application. Do you need help with a special alloy? Tell us about it and if we haven't got it, we'll develop it for you.

Editorial

The Revolutionary Product We Didn't Feature

When the military clamps a lid on performance ratings we're at an impasse in presenting a technical article on a product. That's why we've run no feature on inertial guidance accelerometers, gyroscopes, or stable platforms in *Electronic Design*.

We're a little remorseful that we haven't had a story on these devices. The production of inertial guidance components, particularly those for long range navigation, is one of today's foremost examples of the genius of American industry. The principles of inertial navigation are simple—a design that is manufacturable is the rub. Fabricating tolerance units on a production basis which are the navigational counterparts of the celestial stars is a milestone for American industry. Only a few companies have accomplished the feat, but it has been done. Here are some of the accomplishments.

To keep the drift rate of a gyro for airborne use not exceeding one minute of arc per hour (one nautical mile per hour), the torque acting on the revolving mass would have to be less than 0.08 dyne-cm. This torque is equivalent to the gravity moment exerted by the weight of the paper *within* this letter (o) cut out and stuck on the gyroscope gimbal at a half-inch radius from the gimbal axis, according to an example provided by J. M. Slater of Autonetics. For an air transport to be guided to within 15 miles of its destination after a five-hour, 3000 nautical mile great circle flight, gyro drift rate can be about 0.6 minutes of arc per hour. Autonetics' C. F. O'Donnell points out that this is but one complete rotation in about four years. Exact military demands are not known, but the above examples give an idea of specifications being met.

Sperry Gyroscope, as we have reported before, does ultraprecision machining to 25 millionths of an inch. Test devices for evaluating precision-machined products measure reaction torques of less than 0.05 dyne-cm. Some of these measurements are made on 3-ton instruments mounted on seismic blocks below the ground. The weight of a gnat is supposed to spin the dial beyond its working scale. There is little possibility of gnats being present, though, as most air is filtered to remove all particles larger than 12 one-millionths of an inch.

New levels of ultraprecision machining, dimensional stability, quality control, cleanliness, and manpower skill have been reached in the manufacture of inertial guidance components. To quote J. M. Slater, "[This] . . . is a tribute to the foresight of the national defense authorities for initiating, subsidizing, and maintaining the requisite intensive development programs. It is also a tribute to the scientific, engineering, and manual skills of the personnel involved in such programs." Such statements have been often made. None other has probably been more sincere or more right.—JAL.



Driver-Harris Company

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CIRCLE 3 ON READER-SERVICE CARD FOR MORE INFORMATION

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.



Lightweight Traveling-Wave Tube: Reduction in weight and a substantial increase in operating reliability are the result of a new design in traveling-wave tubes developed by Radio Corp. of America. The experimental tube eliminates the need for external electromagnetic focusing equipment amounting to considerable weight in tubes of high-gain, high-sensitivity design. Vibration, and other variations in environment cannot affect the alignment of the focusing field in the experimental tube. As described, the tube substitutes a compact electrostatic focusing element that is built into the tube and is automatically given a permanent proper alignment during assembly.

The result of the design is a plug-in tube which requires no critical alignment during installation, and which operates under severe conditions without requiring realignment. The tube weighs less than a pound, complete with focusing element, which consists of two pairs of helices, or spiral bifilar windings. Only the larger outer pair carries the signal waves, while the inner pair is used with the outer pair for beam focusing.

Ford Gives Missiles a Free Lift

A floating platform for launching missiles is one solution proposed for eliminating the first fuel-consuming miles of a missile's flight. Within the next few months Aeronautics Systems, Inc., Ford Motor Company's West Coast subsidiary, will launch a rocket vehicle which, it is hoped, will travel several thousand miles above the surface of the earth. Designated Operation Far Side, the program is sponsored by the Air Research and Development Command. The initial phase of the Far Side project represents the first step in a research program aimed at obtaining information regarding the environment at great distances from the earth. Present planning calls for further experiments at even higher altitudes, and it is expected that future weapons systems will benefit from the project.

The first Far Side balloon flight experiment was conducted a few months ago at the General Mills Flight Test Center near New Brighton, Minn. During the test a helium-filled balloon designed and produced by General Mills carried 2300 lb to a height in excess of 104,000 ft. The balloon, which measured over 200 ft in diam, proved extremely stable during the test. The missile-launching experiment will occur at about the same altitude.

The rocket, inserted into the lower end of the balloon transport, will blast upward through the balloon on firing with an initial first stage thrust of 160,000 lb. Boosted in four stages by a combination of ten solid propellant rockets, the Far Side instrumentation will go through its maximum acceleration of 200 g during its 26 sec of powered flight. From stage four the 6 x 4 in. instrument package and the burned-out last stage rocket will continue upward into space as a free projectile.

During its ascent and descent a miniaturized radio transmitter in the instrument package will transmit measurement of cosmic rays and other data to ground receiving and recording stations. Data will be obtained from these experiments on the nature of cosmic rays, the earth's magnetic field, as well as other phenomena present at high altitudes.



The rocket will be fired from its floating platform and will shoot up through the center of the supporting balloon.

Which ceramic characteristics do you need . . .

Characteristic	Material								
	Electrical Porcelain	Steatite	Fused Quartz	Magnesia	Cordierite	Glass Bonded Mica	Raytheon R-95 High Alumina	Forsterite	Zircon
Dielectric Constant (1 mc)	6-7	5.5-6.5	3.7	5.8	4-5	7-8	9	6.5	9
Power Factor (1 mc)	.009	.0008	.00035	.0008	.008	.002	.001	.0002	.0014
Loss Factor (1 mc)	.055	.004	.0013	.004	.03	.016	.009	.0014	.013
Water Absorption (%)	0-1.0	0-.01	0	16	3-8	0.5	0.0	0-0.01	0-0.01
Tensile Strength (p.s.i. x 10 ³)	2.6	13	8	2.8	3	8	25	10	10
Flexural Strength (p.s.i. x 10 ³)	11	20	—	6	7-10	18	45	12	18.5
Compressive Strength (p.s.i. x 10 ³)	30-65	65	200	48	50-95	25	250	80	80
Dielectric Strength (volts/mil)	100-200	250	200	65	200	245	450	250	200
Hardness, Moh's scale	7.5	7.5	5	6	7	—	9	7.5	8
Modulus of Elasticity (p.s.i. x 10 ⁶)	10	14	4	—	5	—	42	—	21
Specific Gravity	2.4	2.6	2.2	3.0	2.5	—	3.7	2.8	3.7
Linear Thermal Expansion 20-100°C (in./in./°C x 10 ⁻⁶)	3.6	6	.20	9.4	2.5-4	—	6.2	8.5	2.5-5
T _E Value (°C)*	—	450°-800°	—	—	750°	—	980°	990°	700°

*T_E is that temperature at which the volume resistivity reaches 1 Meg.

Approximate characteristics of "electronic" ceramic materials. Source: manufacturer sales literature

Reprinted from Electronic Design, November 1, 1956

How Raytheon R-95 High-Alumina Ceramic can save you money—do a better job



Consider well the unusual properties present in Raytheon R-95 High-Alumina Ceramic. If your needs are for a less specialized material, you may find a satisfactory performer at lower cost.

However, when you require a material with remarkably *high resistance to high temperature, shock and vibration; high dielectric strength and high electrical resistance at all temperatures; extreme hardness; high mechanical strength and positive sealing capability*—then you will surely want to be familiar with the ratings of Raytheon's R-95. Proper application of this superior material assures continuing design and assembly economy, particularly where ceramic seals are a factor.

Ceramic parts manufactured from Raytheon R-95 High Alumina are available, either alone or as hermetic ceramic-to-metal assemblies, in accordance with your specifications. The assemblies can be soft or hard soldered into your production in your own plant.

Send sketches or drawings outlining dimensions and tolerances, together with operational conditions. We will be pleased to supply information and help on any of your ceramic needs.

Write for complete specification sheet and your copy of *Ceramics in Electronic Design*, comprehensive questions and answers on the growing role of ceramics in modern design. No cost or obligation, of course.

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Ceramic Sales

Waltham 54, Massachusetts



Excellence
in Electronics

Engineering Review

Computer Testing of Instruments

Fischer and Porter Co., Hathorn Pa., announces the recent purchase of an electronic differential analyzer from Electronic Associates, Inc. The analog computer will be used for studying dynamic control system performance and for analysis of the operating characteristics of the company's industrial instruments and instrument components under development. The unit will provide additional services for the company's customers by providing means of simulating complex processes, such as accurate prediction of transient and steady state phenomena in closed loop process control.

Enlarging Plant for Teflon Coating

The Sparta Manufacturing Co., Dover, Ohio, is enlarging their facilities for the specific purpose of increasing their capacity for coating metallic and non-metallic parts with Teflon. The new quarters will be equipped with completely air conditioned dry rooms so that humidity and temperatures can be accurately controlled. Production line techniques will be installed enabling Sparta to process parts in the quantities that are demanded. The company intends to work closely with the customer to help solve any complex problems that may arise, and it will run certain samples at a nominal fee.

VHF Radio-Telephone System

An inexpensive system which bridges telephone service over terrain where it would be physically or economically impractical to install telephone lines has been developed by Allen B. Du Mont Labs., Inc., New Jersey. Designated the MCA-474-B Three Channel Multiplex Station, the equipment utilizes broadband, point-to-point radio in the 450 mc range. Besides its use as a permanent or temporary telephone installation, operation in the uhf band makes the equipment advantageously adaptable as a broadband two-way radio system, a multi-channel radio communication unit, carrying up to 54 teletype channels, or as the transmission facility for slow-scan industrial television.

◀ CIRCLE 4 ON READER-SERVICE CARD

Automatic Selective Calling For Two-Way Radios

A unit which converts any standard two-way radio network to a fully automatic selective calling system has been developed. Christened Tonicam (Tone Initiated-Carrier Maintained), the unit eliminates co-channel annoyance in two-way radio communications without the necessity of transmitting bothersome continuous low-frequency tones. Tonicam features both a half-second tone burst to activate a receiver and automatic receiver muting at the termination of a transmission. Selective calling automatically rejects the constant stream of messages on a frequency channel shared by many systems and responds only to messages from its own system. Once the initial contact is made, only the caller and the called unit use the channel and other units within that system hear nothing.

As an illustration of Tonicam operation, a base station wishing to contact a specific mobile unit, Car A, transmits a half-second burst of the system's frequency tone, and unmutes all receivers in his network. All mobile units hear the call to Car A and the operator of Car A lifts his mike from its hangup. This automatically returns his radio to normal two-way operation. All subsequent transmissions between the base and the mobile unit are normal, using no tone burst. Only the base station and Car A use the channel; the other units within the system hear nothing. The base station operator can talk with more than one mobile unit by calling the desired units. Those who lift their mikes from the hangup position on the mobile unit are participants in a conference call. The unit was designed by Allen B. DuMont Labs., Clifton, N.J.

Correction: We hope haste doesn't make waste in this case, but haste did make mistakes in "A Voltage Gain Nomogram For Transistor Circuit Design" by Rudolph Wellsand, p. 56, July 15, 1957. In rushing this nomogram article into our "Transistor Issue" we did not catch inconsistencies in subscripts such as r_e , r_c etc. We also confused subscripts by not distinguishing correctly between e's, c's and O's.

1. Following Equation (1), that portion which reads, "Which assumes: $R_E + r_c + r_b \ll r_c$ ", should read: $R_E + r_e + r_b \ll r_c$.

2. Equation (2) should read:

$$r_e \frac{V_{CB}}{I_{c0}}$$

3. The column headings in Nomogram I which read $(1 = \alpha)$ and $r_b (1 = \alpha)$ should read: $(1 - \alpha)$ and $r_b (1 - \alpha)$ respectively.

4. Midway down on the α scale of Nomogram I, the value marked .890 is obviously .990

5. At the very bottom of the R_R scale on Nomogram II, the correct value should read 10 and not 0.

6. Number 6 of the Sample Problems should read: " $R_E > 46$ by approximately 10 times"—not 100.

now . . . **0 TO 32 VOLT,**
0 TO 25 AMPERE, *low cost,*
continuously adjustable

DC POWER SUPPLY

by **PERKIN!**

IMMEDIATE DELIVERY...\$449.00*

Thousands of electronics laboratories and aircraft firms are presently using the PERKIN Model M60V DC Power Supply as an economical and practical solution to their DC power needs where AC line stabilization and precise load regulation are not required.*



SPECIFICATIONS:

DC OUTPUT: 0-32 volts, 0-25 amps.

REGULATION: $\pm 1\%$ (a) at 28 Volts D.C.—Increases to 2% max. over the range 24-32 V.; does not exceed 2 volts regulation over the range 4-24 volts D.C.; (b) from 1/10 Full Load to Full Load; (c) at a fixed AC Input of 115 volts.

RIPPLE: 1% rms @ 32V. and Full

Load—2% rms max. @ any voltage above 4 volts.

AC INPUT: 115 Volts, Single Phase, 60 cps.

MOUNTING: Cabinet 20 $\frac{1}{4}$ " wide x 16 $\frac{1}{2}$ " deep x 13 $\frac{3}{4}$ " high or 19" rack panel (19" wide x 14 $\frac{3}{4}$ " deep x 12 $\frac{1}{4}$ " high.)

WEIGHT: 130 lbs.

*If these are required, write for specifications on Model MR 1040-30A (5-40V. @ 30 A) or 28-30 WXM (24-32 V. @ 30 A.), which are stabilized for AC line changes and regulated to $\pm \frac{1}{2}\%$.

When you require a power supply, SPECIFY PERKIN, for a wider range of standard models and immediate delivery from stock. There are over 15,000 Perkin units in operation in industry today.

†For rack panel units without meters. Wire factory collect for prices for units with cabinet and meters.

For a prompt reply on your application, write factory on your letterhead.

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PERKIN ENGINEERING CORPORATION

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Foreign: New York: BR 9-1296.

CIRCLE 5 ON READER-SERVICE CARD FOR MORE INFORMATION

OTHER
PERKIN
STANDARD

DC POWER SUPPLIES

28 Volt Models

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	15-20% (24-32V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	$\pm \frac{1}{2}\%$	100-125 V 1 phase	1%
MR532-15A	2-36V	15	$\pm \frac{1}{2}\%$	105-125V 1 phase	1%
28-15VFM	0-32 V	15	15-20% (24-32V range)	115 V 1 phase	5%
M60V	0-32V	25	$\pm 1\%$	115V 1 phase	1%
MR1040-30A	5-40V	30	$\pm 1\%$	100-130V 1 phase	1%
28-30WXM	24-32V	30	$\pm \frac{1}{2}\%$	100-125V 1 phase	1%
28-50WX	24-32 V $\pm 10\%$	50	$\pm \frac{1}{2}\%$	230 V* 3 phase	1%
MR2432-100XA	24-32V	100	$\pm \frac{1}{2}\%$	208/230V* 3 phase	1%
MR2432-200	24-32 V	200	$\pm \frac{1}{2}\%$	208/230V* 3 phase	1%
MR2432-300	24-32 V	300	$\pm \frac{1}{2}\%$	208/230V* 3 phase	1%
MR2432-500	24-32 V	500	$\pm \frac{1}{2}\%$	208/230V* 3 phase	1%

* $\pm 10\%$. Also available in 460 V $\pm 10\%$ AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 Volt Models

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6-5WX	6 $\pm 10\%$	5	$\pm 1\%$	95-130 V 1 phase	1%
6-15WX	6 $\pm 10\%$	15	$\pm 1\%$	95-130 V 1 phase	1%
6-40WX	6 $\pm 10\%$	40	$\pm 1\%$	95-130 V 1 phase	1%
12-15WX	12 $\pm 10\%$	15	$\pm 1\%$	95-130 V 1 phase	1%
115-5WX	115 $\pm 10\%$	5	$\pm \frac{1}{2}\%$	95-130 V 1 phase	1%
MR15125-5	15-125	5	$\pm 1\%$ †	95-130 V 1 phase	1%††
6125-25**	115-125	25	$\pm 1\frac{1}{2}-4\%$	230/460 V 3 phase	5%

**Germanium Rectifier Unit ††Increases to 4% @ 15V.
†Increases to 2% @ 15V.



DC Testing of AC Insulation

Despite the fact that the electrical industry is expending much effort in testing insulation on ac apparatus by dc voltage, there is no clear and scientific demonstration of the validity of the practice. These findings were announced by two General Electric Co. engineers, C. M. Foust and B. V. Bhimani, of Schenectady, N.Y.

Their conclusion on the widespread practice of direct voltage testing on cables, transformers, capacitors, switchgear and rotating machinery, followed a large number of tests on 12 different kinds of sheet insulation, using especially designed equipment, including a new type of scintillation probe for ionization detection to study the initiation, severity, location and spread of ionization. Based on observations made, several conclusions were reached.

It was noted that composite insulation life or insulation breakdown strength cannot be predicted by test data for three reasons, namely: the voltage-current data cannot be plotted in any systematic manner such that the insulation breakdown voltage can be calculated by its extrapolation; the voltage-current relation involves many variables and uncertainties not incipient to breakdown such as, uncertain correlation between conductivity current and ionization levels and wide variation in current values from one sample to another and from one test to another on the same sample; all factors such as insulation make-up, electrode configuration, temperature, humidity, etc., being the same, the patterns of stress distribution and the location, severity and extent of ionization are different under direct and alternating voltage stresses.

In addition, fissures and defects inside composite insulations cannot be detected by dc test data, nor may damage possibly suffered from the application of high direct-voltage upon insulation designed for operation under ac service be discovered, even from leakage current characteristics. Finally, the mechanism of extending ionization, similar to that existing under direct voltage stresses, is absent under alternating voltage stresses.

In a previous issue of *Electronic Design*, August 15, 1957, p. 44, the position favoring DC Overpotential Testing for electronic components was discussed by Victor Wouk of Beta Electric Div., New York, N.Y.

Educational Research

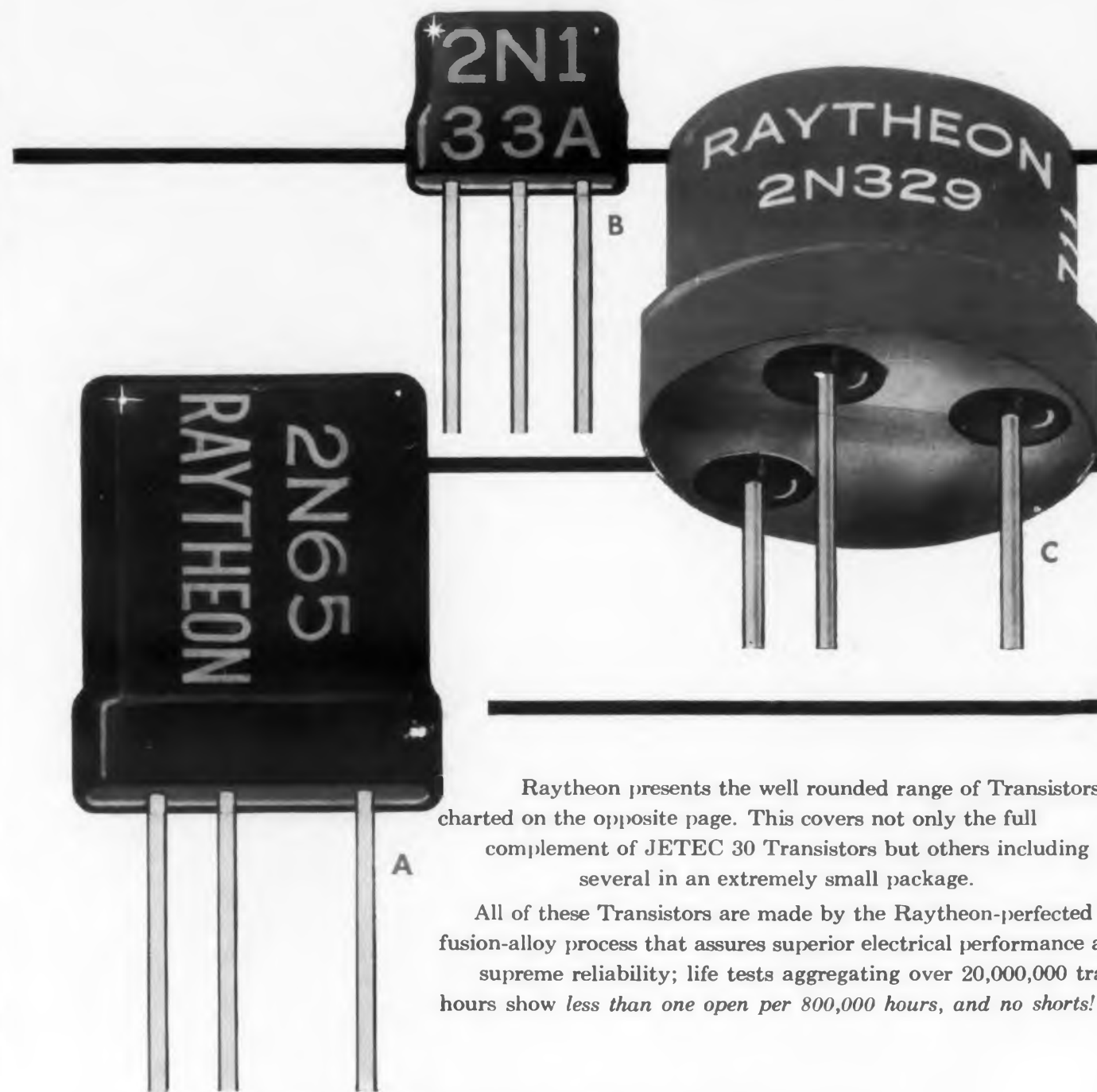
The need for research into what is taught and how it is taught was cited by Dr. Eric A. Walker, President of Pennsylvania State Univ. at the American Society for Engineering Education annual meeting at Cornell Univ. Despite brilliant records

NOW, in the **JETEC 30** package
both Silicon and Germanium, including **NEW AUDIO**



FUSION ALLOY

TRANSISTORS



Raytheon presents the well rounded range of Transistors charted on the opposite page. This covers not only the full complement of JETEC 30 Transistors but others including several in an extremely small package.

All of these Transistors are made by the Raytheon-perfected fusion-alloy process that assures superior electrical performance and supreme reliability; life tests aggregating over 20,000,000 transistor hours show *less than one open per 800,000 hours, and no shorts!*

RAYTHEON TRANSISTORS

for superior reliability . . . superior performance

CIRCLE 6 ON READER-SERVICE CARD FOR MORE INFORMATION

**RAYTHEON
AUDIO
TRANSISTORS**
Temperature Range
-65°C to +85°C

Type	Case	Supersedes	Circuit Usage	V _{ce} max. Volts	Beta	I _{co} max. μA	I _{eo} max. μA	Power Gain Class A db	Diss. Coeff. °C/mw
2N63	A	—	Amplifier	22	22	20	15	39	0.59
2N64†	A	—	Amplifier	15	45	20	15	41	0.59
2N65†	A	—	Amplifier	12	90	20	15	42	0.59
2N130A	B	2N130	Amplifier	22	22	20	15	39	0.59
2N131A	B	2N131	Amplifier	15	45	20	15	41	0.59
2N132A	B	2N132	Amplifier	12	90	20	15	44	0.59
2N133A	B	2N133	Low Noise 6db max.	6	50	20	15	40	0.59
2N362	C	—	AF Driver	22.5	90	25	20	43	0.36
2N363	C	—	AF Driver	22.5	45	25	20	40	0.36
2N422	C	2N133	Low Noise 6db max.	22.5	50	25	20	40	0.36
CK754	B	—	High Gain	10	300	5	10	42	0.59

†Available to Signal Corps specification

**RAYTHEON
AUDIO OUTPUT
TRANSISTORS**
Temperature Range
-65°C to +85°C

Type	Case	Supersedes	V _{ce} max. Volts	Beta	I _{co} max. μA	I _{eo} max. μA	Power Gain		Power Output		Diss. Coeff. °C/mw
							Class A db	Class B db	Class A mw	Class B mw	
2N138B	B	2N138A	12	90	20	15	37	26-31	20	50	0.59
2N359	C	2N138A	22.5	100	25	50*	37	33	50	500	0.36
2N360	C	2N138A	22.5	70	25	50*	34	30	50	500	0.36
2N361	C	2N138A	22.5	40	25	50*	30	30	50	500	0.36

$$*I_{eco} = (\beta_{rev.} + 1) I_{co}$$

**RAYTHEON
AUDIO FREQUENCY
TRANSISTORS**
Temperature Range
-65°C to +85°C

Type	Case	Supersedes	Circuit Usage	V _{ce} max. Volts	f _{aco} Mc	C _c μμf	Power Gain		Conv. Gain db	Diss. Coeff. °C/mw
							at 455 Kc db	at 2Mc db		
2N413	C	2N111/CK759	Oscillator	-15	3	12av.	—	—	—	0.4
2N413A	C	2N111A/CK759A	IF Ampl.	-15	3	12±2	32	—	—	0.4
2N414	C	2N112/CK760	Converter	-15	5	12av.	—	—	26	0.4
2N414A	C	2N112A/CK760A	IF Ampl.	-15	5	12±2	35	—	—	0.4
2N415	C	2N271/CK766	Converter	-10	10	12av.	—	—	30	0.4
2N415A	C	2N271A/CK766A	IF Ampl.	-10	10	12±2	39	—	—	0.4
2N416	C	2N113	Gen. Purp.	-10	10	12av.	—	18	—	0.4
2N417	C	2N114	Gen. Purp.	-10	20	12av.	—	25	—	0.4

For above eight types I_c = -200 mA max.

**RAYTHEON
COMPUTER
TRANSISTORS**
Temperature Range
-65°C to +85°C

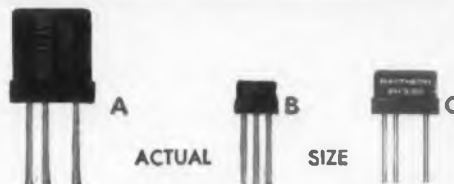
Type	Case	V _{ce} max. Volts	f _{aco} Mc	hfe ₁ (I _b = -1 mA)	hfe ₂ (I _b = -10 mA)	Grounded Emitter Switching Data at I _c = -50 mA				Diss. Coeff. °C/mw
						I _b "on" and "off" mA	Rise Time μs	Storage Time μs	Fall Time μs	
2N425	C	-20	4	30	18	5.0	0.5	0.25	0.3	0.4
2N426	C	-18	6	40	24	3.3	0.5	0.25	0.3	0.4
2N427	C	-15	11	55	30	2.5	0.4	0.25	0.3	0.4
2N428	C	-12	17	80	40	1.7	0.1	0.25	0.3	0.4

For above four types . . . I_c = -400 mA max.; Z_{sat} = 1.5 ohms for I_c of 100 mA

**RAYTHEON
SILICON
TRANSISTORS**
Temperature Range
-65°C to +160°C

Type	Case	Supersedes	Beta	I _{co} μA	I _{eo} μA	r _b ohms	r _c kilohms	C _c μμf	f _{aco} Kc	Noise Factor db (max.)	Diss. Coeff. °C/mw
2N327	C	CK790	14	0.005	0.005	1200	500	35	200	30	0.4
2N328	C	CK791	25	0.005	0.005	1400	500	35	350	30	0.4
2N329	C	—	50	0.005	0.005	1500	500	35	500	30	0.4
2N330	C	CK793	18	0.005	0.005	1300	500	35	250	15	0.4

Write for Data Sheets on individual types for complete ratings and test conditions.



All ratings on this page taken at 25°C.
Dissipation coefficients shown are for free air.
All are hermetically sealed.

SEMICONDUCTOR DIVISION

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in research with materials, processes, methods and the like, Walker felt that research involving the shortage of professional skills has been relatively neglected. "In the next 15 years," he stated, "engineering education in the United States is going to be revolutionized. If the sweeping changes that are going to take place in the next few years are to produce a sounder, better system of engineering education, we must frankly recognize the problems that we are going to face; work out sane, logical solutions to them; and then proceed systematically and courageously to carry them out."

The Penn State president suggested a nine-point program calling for: Identification of potential college material, encourage superior students with the desire to go to college, provide financial assistance for each student to attend college, utilize engineers efficiently, revise the Selective Service System, eliminate costly and wasteful cost-plus-fixed fee government contracts, seek means of financing basic research in engineering, and evaluate the curricula and methods used to teach it.

Bouncing Microwaves

The first commercial microwave system to achieve reliable communications over a 40-mile distance by using mirror-like reflectors instead of regular repeater stations has been installed for the El Paso Electric Co. in Texas. The system is designed to improve communications efficiency between the utility company's facilities at El Paso and Las Cruces. It is capable of handling private conversations, printed material and remote control signals, and will be used to give information on the flow of power between El Paso Electric Co. and interconnected companies.

Difficult terrain problems existed for the General Electric Co. communications engineers who designed the system. The point of origin was 150 ft lower than the surrounding terrain and the electrical utility wanted to avoid the expense of high towers and the problem of acquiring real estate for guying areas. El Paso also desired to eliminate repeater points in the system.

Microwave specialists worked out a system which enabled El Paso to achieve maximum system reliability without the expense and maintenance of a repeater station continuously powered by dc. The resulting system included a 14-ft steel mesh dish placed at a 55-ft elevation at the Rio Grande plant. A 20-ft square aluminum reflector was carried piecemeal by jeep to a location on Mount Cristo Rey 4400 ft above sea level, and a 14-ft dish was placed at a point 80 ft high at the main Las Cruces substation. Under the arrangement, microwaves from El Paso's Rio Grande plant are bounced off the mountain reflector on Mount Cristo Rey, and sent to Las Cruces. The system also operates equally well in reverse, from Las Cruces to Rio Grande.



Pulse Transformer Facility: A pulse testing modulator has been installed by the specialty transformer department of Westinghouse Electric Corp., Pittsburgh, Pa. The modulator can be used to simulate the input to the pulse transformer under test as well as its output load conditions during operation. For load tests, a water-load rheostat, shown, is used to load the secondary of a pulse transformer. The main advantage of the water load is its smaller physical size with resulting reduced capacitance to ground. The water load can be varied from 500 to 2000 ohms by changing salt concentrations in the solution.




Heat's Image




Answering a long-time need in steel mills, a new type of camera, the evaporograph has been put into use by the steel industry for making maintenance checks and detecting hot spots. Heat from the surface of blast furnaces, and other steel-making facilities appears as a colored image through the lenses of the camera, which was developed by Baird-Atomic, Inc., Cambridge, Mass. Differences in temperature of 1 C can be detected, and objects as distant as three miles will register accurately. The instrument will function as long as the measured temperature is above absolute zero and there is a temperature difference existent in the camera's field of view.

The evaporograph consists basically of a membrane which changes in temperature in relation to the infrared radiations focused on it by a lens. An oil vapor condenses preferentially upon the cooler portions of the membrane, causing an oil film of variable thickness to form. Thus, a heat image focused on the membrane becomes visible and distinguishable through the different interference colors formed by the film, much as oil slick on water exhibits varying colors. By employing a reference temperature in the field of view, the evaporograph can be used to calculate unknown temperatures. By comparison of colors on the membrane, differences of temperature in the target area are readily seen.

Switching Problems?...

ELECTRO-SNAP ENGINEERING CAN HELP YOU

	MINIATURES			BASICS			MULTI-POLE			
										
DESIGNATION	E4			S1			D8			
CIRCUIT ARRANGEMENTS	SPST NC	SPST NO	SPDT	SPST NC	SPST NO	SPDT	SPDT 2 Ckt.	DPDT NC	DPDT NO	DPDT 4 Ckt.
AMPS-LIFE @ 125/250 V. AC	2.5A-150,000 CYLS.			10A-750,000			15A-500,000			
AMPS-LIFE @ 30 V. DC IND.	2.5A-50,000 CYLS.			10A-200,000			10A-500,000			
TEMPERATURE RANGE	-45° TO +250° F.*			-100° TO +375° F.*			-100° TO +375° F.*			
WEIGHT	.005 lbs.			10 GRAMS			15 GRAMS			
SIZE (INCHES)	27/32 X 23/64 X 0.240			1-1/4 X 1/2 X 1/2			7/8 X 1-1/4 X 1/2			
COMMENTS	Vibration/shock resistant, precise operation.			To 10,000,000 Ops. @ 1 Amp, 125 V. AC.			Simultaneous operation; poles may have different voltages.			

	MINIATURES			BASICS			MULTI-POLE		
									
DESIGNATION	EF			G3			K3		
CIRCUIT ARRANGEMENTS	SPST NC	SPST NO	SPDT	SPST NC	SPST NO	SPDT 2 Ckt.	TPST NO	TPST NC	TPDT 6 Ckt.
AMPS-LIFE @ 125/250 V. AC	2.5A-150,000			40A-100,000			15A-500,000		
AMPS-LIFE @ 30 V. DC IND.	2.5A-50,000			30A-100,000			10A-500,000		
TEMPERATURE RANGE	-45° TO +100° F.			-45° TO +300° F.*			-100° TO +275° F.*		
WEIGHT	1 OZ. APPROX.			20 GRAMS			30 GRAMS APPROX.		
SIZE (INCHES)	19/32 X 15/16 X 11/32			1-3/4 X 43/64 X 35/64			1-15/16 X 1-1/4 X .491		
COMMENTS	Sealed against dust, dirt, moisture, and corrosion.			Unusual space/capacity achievement; long life; can be ganged.			Reverses 3 ph. motors to 1 HP. Simultaneous make & break. Excellent life.		

* OTHER MODELS AVAILABLE IN TEMP. RANGES FROM -100° TO +400° F.

Need a Special Switch?

Often, a standard or modified-standard switch will do your job. But Electro-Snap engineers are ready to create truly unique switches in any quantity to your specifications. Send us your problem . . . our answers can save you time and money.



CIRCLE 7 ON READER-SERVICE CARD FOR MORE INFORMATION

Switching problems resulting from new size, weight, rating, environment, circuit simplification, or cost requirements can be time consuming and expensive to solve if tackled alone. But Electro-Snap engineering can save you time, money and performance — and usually with "standard" switches — if you bring your switching problems to us. The switches and actuators on these pages may solve some of your problems immediately, but they are only a fraction of the

thousands of switch configurations available "off-the-shelf" at Electro-Snap. Remember that *all* Electro-Snap switches have self-wiping contacts and quick, positive snap action . . . and are built to the toughest aircraft and industrial specifications. Complete data are available for every switch so you always deal with known quantities — no wasted time in finding out for yourself. Ask for this data. Use the coupon below or write us your problem.

HERMETICALLY-SEALED

DIE-CAST



H1-43

ES4-KM

DPDT

SPDT
NO

SPDT
2 Ckt.

10A-200,000

10A-MIN 100,000

10A-200,000

-100° TO +250° F.*

-67° TO +160° F.

8 oz.

4-1/2 oz.

1-1/4 X 3-3/4 X 1-7/32

1-3/4 X 2 X 1-1/32

Hermetically sealed case; adjustable actuator arm. New "Landing Gear Switch".

Impulse one way, opens circuit during over-travel and return.

HERMETICALLY-SEALED

DIE-CAST



H10-7

ES4-D

DPDT
4 Ckt.

DPDT 4 Ckt.

10-50,000

15A-500,000

15-50,000

10A-500,000

-100° TO +250° F.

-67° TO +160° F.

6 oz. APPROX.

7 oz.

1-7/64 X 2-1/8 X 1-7/16

2-1/2 X 2 X 1-3/4

Rotary actuator with seal bonded to shaft AND case; 120° travel.

Environment free; good for machine tool applications; wet areas.

TYPICAL ACTUATORS



TOGGLE



PUSH BUTTON



LEAF



ROLLER



GANG

Tribulations of a Telescope

The great size of Britain's Jodrell Bank Telescope will make it the most sensitive short wave radio receiver yet constructed, and also the most far reaching transmitter. The justification for producing this fully steerable telescope arose from the important results obtained from an earlier fixed reflector. The fixed reflector was 218 ft in diam in the form of a paraboloid facing upwards constructed of thin wires stretched on tubular scaffolding. However, the construction of the 2000-ton fully-steerable instrument posed problems not encountered with the fixed version.

One school of thought proposed building the structure out of aluminum alloy. This idea was soon discarded in favor of steel, for steel had the advantage of a relatively high modulus of elasticity — an important factor since the reflector bowl would suffer great stress-changes during its revolution. Coupled with this, the weight of steel was necessary to combat the effect of sudden gusts of wind. In a structure this large, the coefficient of expansion was also an important factor, and again steel seemed the best solution.

A design had to be evolved which would allow construction firms, who had no previous experience with such structures, to mount the system with a sufficiently powerful driving unit. The power needed to rotate the reflector would be relatively small on a calm day, but the presence of a wind necessitated a tremendous force to keep it revolving. For this purpose, trunnions and trunnion bearings were developed by Cooper Roller Bearings Co., Ltd., of Kings Lynn, Norfolk, Eng., which could each stand a combined dead load and wind load of 1000 tons with minimum resistance.

In order to amplify minute celestial radiations before they were dissipated, it was desirable that the receiving amplifier be located as close as possible to the aerial. For some purposes the first amplifier will be immediately adjacent to the aerial at the summit of the 66 ft tower in the center of the bowl; but the main amplifiers are suspended in a steel laboratory hung immediately below the center of the bowl itself. The suspended laboratory can be reached by gangways from the top of each bearing tower, where further high level laboratories travel round with the azimuth motion of the telescope. Much of this high-level mechanical and electronic equipment was installed under difficult conditions of access by the Brush Electrical Engineering Co. Ltd. of Birmingham, Eng.

Correction: The model 401A Audio Oscillator, made by Waveforms, Inc., 333 Sixth Ave., N.Y. 14, N.Y., is in truth a highly portable instrument weighing 12 lbs, and not 121 lbs as it appeared in the June 15th Issue.

MAIL COUPON FOR CATALOG DETAILS



ELECTRO-SNAP SWITCH & MFG. CO.

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Please send complete information on the Electro-Snap Switches checked below:

- Miniature Switches
 Basic Switches
 Multi-Pole Switches
 Hermetically-Sealed Limit Switches
 Die-Cast Limit Switches

Name _____

Company _____

Street _____

City _____ Zone _____ State _____

CIRCLE 7 ON READER-SERVICE CARD FOR MORE INFORMATION



MINIATURIZED SEALED RELAYS



VIBRATION...yet normal operation

No—we don't use paint mixers to measure the vibration resistance of General Electric miniaturized sealed relays. But, it is a dramatic illustration of the punishment G-E hermetically sealed relays can—and do—withstand.

The best of laboratory equipment is used to measure this vibration resistance, and the results prove—General Electric voltage-calibrated Micro-miniature relays withstand vibration of 20 G's acceleration from 55 to 2000 cycles (.125 inch excursion from 10 to 55 cycles).

Excellent vibration resistance is just one of the many "plus" features—such as high- and low-temperature operation, high shock resistance, and rugged construction—you get with *all* Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric relays are proving their reliability on a variety of military and industrial electronics applications.

What's more, you get all of General Electric's complete line of standard-listed relays on *only 3-week shipment from*

receipt of order—plus—immediate service on samples and prototypes.

For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Sect. 792-7, Schenectady 5, N. Y., for complete relay data. *Specialty Control Dept., Waynesboro, Va.*

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Engineering Review

Acoustic Test Lab

To check sound pressure levels high enough to affect the reliability of mechanical and electrical components, Bell Aircraft Corp. has developed laboratory test equipment to check sound-sensitive components of its own, and that of other companies on a sub-contract basis. Facilities can also simulate a combination of environments such as temperature and vibration, in conjunction with high intensity noise.

Different types of equipment, such as plane wave tubes and resonant and reverberant chambers, make possible a variety of definitive tests. Sound pressure levels up to 160 db for discrete frequency and up to 145 db for random noise are provided over test areas up to 250 sq in.



Hottest Summer Yet: The appearance of this 25 a silicon diode isn't exactly due to the weather but is the result of a fire at an oil refinery. Still functioning, the diode was originally installed in an oil-immersed cathodic protection rectifier, used to prevent galvanic action corrosion of oil pipeline. The rectifier was burned out in a forest fire, the 11-gage steel case badly warped and the oil burned, but three of these diodes were found to still have their original operating characteristics. The units were manufactured by Westinghouse Electric Corp.

◀ **CIRCLE 8 ON READER-SERVICE CARD**

Smooth Nose for Missiles

One of the smoothest surfaces ever created by man exists on the nose cones designed for intercontinental ballistic missiles. The Air Force disclosed recently that several of these nose cones have been successfully brought through the blazing inferno of atmospheric re-entry, using the Lockheed X-17 research rocket as the test missile. A 40-ft tall projectile, the rocket's first stage is a single large solid propellant, the second stage is a cluster of three Recruit rockets, the third is a single Recruit, all built by Thoikol Chemical Corp. The first stage blasts the rocket into the thin air of the ionosphere. Without sufficient air to provide aerodynamic control, the rocket drops tail-first to an altitude where denser air begins to turn its nose down. At this point, the first stage is ejected and the second stage is ignited, starting the accelerated, headlong plunge through the atmosphere. The third stage, with its nose cone, finally comes into action and drives the X-17 downward at an even greater speed, subjecting these nose cones to the high temperatures used to test their design.

Holding 28-Ft Parabolic Antenna

A 28-ft all-aluminum mesh parabolic antenna assembly has been designed to be easily dismantled into 12 separate self-nesting reflector pie sections and 12 backup supports arranged about a center hub. Providing low rate bulk transportation, the entire assembly can be shipped in two 8 x 8 x 4 ft packages. One package contains 12 reflector sections nested within each other, and the other box contains 12 K-frame assemblies with center hub plate mounting brackets and other hardware.

When erected, the antenna withstands 65 lb per sq ft of wind loading when completely iced. It can be supplied with a supporting structure for assembly on remote locations by a four man crew using conventional tools. Gains of 29.1 db at 430 mc to 31 db at 2700 mc over normal isotropic antenna performance are offered by the tropospheric antenna. It is made by Prodelin, Inc., 307 Bergen Ave., Kearny, N.J.

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Washington Report

Herbert H. Rosen

DOD's Reliability Program Grows Teeth

This month the Government Printing Office is selling an 800-page report that reviews all conceivable aspects of reliability. It is the culmination of a 15-month study by nine task groups of DOD's Advisory Group on Reliability of Electronic Equipment—AGREE. It looks at the way reliability is "controlled" by the Department and makes a large number of recommendations as to how the technique may more realistically become a standard operating procedure for both industry and the military. These recommendations may very well become the basis for establishing all future reliability requirements for military electronic equipment.

For more than a month, top technical people from the military departments and DOD have been studying the report in an effort to implement it as soon as possible. A fair proportion of the recommendations are implied in a good number of DOD directives already in force. The problem is that there is probably no one who knows exactly where or if a directive exists covering all aspects of the reliability problem he is interested in. This study should make inroads into this anomolous situation.

Meanwhile, there are reports that another task group may be formed to look at reliability from the management viewpoint. The genesis for the group will be the membership of AGREE's Task Group 5. It will be augmented by top level members of the military departments.

The fact that the recommendations in the report seem to cross over each other indicates a strong need for consolidation of some sort. One plan seems to be gaining acceptance the more it is talked about in the Defense Department and in industry. The first step would be to consolidate the functions of such groups as AGREE and AGECP (Advisory Group in Electronic Component Parts). To this would be added the operations of the Armed Services Electro-Standards Agency—ASESA. Teeth and authority would be put into the directives that established these and similar groups. Then with reliability, parts and performance as the basis of operations, the DOD would have a small bureau of standards to guide its electronic pursuits.

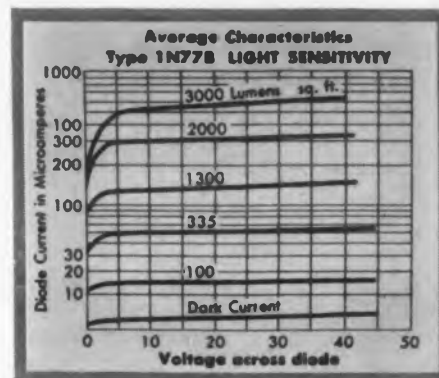
The new group would have the responsibility for establishing specifications, for example, before a component part gets into use. The military would cite a need, and someone would have to come up with an answer. The resulting specification would be the standard for the industry vendor and the military buyer.

In essence, the group would be a judiciary board

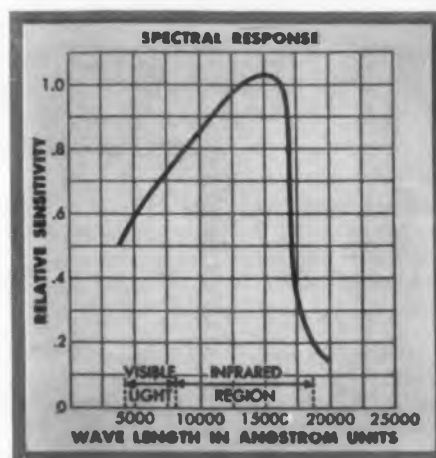
New Sylvania Photodiode

Type 1N77B

... puts tinier beams of



Light sensitivity of the new Sylvania photodiode, type 1N77B



Spectral Response of Sylvania's new 1N77B

Sylvania designs a smaller photodiode with improved capabilities to handle applications where space is limited

Sylvania, leader in diode development, introduces the 1N77B, a new smaller junction photodiode with superior power dissipation and higher temperature capabilities. The improved unit, with a diameter of .077 inch, is ideal for highly compact assemblies and other applications where space is at a premium. The new 1N77B, which replaces type 1N77A, is now available at substantially lower prices in volume quantities.

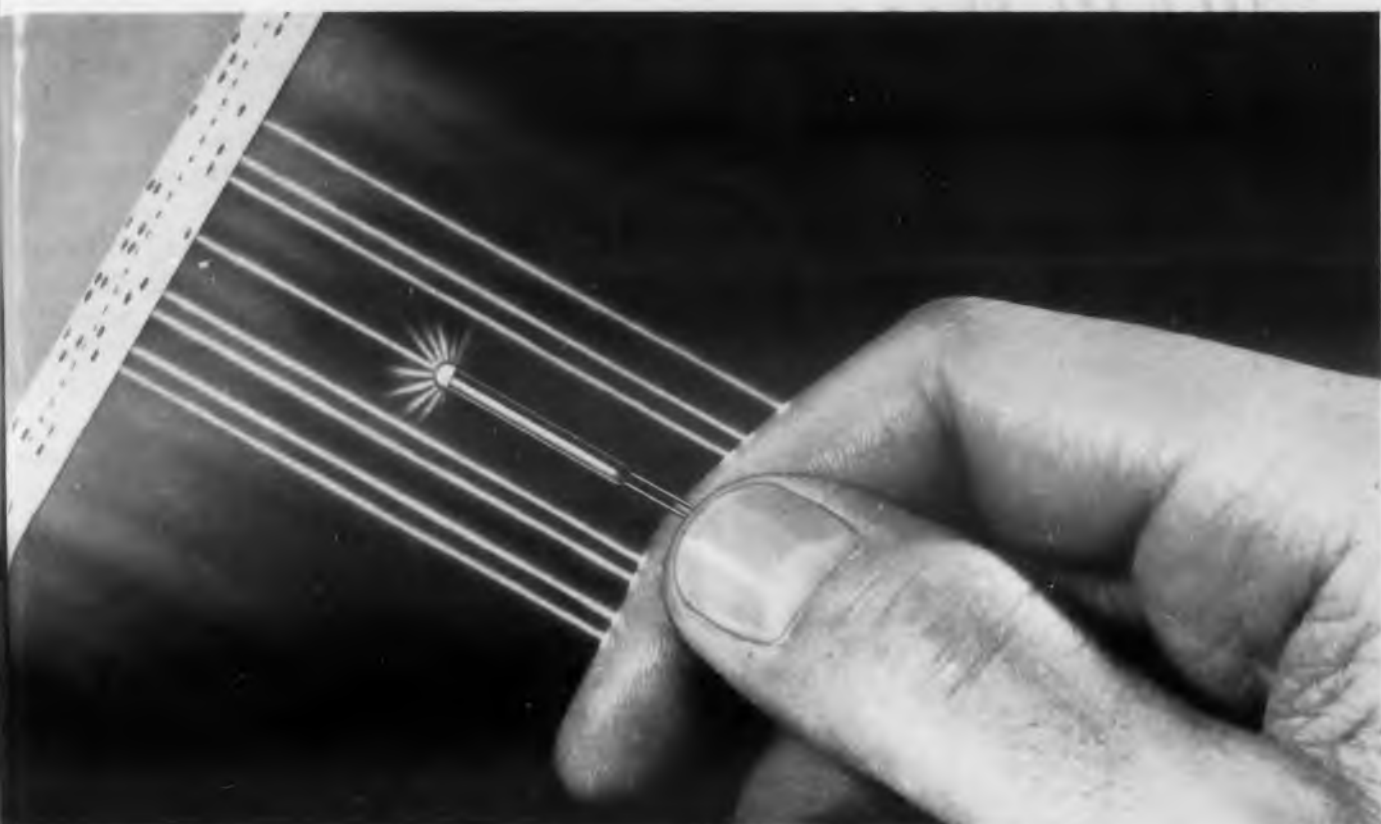
The compact construction and fast response of the Sylvania 1N77B make it ideal for rapid, highly sensitive scanning and reading applications, such as in computer tape or punched cards readout. The new unit is also readily

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ELECTRONIC DESIGN • September 1, 195



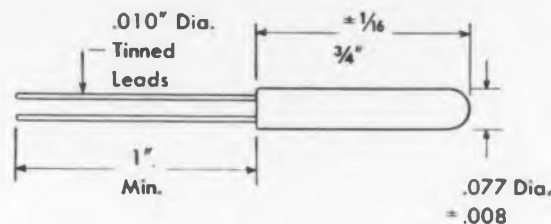
A fraction of an inch in diameter, new Sylvania photodiode, type 1N77B, is ideal for computer tape readout. It operates in the visible and infrared regions

ns of light to work

adaptable to infrared detection and heat-seeking devices because it is sensitive to light wave lengths extending from near ultraviolet into infrared. Other applications for the new 1N77B include liquid level control, headlight and street light dimmers, intensity controls, photoelectric controls and motion picture sound pickup.

Sylvania's improved photodiode has a higher lumen intensity than other types and a high output impedance. This is especially advantageous when coupling into vacuum tube or grounded collector transistor circuits. The new units are hermetically sealed in glass with a built-in lens that focuses light on the sensitive portion of the junction. The light interruption frequency response of the 1N77B photodiode is flat from 300 cycles to 15 kc and 100 percent with 260 lumens/sq. ft.; $R_L = 110,000$ ohms, -45 v.

Contact your Sylvania representative for further information on the new 1N77B.



Sylvania's new photodiode, type 1N77B, is nearly 20 percent smaller in diameter than type 1N77A which it replaces

TABLE OF RATINGS & CHARACTERISTICS

Absolute Maximum Ratings (at 25°C):	
Operating Voltage	50 volts dc
Ambient Temperature (Maximum)	75°C
Power Dissipation	40 Milliwatts
Forward Current	10 MA dc

CHARACTERISTICS

Reverse Current—Dark ($E_R = -10$ volts)	15 ua max.
Reverse Current—Dark ($E_R = -50$ volts)	100 ua max.
Noise Voltage—Dark ($E_R = -45$ volts, $R_L = 100,000$ ohms)	15 Millivolts max.
Light Sensitivity	18.7 peak-to-peak volts—min.
Light Sensitivity	37.5 peak-to-peak volts—max.
Typical Minimum Frequency Response	15.0 KC

having the prestige and authority to enforce the standards and specifications it develops.

In very general terms, the nine task groups looked at reliability from a number of vantage points: Practicality of reliability figures, statistical testing and collection of data, packaging effects on equipment, storage effects, procurement practices impeding or aiding the attainment of reliability objectives, definitions of terms so that all concerned are speaking the same language, and controls over testing, specifying, and compliance.

TV Translators or Boosters?

In response to petitions from the Governors of a number of Western states, the Federal Communications Commission has instituted a rule-making proceeding on the subject of TV translator stations vs. TV booster or repeater stations. The Commission is inviting all interested parties to submit engineering data or other pertinent comment as "to the feasibility of operating low powered apparatus for the purpose of 'repeating' or retranslating the signals of television broadcast stations into remote and sparsely settled areas without adequate TV service." The repeater stations would be permitted to operate on both vhf and uhf TV broadcast channels.

The FCC has licensed a number of translator stations, largely in the mountainous east and in the midwest. These stations pick up either by wire or by sensitive receivers TV broadcasts from large urban stations. The signals are then retransmitted on channels for short-range or local consumption.

Obviously, the same technique will not work in areas in which TV stations are separated by very long distances.

The rules the FCC is proposing would limit the power input to the final rf amplifier to 1 watt. They would establish certain minimum performance standards considered to be necessary to prevent interference to established services. Also, they would require the inclusion of certain automatic devices to prevent malfunctioning if the apparatus were to be operated without a technically qualified radio operator in constant attendance. TV repeater stations would be required to protect other classes of stations from interference but would receive no protection from interference. They would be permitted to operate as simple co-channel linear amplifiers, i.e. "boosters," or could convert to other vhf or uhf channels which could be used without causing interference to other classes of stations.

Comments from interested parties are expected to be based on sound engineering considerations. Data should be supplied which will enable the Commission to determine whether or not such devices are technically feasible and should be authorized. Manufacturers are invited to submit data as to the probable cost of suitable equipment.

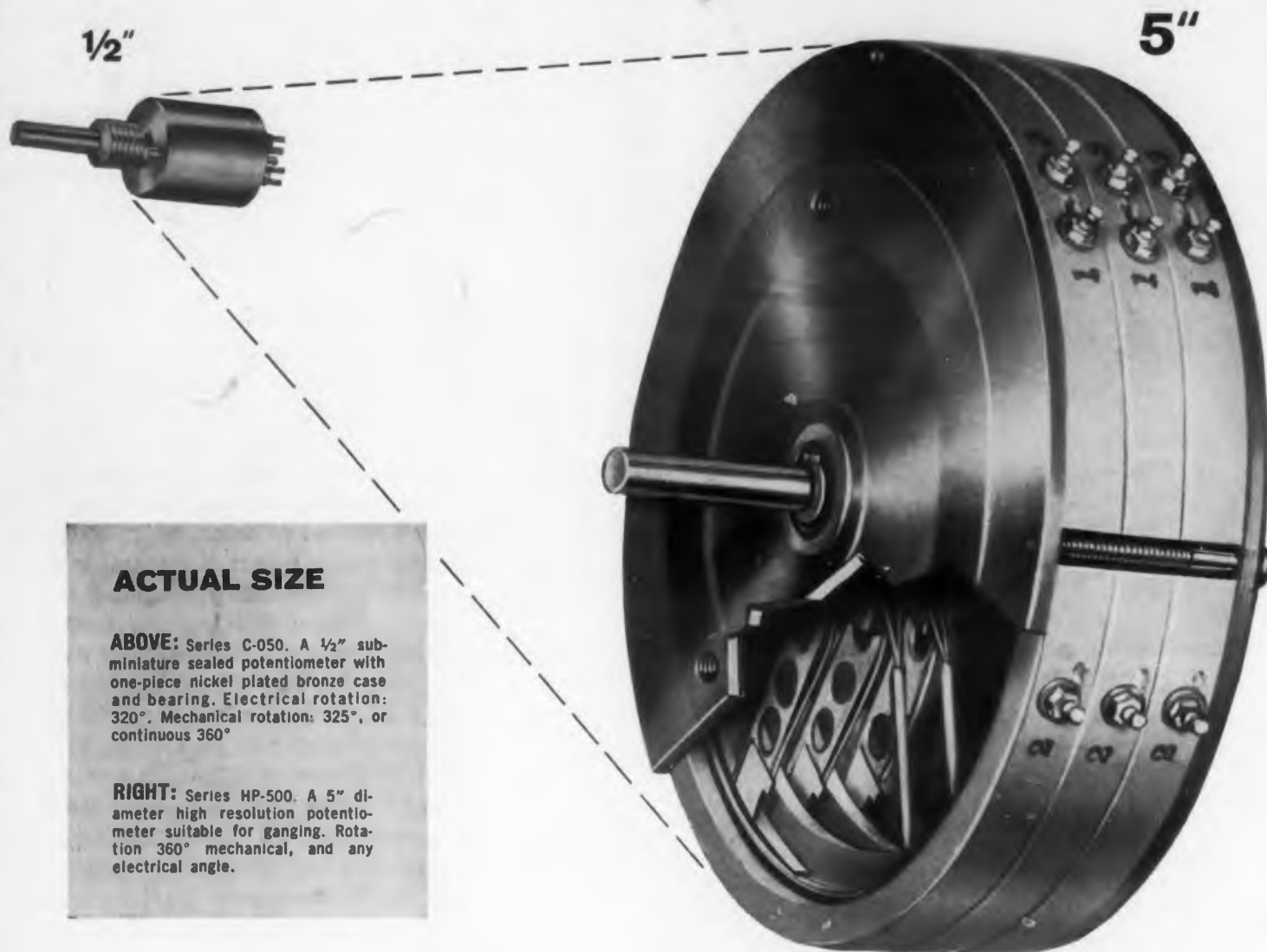


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CIRCLE 11 ON READER-SERVICE CARD FOR MORE INFORMATION

Meetings

Sept. 8-13: Second Annual Course on Investment Castings

MIT, Cambridge, Mass. Sponsored by the Investment Casting Institute. Lectures, laboratory exercises and demonstrations will be offered on investment materials; melting; gating, risering, solidification and heat transfer; metal and alloy systems; defects in castings; and consideration of new investment and allied processes. For further information, write Harry P. Dolan, Investment Casting Institute, 27 E. Monroe St., Chicago 3, Ill.

Sept. 9-13: Twelfth Annual Instrument-Automation Conference and Exhibit

Cleveland Auditorium, Cleveland, Ohio. Sponsored by the ISA. Organized under the unifying theme "Instrumentation for Systems Control," the conference will open with formal sessions devoted to data handling and instrument terminology. Following these there will be individual workshop sessions and limited discussion groups covering such topics as aircraft and missiles (excluding propulsion), wind tunnels, flight propulsion systems, process industries, power generation and distribution, meteorological, nuclear, medical, geophysical exploration and general industrial laboratories. Some 100 papers will be presented at the technical sessions. There will be about 500 exhibits. For details of the technical program write to Herbert S. Kindler, Director of Technical Programs, ISA, 313 Sixth Ave., Pittsburgh, Pa.

Sept. 17-18: RETMA Symposium on Numerical Control Systems for Machine Tools

Ambassador Hotel, Los Angeles, Calif. For details write to RETMA, Room 650, 11W. 42nd St., New York 36, N.Y.

Sept. 17-21: Institute of High Fidelity Manufacturing Show

Morrison Hotel, Chicago, Ill. For further information, contact Bernie Merems, 509 Madison Ave., New York, N.Y., or Howard Alexander, 75 Wacker Drive, Chicago, Ill.

Sept. 24-25: Sixth PGIE Symposium on Industrial Electronics

Morrison Hotel, Chicago, Ill. Sponsored by the Professional Group on Industrial Electronics and AIEE. The main theme for the conference will be the characteristics, use and integration of transistors.

ers into complete systems to measure and con-
complete processes. For further details, write
J. N. Banky, 628 West 18th Street, Chicago, Ill.

**Oct. 27-28: Seventh Annual IRE Professional Group
Broadcast Transmission Systems Fall Symposium**

llhard Hotel, Washington, D.C. Papers will be
d on a variety of subjects ranging from transistor
ulated power supplies for video circuits to the
lication of automation to TV master control
ms and film rooms. More information may be
ained from Clure H. Owen, American Broadcast-
Co., 7 W. 66th St., New York 33, N.Y.

**Nov. 7-11: Fall General Meeting of the American
Institute of Electrical Engineers**

el Morrison, Chicago, Ill. The technical program
consist of more than 50 sessions devoted to the
st advances in electrical engineering and allied
s. Nuclear reactors, telegraph systems, research,
ics, television and aural broadcasting, basic sci-
ence, safety, computing devices, land transporta-
tion, power generation, transmission and distribu-
tion, system engineering, computers, mining and
metal industry, radio, and the chemical industry are
some of the subjects being covered. For details
write to the AIEE, 33 W. 39th St., New York, N.Y.

**Nov. 9-11: Fourth National Symposium on Vacuum
Technology**

el Somerset, Boston, Mass. Sponsored by the
Committee on Vacuum Techniques. Approximately
papers will be presented covering fundamental
advances in vacuum technique, means of producing,
measuring and conducting low pressures, and ad-
vances in applications of vacuum to processing. For
further information, write the Committee on
Vacuum Techniques, Box 1282, Boston 9, Mass.

**Nov. 9-12: 1957 Convention of the Audio Engineer-
Society**

New York Trade Show Bldg., New York, N.Y. Be-
tween 50 and 60 papers will be presented. Covered
topics in such fields as disc and tape record-
reception, components and systems, noise con-
trol and acoustics. The New York High Fidelity
Show, sponsored by the Institute of High Fidelity,
will accompany the Convention. More information
can be obtained from G. K. Dahl, 230 West 41st
St., New York 36, N.Y.

**Nov. 14-15: Third Annual Douglas Aircraft Co. Inc.
Bell Helicopter Corp. Integrated Instrument De-
velopment Program Conference**

El Statler, Los Angeles, Calif. Sponsored by the
Army and Navy. For more information send to the
Personnel Bureau, Bell Helicopter Corp., P.O. Box 482,
Worth, Tex.

1957 ELECTRONIC DESIGN • September 1, 1957



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CIRCLE 13 ON READER-SERVICE CARD FOR MORE INFORMATION

Oct. 16-18: AIEE Conference on Computers in Control

Chalfonte and Haddon Hall Hotels, Atlantic City, N.J. Sponsored by the AIEE Committee on Feedback Control Systems. The conference will stress the role of analog and digital computers in automatic control, both as design tools and as components of systems. For more information, write Prof. J. G. Truxal, Dept. of Electrical Engineering, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, N.Y.

Oct. 16-18: 1957 IRE Canadian Convention and Exposition

Automotive Building, Exhibition Park, Toronto, Canada. Sponsored by the Canadian Sections of the IRE. For information write to Grant Smedmor, IRE Canadian Convention, 745 Mt. Pleasant Rd., Toronto 7, Canada.

Oct. 17: SPE Regional Technical Conference

Hotel Carter, Cleveland, Ohio. Sponsored by the Cleveland-Akron Section of the Society of Plastic Engineers. The theme for the sessions will be "Polyethylene—Properties and Uses." For details write E. J. Haskins, Zenith Plastics Co., 1009 Rockwell Ave., Cleveland 14, Ohio.

Oct. 24-25: Fourth Annual Computer Applications Symposium

Hotel Sherman, Chicago, Ill. Sponsored by the Armour Research Foundation of Illinois Institute of Technology. Advances in automatic coding and new computers and applications will be stressed. Both management and engineering applications will be considered. More information may be obtained by writing the Secretary, Computer Applications Symposium, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 28-30: Fourth Annual East Coast Conference on Aeronautical and Navigational Electronics

Fifth Regiment Armory and the Lord Baltimore Hotel, Baltimore, Md. Sponsored by the Baltimore Section of the IRE and the Professional Group on Aeronautical and Navigational Electronics. Exhibitions will be offered along with the technical sessions. For details write Clayton Knight, 3603 Howland Park Ave., Baltimore, Md.

Oct. 31-Nov. 1: Third Annual Technical Conference of the Professional Group on Electron Devices, IRE

Shoreham Hotel, Washington, D.C. For more information, write W. M. Webster, RCA Semiconductor Div., Somerville, N.J.

Nov. 6-8: Tenth Annual Conference on Electronic Techniques in Medicine and Biology

Boston, Mass. Sponsored by ISA and AIEE. Further

details and advance programs may be obtained from H. S. Kindler, Director of Technical Programs, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

Nov. 6-8: Third Aero-Com Symposium

Hotel Utica, Utica, N.Y. Sponsored by the IRE Professional Group on Communications Systems. The conference will deal with systems, equipment design, techniques, antennas, spectrum conservation, air traffic control, management and other topics. For the presentation of confidential material, there will be a classified session on Nov. 8. For more information, write to R. C. Benoit, 138 River-view Pkwy., Rome, N.Y.

Nov. 11-13: Third Annual Instrumentation Conference

Wiltmore Hotel, Atlanta, Ga. The theme of this conference will be "Instrumentation for Data Handling" with special symposiums on electronic instrumentation as applied to medicine and the sales and purchasing aspects of electronic instrumentation. Papers should be submitted to Lamar Whittle, Federal Telecommunications Lab., 1389 Peachtree St., N.E., Atlanta, Ga. For more information write B. J. Washer, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

Nov. 13-14: Mid-America Electronics Convention

Municipal Auditorium and Hotel Muehlebach, Kansas City, Mo. Sponsored by the Kansas City Section of the IRE. There will be exhibits and twelve technical sessions. Approximately thirty papers will deal with medical electronics, airborne electronics instrumentation, engineering management, electronics in nucleonics and a diversity of other subjects. Persons who want to submit papers should contact the Technical Papers Chairman, MAECON, 909 Cherry St., Kansas City 10, Mo. The deadline for submissions is Aug. 15. For more information write Richard L. Clarke, 425 Volker Blvd., Kansas City 10, Mo.

Per Deadlines

Nov. 1: Deadline for papers to be presented at the 1957 IRE National Convention. The convention will be held March 24-27 at the Waldorf-Astoria Hotel, New York Coliseum, New York, N.Y. Prospective authors should submit a 100-word abstract and a 500-word summary. Both must be in triplicate with the title of the paper and the name and address of the author. The technical field in which the paper falls must also be indicated. Only papers published or presented prior to the convention will be considered. Military or company clearance must be obtained before submittal. Address all material to Dr. George L. Haller, Chairman, 1957 IRE Technical Program Committee, IRE, 1 E. 79th St., New York 21, N.Y.

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CIRCLE 14 ON READER-SERVICE CARD FOR MORE INFORMATION

The electronic design engineer has a basic responsibility for ensuring that the system he is designing has adequate reliability in the ultimate application. This article presents a technique for predicting the reliability of a system while it is in the design stages. In addition, the technique shows readily those factors of design which can be changed to realize the best reliability and economy.

Before a reliability prediction can be made one or more proposed system delineations as well as part-reliability figures must be available, of course. The part reliability figures can occasionally be obtained from experience. Often, however, these figures must be extrapolated roughly from available data or estimated on the basis of part performance description. But the lack of accurate figures need not delay the reliability analysis. The resulting predictions can be modified easily as new data become available.

A further prerequisite to a design reliability analysis is a detailed statement of what minimum performance levels result in "successful" operation of the system. Although it is possible to evaluate "success" in terms of the system operator's satisfaction after the system is working, during the design stages it must be related to criteria that can be stated mathematically. Success-definition, the construction of reliability diagrams, and reliability formulas are presented in this article.

Reliability-Design Technique for Complex Systems

H. Elmore Blanton

Cambridge, Mass.
Hycon Eastern, Inc.

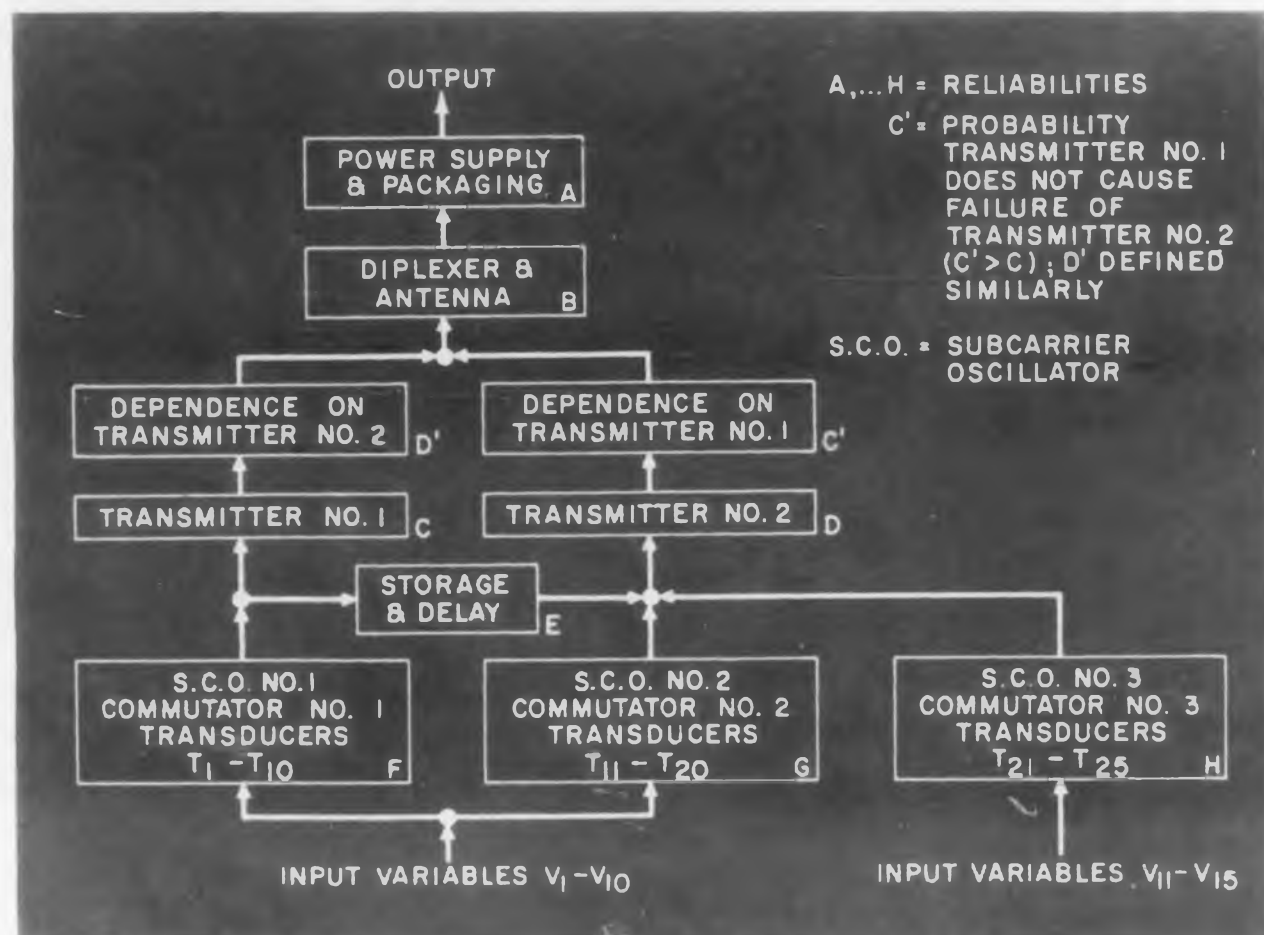


Fig. 1. Reliability diagram of proposed hypothetical airborne telemetering system. Note that this illustration closely resembles an electronic block diagram showing paths of signal flow. These paths can also represent information flow.

A REASONABLY simple reliability-prediction technique has been developed which can be used in the early stages of the design of complex systems. Conventional statistical methods are adapted to a familiar engineering format in order to make an analysis of system reliability easy and straightforward. This technique facilitates comparison of proposed system designs and leads to estimations of the degree of redundancy or component improvement required to realize the target figure for system-performance reliability.

In using this technique, *reliability diagrams* are prepared by making appropriate changes in the engineering block diagrams for the system. After one or more possible definitions of successful performance are stated, basic rules from probability theory lead to the derivation of *reliability formulas* for the system. Effects of failures due to one part depending on another and engineering considerations such as the relative importance of various modes of performance can be included readily. Numerical reliability predictions are achieved by evaluating these formulas using the best available component-reliability data. An example based on an airborne telemetering system illustrates the application and usefulness of this technique.

A simplified block diagram of such a telemetering system is given in Fig. 1. For the present, disregard boxes C' and D'. Fifteen variables, V₁, V₂, etc. are measured by the system. The engineering design proposes the use of two transducers each to measure 10 important variables in order to provide redundancy and consequently possible reliability improvement—relative to that obtainable when using single transducers. The two groups of 10 transducers use separate commutators, subcarrier oscillators, and transmitters. To increase the probability that the signals representing these ten variables will be received successfully in the event of a temporary loss of transmitted signal, the output of Subcarrier Oscillator No. 1 is continuously recorded and re-

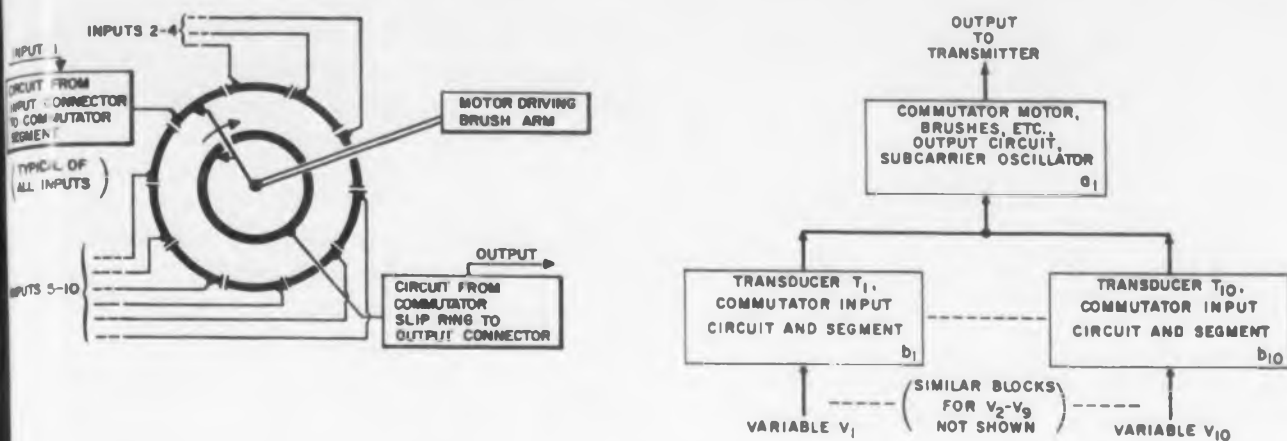


Fig. 2. Reliability analysis of electromechanical commutator. A sketch of this unit is represented in (a), showing that each segment controls one input. If a segment should be inoperant the variable associated with it would not be transmitted. The reliability diagram for this situation is shown in (b).

broadcasted over Transmitter No. 2 after a delay of τ minutes. A common antenna and power supply are used. In this hypothetical system, the simplifying assumption is used that the only part interaction occurs in the transmitters where, if either fails in a particular manner, so will the other.

This telemetering system is used in a missile which is tested during flights of specified duration. Data giving the reliability of the parts under the flight environment are assumed to be available. The problem to be investigated is:

What is the probability that the telemetering system transmits successfully, throughout the test flight, the desired information about the variables which are measured?

Reliability Diagrams

The first step in deriving a formula for system reliability, of course, is to determine the manner in which the reliability of each part affects the reliability of the whole. This information can be displayed effectively by means of *reliability diagrams*. In these diagrams, the series or parallel grouping of parts, the effects of packaging, power supplies and other associated equipment, and the consequences of interdependence between the performance of parts is clearly evident.

A reliability diagram, as defined in this paper, resembles a conventional signal-flow block diagram. The two types of diagram must not be confused however. Basic considerations in constructing and using reliability diagrams are:

- A line represents a unidirectional path of information flow. For electrical systems, *information flow* may be interpreted as *signal flow*.
- A block represents a part or a group of parts which must function successfully if the information is to pass from the input to the output of the block. The information does not necessarily pass through

the parts included within the block.

- The group of parts which are denoted by a particular block preferably should be describable by a probability of successful performance which is independent of the performance of any other part. Dependence between parts in different blocks is admissible if the dependence exists between a specified part shown by one block and the entire group of parts denoted by another block.

- A distinctive symbol represents the probability of success of the parts denoted by each separate block. The probability of success of the parts within a block is defined on the basis of the part specifications and the definition of success in the given application, which will be discussed later.

- A path of information transfer consists of a single series connection of successive lines and blocks from the system input to the system output. Successful transmission occurs along a particular path if the parts represented by each of the blocks operate successfully. Redundant parts that are excluded from one path are included as elements in other parts. A part may serve as a series element in several paths.

The construction of the reliability diagram, Fig. 1, for the telemetering system is initiated by drawing a conventional block diagram. Next, blocks are added as series elements to show the effects of transmitter dependence, power supply, and packaging. Each of these blocks is located on the basis of the manner in which the reliability of the parts influences the system reliability.

A set of transducers, the related commutator, and the subcarrier oscillator are grouped conveniently in a single block in Fig. 1 since these parts function together, independent of other parts, to perform a particular task. The sketch of an electromechanical commutator in Fig. 2(a) reveals that portions of the assembly are associated with individual input signals, whereas other portions are common to all signals. As a result, this single part must be repre-

sented by several blocks in a reliability diagram, as is shown in Fig. 2(b). This figure includes the transducers and subcarrier oscillators in the appropriate blocks to give the complete diagram for the commutated subcarrier channel.

Cables and connectors between parts effectively introduce additional series blocks in a reliability diagram. To eliminate this complication, the reliability symbol assigned to a particular block may be taken as denoting the probability of success of the parts represented by that block *and* of the cables and connectors leading to and from those parts.

Definition of Successful Performance

The reliability of a system in performing its assigned function obviously should be computed with respect to a precise definition of what constitutes success. It may simply be that the operator is satisfied with the system performance, or at the other extreme, it may be that the output of system fails within certain well-defined, measurable bounds. For our purpose, a definition which can be stated mathematically is necessary.

Ideally, the output of the telemetering system is composed of four signals which are members of groups of successive samples originating from the three commutators and transmitted either immediately or after the delay of τ minutes. A definition of successful performance can be stated in terms of the minimum number of samples which must be present in the output during a specified interval.

An engineer, on the basis of his knowledge of the ultimate use of the data, often assigns weights indicative of the relative importance of the record of each telemetered variable. Several procedures may be suggested for incorporating these engineering considerations in reliability calculations.

One procedure is based on exponent weighting factors. These are determined by the relative importance of the various telemetered variables. Exponents in the range of zero to one are affixed to the reliabilities of parts that are associated with the transmission of particular variables. If the variable is of primary importance, the exponent is 1 and the related parts must perform exactly in accordance with specifications. However, if the variable is of secondary importance, an exponent less than one, roughly proportional to the relative importance of that variable is used. A mathematical method to derive the weighting factor appears in reference (6). With exponent weighting factors, the definition of successful performance must state that certain variables must be telemetered satisfactorily with a weight w_1 , others with weight w_2 , and so forth, where $1 \geq w_1 > w_2 > w_3 \dots \geq 0$.

Let us say that our system performs successfully if the signal received by the ground-based receivers during a test flight contains the theoretically maximum number of samples representing:

- (a) At least and four of the five variables V_1-V_5 .

(b) Variable V_6 .

(c) Variables V_7, V_8, V_9 , and V_{10} subject to exponent weighting w_1 ($1 > w_1 > 0$), and

(d) Variables V_{11} to V_{15} , subject to exponent weighting factor w_2 ($1 > w_2 > 0$).

To fulfill this definition, variables V_1 - V_{10} may be received either simultaneously with measurement or after the delay of τ minutes which is inherent in the record-rebroadcast arrangement.

Reliability Formulas

When a reliability diagram is drawn and the definition of success stated, a reliability formula can be obtained as follows:

1. Refer to the reliability diagram and write the probability of success for transmission along each separate path of information transfer from an input to the output. Note if the success of a particular path is required for system success or if alternative paths are available. Indicate applicability of weighting factors.

2. Compute the individual probability of success for each separate combination of paths which can result in system success. Each of these probabilities is obtained as the product of the reliabilities associated with all blocks which are required for the simultaneous success of the several necessary paths. Effects of exponent weighting factors are included.

3. Compute the probability that each pair of combinations of paths, as in Step 2 are successful simultaneously.

4. If more than two combinations of paths which can yield system success exist, compute the probabilities that each group of three, four, etc., of these combinations are simultaneously successful.

5. Compute the probability of success for the system by summing the probabilities obtained in Step 2 subtracting those obtained in Step 3, and alternately adding and subtracting those for the groups computed in Step 4.

An example based on the reliability diagram of Fig. 1 and the definition of successful telemetering given in the preceding section is shown in Table 1. In this table, Lines 1-4 correspond to Step 1, 5-7 to 2, 8-10 to 3, 11 to 4, and Line 12 to Step 5. As may be noted, the reliabilities given on Line 1 for Path 1 and on Line 4 for Path 4 include the factors D, D', E , and E' ; however, the reliability of Paths 1 and 4, Line 5, includes only D and E because these factors are more restrictive than D' and E' , respectively, for the same parts. With this exception, the probability on Line 5 includes each symbol which appears in the probabilities on Lines 1 and 4. The exponent weighting factor w_2 is included in the derivation. The effect of the delay of τ minutes in the storage and delay device is neglected in making a first approximation to the actual problem.

The reliability formulas for F, G , and H in Table 1 and Fig. 1 are derived by reference to a reliability diagram similar to Fig. 2(b). On the basis of the

definition for success, the formulas for the channels associated with Subcarrier Oscillator Nos. 1 and 2 are

$$F = a_1 \left[\prod_{i=1}^5 b_i + \sum_{i=1}^5 (1-b_i) \prod_{\substack{j=1 \\ j \neq i}}^5 b_j \right] b_6 (b_7 b_8 b_9 b_{10})^{w_1}, \quad (1)$$

$$G = a_2 \left[\prod_{i=11}^{15} b_i + \sum_{i=11}^{15} (1-b_i) \prod_{\substack{j=11 \\ j \neq i}}^{15} b_j \right] b_{16} (b_{17} b_{18} b_{19} b_{20})^{w_1}. \quad (2)$$

In each of these formulas, the two terms in the bracketed expression represent the probability that V_i through V_5 are all measured successfully and

that any four of these variables are measured successfully when any one measurement is unsuccessful. The formula for the channels associated with Subcarrier Oscillator No. 3 is

$$H = a_3 b_{21} b_{22} b_{23} b_{24} b_{25}. \quad (3)$$

The exponent weighting factor w_1 is applied to the last group of factors in each of eqs (1) and (2) because only these part reliabilities are affected thereby; however, the weighting factor w_2 is not included in eq (3) because, for convenience, it is applied directly to H in Table 1.

Table 1. Derivation of Reliability Formula

Line	Item	Probability of Success	Remarks
1	V_1 - V_{10} , V_{11} - V_{15} ,	Path 1 ABCD'F	One path required for success Required, weight = w_2
2		Path 2 ABC'DEF	
3		Path 3 ABC'DG	
4		Path 4 ABC'DH	
5	Paths 1 & 4	ABCD'FH w_2	Any one combination yields success
6	Paths 2 & 4	ABC'DEFH w_2	
7	Paths 3 & 4	ABC'DGH w_2	
9	Paths 1, 2, & 4	ABCDEFH w_2	Success of various combinations of paths
10	Paths 1, 3, & 4	ABCDFGH w_2	
11	Paths 2, 3, & 4	ABC'DEFH w_2	
12	Paths 1, 2, 3, & 4	ABCDEFH w_2	
8	Reliability Formula	ABDH w_2 (CF + C'EF + C'G - CEF - CFG - C'EFG + C'FG)	

Table 2. Reliability Predictions

Situation	Formulas	Reliability
1 System-reliability prediction using proposed technique	Line 12, Table 1, and Eqs (1)-(3)	0.819
2 Same as 1 except Subcarrier Oscillator No. 2 and associated transducers eliminated	Same as 1 except $G = 0$	0.740
3 Same as 1 except Transmitter No. 1 eliminated	Same as 1 except $C = 0, C' = 1.0$	0.823
4 System-reliability prediction using product rule	Eq (4)	0.444
5 Same as 4 except part unreliability reduced by factor of 4 (e. g., A is changed from 0.95 to 0.9875, etc.)	Eq (4) with variables redefined	0.818
6 System reliability prediction considering redundancy shown in Fig. 1 and all data required for success	Eq (5)	0.749

Overall reliability is based on the following part-reliability estimates:
 $A = C = D = E = 0.95$ $w_1 = 0.8$ $a_1 = a = 0.97$ $(i = 1, 2, 3)$
 $B = C' = D' = E' = 0.99$ $w_2 = 0.5$ $b_1 = b = 0.98$ $(i = 1, \dots, 25)$

The importance of assigning a distinctive symbol to represent the reliability of each separate block of the reliability diagram is emphasized by the process of deriving the reliability formula. During this derivation, these symbols mean that the success of the respective parts is required for the success of the associated paths of information transfer. The symbols, as factors in the formula, may be manipulated in accordance with the associative, commutative, and distributive laws of algebra and the special rules previously stated. But after the complete reliability formula is written, the symbols again represent merely the reliability of the parts. At that time, the rules of ordinary arithmetic apply; equalities between the numerical values of factors can be recognized and appropriate substitutions made if desirable.

Reliability Predictions and Analyses

When reliability formulas are evaluated using the best available estimates for part reliabilities, numerical reliability predictions are obtained. Another important use of the technique, however, is in the design analyses which are directed towards achieving the highest possible reliability under stated restrictions. Several sample computations for the telemetering system and a comparison between the predictions obtained using the technique described in this article and other methods is given in Table 2. The arbitrary set of point estimates for the part reliabilities, as used in the computations, is given below the table.

Situation 1, Table 2, indicates that the predicted reliability for the system is 0.819 when the reliability formulas derived in the preceding section are used. If this reliability is assumed to be acceptable, the question arises if the engineer's choice of redundancy in the system is wise. Situation 2 shows that the elimination of Subcarrier Oscillator No. 2 and associated transducers for V_1 through V_{10} reduces the reliability by roughly 10 per cent. This change probably is undesirable. The opposite effect is obtained when Transmitter No. 1 is eliminated, as shown by Situation 3. An increase in system reliability is realized because the interaction that reduces the reliability for transmission through Transmitter No. 2 is eliminated. Other situations can be investigated in a similar manner.

If the conventional product rule for system reliability is used without consideration either of the manner in which the parts are interconnected or of the actual definition of successful performance, the reliability formula for the telemetering system is

$$P_s = ABCDE a^3 b^{25}. \quad (4)$$

This formula, which includes the assumption that all a 's and b 's are equal to a and b , respectively, is evaluated as Situation 4. As can be noted, the resulting prediction of 0.444 is lower by nearly a factor of two when compared with the prediction for Situation 1.

Situation 5 shows that when the product rule is used the unreliabilities of the various parts must be decreased by factors of four in order to set a system reliability roughly equivalent to Situation 1. When the effect of the system redundancy is included in the reliability prediction, and successful performance is defined as the transmission of signals representing all variables (Situation 6), the reliability formula is

$$P_s = ABD a^2 b^{15} [1 + (1 - ab^{10})(C + E - CE)]. \quad (5)$$

As anticipated, the predicted reliability of 0.749 obtained using this formula is higher than for Situation 4, but it is again less than for Situation 1.

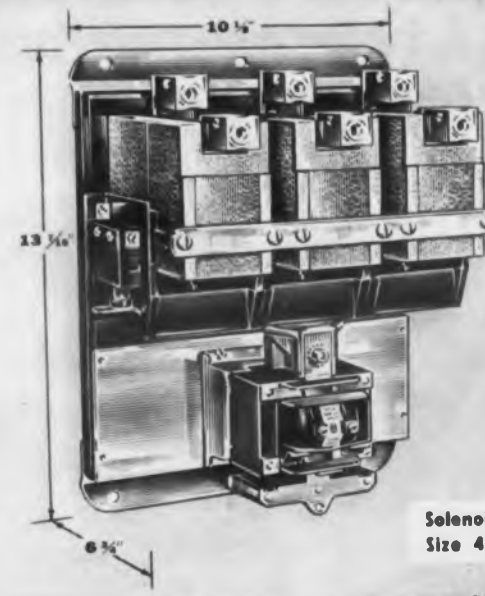
The principal significance of the comparison between the predictions for Situations 1, 4, and 6 is that the more nearly the reliability formula approximates the characteristics of the actual system and the engineering requirements for success, the more valid and useful is the reliability prediction. If the specified reliability for this particular system is indeed 0.8, the prediction obtained using the technique proposed in this paper indicates that the present design is adequate. The erroneously low prediction obtained using either eq (4) or eq (5) would result in substantial additional work on system design and part improvement. If the designer wisely wishes to include a safety factor in the predicted reliability, the reliability diagrams and formulas for Situation 1 enable him to determine quickly the places in the system where design changes—for example, Situation 3—or increases in part reliability are most beneficial. In fact, the greatest advantage of this technique is not that the reliability predictions are usually higher than those obtained by other methods, but rather that it leads to effective and economical plans for improving system reliability.

For further information on this reliability-prediction technique, and for derivations of exponent weighting factors and representation of statistical dependency see 1. the IRE Convention Record, Vol. 5, Part 10, 1957 and 2. reference (6).

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			440-550	100	
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			220	30	
			440-550	60	
Service	8-Hour Ampere Rating	Single Phase Volts	Single Phase K.W.	Three Phase Volts	Three Phase K.W.
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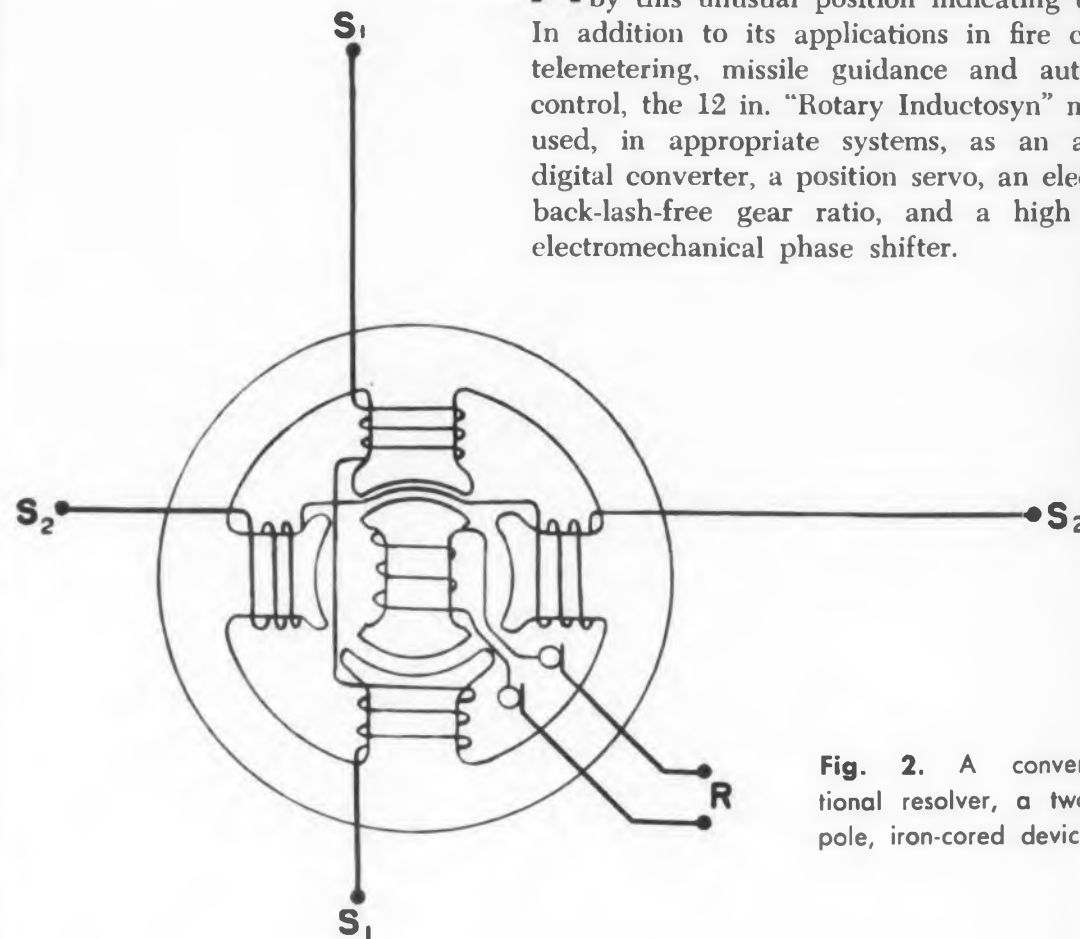


Fig. 2. A conventional resolver, a two-pole, iron-cored device.



Fig. 1. The "printed" silver conductors of the rotor (top) and stator are etched on a glass disc.

Element

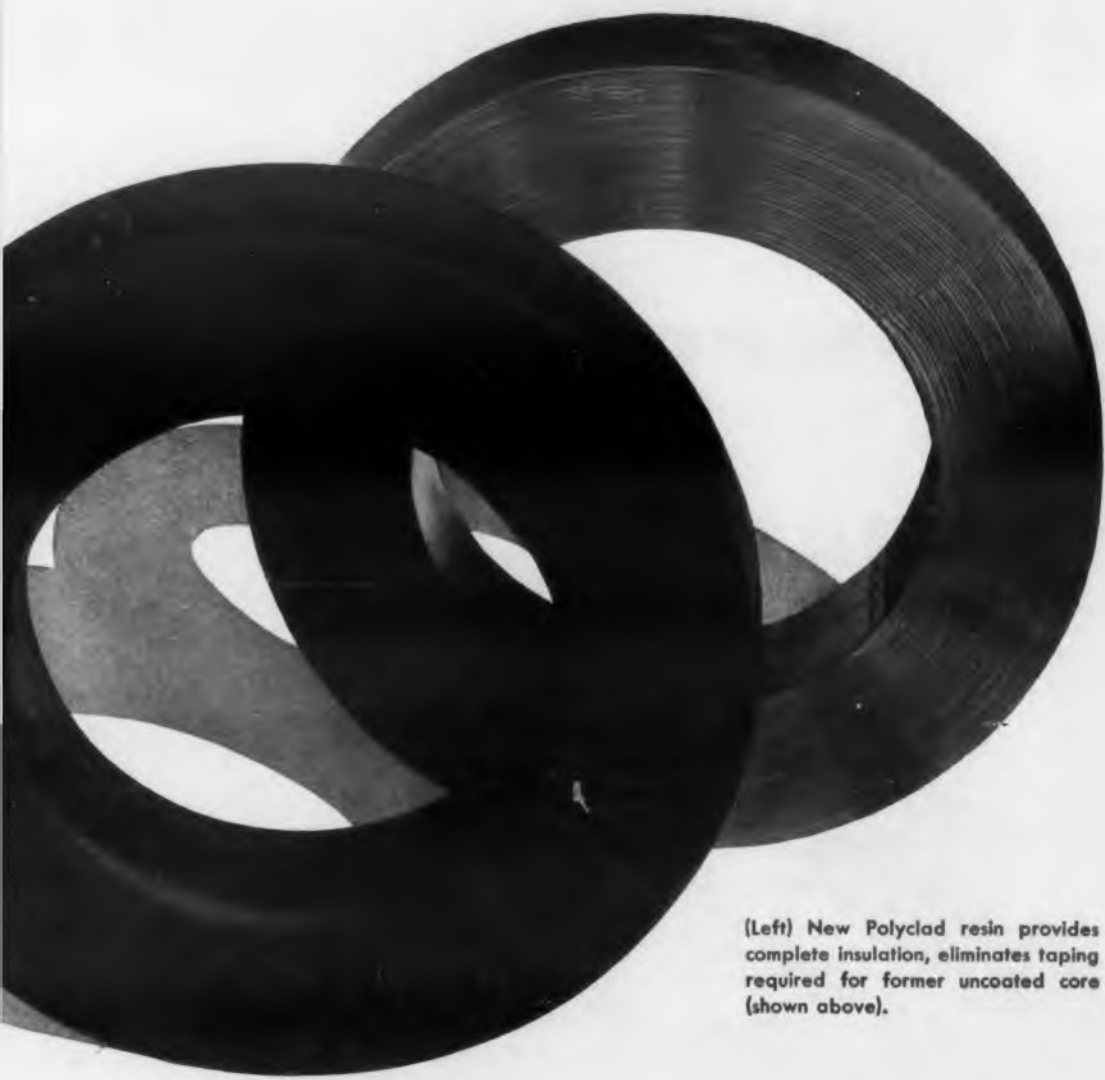
The "Inductosyn," a two-phase device manufactured by Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y., utilizes the inductive coupling between a pair of silver patterns on parallel glass discs, about 12 in. in diameter. A .01 in. air gap separates the stator disc from the rotor which is directly coupled to the rotating shaft. The stator (Fig. 1), is divided into successive sectors, out of phase with each other by one-quarter cycle. Leads are brought through the glass to prevent interference with rotor and stator magnetic fields. Due to the low coefficient of coupling, a high-frequency oscillator (10 kc) is used for excitation.

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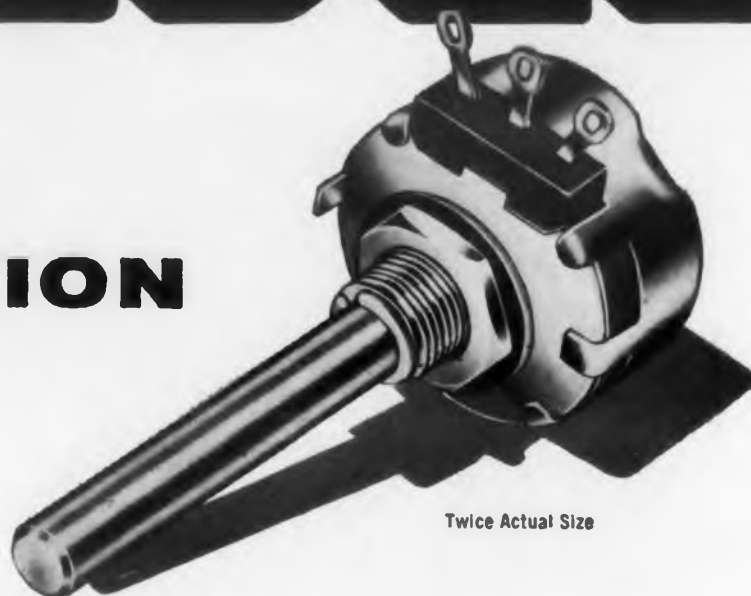
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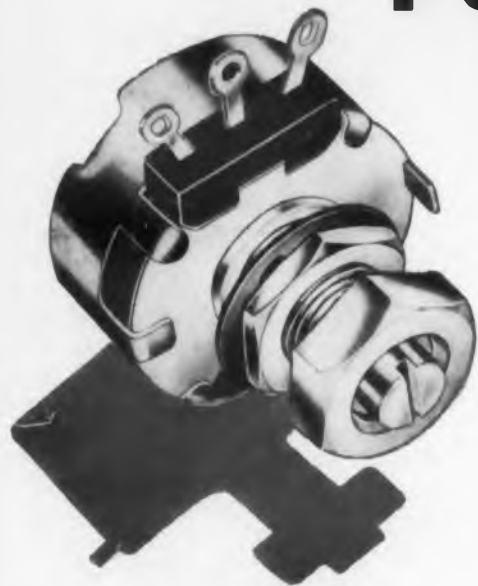
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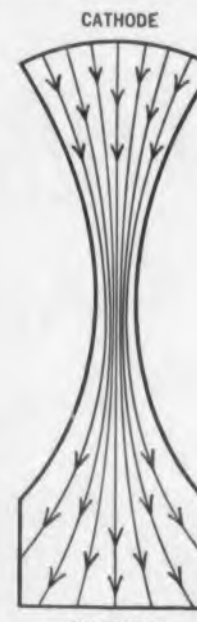
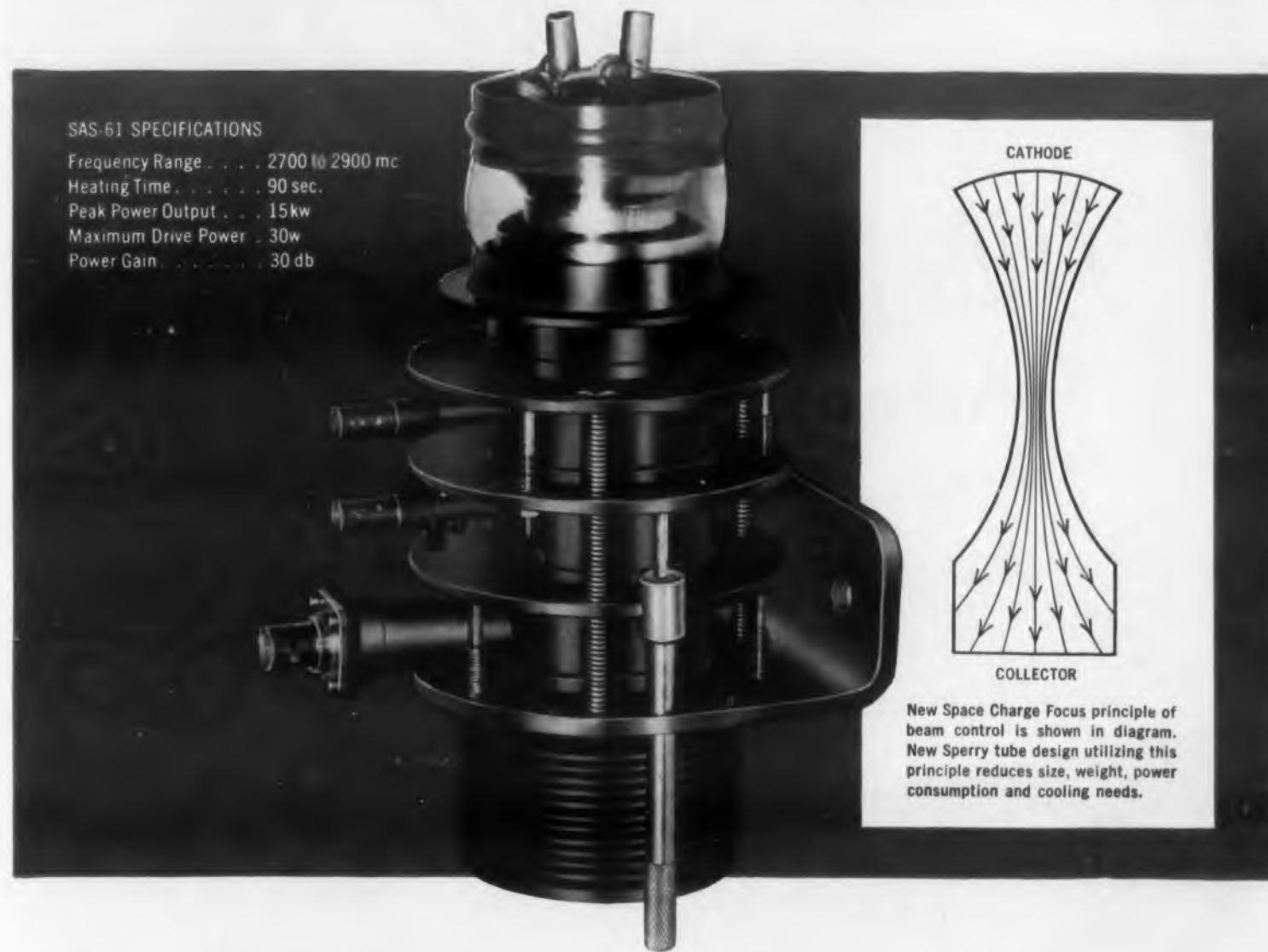
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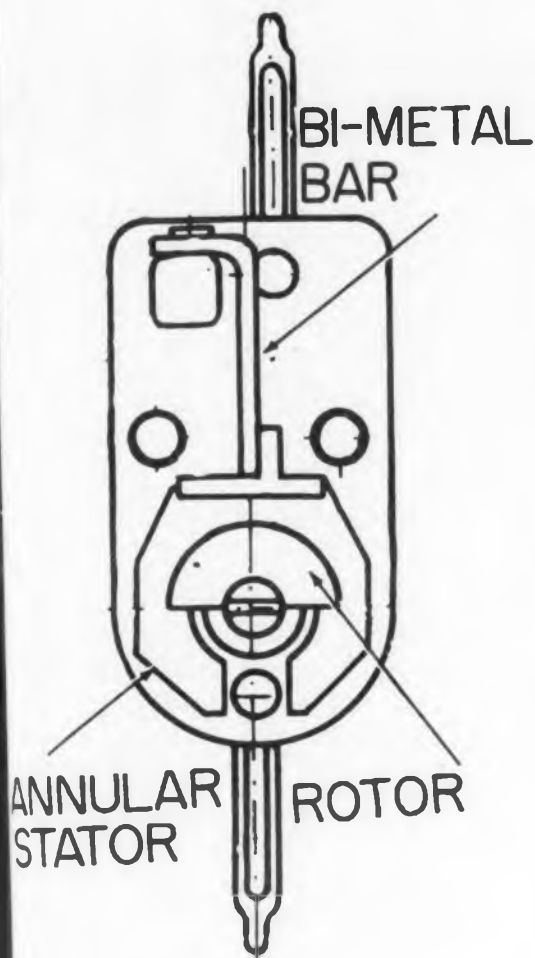
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structure of variable temperature efficient trimmer. The semi-circular electrode moves on a bimetal rod. The amount of temperature compensation is determined by the trimmer setting. Nominal capacity at room temperature is 6.5 μf .

$I = \frac{E}{\sqrt{R^2 + (WL - \frac{1}{wc})^2}}$

FORMULA for LONG LIFE

THE KEY COMPONENT

$Z = \sqrt{R^2 + (WL - \frac{1}{wc})^2}$

$f = \frac{1}{2\pi LC}$

El-Menco Dur-Mica CAPACITORS

Rugged Endurance up to 18 years!

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Capacitors

Editor's Note: Part I, which appeared in the Aug. 15 issue, investigated meters intended for laboratory measurements. Part III will investigate meters which could have been included in either the Laboratory or Service Groups, but because of their unusual features they are given the catch-all designation—Special Group. It will appear in the Sept. 15 issue.

VTVM Survey—II

Sol Prensky

VACUUM-TUBE voltmeters intended for general-purpose maintenance measurements are analyzed in Part II of the survey. A representative cross-section of these meters has been investigated and pertinent information listed in tabular form. The survey is offered to aid the engineer in choosing a VTVM best suited to his needs. Meters included in Part II are priced at less than \$150.

Circuit Type

The last column of the tabulation lists circuit design features and places each meter in one of four general circuit types. Circuit Types 1 and 2 employ dc amplification and circuit Types 3 and 4 ac amplification. A detailed discussion of the circuit types is given in Part - I of the survey.

Circuit Type 1: This circuit is a straight dc amplifier and is generally used in a symmetrically balanced form. Amplifier gain stability is greatly improved by feedback, especially when more than one stage of amplification is used. Grid current, which is an inherent characteristic of the input tube, is not changed essentially by feedback, as is sometimes believed. In spite of grid-current limitations of around 10⁻¹¹ amp, many special applications using electrometer type tubes are in commercial use. When the single-stage balanced bridge is preceded by a rectifier, it becomes a Type 2 circuit.

Circuit Type 2: A rectifier plus a single

SERVICE METERS

Manufacturer	Model & Price	DC Scales				AC Scales				Power Tube Compliment	Accessories	Circuit Design Features
		Voltage Range	Impedance Megohms	Accuracy Per Cent	Resistance Ranges—Ohms (CS) Center of Scale	Voltage Range	Impedance Megohms	Accuracy Per Cent	Freq. Range			
Allied Radio 100 N. Western Ave. Chicago 80, Ill.	83Y125 Knight-Kit \$24.95	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	.2—2 Meg. 75—50 μmf	±5	30 cps to 3 mc	AC (1) 6AL5 (1) 12AU7 (1) Sel. Rect.	Available: HV probe to 50 kv; HF probe extends ac to 250 mc. Provided: DCV, ACV, Ohms probe.	Type 2. Circuit: Rectifier and balanced bridge; printed circuitry. Peak to Peak voltage range from 4-4000.
American Chronoscope Corp. 106 W. First St. Vernon, N.Y.	601 \$79.50	3—1200 (6 ranges)	13	—	1—100 Meg. (6 ranges)	3—300 (5 ranges)	6 (approx.)	—	—	BATT (2) 3V4 (1) 1A3	Batteries and dc probe included.	Type 2. Circuit: Feedback in battery-powered circuit. DC milliammeter with 6 ranges from 0.3 ma. to 0-1200 ma. at 300 mv drop.
Cornell-Dubilier Electric Corp. 100 Hamilton Blvd. Plainfield, N.J.	BF 100 \$59.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	—	±5	—	AC (1) 12AU7 (1) 6AL5	Available: HV, DC probe to 30 kv; RF probe to 30 v at 250 mc. Provided: DCV, ACV probe.	Type 2. Circuit: Peak to Peak voltage ranges from 4-4000.
Electronic Design 100 School St. Yonkers, N.Y.	100 \$52.50	3—100 (6 ranges)	11	±3	1—1000 Meg. (6 ranges)	10—1000 (5 ranges)	1000 ohms/v	±5	—	AC	Provided: Test Leads, DC probe and batteries. Available: Ediprobe, HF and HV probes.	Type 2. Circuit: Null detector position for FM TV alignment.
Radio-Electronic Inst. Co. Inc. 100 Withers St. Brooklyn, N.Y.	232 KIT \$29.95 (Wired \$49.95)	1.5—1500 (7 ranges)	11	—	0.2—1000 Meg. (7 ranges)	1.5—1500 (7 ranges)	—	—	—	AC (1) 12AU7 (1) 6AL5	Provided: Probe with internal switch for all functions. Available: HV probe to 30 kv and RF probe to 250 mc.	Type 2. Circuit: Zero-center position provided. Peak to Peak voltage ranges from 4-4200.
Electronic Measurement Co. 100 Lewis St. & Maple Ave. Montclair, N.J.	106 KIT \$23.90 (Wired \$35.90)	1.5—1000 (5 ranges)	16.5	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	1.5—1000 (5 ranges)	2	±5	25 cps to 200 kc	AC (1) 12AU7	Available: HF probe to 250 mc; HV probe to 30 kv. Provided: DCV, ACV, Ohms probes.	Type 1. Circuit:
	107 KIT \$34.50 (Wired \$48.90)	1.5—1000 (6 ranges)	16.5	±3	Rx1—Rx1 Meg. (6 ranges) 10 (CS)	1.5—1000 (6 ranges)	1.5	±5	25 cps to 200 kc	AC (2) 12AU7	Available: HV probe to 30 kv and HF probe to 250 mc. Provided: DCV, ACV, ohms probe.	Type 2. Circuit: Measures capacity (6 ranges). Peak to Peak voltage ranges from 4-2800.
M. Harrison Labs. 100 Winchester St. Newton Highlands 61, Mass.	735 \$159.95	0—1000 (4 ranges)	13.3 with multiplier 38.3	±4	Rx1—Rx1 Meg. (4 ranges) 20 (CS)	0—1000 (4 ranges)	—	±6 100 v ±7 over 100 v	5 cps to 50 kc	AC (1) 5751 (1) 5814 (1) 5726	Available: HF probe 1kc—100 mc.	Type 2. Circuit: Log. Scale Meter DC current 0-1000 ma ±5. Peak to Peak voltage ranges from 0-3000.
Radio Shack Co. 100 Territorial Rd. Ann Arbor 4, Mich.	V-78 KIT \$24.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges) 4—4000 V P to P	750 k 25 μmf	±5	60 cps to 7 mc	AC (1) 12AU7 (1) 6AL5	Available: HV probe to 30 kv and RF probe to 250 mc.	Type 2. Circuit: Printed circuit etched copper foil. .00135 on 3/32 in. xyp laminated phenolic. Peak to Peak voltage ranges from 0-1400.
Radio Shack Electrical Inst. Co. 100 Dupont Ave. Cleveland 8, Ohio	209A \$140.25	3—1200 (6 ranges) zero center	12	±3	Rx1—Rx1 Meg. (8 ranges) 100 (CS)	3—1200 (6 ranges)	12 7 μmf	±5	50 cps to 150 mc	AC (1) 6AL5 (2) 6X5GT (1) 6SJ7 (1) 6SN7	Provided: Inductance conversion chart and AC and DC probes.	Type 2. Circuit: Rectifier and balanced bridge circuit. Peak to peak voltage ranges from 3-300.
	225 KIT \$59.50	1.5—1200 (7 ranges) zero center	10.5	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1200 (7 ranges)	10 150 μmf	±5	40 cps to 3 mc	AC (1) 12AU7 (1) 6AL5	Provided: Single unit AC-DC probe.	Type 2. Circuit: Continuity test provided by audio tone. Peak to peak voltage ranges from 4-3200.
	415 \$82.50	1.5—1500 (7 ranges)	13.3	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	15 150 μmf	±5	40 cps to 3 mc	AC (1) 12AU7 (1) 6AL5	Provided: AC-DC probe ohm leads.	Type 2. Circuit: Rectifier (6AL5) and balanced bridge (12AU7) circuit.
Radio Mfg. Co. 100 E. Colorado St. Redden 8, Calif.	614	1.5—1500 (7 ranges)	11	±3	0—1K— 0—1000 Meg. (6 ranges)	1.5—1500 (7 ranges)	1 60 μmf	±5	30 cps to 3 mc	AC 6w (2) 6AL5 (1) 12AU7	Provided: Auxiliary probe jack for rf crystal probe.	Type 2. Circuit: One-half of second 6AL5 bucks out contact potential, and second-half acts as power-supply rectifier.
Radio Elec. Inst. Co. Inc. 100 S. Patterson Bl. Canton 2, Ohio	709 \$95.00	1.0—1000 (7 ranges)	11	—	0—1000— 0—1000 Meg. (7 ranges)	1—1000 (7 ranges)	0.2 150 μmf	—	4.5 mc	AC (1) 12AU7 (2) 6AL5	Provided: Single probe with switch for DC, AC, ohms. Available: HV probe to 30 kv and HF probe to 200 mc.	Type 2. Circuit: One-half of second 6AL5 bucks out contact potential, and second-half acts as power supply rectifier. Identilite windows illuminate the selected function and large scale in use. Peak to Peak voltages range from 2.8-2800.

SERVICE METERS

Manufacturer	Model & Price	DC Scales				AC Scales				Power Tube Compliment	Accessories	Circuit Design Features
		Voltage Range	Impedance Megohms	Accuracy Per Cent	Resistance Ranges—Ohms (CS) Center of Scale	Voltage Range	Impedance Megohms	Accuracy Per Cent	Freq. Range			
Measurements Corp. Boonton, N.J.	62 \$135.00	1—100 (5 ranges)	—	±2	—	1—100 (5 ranges)	—	±2	30 c to 150 mc	(1) 6H6 (1) 5W4 (2) 6C5		Type Circuit: Designed with stabilized, balanced degenerative amp. to make possible the changing of dc voltage ranges without readjustment of zero for each range.
Phaotron So. Pasadena, California	777 \$74.95	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 9.1 (CS)	1.5—1500 (7 ranges)	—	±5	30 cps to 1 mc	(1) 6AL5 (1) 12AU7	Available: HV probe to 50 kv. DC, RF probe to 400 mc 10 per cent.	Type 2. Circuit: Rectifier (12AL5) and balanced bridge (12AU7) circuit. Peak to peak voltage ranges from 0-4000.
Precise Development Corp. 2 Neil Court Oceanside, N.Y.	9071 KIT \$35.95	5—1000 (5 ranges)	25	±2	Rx1—Rx1 Meg. 10 (CS)	5—1000 (5 ranges)	3	±3	30 cps to 1 mc	AC (1) 6AL5 (1) 6X5 (1) 6SN7 (1) 0A2	Available: RF probe to 250 mc; HV probe to 50 kv. Provided: DC, AC, ohms lead.	Type 2. Circuit: Voltage regulated.
	909 KIT \$25.95 (Wired \$37.50)	5—1000 (5 ranges)	25	±2	Rx1—Rx1 Meg. 10 (CS)	5—1000 (5 ranges)	3	±3	30 cps to 1 mc	AC (1) 6AL5 (1) 6X5 (1) 6SN7	Available: RF probe to 250 mc; HV probe to 50 kv. Provided: DC, AC, ohms lead.	Type 2. Circuit:
Precision Apparatus Inc. 70-31 84 Street Glendale 27, L.I.	68 \$54.50	3—1200 (5 ranges)	13	—	— (5 ranges)	3—1200 (5 ranges)	.5	—	—	AC (1) 12AU7 (2) 6AL5	Provided: Single probe with switch for all ranges.	Peak to peak voltage range from 3-1200.
Radio City Products Co. Inc. Centre & Glendale Sts. Easton, Pa.	655 \$59.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	1 40 μmf	±5	3 mc	AC (1) 6AL5 (1) 12AU7	Available: HV probe.	Type 2. Circuit: Peak follower rectifier and balanced bridge (12AU7) circuit. Peak to peak voltage ranges from 4.2-4200.
	65 \$99.85	1.5—1500 (7 ranges)	11	±3	Rx1—Rx10 Meg. (8 ranges) 10 (CS)	1.5—1500 (7 ranges)	1 95 μmf	±5	3 mc	AC (1) 6AL5 (1) 12AU7	Provided: Jack for 6 kv DC or AC. Available: HV probe to 30 kv.	Type 2. Circuit. Six ranges of capacity 1 μmf to 1000 μmf. Peak to peak voltage range from 4.2-4200.
Radio Corporation of America Camden, N.J.	WV77C \$59.50	0.05—1200 (5 ranges)	11	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	0.1—1200 (5 ranges)	1 50 μmf	±5	30 cps to 3 mc	AC (1) 12AL5 (1) 12AU7	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit. Rectifier (12AL5) and balanced bridge (12AU7).
	WV87B \$137.50	0.1—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	0.05—1500 (7 ranges)	1.3 80 μmf	±3	30 cps to 3 mc	5W (1) 12AU7 (2) 6AL5	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit: Rectifier (6AL5) and balanced bridge (12AU7). Peak to peak voltage ranges from 0.2-4200.
	WV98A \$79.50	0.02—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	0.05—1500 (7 ranges)	1.3 60 μmf	±3	30 cps to 3 mc	AC (1) 6AL5 (1) 12AU7	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit. Rectifier (6AL5) and balanced bridge (12AU7). Peak to peak voltage ranges from 0.2-4200.
Radio Kits Inc. 120 Cedar St. New York, N.Y.	O-12	3—1000 (5 ranges)	11	—	0—1000— 0—1000 Meg. (5 ranges)	3—1000 (5 ranges)	6.5	—	—	AC (1) 6SN7 (1) 6H6 (1) 6X4		Type 2. Circuit:
Simpson Electrical Co. 5200 W. Kenzie St. Chicago, Ill.	303 \$68.00	1.2—1200 (5 ranges)	10	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	1.2—1200 (5 ranges)	275 k 200 μmf	±5	25 cps to 100 kc	AC (1) 6AL5 (1) 12AU7	Available: HF probe 20 kc to 100 mc (20 v max.); HV probe 30 kv. Provided: AC-DCV, ohms probe.	Type 2. Circuit: Rectifier and balanced bridge.
Teletronics Lab. 54 Kintel St. Westbury, L.I.	VM236 \$125.00	—	—	—	—	.01—300 (10 ranges)	1	±5	10 cps to 200 kc	AC (2) 12AT7 (1) 6C4		Type 3. Circuit: Cascade amplifier.
	VM237 \$95.00	1.5—1500 (7 ranges)	10	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	10	±5	50 cps to 5 kc	AC (1) 12AU7 (1) 6AL5		Type 2. Circuit: Rectifier (6AL5) and balanced bridge (12AU7). Peak to peak voltage ranges from 4-4000.
Triplet Elec. Inst. Co. Bluffton, Ohio	650 \$89.50	1—1000 (7 ranges)	11	±3	Rx1—Rx1 Meg. (6 ranges) 10 (CS)	1—500 (6 ranges)	1.4 13 μmf	±3	15 cps to 110 mc	AC 6.5W (1) 12AU7 (2) 6AL5	Available: HV probe to 50 kv. Provided: DCV, ohms lead, ac-rf shielded tube probe.	Type 2. Circuit: Rectifier and balanced bridge circuit; meter shorted in off position for damping when carrying. Peak to peak voltage ranges from 2.8-700. Thirty per cent accuracy at 110 mc.
Weston Electrical Instrument Corp. 614 Frelinghuysen Ave. Newark, N.J.	982 \$76.50	1.6—1600 (7 ranges)	10	±3	Rx1—Rx10 K (7 ranges) 25—250 K (CS)	1.6—1600 1.6—1200 (7 ranges)	2.8 1.0	±5	20 cps to 1.5 kc	DC OP. (1) CK 548 DX	Available: RF probe to 250 mc; HV probe to 20 kv. Provided: Low cap probe, isolation probe, shielded cable leads.	Type 2. Circuit: Rectifier and balanced bridge with 2 gm bonded germanium diode CK 740. Peak to peak voltage ranges from 1.6-1600.



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- 4 microvoltmeter

... and can
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a beating

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This reliable, general purpose unit is ideal for use as a direct reading indicator for strain gage, thermocouple and other current or voltage measurements in industry or laboratory. The 204A's simplicity of operation makes it the key to efficient production line testing. Its unequalled stability makes it ideal for low level DC amplification to extend the range of recording and other measurement instruments.

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- Less than 1 Microvolt P-P Noise

Model 204A Price \$325.00

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stage balanced-bridge dc amplifier make up this circuit. It is widely used for providing a combination of ac and dc voltage ranges. It can be readily adopted to resistance and peak-to-peak ranges, especially for service work. When used for laboratory ac measurements, this circuit is capable of covering a frequency range up to 300 mc, if maximum voltage sensitivity is not a prime consideration. The nonlinearity of the rectifier limits accuracy in low-voltage measurements. Lowest full scale range is usually 10 to 1 v, if the wide-frequency capability is retained.

Circuit Type 3: Particularly suitable for measuring small ac voltages. This type employs an ac amplifier-plus-rectifier circuit. It has wide use in audio and low frequency applications where it is often provided with logarithmic meter indications. For laboratory use, it appears most often in an arrangement having a frequency-compensated, constant-impedance input for a multi-stage ac amplifier, with large amounts of feedback to stabilize gain and expand bandwidth. Shunt capacitance in the input circuit is fairly high, but generally acceptable for applications up to 10 mc. Lowest full-scale ranges are usually around 0 to 10 mv. Overload protection is obtained from the buffer action of the amplifier.

Circuit Type 4: This type uses a modulator for conversion of dc to ac, plus a rectifier circuit. It is capable of very high dc voltage sensitivity at a high input impedance. With chopper dc to ac conversion, only a narrow frequency response of the amplifier is required, since it need cover only the driver frequency as expanded by the rate of the dc input variation. Use of large amounts of feedback in the multi-stage ac amplifier allows improvement of stabilized gain and higher input impedance. In a pH application, input impedance can be made to exceed 100 megohms.

When a modulator of the capacity type is used for dc to ac conversion, an input impedance as high as 10^{15} ohms is achieved and measurement of very small voltages from a high-resistance source can be made. Current measurements in the micromicroampere range are attainable. At measurement levels or around 100 mv, zero stability of this circuit becomes better than that of the chopper type.

The less common galvanometer-type modulator allows full-scale measurements as low as 0 to 10 μ amp at a 50 ohms input resistance, with long-term stability ± 0.2

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Radio frequencies up to 250 mc can be switched by this coaxial switch making possible the use of one detector for signal comparisons.

250 Mc Coaxial Sw

A COAXIAL switch which can handle rf signals up to 250 mc makes it possible to use one detector for both the reference circuit and the unit being tested. Consequently, the possibility of error caused by non-identical detectors is avoided.

The switch manufactured by Jerrolds Electronic Corp., 23rd and Chestnut Sts., Philadelphia 3, Pa., utilizes two Clare Mercury Wetter switch elements mounted in a coaxial circuit. The unit has a maximum current rating of 5 a at 50 v and can be supplied for either 50- or 75-ohm lines with a vswr of less than 1.08 from 0 to 25 mc. The insertion loss of the unit is approximately 1/2 db.

Telemeter Decommutation Sy

A 27-channel, completely self-contained decommutation system has been developed for use in airborne or trailer-installed telemeter receiving stations and in portable ground check-out equipment. The system, consisting of a gating unit, a pulse selector, and a regulated power supply, occupies 19-1/2 in. of panel height with an overall depth of 13 in. Two spare module gating units are maintained on standby for instant use.



This twenty-seven channel decommutation system consists of a gating unit (top), a pulse generator (middle) and a regulated power supply (bottom). The system measures 19-1/2 in. high and 13 in. deep.

a Switch

The switching functions are controllable by a blocking oscillator synchronized to some sub-multiple of the 60 cps of the line. Synchronization is obtained by varying a potentiometer through a screwdriver control. A phase reverse switch and a phasing control are provided for adjusting the phase with respect to the line. Gain adjustment is obtainable with the use of an rf attenuator which must be connected externally to the switch.

When used in conjunction with an oscilloscope, the switch displays two voltages simultaneously for qualitative measurements, making point-by-point analysis unnecessary.

For additional information concerning this coaxial switch, fill out the enclosed Reader's Service Card and Circle 25.

System

All standard RDB inputs, either PAM or PDM, at any repetition rate from 2-1/2 to 40 rps, and either single-ended or push-pull signals are accepted. Outputs may be operated single or double ended. The overall linearity is within 1/2 per cent at maximum signal level. Circuitry design does not reflect errors produced by center frequency drift of subcarrier oscillators, drift of discriminator dc output level, or playback speed errors. Long term level drift is within 1/2 per cent and gain drift is negligible.

The system, manufactured by Arnoux Corp., 11924 West Washington Blvd., Los Angeles 66, Calif., includes a built-in test selector which permits visual inspection of waveforms throughout for rapid malfunction detection. Neon indicators on each gating unit give continuous visual indication of correct sequence operation.

Miniaturization is accomplished through the use of seventy-six tubes in the design as compared to a hundred in similar systems. Modular construction permits the expansion of the system to any desired capacity.

The power required by the unit is 115 v, 60 cps single phase. An optional 115 v, 400 cps power supply is available for airborne use.

Further information on the decommutation system may be obtained by filling out the enclosed Reader's Service Card and circling 26.



At Boeing, Seattle, Washington

MIL-W-5086 low tension airframe wire is used in low voltage circuits throughout the B-52 Intercontinental Jet Bomber.

At Douglas, El Segundo, California

MIL-W-5274A hook-up wire is used in the electrical, radio and radar components of the A4D Skyhawk and F4D Skyray.



At Western Electric, Burlington, N. Carolina

MIL-W-76A is used extensively in the Nike Ajax guided missile system.



At Raytheon, Waltham, Massachusetts

MIL-W-16878B high temperature hook-up wire is used in classified airborne navigation and bombing radar.

CLASSIFIED



At Chance-Vought, Dallas, Texas

MIL-C-7078A shielded air frame wire is used near radio and radar apparatus to assure distortion-free operation of electronic equipment on the F7U-3 fighters.

At Burgess Battery, Freeport, Illinois

JAN-C-76 general purpose hook-up wire is used to interconnect cells of dry batteries for portable military equipment.



At North American Aviation, L. A., Calif.

MIL-C-17B coaxial cable is used in high frequency radio and radar circuits on the F100 Super Sabre fighters.

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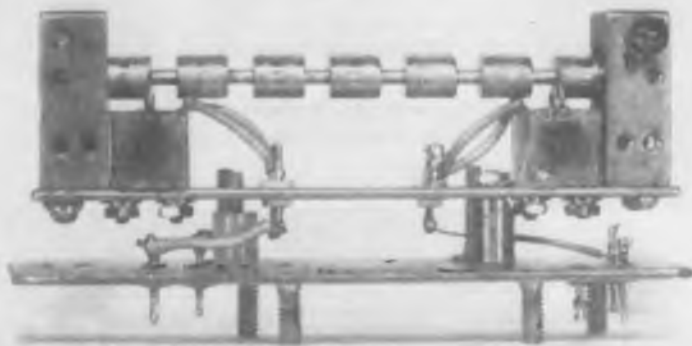
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Ferrite Transducers for Electromechanical Filters

Glyndon S. Hipkind
Radio Corporation of America

In any magnetostrictive transducer the efficiency of operation depends upon the magnetostrictive activity of the core or resonator material. One useful way to express this efficiency is by the coefficient of coupling between a given coil and the associated core. The coil with core in place may be represented by the equivalent circuit shown in Fig. 1. In this figure, L is the inductance of the coil with resonator in place, K is the coefficient of coupling, and C is the distributed capacitance of the coil plus any external capacitance necessary to resonate the coil. The antiresonant frequency of the parallel branch of the circuit is the same as the natural frequency of the resonator; the Q of the parallel branch is the same as the mechanical Q of the resonator. The impedance of the parallel branch may be expressed as

$$Z_p = \frac{j\omega K^2 L}{1 - \omega^2 K^2 LC} \quad (1)$$

For the frequency where the circuit is series resonant, the total impedance Z will be equal to zero, neglecting the resistance of the coil.

Let ω_2 be the series resonant frequency; then,

$$Z = j\omega_2 L + \frac{j\omega_2 K^2 L}{1 - \omega_2^2 K^2 LC} = 0 \quad (2)$$

and

$$K^2 = \frac{1}{\omega_2^2 LC - 1} \quad (3)$$

Let ω_1 be the frequency at which the parallel branch of the circuit is at resonance (antiresonance condition); therefore:

$$LC = \frac{1}{\omega_1^2 K^2} \quad (4)$$

An interesting application for the magnetostrictive property of ferrites is in an electromechanical filter. Such a filter, which can be an extremely selective band-pass device, consists of an input transducer, a section of mechanically coupled resonant elements tuned to a specific frequency, and an output transducer. Ferrite rods or cores are used as the input and output transducers. Assume that a small ferrite rod having relatively high magnetostrictive characteristics is placed in a coil in such a manner that the rod is free to vibrate. Then a small permanent magnet is placed near the coil assembly to supply a biasing effect on the core. If the coil assembly is excited with an ac signal, the circuit can be tuned by means of capacitor so that the coil energy is absorbed by the core. The core is mechanically resonant and the energy of the coil is used to provide mechanical motion to the core.

Such a device is a transducer converting electrical energy to mechanical energy. A reversal of energy conversion can also take place. If the core is provided with mechanical motion, it will induce a current in the coil at the same frequency as the mechanical motion of the core. The important parameters for the evaluation of a ferrite rod for transducer applications and methods for the measurement of these parameters are described in this article. Empirically obtained values for these parameters are given for rods having differences in size, composition, and firing conditions. In conclusion, performance data including frequency-response and temperature stability characteristics are given for a developmental electromechanical 200 kc filter utilizing ferrite-rod transducers.

Substituting the value of LC from eq (4) in eq (3),

$$K = \frac{(\omega_2 + \omega_1)(\omega_2 - \omega_1)}{\omega_1^2} \quad (5)$$

If it is assumed that $\omega_2 \approx \omega_1$, then

$$K = \frac{1}{\sqrt{2}(\omega_2 - \omega_1)} = \frac{1}{\sqrt{2}(f_2 - f_1)} \quad (6)$$

The coefficient of coupling K , therefore, can be determined with eq (6) from f_2 , the series resonant frequency of the circuit, and f_1 , the natural resonant frequency of the core.

Natural Resonance and Propagation Velocity

The resonant frequency of the ferrite core is a function of the velocity of propagation of sound through the body, Young's modulus, the length of the core, and the density of the core material. For

rods vibrating in the longitudinal mode, this frequency is expressed by

$$f_1 = \frac{M}{2l} \left(\frac{E}{\rho} \right)^{\frac{1}{2}} \quad (7)$$

Where f_1 is the frequency in cycles per second, n is a small integer (for the fundamental frequency, $n = 1$; for the second harmonic, $n = 2$; etc.), l is the length of the rod in meters, ρ is the density of the rod in kilograms per meter³ and E is Young's modulus in newtons per meter². The expression $(E/\rho)^{\frac{1}{2}}$ is equal to the velocity of propagation in meters per second.

Because the rod is not affixed at either end, it is free to vibrate as a half-wave resonator. The velocity of propagation of sound through the ferrite medium, therefore, is given by:

$$V = f_1 \lambda \quad (8)$$

Where v is the velocity of propagation, f_1 is the resonant frequency, and λ is the full-wave length, $\lambda = 2l$, in meters.

Testing Procedures

The coefficient of coupling may be measured by means of the circuit arrangement shown in Fig. 2. The frequency of the signal generator is adjusted until the voltmeter reading is a minimum. This reading indicates the antiresonant condition: the impedance of the coil is a maximum and the current is a minimum. This frequency is recorded as f_1 . The frequency of the signal generator is then increased until the voltmeter reading is a maximum. This reading indicates the series-resonant condition. The frequency at this point is recorded as f_2 . The coupling coefficient may now be calculated from eq (6). The coefficient of coupling depends to some extent upon the coil design. Such factors as how close the winding is to the core, how long the coil is with respect to the core, and how the cores fit into the coil form affect the coefficient values.

Initial Permeability

Another characteristic of importance is the initial permeability of the core material. Because of its relationship to the termination impedance of a filter using ferrite transducers, the permeability of the ferrite must be controlled within very close limits. Since the ferrite is in the form of a rod instead of a ring, this property can be controlled by measuring the effective permeability in place of the actual ring permeability. The effective permeability is defined as the ratio of the inductance of the coil with core inserted to the inductance of the coil with an air core. This effective permeability — μ_{eff} — is measured with a Q-meter and may be expressed

$$\mu_{eff} = \frac{C \text{ (coil only)}}{C \text{ (coil with core)}} \quad (9)$$

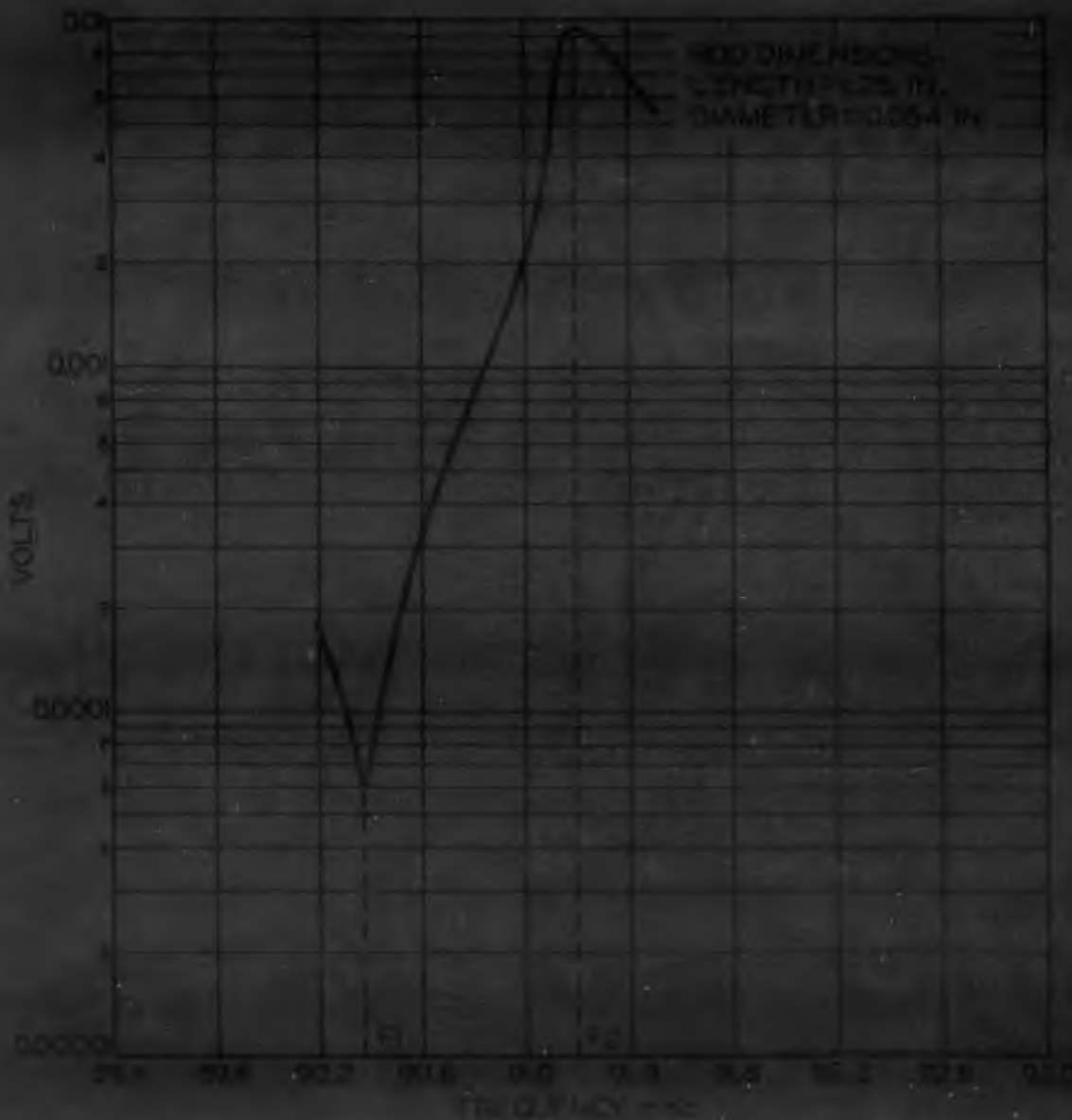
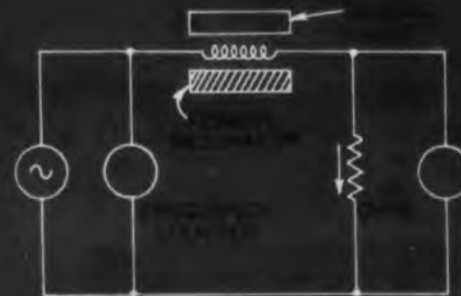
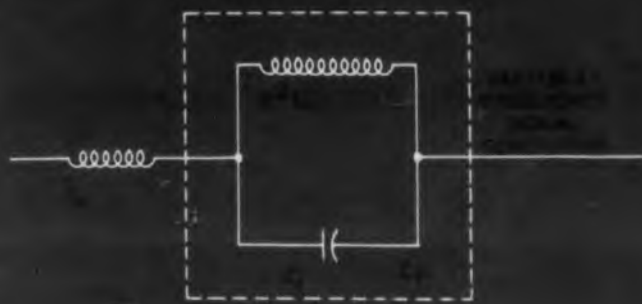
The capacitance C indicated on the meter for both conditions is measured at the same frequency.

Frequency Stability

The frequency stability of the core depends on the change of permeability of the ferrite resonator with temperature as well as the magnetostrictive quality. The exact extent of this change, expressed as a temperature coefficient, depends upon the composition and processing conditions. This temperature coefficient is most easily determined by measurement of the resonant frequency of the ferrite resonator at different temperatures. The coefficient is expressed as follows:

$$a = \frac{f_{t_2} - f_{t_1}}{(t_2 - t_1) f_{t_1}} \times 10^6 \quad (10)$$

where a is the temperature coefficient in cycles per mc, f_{t_1} is the resonant frequency at room tem-



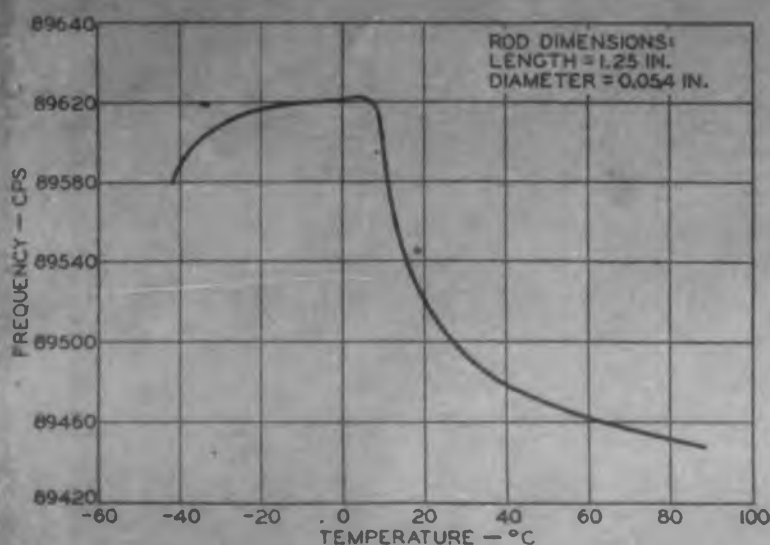


Fig. 4. Temperature stability characteristic of a 100 kc ferrite resonator.

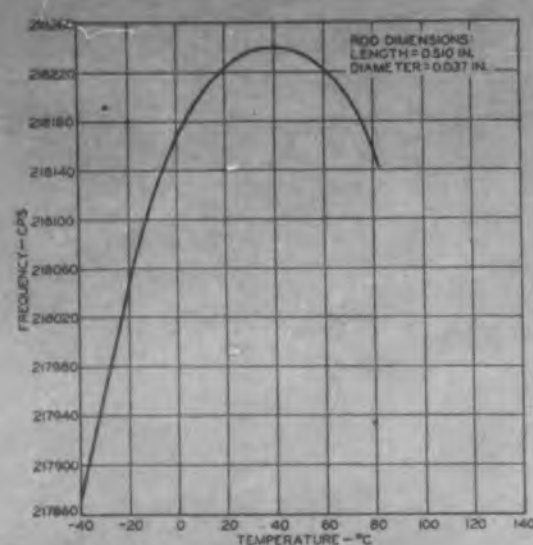


Fig. 5. Temperature stability characteristic of a 200 kc ferrite resonator.

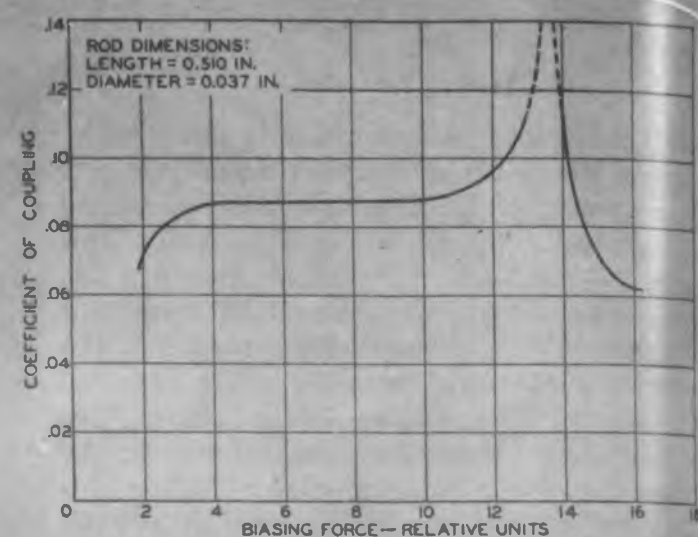


Fig. 6. Effect of change in biasing force on coefficient of coupling.

perature t_1 , in deg C and f_{12} is the frequency at any other temperature, elevated or reduced, t_2 . The resonant frequency for determining the temperature coefficient is measured in the same way as the resonant frequencies for the coupling coefficient.

Experimental Results

Fig. 3 shows a typical frequency-response curve of a ferrite resonator core. The ratio of the peak voltage to minimum voltage is about 150 or 200 to one. As previously stated, the anti-resonant fre-

quency, f_1 , of the parallel branch is the natural resonant frequency of the core. The series resonant frequency f_2 is about 1000 cycles above frequency f_1 . The greater the difference between f_1 and f_2 , the greater the coefficient of coupling.

Five ferrite rods having different compositions or firing conditions, each 0.510 in. long and 0.37 in. diam and designed for operation in the vicinity of 200 kc were tested for coupling coefficient, resonant frequency, Young's modulus, velocity of propagation, effective permeability, and density. The results are given in Table 1. With the addition of small amounts of impurities, the coefficient of coupling increases. This increase continues until somewhat over the 1 per cent impurity point is reached. It then decreases. The value of Young's modulus increases with addition of impurities. The velocity of propagation decreases slightly with small additions of impurities, but further impurity additions cause an increase in velocity. Effective permeability increases with the addition of impurities regardless of the change in firing conditions. The densities show a slight decrease with the addition of impurities.

Table 2 lists the various parameters for two 100 kc ferrite rods produced under different conditions. There is a considerable difference in almost every parameter, but the two that stand out most are the values for the effective permeability and density.

The frequency vs temperature characteristics of a 100 kc transducer rod are given in Fig. 4. The temperature range studied was -40 to 85 C. It will be noted that the frequency increases with increase in temperature until 4 C is reached. At this tem-

Table 1. Parameters for different ferrite rods 0.510 in. long and 0.037 in. diam designed for operation at approximately 200 kc.

Composition	Coeff. of Coupling K (per cent)	Resonant Frequency f_1 (cps)	Young's Modulus E (newtons/m ²)	Velocity of Propagation v (m/sec)	Eff. Perm. μ_{eff}	Density ρ (kg/m ³)
Ni Ferrite	.1253	219899	1.65×10^{10}	5,740	2.45	5.30×10^3
Ni Ferrite with 1/3 per cent impurity added	.1450	217903	1.681×10^{10}	5,680	2.74	5.21×10^3
Ni Ferrite with 1/3 per cent impurity added. Fired under different conditions than above.	.1495	218052	1.692×10^{10}	5,690	2.66	5.23×10^3
Ni Ferrite with 1 per cent impurity added	.1593	220358	1.718×10^{10}	5,750	2.82	5.19×10^3
Ni Ferrite with 2 per cent impurity added.	.1389	222941	1.765×10^{10}	5,820	3.02	5.21×10^3

Table 2. Parameters for two 100 kc ferrite rods 1.25 in. long and 0.054 in. diam produced under different conditions.

Composition	Coeff. of Coupling K (per cent)	Resonant Frequency f_1 (cps)	Young's Modulus E (newtons/m ²)	Velocity of Propagation v (m/sec)	Eff. Perm. μ_{eff}	Density ρ (kg/m ³)
Ni Ferrite	.1445	90406	1.700×10^{10}	5,760	7.66	5.12×10^3
Ni Ferrite	.1288	91381	1.815×10^{10}	5,800	4.60	5.39×10^3

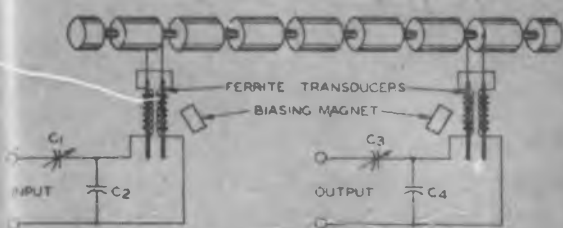


Fig. 7. Schematic diagram of electromechanical filter using Ni-span filter elements and ferrite transducers.

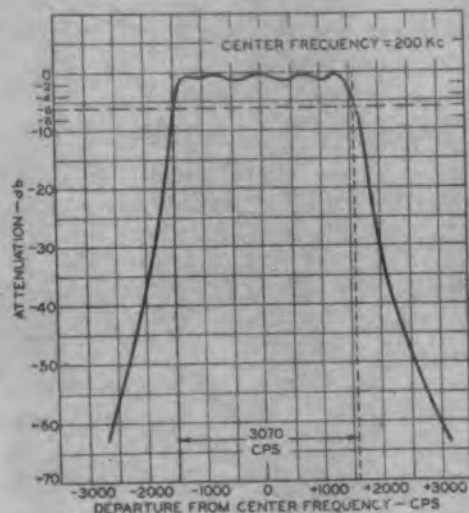


Fig. 8. Frequency response characteristic of 200 kc electromechanical filter.

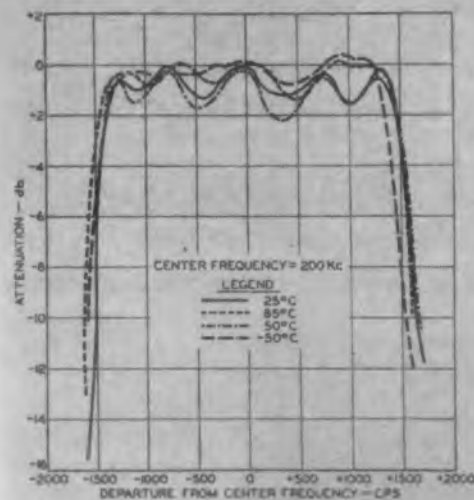


Fig. 9. Temperature stability characteristic of 200 kc electromechanical filter.

trends exist except that the curve rises faster and peaks at a higher temperature than does the curve for the 100 kc rods. There is no indication of a tendency for frequency response to level off as it does for the 100 kc rod.

Although the 100 and 200 kc rods were made of the same compounded material extruded in the same manner, they have different characteristics due, undoubtedly, to differences in extrusion pressures for each size.

Another interesting feature of this magnetostrictive material is the effect of the biasing force on the coefficient of coupling. Fig. 6 shows the results of a typical core subjected to different biasing forces produced by changes in the position of a permanent magnet. With a very weak field, the coefficient of coupling is low. As the field is increased, the coefficient increases and then levels off. A further increase in bias causes the coefficient to increase at a very rapid rate. The maximum value is limited only by the effective resistance of the circuit. With still further increase in the biasing force, the coefficient of coupling again drops off. Obviously there are bias limits within which the rod vibrates most efficiently; the extent of this range depends on the composition and processing conditions of the rod.

Use as Transducer in Mechanical Filter

The best proof as to the effectiveness of these ferrites as transducers is how they perform in an actual filter. A complete filter was built using transducer elements having a coupling coefficient of 0.14 to 0.17, an effective permeability of 2.46 ± 3 per cent and a temperature coefficient of ± 35 cycles/C/mc. Fig. 7 is a schematic diagram of the filter. The filter was tuned by means of capacitors C_1 and C_2 for a 200 kc center frequency. After the tuning, the capacitor received no further adjustment for the remainder of the tests. Several response curves were taken at various temperatures. The filter was placed in an oven for elevated temperature tests and in a ventilated box with dry ice for the tests below room temperature. The frequency response of the filter is given in Fig. 8. The bandwidth, measured at the -6 db point, is a little over 3,000 cycles. The peak-to-valley variation is not more than 2 db over the passing range. The sides of the curve are quite steep as far down as -50 to -60 db.

Fig. 9 shows the temperature characteristics of this filter for temperatures ranging from -50 to $+85$ C. The greatest peak-to-valley variation occurs at a temperature of 50 C; however, the value is not more than 2 db. The bandwidth is approximately the same for all temperatures.

The author wishes to express his appreciation to Messrs. George Katz and R. E. Hurley who made the magnetostrictive ferrites; to R. D. Hunter who conducted the tests on the rods and filter; and to L. Dimmick who built and supplied the filter.

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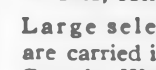
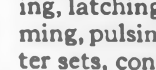
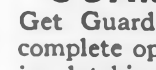
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Safe Lighting, Inc., Dept. ED, 527 Lexington Ave., New York 17, N.Y.

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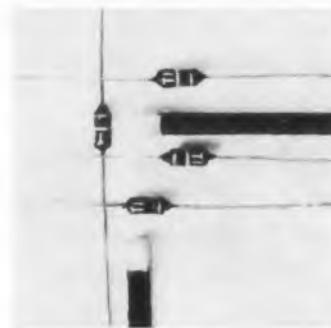
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This multichannel sampling switch is designed for use in missile telemetering applications. The cylindrical pressure sealed container allows the switch to operate at altitudes up to 200,000 ft and in temperatures from 125 down to -65 C. This switch is available with from one to five poles with up to 60 contacts per pole, at sampling speeds ranging from 0.5 to 30 rps. The various motor drives offered include 6, 12, and 27.5 v dc governed or ungoverned, 60 cps single phase, or 400 cps single

or three phase. The governed dc units have a speed regulation of ± 3 per cent. The construction will withstand 150 g shocks and 100 g continuous acceleration bi-directional in each of 3 planes, and a vibration of from 20 to 2000 cps at 20 g for 1/2 hr. This switch will provide continuous operation for 100 to 1000 hr depending upon the sampling speed, the severity of environmental conditions, and the quality of switching required.

Applied Science Corp. of Princeton, Dept. ED, P. O. Box 44, Princeton, N.J.

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Diffused Silicon Diode

400 Ma, 600 V Peak Inverse

The diffused silicon diode/rectifier features 400 ma average rectified forward current plus 600 v peak inverse voltage ratings. The IN649 highlights a guaranteed minimum 2-million-to-1 forward to reverse current ratio. Other significant parameters on the unit include 1.25 a recurrent peak forward current rating, a 3 a surge current (one sec), 600 mw power dissipation, and a 720 v breakdown voltage.

Four other silicon diode/rectifiers, the IN645, IN646, IN647, and IN648, all diffused silicon glass devices, differing from the IN649 only in peak inverse voltage (225 to 500 v), breakdown voltage (275 to 600 v), and reverse current ratings at elevated temperatures, have also been introduced.

Texas Instruments Inc., Dept. ED, Semiconductor Components Div., 2929 Cedar Springs Rd., Dallas 21, Tex.

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High precision plug-in transformers for printed circuit application are epoxy encapsulated units designed for maximum moisture resistance and insulated for high operating temperatures. Plug-in terminals are spaced on multiples of 0.1 in. for standard grids.

Celco Constantine Engineering Labs. Co., Dept. ED, Island Ave., Mahwah 1, N.J.

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Photocon Research Products, Dept. ED, 421 N. Alhambra Dr., Pasadena, Calif.

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Waterman Products Co., Inc., Dept. ED, 2445 Chestnut St., Philadelphia 25, Pa.

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OUTPUT VOLTAGE DC: 0-30 volts continuously variable.

OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.

REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.

RIPPLE VOLTAGE: Less than 3 millivolts RMS.

FUSE PROTECTION: Input and output fuses on front panel.

OUTPUT #2

OUTPUT VOLTAGE DC: 0-30 volts continuously variable.

OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.

REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.

RIPPLE VOLTAGE: Less than 3 millivolts RMS.

FUSE PROTECTION: Input and output fuses on front panel.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than .05 volts for line fluctuations from 105 to 125 volts or load variations from 0 to maximum current.

STABILITY: The output voltage variation is less than .05 volts for a period of 8 hours.

OUTPUT IMPEDANCE: Less than 0.1 ohms from 1KC to 100KC. Less than 0.01 ohms from DC to 1KC.

POWER REQUIREMENTS: 105-125 volts, 50-400 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals are also brought out at the rear of the unit.

PHYSICAL SPECIFICATIONS: Height 7", width 19", depth 11", color gray hammertone. This unit is designed for relay rack mounting or bench use. Carrying handles are provided.

METERS: Voltmeters: Two 0-30 volts, 2½"
Milliameters: Two 0-1.5 amperes, 2½"

CONTROLS: Power on-off switch; outputs 1 and 2 DC on-off switch; outputs 1 and 2 ten turn voltage controls.

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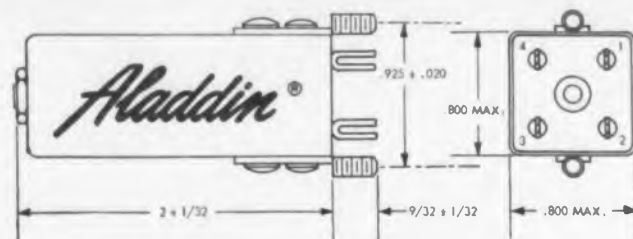


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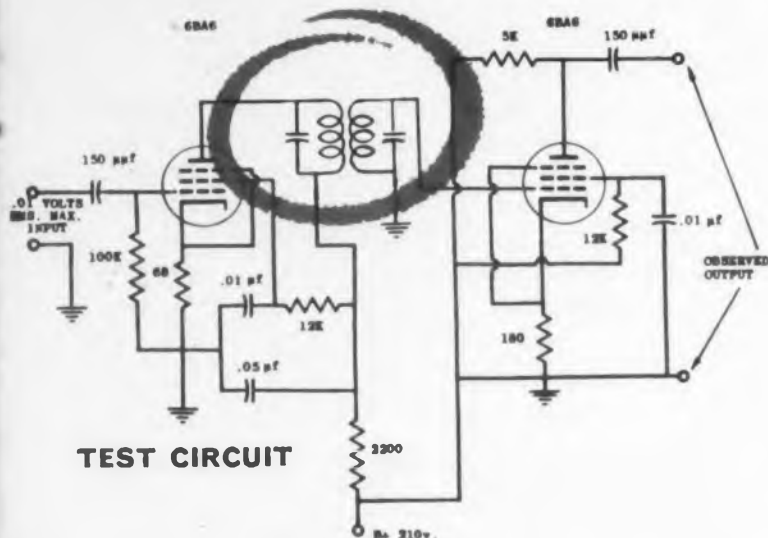
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standard transformers



I. F. SPECIFICATIONS

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		3DB	6DB	20DB	40DB			3DB	6DB	20DB	40DB
*-250	50	3.5	5	12.5	39	*-417	1700	35.7	46.5	113	369
*-285	85	4	5	12.4	40	*-418	1800	39.5	50.9	123	396
*-313	132	5.2	6.9	17.4	56	*-420	2000	36.4	47.6	117	375
*-326	262	7	9.2	22.6	13	*-422	2200	43.7	55.8	137	441
*-337	370	9.9	12.2	30.1	96.5	*-425	2500	46.2	59.1	144	466
*-346	455	10.3	14	33.6	108	*-427	2700	52.4	68.1	165	504
*-350	500	11.9	15.5	37.8	122	*-429	2900	52.4	68.3	167	541
*-380	800	23	30.1	72.9	236	*-440	4000	76.5	98.8	241	790
*-410	1000	27.6	36.1	87.9	286	*-511	10700	203	258	643	2130
*-415	1500	32.8	43.2	106	346	*-525	25000	296	390	970	3010

*Supply proper prefix. See text for available styles.



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Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 40 ON READER-SERVICE CARD

Ferrite Isolators X and K_u Bands



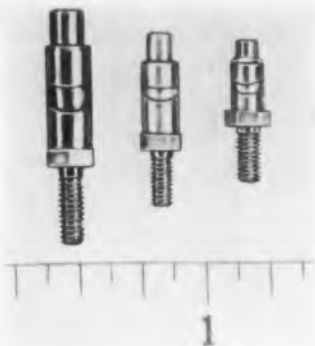
Model IXL1, an X-band type, has a frequency range of 8.5 to 9.6 kmc and provides greater than 18 db isolation. It weighs 6 oz, and is 1-1/8 in. long. Model IK_EL1, another standard type, covers a range of 13.2 to 13.7 kmc in the K_E band with greater than 20 db isolation; it weighs 7.5 oz and is less than 1-1/2 in. long. Modified standard units with flanges rotated to any desired twist angle are available on order, thus providing versatility for system packaging with negligible increase in insertion length.

Raytheon Mfg. Co., Dept. ED, Special Microwave Device Group, Seybold Bldg., Waltham 54, Mass.

CIRCLE 41 ON READER-SERVICE CARD

CIRCLE 39 ON READER-SERVICE CARD

Diode Clips
Spring Loaded



Two spring-loaded diode clips have been designed to hold securely diode pigtail leads. The two, plus one other previously offered, can handle pigtail leads in sizes from 0.005 to 0.085 in. diam.

The smallest size clip has been designated as X2146 when furnished with a screw stud and X2147 when furnished with a rivet mounting. The middle size clip has been designated as 2329 with a screw stud and 2330 with a rivet mount; the large diode clip is 2339 with a screw stud and 2340 with a rivet mount. Each of the three rivet mounted clips is available with five different shank lengths.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge, Mass.

CIRCLE 43 ON READER-SERVICE CARD

AC Motors

Induction, Torque and Hysteresis

The 3800 Frame series of ac motors, designed for induction, torque or hysteresis synchronous applications, is available with input voltages of from 115 to 230 v, 1, 2, and 3 phase with an output frequency from 25 to 400 cps. For induction applications, units in this series are offered in outputs to 1 hp; torque motors 10 to 200 oz in. stall torque; hysteresis synchronous 1/200 hp. Motors can be wound for single, dual, or three speed, and can be supplied as self cooled with inter-locked fan. Units in this frame series vary in weight from 8 to 11 lb. All can be used as fan and blower motors and permanent magnet generators.

Induction Motors Corp., Dept. ED, 100 Main St., Westbury, N.Y.

CIRCLE 44 ON READER-SERVICE CARD

CIRCLE 45 ON READER-SERVICE CARD ➤

**INDUSTRY
APPROVED**

ALSiMAG[®] 196

PRECISION CERAMICS
High Strength - Low Loss

Your best buy for uses requiring rugged strength, low dielectric loss, precision tolerances. Dependable performance. Produced by the source offering widest choice of specialized ceramic compositions in the field. Withstand high temperatures. Hard. Minimize chipping, breaking. Chemically inert. Permanently rigid. Cannot rust, corrode or deteriorate with time. Wide latitude of shapes and sizes. Pressed . . . extruded . . . machined. The right equipment for every operation, every size order . . . to improve quality, decrease cost. Rapid delivery of uniform parts. Prototypes available . . . small lots for test purposes without special tooling.

**VERSATILE ALSiMag 196 STARS
IN SUCH APPLICATIONS AS THESE:**

- | | |
|---------------------------|----------------------|
| Atomic Applications | Mounting Plates |
| Appliance Parts | Spacers |
| Bobbins | Standoffs |
| Bushings | Supports |
| Coil Forms | Switchbacks |
| Dowels | Terminal Boards |
| Grommets | Transformer Bushings |
| High Frequency Insulators | Trimmers |
| | Tube Parts |

Why not investigate the many advantages of ALSiMag 196 for your application? Sketch or blueprint, together with details of operation, will bring you complete information.

AMERICAN LAVA CORPORATION
A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY
CHATTANOOGA 3, TENN.



you're **SAFE**



...when you

RELY on GI

Fractional H. P. Motors
1/40 H. P. to 1/1100 H. P.

Your product is only as good as the motor that powers it. Play it safe by specifying the choice of leading O.E.M.'s — *Specify G.I.!* We have the complete manufacturing facilities and vital know-how to handle your particular job efficiently, economically, on time. Our design staff will be happy to work with your engineers to solve special fractional hp. problems. You can rely on G.I.

Write for complete specifications and quantity-price quotations today!



MODEL C
2-pole, shaded pole
AC Induction Type



MODEL F
2-pole, shaded pole
AC Induction Type



MODEL E
4-pole, shaded pole
AC Induction Type



MODEL D
4-pole, 4-coil, shaded
pole AC Induction Type



MODEL B
4-pole, 4-coil shaded
pole AC Induction Type



MODEL A
2-pole, shaded pole
AC Induction Type



MODEL O
2-pole Capacitor Reversi-
ble Type AC only (for 6,
12, or 24 volts)



THE GENERAL INDUSTRIES CO.
DEPT. GJ • ELYRIA, OHIO

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



AC Accelerometer
High Response

An ac output linear accelerometer for high response systems, this unit has an accurate, large output signal obtained while maintaining high natural frequency and low cross talk. Temperature-compensated fluid damping maintains constant damping over the operating temperature range without a heater, and according to the company, provides exceptionally good dynamic characteristics.

Available in a wide selection of g ranges, the accelerometer meets MIL-E-5272A for all conditions with the following variations: temperature range from -40 to 185 F; shock to 60 g; and vibration of 30 g, 10 to 2000 cps.

Pacific Scientific Co., Dept. ED, P.O. Box 22019, Los Angeles, Calif.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

Two Phase Power Supply
Total Output of 550 VA

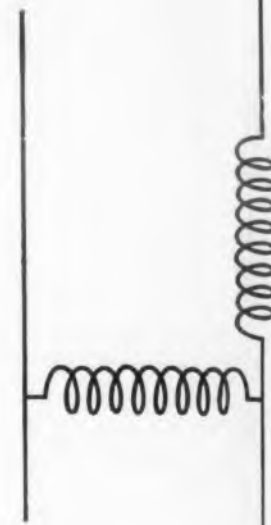


This supply is designed for the development and testing of 400 cps servo systems, two phase gyro motors and similar components. Three continuously variable outputs—two at zero degrees and one at ± 90 deg provide flexibility. No. 1 output provides 0 to 225 v, 1 a, zero phase; No. 2 provides 0 to 225 v, 1 a, zero phase; and No. 3 provides 0 to 130 v, 1 a, ± 90 phase. Phase switch allows output no. 3 to be switched to either lead or lag outputs no. 1 and no. 2 by 90 deg. Input is 115 or 200 v line to line, 400 cps, 3 phase. The unit measures 22 x 15 x 11 in., and weighs 51 lbs.

Pacific Technical Co., Dept. ED, 2047 Sawtelle Blvd., Los Angeles 25, Calif.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

No Brushes



G-E Inductrol* Voltage Regulators Mean Reliability

Because it is an induction regulator, the Inductrol maintains $\pm 1\%$ a-c output voltage *without using brushes.*

This means radically lower maintenance costs than are possible with brush-commutator type regulators. There are no brush inspection, cleaning, or stocking problems. There are no commutators to arc over or wear down. General Electric Inductrols measure precise, highly reliable, economical voltage regulation.

For more information, write Section 425-7, General Electric Co., Schenectady 5, N.Y., or contact your nearest General Electric sales office or agent.

*General Electric Trademark for induction voltage regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 50 ON READER-SERVICE CARD

**Magnetic Voltage Regulator
400 Cps Applications**



Type TMH7101 is designed for 400 cps, single phase applications where requirements demand lightweight equipment. It has no tubes, transistors or moving parts. The unit can be ordered cradled on a shock mount. Input is 95 to 130 v for nominal output voltage; output is 115 v nominal, adjustable from 110 to 120 v; load is 1.0 ma; stabilization and regulation is 1.0% bandwidth for line voltage variation. It measures 7-3/4 x 5 x 14-3/8 in. and fits military standard case MS91403-1B.

The Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.
CIRCLE 52 ON READER-SERVICE CARD



**Temperature Probes
For Low Measurements**

For precise measurements at very low temperatures. Model S-101 is a platinum type thermistor used for liquid nitrogen at temperature range of -185 to -170 C. Model S-102 is designed for measurement of air with a range of -20 C to 100. The S-105 probe is designed to determine temperature ranges of electronic components, and operates from 0 C to 60 C with an accuracy ± 2 per cent of resistance. Three-point temperature vs. resistance calibration is available for all probes except Model S-101.

Gulton Industries, Inc., Dept. ED, Hightstown, N.J.

CIRCLE 53 ON READER-SERVICE CARD

CIRCLE 54 ON READER-SERVICE CARD

**ALLIED'S
New
General Purpose Relay***
for d-c Operation



Type GK Relay

Long life, stability and high reliability are the features of this new general purpose relay. Allied's type GK relay uses twin palladium contacts with bifurcated stationary contact arms. Designed for a wide variety of Industrial and Military applications, Allied's type GK relay has a capacity of 20 springs which can be assembled in a variety of combinations of A, B, C and D contact forms.

Here are the facts:

Operating Voltage:
up to 220 volts d-c

Contact Rating:
up to 4 amperes at 150 watts

Temperature Range:
up to -55°C to +85°C

Vibration:
up to 10 to 55 cps at .062 inch double amplitude

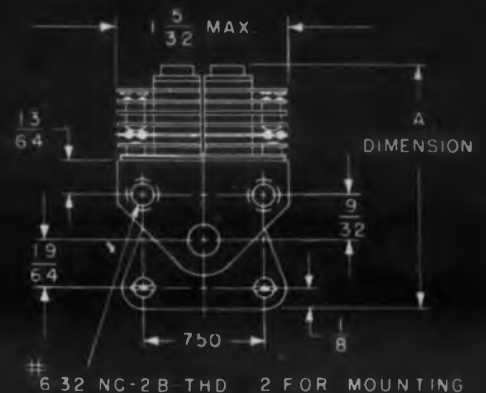
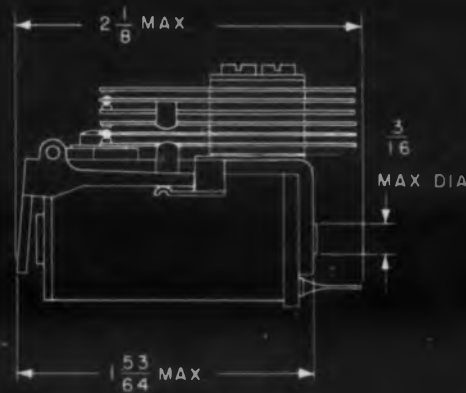
Operating Shock:
up to 30 "g"

*
For complete details send for Allied's GK catalog sheet.

DIMENSIONAL
TOLERANCES:

DECIMALS ± 0.10

FRACTIONS $\pm \frac{1}{64}$



ALLIED CONTROL



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



THE REL-1001 AUTOMATIC
ELECTRON TUBE ANALYZER

a new addition to the Rheem Electronics product line

THE FIRST OF A NEW SERIES OF TEST EQUIPMENT DEVELOPED
AND PRODUCED BY RHEEM.....

The Rheem REL-1001 is an automatic electron tube analyzer incorporating new concepts of design for faster, more accurate, highly flexible and extremely simple operation. The unit provides 17 test positions which can be set up to perform any combination of 19 basic tests utilizing the "programmer" principle consisting of individual, easily inserted patch panels, each unique to a particular tube type. Tests may be conducted singly or in sequence, and may be accomplished automatically, semi-automatically or manually at the rate of 3000 tests per hour, to $\pm 3\%$ accuracy.

The accuracy and speed of the REL-1001 permits tests to be conducted that heretofore have not been feasible because of the high cost. The Rheem electron tube analyzer performs test operations which would require 17 skilled personnel and as many testing machines of the types available up to this time.

The analyzer tests practically all basic tube types. The unit will accommodate new types and is adaptable for special tests.

For further information, write direct to Rheem. A study of your requirements will show how the automatic tube analyzer may improve your quality control at a greatly reduced cost.

See Rheem Booth No. 1240
at the I.S.A. Show
Cleveland, Ohio, Sept. 1957



ELECTRONICS DIVISION / RHEEM MANUFACTURING COMPANY

phone number: RAymond 3-8971..... 7777 INDUSTRY AVENUE, RIVERA, CALIFORNIA

11-57

CIRCLE 56 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



**Recording
Potentiometer**
Two Continuous Records

This recording potentiometer features 2 pens both writing margin to margin on a single 5-in strip chart, producing two continuous records. The recorder is available with one front set limit switch and 3 back set limit switches on each pen. The amplifiers are completely transistorized. The instrument offers 0.5 per cent accuracy on each pen, 0.1 per cent of scale span sensitivity, and maximum source impedance of 1000 ohm per mv of span. The case extends 13 in. behind the panel face. Optional features include transmitting slidewires, quick change or manual change gears for 3 speed change drive, selsyn motor, or synchronous motor change drive, automatic reference junction compensation table or panel mounting and margin marker pens.

Westronics, Inc., Dept. ED, 3605 McCart St., Fort Worth, Tex.

CIRCLE 57 ON READER-SERVICE CARD FOR MORE INFORMATION

Load Sentry Controls Overload



Load Sentry, a fail-safe electro-mechanical overload control, is intended for use wherever overload of any kind may be registered on an electric motor. It is built around the positive action of a contact meter-relay. It is readily hooked into start-stop switches. The maximum load to be permitted on the motor being monitored is set by an adjustable pointer anywhere on the dial of the meter-relay. The dial has 30 divisions, ranging from zero to 100 per cent of normal load. Another pointer indicates the actual running load on the motor. When the pointers meet at an overload position, contacts close and the circuit is broken. The Load Sentry will then sound an alarm and/or shut down the system.

Assembly Products Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1, 1957



Coaxial Switch Remotely Controlled

This remotely controlled coaxial switch, Type 10, provides 4-sec switching of 3-1/8 in. coaxial transmission line to standby equipment at frequencies up to 1000 mc. It can be used in high power communication systems, as well as uhf and vhf television stations. Use of these switches eliminates time-consuming manual changes of coaxial transmission line connections. Standby equipment may be quickly checked under actual operating conditions. In the event of main equipment failure, the standby equipment is switched in with negligible off-air time. The switch is operated from 115 v, 60 cps. Other motors are available on special order. Control circuitry includes a wafer switch for use in remote position indication circuits. The micro-switch is mechanically linked to the switching mechanism so that transmitter power is removed before switching and is reapplied only after new contact is made.

Andrew Corp., Dept. ED, 363 E. 75 St., Chicago 4, Ill.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Power Supply Dual Range



The EFB dc power supply is designed for transistor circuitry. Designed to operate under almost any voltage input condition, the unit supplied a continuous variable power source from 0 to 16 v for current loads to 8 a, and 0 to 32 v for current loads to 4 a. Current and voltages are indicated on universal-type meters. At greatest load it has less than 10 mv ripple. The unit is built into a 12 x 7 x 2 in. blue hammerloid heavy steel cabinet. Electro Products Laboratories, Dept. ED, 4500 Ravenswood Ave., Chicago 40, Ill.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION



for
analog computer
readout:

modern, compact, mobile

SANBORN CONSOLE RECORDING SYSTEMS

Up to eight problem variables can be recorded in inkless, permanent, rectangular-coordinate tracings—with Sanborn's improved six- and eight-channel 156-, 158-5490 Console Systems. Less than four feet high and about two feet in width and depth, these Systems are completely mobile and designed for maximum operating convenience. Controls and indicators on the sloping top panel include individual-channel attenuation, position, balance, sensitivity and stylus heat adjustments; switch for turning off B+ of output amplifiers; chart drive motor switch (can also be remotely controlled); code marker and/or one-second interval timer stylus switch. The Recorder unit, either six or eight channels, features paper loading from the top, and nine precisely controlled speeds from 0.25 to 100 mm/sec. Four dual-channel DC Driver Amplifiers of current feedback design are housed below the Recorder, and are mounted on a chassis which may be withdrawn for inspection.

Electrical specifications of the Console Recording Systems include a basic sensitivity of either .01 volt/chart division (5490 types) or 0.1 volt/chart division (5495 types); linearity of 1%; drift less than 1/2 chart division/hour (5490), less than 1/20 chart division/hour (5495); flat frequency response to 20 cps, down 3 db at 60 cps for all amplitudes to 5 cm peak; either single-ended or push-pull input signals of 5 meg. impedance (each input lead to ground).

A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on—feeds calibration signals to all channels—reads initial DC levels of computer—closes contacts to start computer problem—records computer output for a preset chart length—turns off recorder drive and resets itself for another cycle.

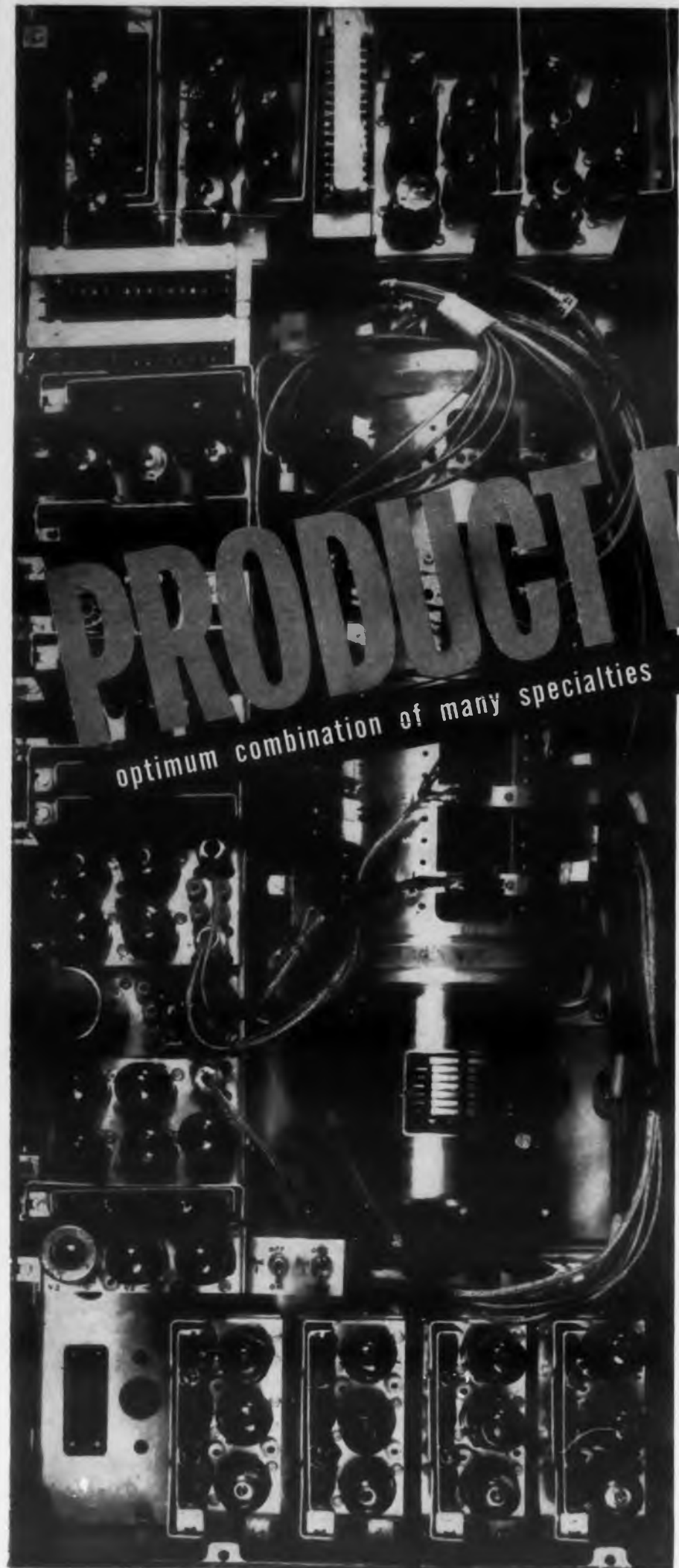
Further technical data, prices and delivery information—on the 5490/5495 Console Recording Systems and two- to eight-channel 5475/5480 Systems are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.



SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

Visit Sanborn Booths 1318-1320 ISA Show, Cleveland, Ohio, September 9-13, 1957

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION



PRODUCT DESIGN

optimum combination of many specialties

- RELIABILITY ANALYSIS.
- MAINTAINABILITY. HEAT TRANSFER.
- COMPONENT APPLICATION.
- MINIATURIZATION.
- ECONOMY

Electronic Product Design at Hughes is the optimum of many and varied specialties. This expert coordination of specialists has resulted in the solution of complex packaging problems, including the airborne Electronic Armament System and the Falcon guided missile.

New projects soon to be underway concern developing practical solutions to the theoretical and actual problems associated with Electronic Product Design.

These Hughes projects have both military and commercial application, assuring you of an unlimited future. Engineering positions to be filled include the following: Reliability, Component Application, Electromechanical Development, Miniaturization and Packaging, Chemical and Metallurgical, Applications and Precision Electronics Test-Supervisor.

Investigate this opportunity to combine challenging work with the ideal living conditions in suburban Los Angeles. Send your resume to the address below.

THE WEST'S LEADER IN ADVANCED ELECTRONICS



RESEARCH AND
DEVELOPMENT LABORATORIES

SCIENTIFIC STAFF RELATIONS
HUGHES AIRCRAFT CO., ROOM 2046-D
CULVER CITY, CALIFORNIA

CIRCLE 551 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Temperature Indicator Direct Reading



This small direct-reading temperature indicator, a self-balancing potentiometer, is designated the NI-10. Used for flight testing, readings on the potentiometer are recorded by photograph, which includes other instrument readings at the same time. Superior legibility of the NI-10 is the featured improvement over the familiar clock-face temperature gage. One model covers the -100 to $+600$ F range and the other covers the 300 to 900 C range.

Handley Electronics Co., Dept. ED, Van Nuys, Calif.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION



Shaft Angle Converter 1000 Hour Life

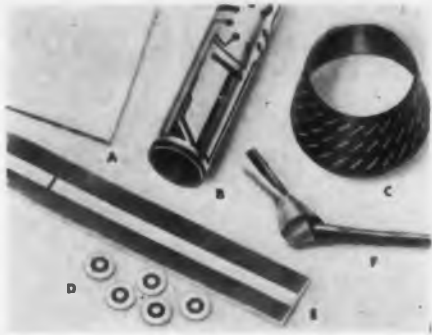
The shaft angle converter converts rotary motion into an accurate coded system of numbers. It provides a binary decimal read-out of 1 in 360 counts at 40 codes per revolution of the input shaft. Special intermittent gearing and precision bearings provide extremely low driving torque. The input shaft can rotate at speeds up to 300 rpm in either direction and will provide digital output coding on-the-fly. The code drum cylinder has a 0.65 in. diameter and is approximately 1-1/8 in. long. The cylinder is composed of an epoxy fiber glass tube with 0.005 in. thick copper tubing bonded to its outer surface. The fiber glass tubing provides a mechanical method for supporting the code drum and rigid member for translating motion to the first stage of gearing. The brushes are rated at 10 v dc at 20 ma current and can operate directly in the most associated circuit. They operate at low noise and negligible bounce. The drive system translates each code read-out within the least significant figure. The entire converter is 1.87 in. in diameter and 2.37 in. long. It weighs slightly more than 3 oz. Its total expected life is in excess of 1000 hrs.

Instrumental Development Labs. Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Circuits

For Many Shapes or Materials



In applications for which they are suitable, these circuits remove many of the limitations imposed by copper-clad printing methods. Conductive silver inks are applied only where required by circuitry, thus etching is eliminated. The silver inks though, are not for sale.

Circuits may be applied to a base of most any geometrical shape including the inside or outside of tubes, the surfaces of flats, cylinders, spheres, cones, etc. The choice of base material also covers a wide range including cellophane, cellulose acetate and butyrate, vinyl chloride and acetate, acrylics, styrenes, polyesters (including Mylar), Nylon, CR39 resin, phenolics, epoxies, silicones, melamines, Del-F, Teflon, mica, paper, wood, ceramics and glass.

Examples listed in photo are: (A) Condenser terminals printed on Teflon before die-cutting. (B) Tubes may be printed on outside or inside. (C) Depolarizing element of discone-type antenna, printed on Teflon. (D) Condenser terminals after die-cutting. (E) Microwave strip line filter. Solderable silver printed on both sides within 0.005" limits. Ends are soldered. (F) Flexibility illustrated by copper-plated silver circuit printed on 0.005 in. Teflon.

J. Frank Motson Co., Dept. ED, Flourtown, Pennsylvania.

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

Single Pole Voltage Tester

6 to 250 v



The tip tester tests ac or dc voltage from 6 to 250 v as a single pole tester, indicating polarity on dc. The tester clips into a pocket like a pen with no trailing wires. For voltage above 250 and up to 500 v, an extension is supplied and converts the instrument to a bi-polar tester. Contact point can be grounded to a needle point for puncture testing with negligible damage to insulation.

Dept. ED, Dick Inc., Dept. ED, 2210 Hampton Rd., Erie,

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION



Speed! Of all structural metals, Magnesium costs less to machine

In the picture above, a lathe is making a roughing cut of 0.800" in an eight inch magnesium billet. The feed is 0.030 inches per revolution at a speed of 630 feet per minute. In finishing operations, cuts of 0.500" can be made with a feed of 0.003 ipr and a speed of 5,000 fpm.

That's real speed and efficiency—the kind you can always expect when you machine magnesium. This remarkable metal can be milled, drilled, sawed, reamed, bored, planed, tapped and threaded faster than any other structural metal!

Faster machining means easier machining and lower cost machining. It means more production per hour and per dollar, and longer tool life.

The following table shows how well magnesium compares to the others:

METAL	RELATIVE MACHINABILITY
magnesium	1.0
cast aluminum	1.8
brass	2.3
cast iron	3.5
rolled aluminum	5.0
mild steel	6.5

Let us give you more information about the machinability of magnesium. Contact the nearest Dow sales office or write to THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan, Dept. MA 1404R.

YOU CAN DEPEND ON

DOW

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

DC Microvolt-ammeter and Amplifier Fifteen Voltage Ranges



The Model 203AR is a 19-in. rack-mountable combination dc microvoltmeter, microammeter, and low-level dc amplifier. Partially transistorized, the unit uses chopper circuitry to provide high sensitivity with previously unobtainable drift-free stability and high input impedance. Fifteen voltage ranges cover from 100 μ v full scale to 1000 v full scale and nineteen current ranges cover from 0.001 μ a full scale to 1 a full scale. The uncluttered zero-center meter face instantly indicates polarity on two mirrored scales which cover all ranges. The instrument can measure 10 μ v to 100 μ a. Input impedance is 10 megohms on the 30 mv range or below and 100 megohms on the 100 mv to 1000 v ranges. Impedance accuracy is ± 1.5 per cent. Output terminals on the front panel are provided for its use as a low-drift dc amplifier with high gain, high input impedance, and low output impedance. Maximum gain as an amplifier is 80 db, and maximum output is ± 1 v across 500 ohms or greater. Output impedance is less than 2 ohms, and drift less than 10 μ v equivalent input.

KIN TEL., Dept. ED, 5725 Kearney Villa Rd., San Diego 11, Calif.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION



Potentiometer
-65 to 400 F
Temperature Range

Designed for missile systems, this circular potentiometer, Type CPO5-0101-1, is moisture-proof and will meet explosion-proof requirements. It has 1-3/4 in. square base and 1/4 in. diam stainless steel shaft with Graphitar bearings. The temperature range is -65 to 400 F; vibration 10 g to 2000 cps. The 10,000 ohm winding is constructed so that it can be furnished with taps.

Humphrey Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

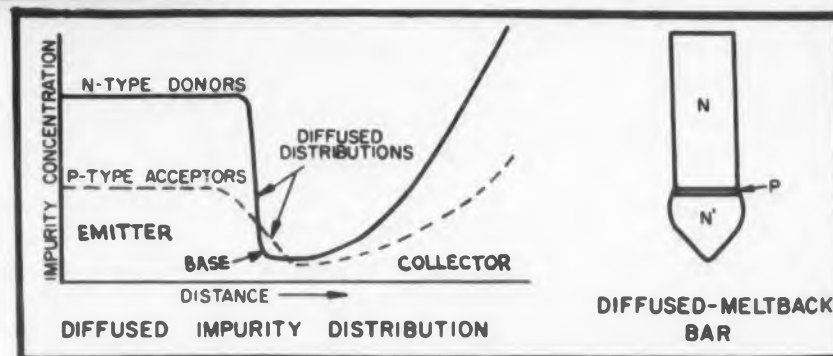
Using the diffused-meltback process

G.E. gets the most from silicon... to



Before going through the diffused-meltback operation, a crystal of silicon is sawed into wafer-form: wafers are then diced to produce 4000 to 5000 individual silicon bars. Photomicrograph at left shows size-comparison of a silicon NPN bar, or pellet, with human hair (Arrow 2). "Tear drop" at end of bar is formed during meltback process. Micro-thin base, or "P", region (Arrow 1) is created through G-E diffusion technique. Base regions of 2-micron size are made with relative ease.

Curves illustrating impurity distribution after diffusion. P-type impurities in the high concentration side of the meltback junction diffuse, within solid semiconductor, into "plateau" region of low impurity concentration. High resistivity "plateau" contributes to elimination of punch-thru effects.



to put the most into transistors

High degree of uniformity and control in junction formation. General Electric's diffused-meltback process was developed by Dr. I. A. Lesk of the G-E Advanced Semiconductor Laboratory. The development came about as the result of Dr. Lesk's efforts to create a transistor manufacturing process that would yield high-quality results at reasonable cost.

Not only does the G-E diffused-meltback process result in a maximum number of transistors from a single crystal (4000 to 5000 NPN transistors), but it offers an extremely high degree of uniformity and control in transistor junction formation.

Opens the door to high frequency performance. Diffusion of a melted-back silicon bar, or pellet, is the final step in the diffused-meltback process. It's the stage in which the micro-thin base, or "P" region is formed, establishing the final NPN transistor structure. Because the actual diffusion is accomplished over a high temperature heating cycle lasting several hours, the need for split-second accuracy is eliminated. The result is a high degree of process control.

By proper choice of the initial impurity concentrations and the time and temperature of the diffusion cycle, heavily-doped base regions as thin as 2 microns are easily obtained. *These micro-thin, uniform base regions are the "open-sesame" to ex-*

tremely reliable high frequency transistor performance.

High current gain. Silicon NPN transistors feature inherent high current gains and high frequency cut-offs. The diffused meltback process permits mass production, since it combines the principles of impurity segregation and solid-state diffusion.

G-E silicon NPN transistors are nominally rated for 25 megacycles, but with useful gain to 50 megacycles—the highest frequencies offered by any mass-produced silicon NPN triode on the market today. All production units are aged at extremely high temperatures for over 150 hours. This is to provide maximum stability of I_{co} and current gain (beta). The header assemblies of G-E silicon NPN transistors are constructed of high-purity materials. A gold-silicon alloy is used for end connections: the base lead is pure aluminum. There are no solders or fluxes, eliminating any danger of transistor "sleeping sickness" caused by corrosion at soldered junction points.

Outstanding For Switching Applications and Linear Amplifier Use. The gold-alloy mountings, with a melting temperature of over 350°C represent the lowest melting point of the entire transistor assembly structure. The G-E Series 4JD4A silicon transistors provide reliable operation to 150°C, with storage temperatures to 200°C.

With well-controlled high frequency characteristics and a low saturation resistance of 40 ohms, G-E silicon NPN transistors are "naturals" for switching applications and linear amplifier use.

Would you like complete specification information? Please contact your nearest G-E Semiconductor Products district office, or write to General Electric Company, Semiconductor Products, Section S2397, Electronics Park, Syracuse, N. Y.

Ordering Data—G-E Silicon NPN Transistors

High Frequency Amplifier Type

ask for: **2N429** (formerly 4JD4A2)

Computer DCTL Type

ask for: **2N430** (formerly 4JD4A3)

General-Purpose Amplifier Types

ask for:	Beta
2N431 (formerly 4JD4A4)	9 to 30
2N432 (formerly 4JD4A5)	20 to 55
2N433 (formerly 4JD4A6)	45 to 100



of uncapped G-E silicon NPN diffused-meltback transistor, showing mounted silicon bar with aluminum base lead connected. Bar attached using a gold-alloy mounting technique. No solders or fluxes are used.



Diffusion furnace. Operator places quartz vials, with large quantity of silicon bars, in furnace. Diffusion occurs through high-temperature heating cycle lasting several hours.



An aging oven in which G-E silicon NPN transistors are aged at extremely high temperatures for over 150 hours. Provides maximum stability of I_{co} and current gain (beta).



**Set Screws
For Miniaturized
Equipment**

Mini-Mite No. 0, 1, 2 and 3 set screws are available in socket, socket cap and slotted styles, and in a variety of points. The advantages of Mini-Mite set screws include elimination of need for special design set screws. They have precision, fully formed threads, uniformity for maximum contact with driving tools and special heat-treating to give high tensile strength without brittleness or decarburization. The set screws give maximum reduction in weight and bulk, without sacrificing holding power in sub or final assemblies. They are available in specified lengths, threaded lengths and special materials.

Set Screw & Mfg. Co., Dept. ED, Bartlett, Ill.

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer Multiturn



The type 909 potentiometer, a 7/8 in. diam multi-turn, uses a stainless steel for the case as well as for major structural components, completely eliminating structural parts of phenolic, plastic or other non-metallic materials. Cylinders of stainless steel tubing form the case, which is insulated from the mandrel by a dielectric film. The design utilizes a helical slip bar, which serves also as a guide for the wiper. The wiper assembly straddles the slip bar and the wiper rides on the resistance winding in the middle. Therefore, dual slip bar contact and, due to the different resonant frequencies of the two contacts, excellent vibration characteristics are provided. By riding the helical bar, wear on the resistance element is eliminated and life characteristics are improved. Metal to glass type terminals are used which are welded to the case.

Typical resistance range is 100 ohms to 200,000 ohms for a 10 turn version of the type 909. Standard linearity is 0.5 per cent with 0.05 per cent available on special order. Rated at 2.5 w at 40 C the standard 909 derates to 0 at 90 C and the high temperature version, available on special order derates at 150 C.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, N.Y.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION



Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

before
pan
or
can...



Synthane laminated plastics are at work



Synthane-covered tin plate rolls last three times as long as other materials because of resistance to acids and surface toughness.

Few industries escape the multiple benefits of Synthane laminated plastics. The food industry puts Synthane to work as star wheels for bottling equipment, bread slicing guides as oil-less bearings in processing of sugar syrups and even in the tin-plating operation of metal containers.

Resistance to moisture, anti-friction characteristics, chemical and wear resistance are but a few of the reasons why Synthane is at work in this vital industry.



EASILY MACHINED



DIELECTRIC STRENGTH



CHEMICAL RESISTANCE



WEAR RESISTANCE

SYNTHANE . . . industry's unseen essential.

SYNTHANE CORPORATION, 1 RIVER ROAD, OAKS, PA.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Wave and Power Meter Set 500 to 1500 Mc, 0.5 Mw to 2 W



This portable wave and power meter set measures power and frequency from 500 to 1500 mc at power levels of 0.5 mw to 2 w average (-3 dbm to -33 dbm). Model 107 consists essentially of a transmission line comprising a coaxial step attenuator and a coaxial direct reading frequency meter; the line is terminated in a power measuring thermistor mount and bridge. These three principal components are connected in series by coaxial cables and are mounted on the front panel of the set. A fixed 10 db attenuator (CN-388/UP) is provided to extend the power range of the step attenuator. The frequency meter has a direct reading dial and power measurements are obtained directly in db by adding the meter reading and attenuator setting. The set is housed in a combination type carrying case with a separate lid. The carrying case is water tight with the cover on. The power input connector is a coaxial series N connector on the front panel. A video pulse envelope detector, series BNC, is also provided.

The Narda Corp., Dept. ED, Mineola, N.Y.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION



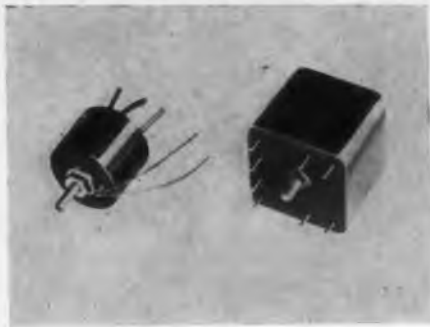
Power Monitor Radio Frequency

This feed-thru rf power monitor measures incident power between 2 and 500 mc and reflects power and vswr between 10 and 500 mc. The instrument can be calibrated and the calibration can be checked frequently at 60 cps with aid of a 60 wattmeter. The power measuring range is 0-15 w and 0-60 w.

Electro Impulse Lab., Dept. ED, 208 River Street, Red Bank, N.J.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers Encapsulated



Hermetically sealed pulse transformers are being manufactured to meet military specifications such as MIL-T-27. They will operate at ambient temperatures up to 85 C. Special designs for high acceleration applications are available for specific customer requirements. Also available are sub-miniature pulse transformers for printing wiring board, transistorized circuit and miniaturized circuit applications. All of the units meet the standard voltage, life, pull, temperature, immersion and moisture resistance tests.

A fixed Telex, Dept. ED, Telex Park, St. Paul 1, Minn.
CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator and Scope Unit Displays Gain vs Frequency Response



Called the Wobbulator Model 7200, this integral unit combines a swept frequency signal generator with a built-in oscilloscope. The latest model permits the visual display of the gain or loss vs frequency response of amplifiers and networks in the range from 2 to 1000 mc. A swept frequency range of 2 to over 55 mc centered anywhere in the 2 to 1000 mc region allows rapid play. The effect of component or adjustment changes or gain and frequency response are instantly pictured on the crt as gain, or loss, vs frequency characteristics.

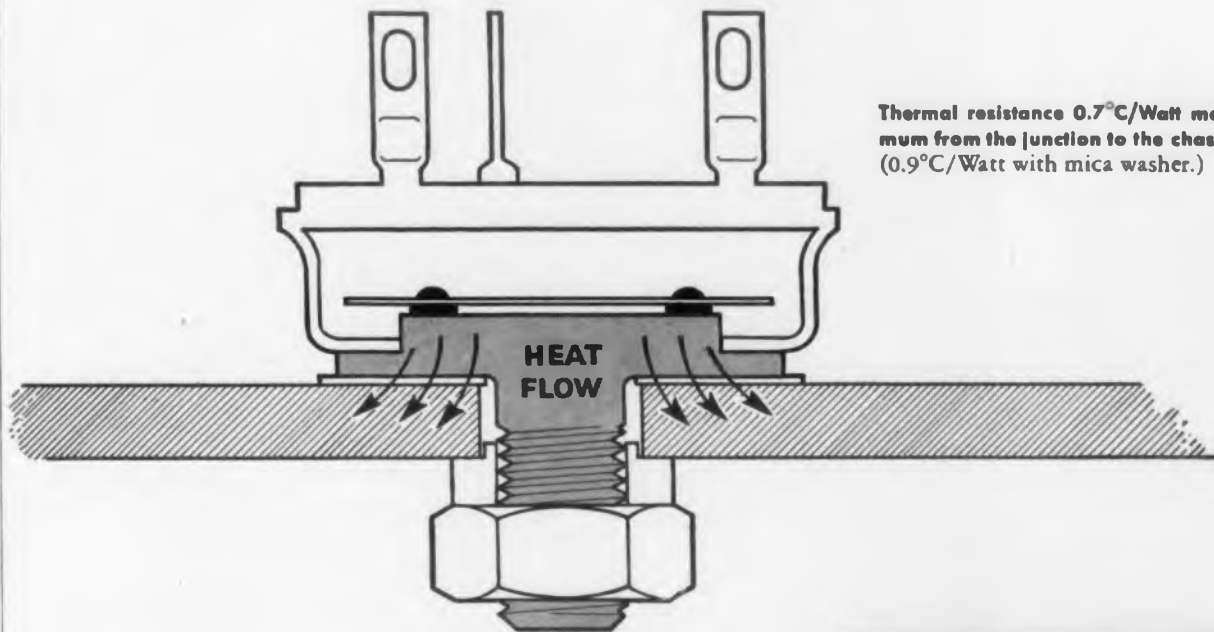
The scope has a display sensitivity of 50 μ v. Since the maximum output voltage of the generator is more than 0.03 v, the Wobbulator has much greater sweep sensitivity than older equipment offered. The amplitude variation of the swept output voltage is constant within +1 db over 40 mc and constant within fractions of 1 db over 30 mc. High impedance and low impedance probes are furnished.

Canoga Corp., Dept. ED, Van Nuys, Calif.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Lowest Thermal Resistance of any Transistor!

Honeywell's New H10 Weld-Seal



Thermal resistance 0.7°C/Watt maximum from the junction to the chassis.
(0.9°C/Watt with mica washer.)

- Long thermal time response of junction temperature and low thermal resistance make overload possible for a longer period of time without permanent damage to transistor.
- Allows delivery of 10 watts to a servo motor in an ambient of 85°C.
- Handles 15 amps.

HONEYWELL'S NEW H10 Weld-Seal has a larger collector area for more rapid heat dispersion. *You get the lowest thermal resistance of any transistor!*

And you get the other advantages for which all Honeywell Weld-Seal transistors are famous—high and uniform power gain over a wide range of collector currents, long life, outstanding stability and economy.

Honeywell's H10 is hermetically sealed by welding—so you can build ruggedness and durability into your equipment.

Take advantage of this new and improved transistor. Check to the right for the Honeywell office nearest you and write or phone for complete information today!



Typical H10 Operating Characteristics

Transconductance: .9 at 10 amps.
Current gain: 18 at 10 amps.
Maximum collector current: 15 amps.

In applications where the capacity and capabilities of the H10 transistor are not necessary, the high gain H7 transistor provides outstanding operating characteristics. Write or phone for specifications.

UNION, N. J.
MURdock 8-9000
P.O. Box 161

CHICAGO
IRving 8-9266
7350 N. Lincoln Ave.

BOSTON
ALgonquin 4-8730
1230 Soldier Field Rd.

MINNEAPOLIS
FEderal 2-5225
2749 4th Ave., So.

LOS ANGELES
RAmond 3-6611 or
PArkview 8-7311
6620 Telegraph Road

MINNEAPOLIS
Honeywell



First in Controls

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Vernier Potentiometer

3 Terminal Construction

Featuring 3 terminal construction, for use in circuits having a common ground, a vernier potentiometer provides single knob control of two resistance decades. Standard resistance ranges are, 1000 ohms, 10,000 ohms and 100,000 ohms; accuracy is ± 5 per cent of full scale resistance; linearity is ± 0.5 per cent; resolution is 0.1 per cent; power rating is 4 w when used as a potentiometer and 20 ma when used as a rheostat. Elimination of helical elements allows accurate operation over an unusually wide frequency range from dc to 10 kc. No disassembly is required for mounting.

Research Instrument Co., Dept. ED, P.O. Box 9168, Portland 16, Ore.

CIRCLE 87 ON READER-SERVICE CARD

Teflon Hook-Up Wire

300 V, 32 to 22 AWG

Extruded Teflon insulated, 300 v hook-up wire with a wall thickness of extruded insulation of 0.003 in. to 0.006 in. is available. Sizes available are 32 AWG to 22 AWG inclusive.

Hitemp Wires, Inc., Dept. ED, 1200 Shames Drive, Westbury, L.I., N.Y.

CIRCLE 88 ON READER-SERVICE CARD

Teflon Film Capacitors

-65 to +165 C Range

An operating temperature range of -65 to +165 C without derating is normal for a new line of hermetically sealed Teflon film capacitors. Special models are available up to 200 C. Multiple layer Teflon dielectric construction, together with glass-to-metal compression-type end seals, provides exceptionally high insulation resistance, low dissipation factor, and minimum effect from dielectric absorption. The capacitors' service life is unusually long, as shown by tests.

Electronics Development Corp., Dept. ED, 1323 Airway, Glendale 1, Calif.

CIRCLE 89 ON READER-SERVICE CARD

CIRCLE 90 ON READER-SERVICE CARD ➤

P&B PROGRESS/

UNIQUE DESIGN IMPROVES WEIGHT, SIZE, PERFORMANCE FACTORS

NEW!

Miniature telephone type relay has superior shock/vibration resistance



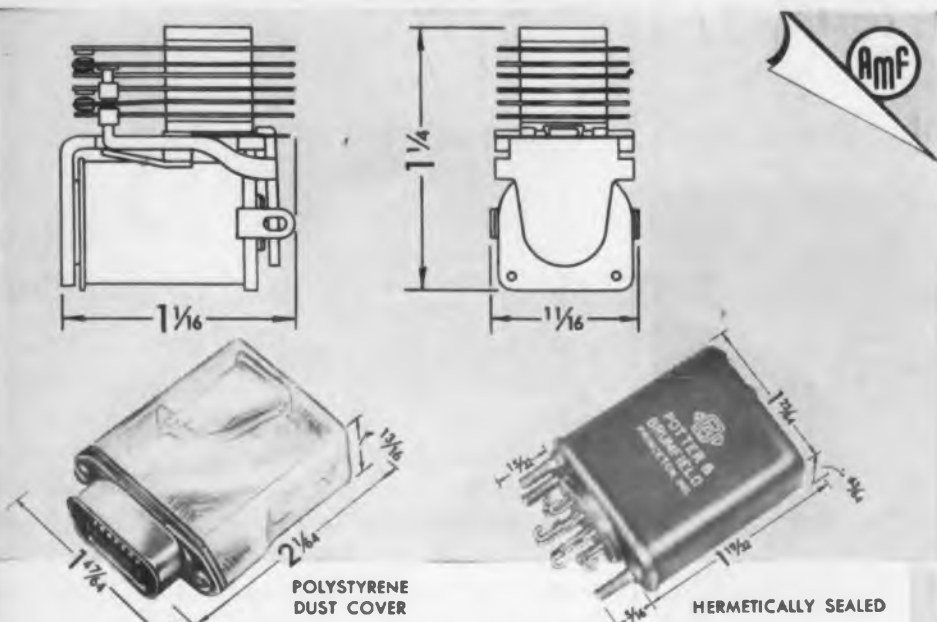
NEW
POTTER & BRUMFIELD
MG SERIES RELAY

Unusual for a telephone type relay, the MG Series has excellent stability under high shock and vibration conditions. Tests show this miniature, light weight (only 1.2 oz., open) relay withstands vibration of 10g 55 to 500 cycles per second and will operate under shock to 30g according to Mil-R-5757C.

The superior performance of the MG is due in part to its unique single stack con-

struction and to an exclusive hinge design which provides zero heel gap.

Open, dust covered or hermetically sealed, the MG is available with contact arrangements up to 4 Form C (4PDT). It is rated for ambient temperatures of -55°C to +85°C. A high-temperature version with a range of -65°C to +125°C will soon be available. Write or wire today for complete specifications and delivery



MG SERIES

TERMINALS:

Open Relay: Pierced Solder Lugs.

Contacts: Two #18 AWG wires. Coil: Two #20 AWG wires.

Hermetically Sealed:

Miniature plug-in header with 7, 9 or 14 pins. Multiple Solder header with hook and terminals for three #20 AWG wires.

Polystyrene Dust Cover: Micro Ribbon plug-in type.

Mating receptacle: Amphenol #57-20140 or similar.

INSULATION RESISTANCE: 100 megohms min.

VIBRATION: .065" excursion 10-55 cps.

10g 55-500 cps. upon request.

SHOCK: 30g according to Mil-R-5757C upon request.

TEMPERATURE RANGE: -55°C to +85°C.

WEIGHT: 1.2 ozs. (open) 2.0 ozs. (sealed).

PULL-IN SPEED: Approximately 15 ms at nominal voltage.

DROP-OUT SPEED: Approximately 10 ms at nominal voltage.

CONTACTS: 3/32 silver.

CONTACT ARRANGEMENT: 4 pole, double throw (4 Form C).

COIL POWER: 3 watts max. DC @ 25°C. Continuous duty.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL
ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS
See our catalog in Sweet's Product Design File.

Potter & Brumfield, inc.

PRINCETON, INDIANA

SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

Mail the coupon below for further engineering data on P&B's MG Relay plus new compact catalog of standard type relays. If you need answers to a specific application problem, write in detail.

Potter & Brumfield, Inc., Princeton, Indiana
Attn: T. B. White, Brig. Gen. USMC (Ret.)
Special Projects Engineer

Please send me complete engineering data on the MG Relay plus the new compact catalog of P&B standard relays.

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

CIRCLE 90 ON READER-SERVICE CARD FOR MORE INFORMATION



Unity-Gain RF Probe Employs Transistors

A new departure from passive type probes, the Transprobe has unity gain—which is held constant by a transistorized feedback amplifier, ensuring complete stability. The unit is powered by mercury cell batteries. Standard BNC connectors are provided to the scope and battery-box power supply. Low input capacity makes it ideal for use with broad-band oscilloscopes and as an oscilloscope isolation amplifier. Features included in the Transprobe are low power dissipation, no hum and open design for easy manipulation.

Frequency response is 20 cps to 15 mc, 1 db down at 50 cps and 12 mc, and 3 db down at 20 cps and 15 mc. Nominal output impedance is 50 ohms. Input impedance: capacitive, 4 μ f; resistive, 100,000 ohms. Maximum input voltage: 0.3 v peak-to-peak. Power supply: mercury cells, 800 hr life; constant supply over life of cells. Separate power supply and connecting cables provided with probe.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION



Ballistic Computer Seven Parameter Display

The Type K-1 Ballistic Computer contains all necessary amplifiers, programming circuitry and balance equipment for direct hookup to thrust and pressure transducers, and automatically displays such parameters as ignition delay, action time, integrals of thrust and pressure, as well as peak values. The K-1 can be supplied either for print-out on paper tape by a clary printer or on cards by IBM summary card punch. It is also available as the Type K-2 which contains special tape recording equipment and a play-back analyzer section for detailed examination of isolated portions of a record.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mt., Cumberland, Md.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Investigate ADVANTAGES of the New MASSA ELECTRODYNAMIC RECORDER

TRUE RECTILINEAR MOTION
CRITICAL ACOUSTIC DAMPING
WIDER FREQUENCY RANGE
INK OR ELECTRIC WRITING



FEATURES

LIGHTWEIGHT ELECTRODYNAMIC DRIVE for true rectilinear recordings free of distortions.

CRITICAL ACOUSTIC DAMPING eliminates resonant peaks overshoot and ringing.

WIDER FREQUENCY RANGE reproduces signals up to 200 cps.

MICROMETER ADJUSTING SCREWS conveniently located for accurate pen alignment.

DECIMAL SPEED CHANGER with 3 speeds. Max. — 200 mm/sec.

DISPOSABLE INK CARTRIDGE hermetically sealed prevents evaporation and maintains correct ink viscosity.

NEW PEN DESIGN with mechanical filter permits splatter-free writing at all frequencies.

WEIGHT 9 lbs. — Dimensions 13" L x 4 3/8" W x 4 1/2" H.

Also available is the Massa Model M-220 DUAL CHANNEL DC AMPLIFIER with self-contained power supply. Sensitivity range is 5mV/mm to 200 volts full scale with compensation to yield flat response from dc to 200 cps.

Write to Dept. 14 for technical data.

Other Massa Products for Industry:
SONAR TRANSDUCERS ULTRASONIC CLEANERS
ACCELEROMETERS PREAMPLIFIERS
MICROPHONES AMPLIFIERS
HYDROPHONES RECORDERS

precision in  electroacoustics

MASSA
LABORATORIES, INC.
HINGHAM, MASSACHUSETTS

CIRCLE 94 ON READER-SERVICE CARD

"How would YOU measure RF power accurately...reliably?"

...Lou G. Dameson,
Chief Design Engineer, Cubic Corporation



Designed to meet the requirements of the Military and Industry

Manufacturers of radar and other high frequency pulse equipment have long felt the need for a primary standard laboratory instrument to measure RF power in the microwave region. The Cubic Calorimetric Wattmeter, Model MC-1B, was designed particularly to provide you with a highly precise instrument of this type, and one with simple and fundamental instrumentation methods to establish long calibration life.

For example, precision thermometers are used, since they are far more stable and reliable than thermocouple or thermistor temperature-indicating circuits. The high accuracy of the MC-1B is maintained without frequent calibration.

Our Calorimetric Wattmeter consists of two units—a liquid circulator and a water load termination. The circulator unit controls the flow of metered amounts of distilled water through the termination, where RF output is converted to heat by means of a water load. Heat absorbed by the distilled water calorimetric fluid is measured on precision thermometers. A power scale on the termination permits direct, precise power readings in watts.

Distilled water is used as calorimetric fluid because of its

high dielectric loss characteristics above 1000 mcs. The circulator permits visual monitoring of the fluid flow rate at all times. All parts of the circulator are designed and fabricated to prevent fluid contamination.

Through the use of RF adapters, a match better than 1:15 in VSWR from 2600 to 26,500 mcs is achieved without problems associated with the excitation and propagation of higher order waveguide modes.

Metered fluid flow, precision temperature readings and well designed control of heat transfer permit extreme accuracies of power measurement.

Cubic Calorimetric Wattmeters are being used extensively by industrial and government laboratories. For example, RCA has over 30 of these instruments in use to check out and calibrate magnetrons and radar systems. Hughes Aircraft Company uses them in the same manner.

Cubic's Calorimetric Wattmeter will prove its accuracy—as no other wattmeter can—in your laboratories, in your plant, or in the field.

For a prove-it-yourself demonstration of how you can obtain consistent, repetitive results in RF measurement, telephone or write...



CUBIC CORPORATION
5575 Kearny Villa Road, San Diego 11, California

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



**Voltage Monitor
for Power Supplies**

The series 2303 Compacts are voltage sensitive meter-relay controls for monitoring voltages. A Compact contains a VHS meter-relay, load relay and other components for continuous monitoring and control of voltage supplies. Relay action may be manual reset or automatic reset. Several variations are available for detecting either over-voltage, under-voltage, or both over- and under-voltage, either ac or dc. Specifications include: Input—10 mv dc to 500 v dc, accuracy 2 per cent at 75 F, 4 per cent from -40 to +150 F; 250 mv ac to 500 v ac, accuracy 3 per cent at 75 F, 6 per cent from -40 to +150 F. Other inputs down to 0.1 mv ac or dc are available at reduced accuracy. The input of low range voltmeters and millivoltmeters is protected against overload with Stabistors. Load switch is spdt, 5 a, 125 v ac, non-inductive. Connections and mounting are 9 pin plug-in, octal type with AL connectors and 4 hold down screws optional. Case measures 1-3/4 x 4-1/4 x 4-3/4 in., and is steel and dustproof with hermetic sealing optional.

Assembly Products, Inc., Dept. ED, P.O. Box XX Palm Springs, Calif.

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION



**Servo Digitizer
Binary-Decimal Output**

The servo driven digitizer, SL-1004, designed to digitize an ac input signal, operates directly from the 400 cps line, and is packaged for inclusion in larger equipment. It includes a miniaturized, high gain transistor-magnetic servo amplifier and power supply. The output is binary-decimal, and the encoder shaft is driven ± 170 deg from null. Full scale corresponds to 10 v rms 400 cps, in phase with the line. The static error is 0.15 per cent of full scale, and fast rates can be followed with velocity error constant of 500 sec⁻¹.

Industrial Control Co., Dept. ED, 805 Albin Avenue, Lindenhurst, L.I., N.Y.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Speed Drive

1/8 and 1/15 Hp



These Magne-Speed Junior drives incorporate dynamic braking and reversing. These features may be disconnected by the user if not required. Motors may be mounted in any position and may smoothly be adjusted from zero rpm to full rated speed. Base speed is 8000 rpm. They will operate in ambient temperature of 32 to 110 F. Motor is a dc shunt, open construction (closed on special order), with die cast housing. The 1/8 model has ball bearings, and the 1/15 hp has sleeve bearings with thrust washers. Available with or without gear reduction. All motors equipped with 5 ft cable.

Magnetic Amplifiers, Inc., Dept. ED, 632 Tinton Ave., N. Y. 55, N. Y.

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION



**Pressure Transducer
High Output**

The Model R-3 is similar to the standard S-3 dual coil transducer, except that it contains four active elements so that a four-arm bridge can be completed within the transducer. The magnetic circuit within the transducer is designed for applications that require very high output sensitivity. This unit has adequate output to drive typical ruggedized accelerometer movements without application and may be used in most servo applications.

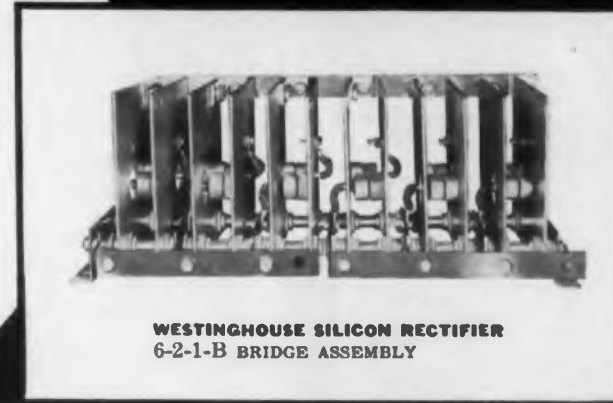
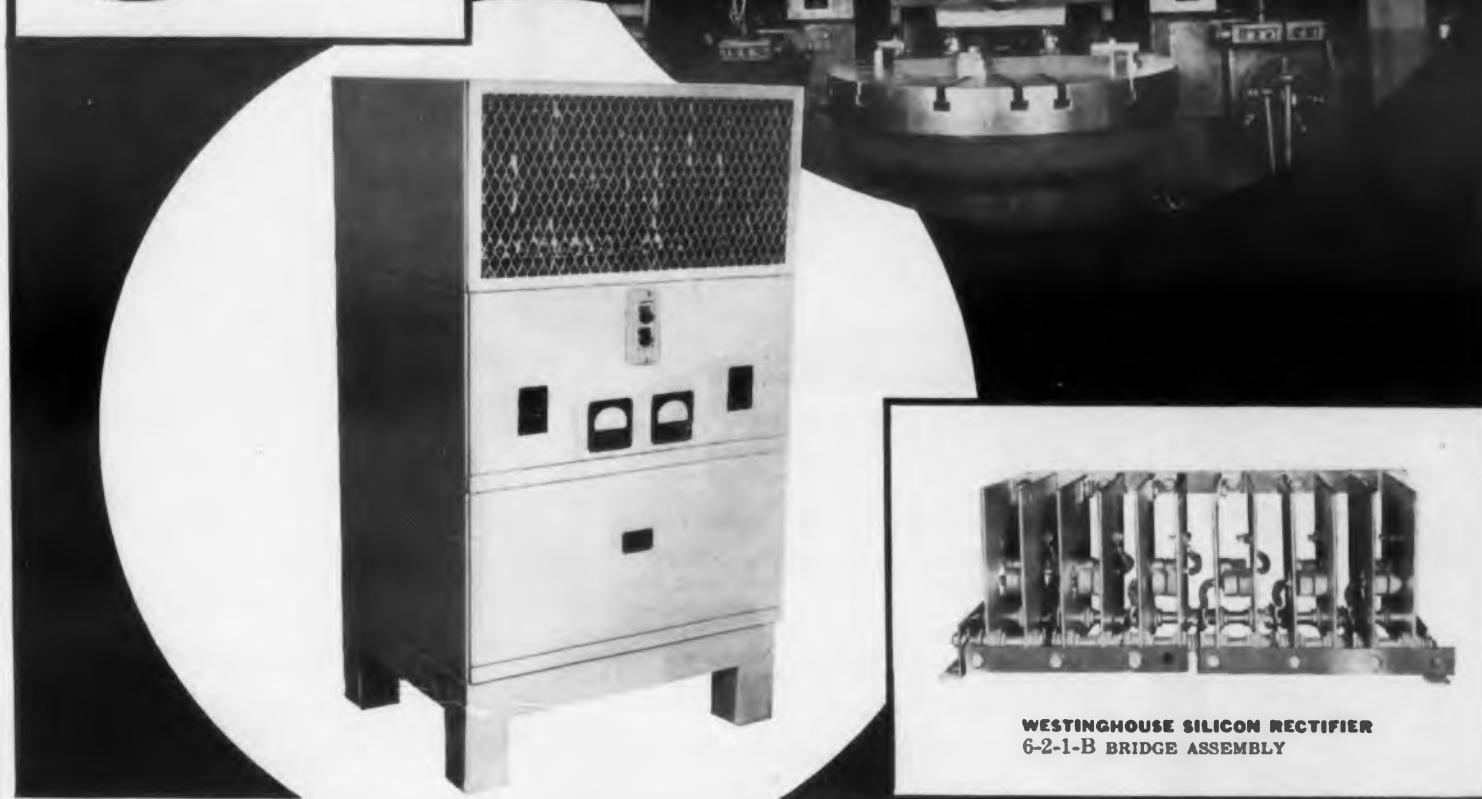
Specifications include: pressure range, 5 to 1000 psi; acceleration sensitivity 0.01 to 0.03 per cent per g or less, referred to full range pressure in most positive plane; rise time, 150 to 250 μ sec, dependent on pressure range; output sensitivity, dependent on carrier frequency and pressure range and will vary from 600 mv/v at 400 cps to approximately 100 mv/v at 20 kc; zero drift with temperature, 0.06 per cent per deg F or less referred to full range, and change in sensitivity temperature is 0.09 per cent per deg F. or less referred to full range. It measures 7/8 in. diam x 1 in. long.

UltraDyne Engineering Labs., Inc., Dept. ED, P. O. Box 3303, Albuquerque, N.M.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION



**WESTINGHOUSE
SILICON RECTI-
FIER WN-5082,**
with maximum
peak inverse volt-
age ratings of
50-400 v. (300 to
5000 amperes in
bridge assem-
blies.)



**WESTINGHOUSE SILICON RECTIFIER
6-2-1-B BRIDGE ASSEMBLY**

Westinghouse SILICON^(Si) RECTIFIERS put more muscle in DC power converter!

Successfully proven in rigorous welding, aircraft and guided missile applications, Westinghouse Silicon Power Rectifiers offer many advantages for power supplies.

Used in the Westinghouse 50KW Power Converter to drive the boring mill above, the WN-5082 bridge assembly supplies greater power and higher efficiency in less space. The 3-phase 60-cycle 440 v. power supply operates with a full load efficiency of 90% and an even higher half load efficiency. Regulation is approximately 8% from no load to full load with a Power Factor of 96 to 97.

Especially rugged for varying duty cycles, the WN-5082 withstands heavy loads of constant on-off operation, high-voltage transients, alternate heating and cooling.

YOU CAN BE SURE...IF IT'S

Westinghouse

Westinghouse can supply single diodes or complete bridge assemblies built to your specifications. For full information on how Westinghouse Silicon Rectifiers can bring new efficiency and economy to your applications, mail the coupon today.

WESTINGHOUSE ELECTRIC CORPORATION
P. O. Box 364, Pittsburgh 30, Pa.

Please send me data on the new Westinghouse WN-5082 Silicon Rectifier.

Please send me data on other Westinghouse Silicon Rectifiers. (Describe types or applications) _____

NAME _____

TITLE _____ FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION

from Magnet Charger

HEADQUARTERS

MODEL 942

Recommended
by Leading
Magnet
Makers



3
VERSATILE
MODELS



MODEL 107A



MODEL 1221

For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than \$2100.

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price \$530.

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price \$180.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

WE CAN
HELP
YOU

12 years' magnet charging experience is yours for the asking—send for illustrated data sheets.



Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Molded Composition Potentiometer

Diameter of 0.5 In.



Type AS potentiometer is rated at 0.5 continuous duty and measures 1/2 in. diam. The relatively thick molded resistance elements offer a large factor of safety. The brush is also molded for long wear and lower noise level. Type AS units are furnished in linear taper with locking type, screw-driver-slotted shafts. The units are dust-tight, splashproof and fungus-resistant. Terminals are gold plated to speed soldering. They are available in 15 resistance values from 100 ohms to 5 meg.

Ohmite Manufacturing Co., Dept. ED, 3630 Howard St., Skokie, Ill.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Shaft Position Encoder

Accuracy within 3 Min of Arc



The type RD-13 Digisyn is a high precision photoelectric shaft position encoder which provides angular position data in cyclic binary code to an accuracy of 13 digits, or better than three minutes of arc. The unit consists of a glass disc coded by an array of opaque and transparent segments, a flash lamp to illuminate a radius of the code disc, a multi-element photosensitive detector to detect presence or absence of illumination, and a 13 channel transistor preamplifier. Each channel is encapsulated separately and is readily replaceable. The flash lamp assembly also is encapsulated and can be replaced readily. Type 23x6a synchro mounting has been provided. Maximum rotation rate is 1200 rpm for full accuracy readout; operating temperature ranges from -55 to +85 C. Diameter measures 3-1/2 in. od.

Adcon Inc., Dept. ED, 1117 Commonwealth Ave., Boston 15, Mass.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

STROMBERG-CARLSON Special-Purpose TELEPHONE HANDSET



You can mount this special-purpose hang-up telephone almost anywhere: on desk, wall or piece of equipment. The handset shown is only one of many standard and special-application types you may order. The right-angle bracket provides 6 different mounting positions.

HOOKSWITCH



You can get hookswitches with any spring combination you need. Illustrated are two of many possible arrangements.

BRACKET



This special bracket gives you a choice of 12 different mounting positions. You may order it separately or with any combination of components you need. You'll find complete details in Booklet T-5005. To get your free copy, write to



STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales

116 Carlson Road, Rochester 3, New York

CIRCLE 106 ON READER-SERVICE CARD

Using Thermistors

Edited by
FENWAL ELECTRONICS

Thermistors, with their almost incredible sensitivity to temperature change, now get news column all their own.

The cases in point for the first column: temperature measurement and temperature control.

Three basic circuits for temperature measurement with thermistors:

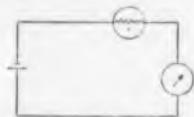


FIG. 1



FIG. 2

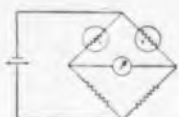


FIG. 3

The first is a battery, a thermistor, and a micro-ammeter. The second, more sensitive, has a thermistor as one leg of a bridge circuit. The third incorporates two thermistors in a bridge, making possible even precise temperature differential measurements.

Two basic circuits for temperature control with thermistors:



FIG. 4



FIG. 5

The first has a thermistor in series with a battery, a battery, and a variable resistor. By adjusting the resistor, it is possible to make the relay operate at any desired temperature of the thermistor.

The second is more sensitive, and has a thermistor as one leg of a bridge circuit, a variable resistor in another leg, and a relay across the output. Even sensitive control can be had by applying AC to the bridge and placing a high-gain amplifier between the bridge and the relay.

Designers: if you are not already familiar with the tremendous possibilities of thermistors, write for details to FENWAL ELECTRONICS, INC., 310 Mellen St., Framingham, Massachusetts.



Makers of Precision Thermistors

CIRCLE 108 ON READER-SERVICE CARD



200 Channel Analyzer
Simplified Circuitry

The Model 3302, 200 channel analyzer offers all the advantages of a 256 current analyzer but retains the simplicity of the 100 channel analyzer. Burroughs tubes greatly simplify the address circuits and a simple computer logic is used to program computer and other non-storage functions. The memory may be divided and separate data stored in each half. On special order, the analyzer may be had with the ability to store in one half the memory while simultaneously printing out of the other half. A deadtime correction factor correlates data regardless of energy distribution or counting rate. The analyzer presents data on a cathode-ray tube during and after measurements. It automatically subtracts background and may be operated in coincidence with external pulses, either prompt or delayed. Provision is made for precision recording or decimal printed readout which totals every 10 or 100 channels with channel numbers printed directly.

Radiation Instrument Development Laboratory, Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

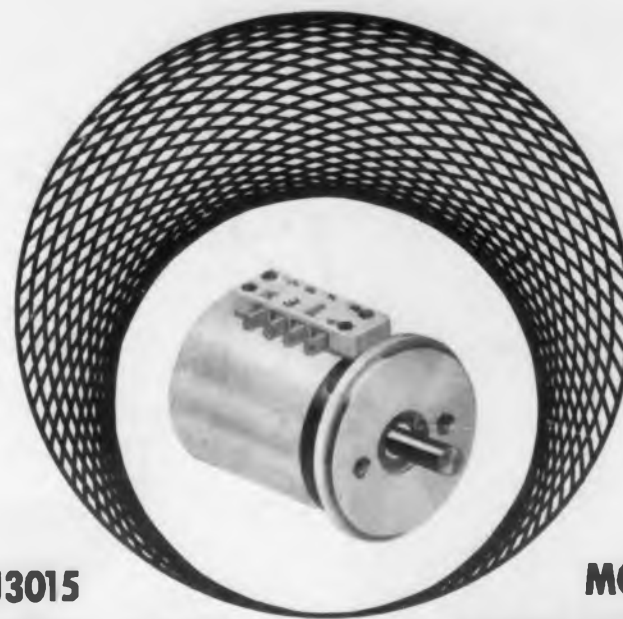
Waveguide Pressure Window 9.5 to 10.1 KMC



This flange-mounted waveguide pressure window for use in half-X waveguide applications covers the frequency range from 9.5 to 10.1 kmc with maximum vswr of 1.10 at the band edges. Resonant frequency is 9800 mc. Designated the MA-1339 it is used in 0.2 x 0.9 ID waveguide applications. Window flange thickness is 0.060 in. Maximum power rating is 20 kw. Maximum pressure handling capability is 45 lbs on the glassed side of the window. Pressure-handling capability in the reverse direction is 30 psi. The windows are constructed of kovar and glass. All metal surfaces are silver plated.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION



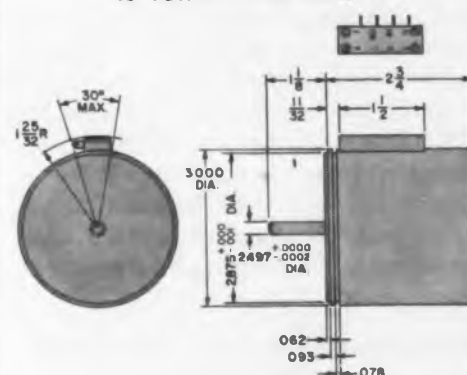
MODEL J3015
LINEARITY .005%

MODEL F1810
LINEARITY .01%

HIGH PRECISION POTENTIOMETERS

IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES
SAMPLES SHIPPED IN 48 HOURS

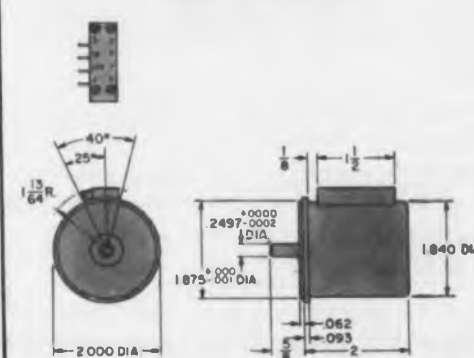
15 TURN - 3 IN. DIA.



MODEL J3015

RESISTANCE RANGE	2K TO 150 K
LINEARITY (STANDARD)	.05% TO .01%
LINEARITY (BEST)	.005% ABOVE 4 K

10 TURN - 1.8 IN. DIA.



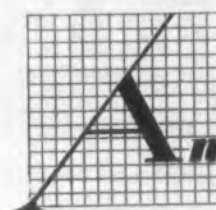
MODEL F1810

RESISTANCE RANGE	1 K TO 50 K
LINEARITY (STANDARD)	.05% TO .02%
LINEARITY (BEST)	.01% ABOVE 2K

Now you can design your circuits with Analogue Controls Potentiometers with the assurance that they will be available when you need them!

Complete mechanical and electrical specifications of all our potentiometers are available. Write for Catalog P103 today.

POTENTIOMETERS MEET THE REQUIREMENTS OF NAS-710



Analogue Controls, Inc.

39 ROSELLE STREET, MINEOLA, NEW YORK
PIONEER 2-8901

CIRCLE 111 ON READER-SERVICE CARD FOR MORE INFORMATION

*Ah
precision!*



FREQUENCY METER MODEL 802B

Range of 2350 to 10,500 megacycles covers the most used frequencies. Veeder-root digital counter provides accurate, legible readings which are referred to calibration charts for frequency in megacycles to rated accuracy of 0.2% without calculation. Completely self-contained with built-in detector and indicating meter.

SLOTTED LINES MODELS 219 THROUGH 224

Six portable models, incorporating carriage drive mechanism integral with wave guide assembly measures VSWRs and impedances from 2600 to 18,000 megacycles per second, covering wave guide sizes from 3 X 1 1/2 inches to .702 X .391 inches. Can be used with all standard military and commercial RF probes and detectors.

COMPLETE LINE OF COAXIAL AND WAVEGUIDE INSTRUMENTS INCLUDES:

DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
TUNERS
ECHO BOXES

SLOTTED LINES
BENDS
ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
THERMISTORS

FREE ILLUSTRATED CATALOG

contains much valuable data



160 HERRICKS ROAD, MINEOLA, N. Y. • PIONEER 6-4650

COMPLETE INSTRUMENTATION FOR MICROWAVE AND UHF

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Microwave Oscillator

9000 to 10,500 Mc



The Model 815 makes a stabilized signal source available for the X-band microwave region from 9000 to 10,500 mc. It delivers a nominal 40 mw of power from a 40/U choke flange. It offers short term stability of five parts in 10⁶ and long term stability of one part in 10⁶. Stability is obtained by means of an invar reference cavity and a high gain, low noise feedback amplifiers. The direct reading dial and the automatic stabilization indicator make this instrument easy to operate. The size is 19-1/2 x 13 x 18 in., and it can be rack mounted. This instrument is similar to the Model 814 ultrastable microwave oscillator covering the X-band region from 8500 to 10,000 mc, and the Model 803 covering the S-band region from 2680 to 3405 mc.

Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

Travel Rate Meter

Measures Linear Speed and RPM



The MF-2 speed-feed meter measures and indicates linear rates of travel and rpm by converting linear motion of any length of travel into an electrical signal. An illuminated meter gives the reading directly, with push-button selection of four scale ranges from 0-1 to 0-125 in. per min. Models are available with four speed ranges or with combinations of linear rate and rpm scales. The small fixed tachometer pickup has no moving parts and is mounted near a gear on the shaft being measured. Neither pickup or indicator can be harmed by over-speeding or sudden starts and stops.

Maico Co., Inc., Dept. ED, Industrial Div., 21 North 3rd St., Minneapolis 1, Minn.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Originally developed for EECO custom systems and proven in critical use, the EECO Computer-Series Plug-ins represent a refinement of the building-block concept to a degree hitherto unknown. Each of the full line of reliable, tested, and proven circuits is a complete off-the-shelf package function, performance-engineered for application where ultra-conservative design at the component level is essential because of system complexity.

New EECO Computer-Series Plug-ins enable you to meet your project delivery schedules by reducing systems-development time to a bare minimum and practical, eliminating drafting and layout time. You, the engineers can concentrate on system design instead of routine circuit detail. You, the technicians can cut fabrication time by step up production by performing simple point-to-point wiring instead of wiring complex circuits. And system prototypes can generally be built directly without need for the "breadboard" stage.

Detailed information on new EECO Computer-Series Plug-ins and compatible equipment, as well as on other EECO products, is available in Catalog No. 856-A. Write for your copy—today.

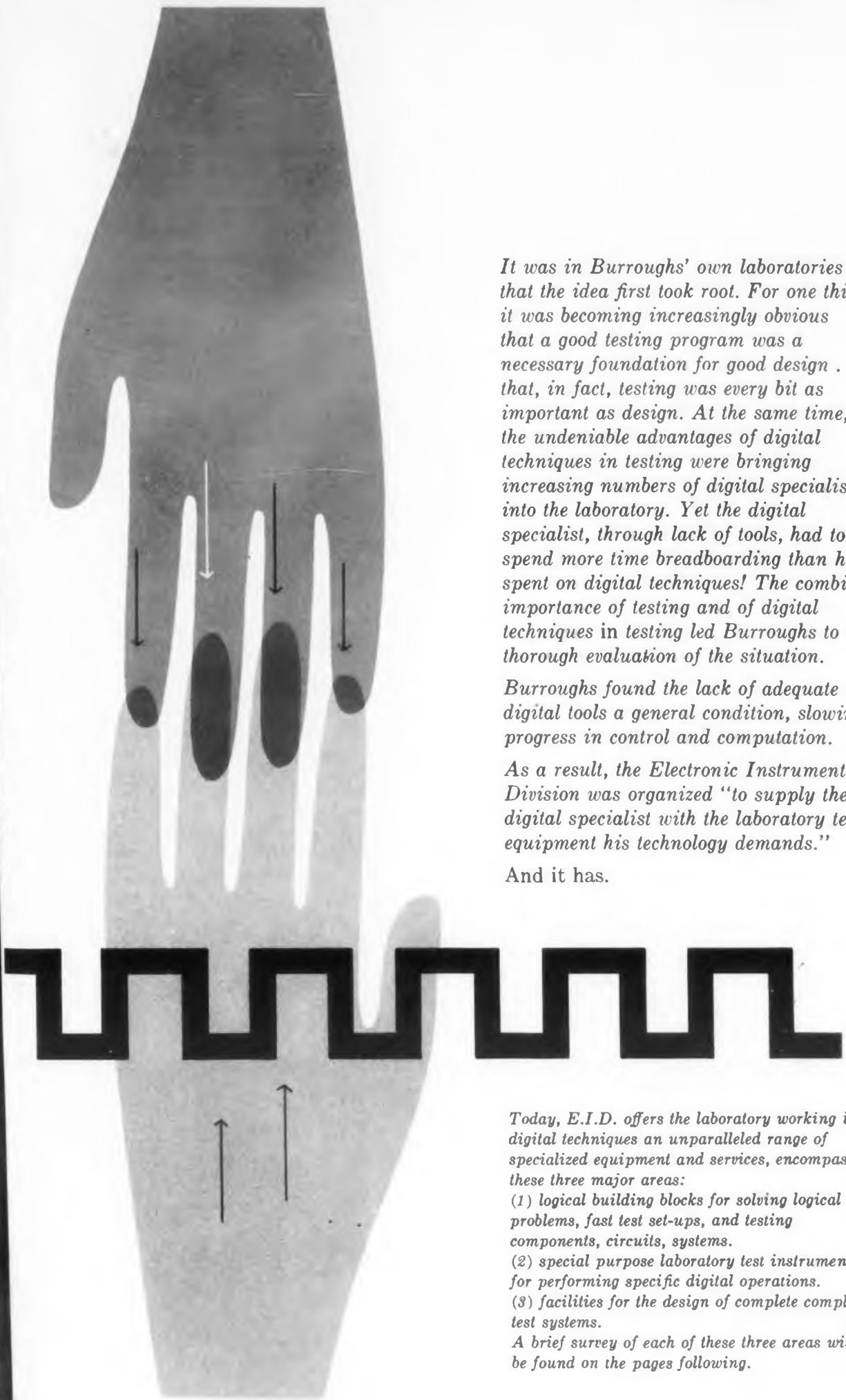
ELECTRONIC ENGINEERS AND PHYSICISTS — EECO offers immediate opportunities for qualified engineers in the transistor, amplifier, data-handling, pulse, timing, and systems-design fields. Send a resume of your qualifications to R. F. Lander, Dept. CS-2.

ENGINEERED ELECTRONICS COMPANY (formerly EECO Production Company)

a subsidiary of
Electronic Engineering Company
of California
506 EAST FIRST STREET
SANTA ANA, CALIFORNIA

CIRCLE 116 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD



It was in Burroughs' own laboratories that the idea first took root. For one thing, it was becoming increasingly obvious that a good testing program was a necessary foundation for good design . . . that, in fact, testing was every bit as important as design. At the same time, the undeniable advantages of digital techniques in testing were bringing increasing numbers of digital specialists into the laboratory. Yet the digital specialist, through lack of tools, had to spend more time breadboarding than he spent on digital techniques! The combined importance of testing and of digital techniques in testing led Burroughs to a thorough evaluation of the situation.

Burroughs found the lack of adequate digital tools a general condition, slowing progress in control and computation.

As a result, the Electronic Instruments Division was organized "to supply the digital specialist with the laboratory test equipment his technology demands."

And it has.

Today, E.I.D. offers the laboratory working in digital techniques an unparalleled range of specialized equipment and services, encompassing these three major areas:

- (1) logical building blocks for solving logical problems, fast test set-ups, and testing components, circuits, systems.*
- (2) special purpose laboratory test instruments for performing specific digital operations.*
- (3) facilities for the design of complete complex test systems.*

A brief survey of each of these three areas will be found on the pages following.

digital techniques in the laboratory

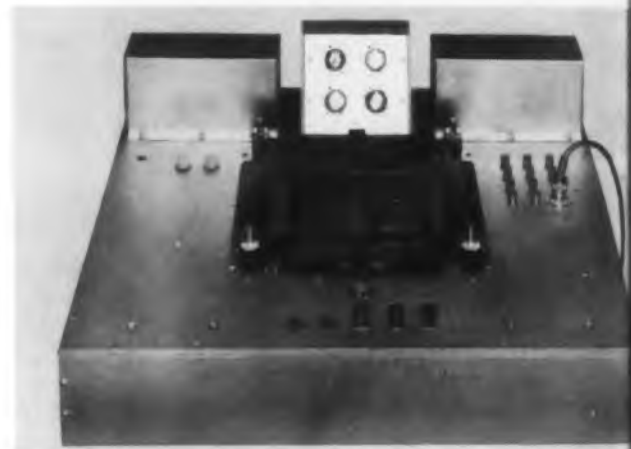
3

complete systems design

While Burroughs pulse control units are ideal laboratory tools for solving logical problems in computer design . . . testing individual components for pulse circuitry . . . performing specific digital operations . . . there are design and test requirements so complex as to require an entirely different approach. Designing and testing a complete core memory, for example . . . or building and testing complete digital computer subsections. Actually, both these jobs have been done by Electronic Instruments Division with Burroughs equipment. But chances are, they could not have been done successfully without the full-time efforts of Burroughs logical circuit and logical hardware designers . . . the men who developed the equipment. Should your needs be of this order of complexity, their experience and knowledge are available to you. Electronic Instruments Division can either serve you in a consulting capacity . . . or design, develop, and install the entire system from start to finish.



Installing Magnetic Memory For Large Computer



Memory Plane Tester

Burroughs Corporation Electronic Instruments Division

1209 VINE STREET PHILADELPHIA PENNSYLVANIA



FOR FURTHER INFORMATION

Complete the reply card on the other side of this sheet . . . insert in an envelope, or attach to a postcard . . . and mail to Burroughs Corporation, Electronics Instruments Division, 1209 Vine Street, Philadelphia 7, Penna. Your request will be given prompt attention.

tools for engineers



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CIRCU
ELECT

An Engineer Speaks Out...

Exciting Thriller Breaks Model Shop Mystery



This saga of the intrepid investigator veers off on a taut and timely theme — the engineering enigma of that inexplicable time lag in getting new servosystem designs into prototype form. Scene of the crime, written in a tempo of gore and gusto, is cued by the title — MURDER IN THE MODEL SHOP.

There's a switch in the pitch of this turbulent tale . . . no one seems to care who done it! The question is, what can be done about it. And this crime has its solution too, but agreement with the publisher precludes revealing the denouement here.

A possible clue to the answer is suggested by the sleuth's bringing in his trusty SERVBOARD®, that life-saving instrumentality for assembling models or prototypes of systems in jig time. The SERVBOARD is armed with a rigid aluminum base plate perforated with tapped holes, and a comprehensive range of gear sets, dial assemblies, hangers, clamps, and other hardware for summary execution of any and all servo designs.

And if there's any question whether the varmint is a true mechanism or a machination, the SERVSCOPE® beats out any lie detector ever concocted — gets the facts, ma'am, on gain, and phase lead or lag, digs the figures for plotting Nyquist diagrams, sings out with the square wave for transient functions.

With the latest edition now coming off the press, MURDER IN THE MODEL SHOP contains fifty pulse-packed pages — printed on genuine pulp. You've never had such an adventure in lurid lingo, even at many times the price which is exactly nothing . . . to engineering and design people.

SERVO CORPORATION
OF AMERICA

20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Write, wire, or call for your free copy of MURDER IN THE MODEL SHOP, published by SERVO CORPORATION of America. The publisher also produces SERVBOARD, SERVSCOPE Servosystem Analyzer, etc.

CIRCLE 118 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 1, 1957

Optical Circular Table

Projects Readings



The Matrix 18-in. optical circular table is equipped with a 2-in. diam illuminated screen, protected by armour plate glass, on which direct readings to 3 sec of arc are clearly visible. The projection is accomplished by system of lenses from a large diameter glass circle graduated in 10 min intervals. This glass circle built within the table is supported in mounting that prevents movement arising from temperature change or shock.

The entire optical system is sealed against dust or oil and insulated from heat radiated by the projection lamp. Smooth and uniform rotation of the table and minimum back-lash are obtained through a precision worm wheel drive. The table is clamped by two diametrically opposed clamps operated by a single lever.

Engis Equipment Co., Dept. ED, 431 S. Dearborn St., Chicago 5, Ill.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION



Regulated Power Supply For Traveling Wave Tubes

The multiple-voltage regulated power supply is used to operate traveling wave tubes. The supply contains eight output voltages:

Helix output	0-1500 v, 0-20 ma
Collector output	0-150 v, 0-20 ma
Grid no. 4 output	0-850 v, 0-5 ma
Grid no. 3 output	0-300 v, 0-5 ma
Grid no. 2 output	0-150 v, 0-5 ma
Grid no. 1 output	—150-0 v, 0-5 ma
Filament supply	0-13 v, 0-2 a
Solenoid output	20-150 v, 0-2.5 a

All voltages are continuously variable and the supply is designed for continuous duty operation. The unit features undercurrent protection on the solenoid voltage and provides for the application of external helix voltages.

Kepeco Labs., Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION



"FLYING SAUCER" FILTER solves R-F NOISE problem

The usual black box filter was out of the question. Too much bulk to fit the oddly-shaped space available . . . too little room to add components elsewhere in the system . . .

But the problem was solved by taking advantage of Sprague's assortment of designs including rectangular and cylindrical filter elements. Those needed were taken from the shelves and packaged together in the "flying saucer" shape illustrated.

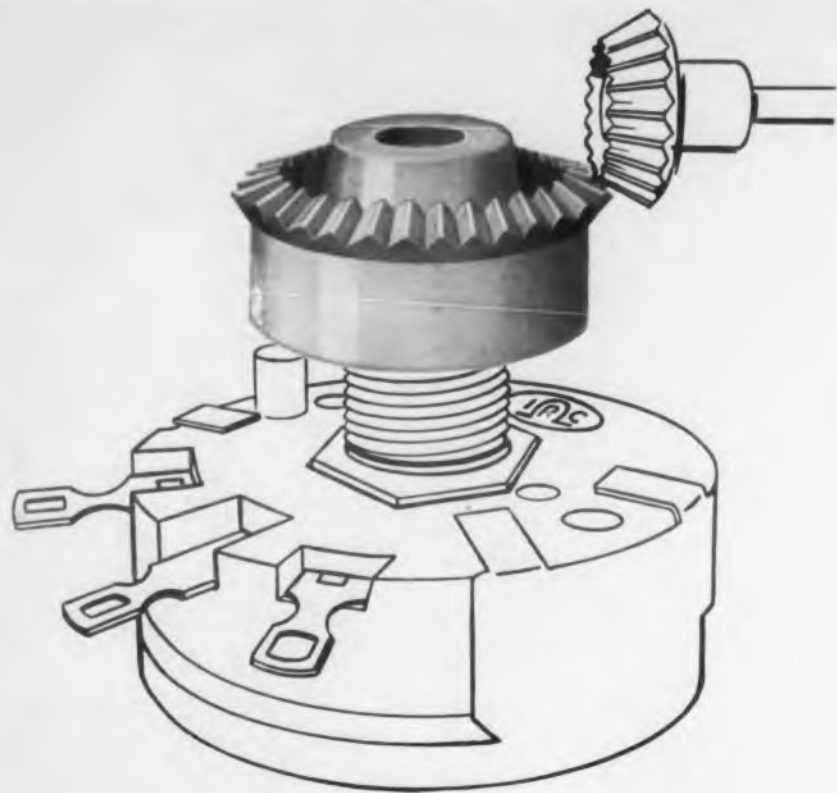
Chances are that Sprague's filter elements will add up to the fastest, most economical and efficient solution to many of your filter problems . . . whether you package them yourself, or Sprague assembles them for

you. But if not, you can depend on Sprague's three filter research and development laboratories, complete facilities for special tests and measurements, library of more than four thousand proven filter designs, mass production facilities on the East and West Coasts, and field engineering consulting service.

If you have an interference problem, pick up your phone and call your nearest Sprague Electric Field Engineering Laboratory. They are located at 12870 Panama Street, Los Angeles 66, Calif. (TEexas 0-7531); 224 Leo Street, Dayton 4, O. (ADams 9188); Marshall Street, North Adams, Mass. (MOhawk 3-5311).

see **SPRAGUE** for filters

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION



precisionmeered

MINIATURE MAGNETIC CLUTCHES at 1/10th the usual cost!

Now . . . design single and multiple clutching into your electronic equipment at low cost. The Hycor line of miniature magnetic clutches is designed around a common clutch body assembly, keeping unit costs low and performance standards high.

Only 2 watts of power develops up to 15 oz. in. of torque with a response time of 5 milliseconds. Zero clutch slip within rated operating conditions. No maintenance—only 2 moving parts. Ideally compact.

Nine precision-manufactured single and multi-turn models for gear, cable and direct-in-line drives. Also available in multi-shaft drive units.

Write for Bulletin C-2 . . . or for special design help from a Hycor systems engineer.

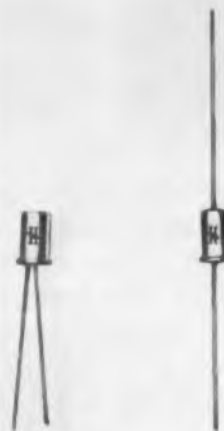


INTERNATIONAL RESISTANCE COMPANY

HYCOR DIVISION
12970 Bradley Ave., Sylmar, California

CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

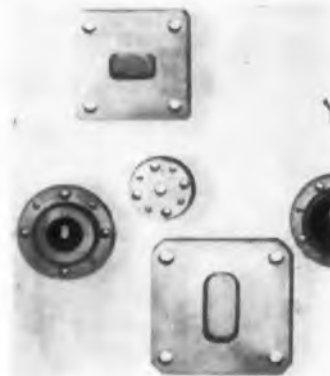


High Voltage Rectifiers
Diameter of 0.22 In.

The HDMP Series of high voltage medium power silicon diffused junction rectifiers are designed for applications requiring up to 1000 peak inverse working volts. Rated for operation in free air with no external heat sink, there is a choice of axial or single ended body construction. Maximum dimensions are 0.22 in. diam x 0.36 in. long. The line of HDMP rectifiers includes ten different models.

Hoffman Electronics Corp., Dept. ED, Hoffman Semiconductor Div., 930 Pitner Ave., Evanston, Ill.
CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

Waveguide Window Seals
Ranges from 0.2 - 90 KMC



This hermetic waveguide window seal, passes microwave energy with minimum reflection loss, and is thermally stable. The D-B seal maintains a constant pressure and constant dielectric inside when soldered directly to the waveguide flange, and seals out moisture, dust, oil and salt spray. The unit will hold hard vacuum, and withstand shock and vibration. Temperature range is from -55 to +100 C, and the seal will withstand degassing by baking. Pressure differential is 30 psi, and vswr averages 1.19 over the entire range. The seal is designed with optically clear metal-glass-mica windows, and is available in seven standard sizes covering the microwave and ultra-microwave range from 8.2 to 90 kmc.

DeMornay-Bonardi, Dept. ED, Pasadena, Calif.
CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION



A LIGHT-BEAM

GALVO

RUGGED

Will take
25 G's!

COMPACT

Size: Only 2.6"
x3.62"x3.615"

sensitive

.105 microamps
per millimeter

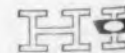
Here is a new series of light-beam galvanometers that were developed to withstand the extremely severe conditions of shock and vibration encountered in field servicing and testing of jet aircraft.

Through unique folding of the light beam, great compactness is achieved while retaining sensitivity to the highest degree . . . equal to that of laboratory instruments!

These Howell Galvanometers feature excellent readability. They are readily adaptable to existing instruments. They are competitively priced.

Resistances: 20, 100, 500 and 1000 ohms
Short period; high speed response. Sealed construction.

For full information
please write or wire



HOWELL INSTRUMENT Company
3101 Trinity St. • Fort Worth 7 Texas

SALES-ENGINEERING OFFICES

VALLEY STREAM, L.I., N.Y.: 108 So. Franklin • LO 1-9280
DAYTON, OHIO: 209 Commercial Bldg. • Michigan 4560
COMPTON, CALIFORNIA: 105 N. Bradfield St. • NE 6-8970
CIRCLE 125 ON READER-SERVICE CARD

AL PURPOSE

TRANSISTORIZED ELECTROMETER

Combined preamplifier and dc vtvm has 100 ohms input, 1 mv sensitivity

High input impedance is only part of the story with the new Keithley Model 220. As a sensitive dc vtvm, it's especially convenient for measuring voltages of transistors, amplifiers and computers, as well as many electrochemical and biological tests. In its alternate role as a dc pre-amplifier, the 220 has gains of 0.05 to 167 with suitable outputs. Uses include recording the variations in piezo-electric and pH voltages; currents in photocells, vacuum tube grids and ion chambers; and other long-term monitoring functions.

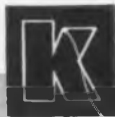


KEITHLEY
MODEL 220
DC VTVM

LINE-OPERATED, the 220 has 8 voltage ranges from 30 millivolts to 100 volts full scale. With added accessories, the instrument measures voltages from 1 mv to 20 kv, currents from 10^{-8} to 5×10^{-14} ampere, resistances from 10^4 to 10^{16} ohms.

USEFUL FEATURES include a 5-volt unbalanced output for amplifiers and oscilloscopes, and a one-milliamper output for sensitive recorders; a polarity reversing switch; and zero drift below 3 mv/hr.

DETAILS about the Model 220 are given in Keithley Engineering Notes, Vol. 5, No. 2. A request on your company letterhead will bring a copy promptly.



KEITHLEY
INSTRUMENTS, INC.
12475 Euclid Ave., Cleveland 6, Ohio

CIRCLE 127 ON READER-SERVICE CARD

Intermittent Condition Analyzer For Radio and TV Troubleshooting



This Model 828 Intermittent Condition Analyzer provides for faster troubleshooting of intermittent circuits using a new principle which makes TV or radio receivers supersensitive to intermittent and pre-intermittent noises caused by capacitors, resistors, tubes, coils, chokes and other components. A sensitive amplifier and an intermittent tracer probe pick up and localize the noises produced by borderline components without waiting for actual breakdown to occur. Phantom probe attachments provide signal pickup from tubes and wiring without making actual circuit connections. A built-in line voltage step-up transformer provides a high line voltage supply to make intermittents easier to locate.

Winston Electronics, Inc., Dept. ED, 4312 Main St., Philadelphia 27, Pa.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Balance Bridge For Large Systems



Ten 4-arm gage bridge or resistive type pickups may be calibrated individually or simultaneously with a rack-mounted balance unit designed for large-scale instrumentation systems. The Model 228 Bridge Balance employs individual plug-in calibration resistors which are inserted from the front through a hinged door on the panel. Precision 10-turn balance and sensitivity potentiometers are provided with knurled finger locks for maintaining desired settings. Toggle switches permit individual transducer calibration, or all transducers may be calibrated by a remote contact closure. Individual or common voltage supplies of 0 to 30 v may be used. The system is designed for 4-arm resistive transducers of 120 ohms or more.

Consolidated Avionics Corp., Dept. ED, 66 Brooklyn Ave., Westbury, N.Y.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION



According to Mrs. L. B. Q. (who is pictured in the above candid photograph of the advertising department's mail department and is in charge of Sigma premiums, box tops, blown tops and the like) Sigma's July offer of free Slidecharts has turned into a polymorphous hydra.

Now it becomes necessary, due to the laws of Kirchoff and diminishing returns, to terminate the free offer.

Hereafter we'll be glad to oblige, but at 25¢* (C. I. A.) per. (It's either this, fellows, or raising the price of Sigma relays.)

Don't think we do not appreciate the interest displayed — it's just Still free is the EBG reprint which resumes SIGMA products and is big enough so you can read it.

*Cash, stamps or rare fiduciary objects.

SIGMA SENSITIVE RELAYS

Prices shown are list, for quantities from 100. Discounts are available for quantities above 10 unless otherwise noted. Price ranges vary with quantity. Standard lead time 4 weeks. Minimum order 100 units.

GENERAL CLASSIFICATION	SIGMA SERIES	Maximum Current (amp)	Contact Rating (amp)	Sensitivity Range (mv or v)	Price Range (list)	APPLICATION NOTES
General Purpose Sensitive DC	4	SPDT	1.0	30 or 30	5.00-11.00	High sensitivity shock resistance, stability and vibration resistance
	5	SPDT	25.0	1-100	7.00-22.75	Low price, small, light, low mounting space, including use for ground control. Standard lead time only
	11	SPDT	1 or 5	30 or 300	1.90-2.90	Low price, small, light, low mounting space, including use for ground control. Standard lead time only
	41	SPDT	1.0	25-300	3.90-10.15	Low price, long mechanical life
Miniature General Purpose DC	22	SPDT or DPDT	1 or 1	30 or 30	14.00-22.50	Manufacture hermetically sealed relay. Vibration and shock resistant
	26	SPDT	5.0	4.30	4.80-13.80	Stripped down. 32 pins. Can be used without enclosure. Small mounting
Sensitive AC	5	SPDT	0.5	20-130	10.00-14.75	Series DC with inherent resistance for various AC voltages
	41	SPDT	2 or 3	0.0-0.4	3.80-7.43	Sensitivity shunted pole, low price, used for extremely weak signals or current operated (10-100 cycle range)
	42	DPDT	2 or 3	0.5	5.75-14.00	More economical in price than most competitive types. Allow for time
Polar 3 Position (Multi-throw, center-throw)	6	4PDT	2 or 3	5-44	22.00-38.00	High load rating, all mechanical power in steel case, also available in brass. Standard lead time 4 weeks
	23	SPDT or DPDT	1.0	0.2-1.0	30.00-34.00	Center-throw version of high speed polar relay. Best for "latching" use. Standard lead time 4 weeks
	72	SPDT	1.0	0.2-1.0	30.00-34.00	Center-throw version of high speed polar relay. Best for "latching" use. Standard lead time 4 weeks
High Speed	41	SPDT	1.0	23-130	3.90-10.15	High speed version of high speed polar relay. Best for "latching" use. Standard lead time 4 weeks
	72	SPDT	0.5	0.15-1.5	30.00-34.00	High speed version of high speed polar relay. Best for "latching" use. Standard lead time 4 weeks
25 Amp. Sensitive Contacts	51	SPDT (MC)	25	100	9.00-9.30	Patented permanent magnet latching contacts. Available in hermetically sealed version. Standard lead time 4 weeks
	61	SPDT	30	275 or 430	18.00-26.00	High sensitivity, high reliability, easy mounting and adjustment. Very economical in price. Standard lead time 4 weeks
Relays for Radio-Cameras, Modems, Telex, etc.	49	SPDT	2.0	30 or 30	5.50-6.20	Medium sensitivity, high reliability, easy mounting and adjustment. Standard lead time 4 weeks
	58	SPDT	0.25-2	1-100	7.00-12.50	Simple precision, rugged — recommended by 500 g shock. Good in high vibration environments. Standard lead time 4 weeks
	11P	SPDT	1 or 5	30 or 300	1.50-2.30	Magnet less type DC relay. For its voltage a good combination of high sensitivity and low price
	28P	SPDT	0.5	4	4.80-7.80	High sensitivity version of Series 5 designed especially for low power applications. Standard lead time 4 weeks
41P	SPDT	1 or 5	30-300	2.30-4.83	High switching capacity class 11P. Special version to handle free light load currents	

OTHER SIGMA PRODUCTS

DEFINITION SIGMA DESIGNATION PRICE RANGE (list)

Cyconema® \$5.00-10.00

SIGMA INSTRUMENTS, INC.
91 Pearl Street, So. Braintree 85, Mass.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

CLARE RELAYS and AUTOMATION

How *AccuRay*[®] uses long-life CLARE Mercury-Wetted-Contact Relays to provide accurate, continuous and automatic control of a manufacturing process

Actuated by variations in the electric current set up by a constant intensity beam of radiation through a cigarette "rod," two CLARE Mercury-Wetted Contact Relays help the AccuRay Cigarette-Gauge controller to proportion the weight of cigarettes as they are being produced.

In this way AccuRay, a revolutionary precision process control system, uses electronics to provide automatic control of cigarette and other manufacturing production processes.

Engineers of Industrial Nucleonics Corporation, makers of this new process control, picked CLARE Relays to perform these important functions because only these relays gave the long life and low maintenance required. These machines wrap and cut 20 cigarettes a second, day and night, day after day.

With a service life of billions of operations it is no wonder this relay has become the first choice of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122 to C. P. Clare & Company, 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

Drawings (right) from high-speed photographs show the cycle. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing globule of mercury to fall out. Mercury flows up the capillary path, replaces amount lost, restores the equilibrium. (d) The momentary bridging of the parting contacts—and the extremely fast break that ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges mechanical bounce and prevents any chatter from appearing in the electrical circuit.

© Industrial Nucleonics Corporation, Columbus, Ohio

CLARE RELAYS
FIRST in the industrial field

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Silicon Transistors High Frequency



Eleven types are included which provide a range of current gains up to 60, and collector voltage ratings to 45 v. Rated for operation to 175 C, these units feature low collector cut-off currents. All types are specified for a maximum of 0.5 μ a at their maximum collector voltage rating. Types ST13 and ST33 have a typical cut-off frequency of 17 mc. Manufactured by the diffusion process, close control is maintained on all characteristics to achieve uniformity and interchangeability. All units are subjected to temperature cycling and storage, and other environmental tests.

Transitron Electronic Corp., Dept. ED, Melrose 76, Mass.

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION



VHF Amplifier Broadband

This automatic level controlled, broadband trunk line vhf amplifier is equalized to compensate for cable slope between 53 and 89 mc with a flatness of ± 0.25 db. It can deliver up to 0.2 v output into a 75 ohm load and has a maximum gain of 45 db on channel 6. Automatic level control uses stable, drift free circuits to hold the output level within 1 db for 10 db increases of input level. The input stage of the amplifier uses the newly developed 6922 long life, low noise, dual triode to achieve an 8.5 db noise figure. A constant voltage transformer and silicon diodes provide a power supply that requires only 45 w and maintains an output stability of ± 0.2 db for ± 20 per cent line voltage variations.

Entron, Inc., Dept. ED, P. O. Box 287, Bladensburg, Md.

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION



New BRADY Aluminum Foil Wire Markers — Give Permanent Identification

Stick and stay in elevated temperatures, oils, most solvents

New Brady Aluminum Foil Wire Markers show which wire goes where at a glance. Permanently identify machine tool electrical systems, motor leads, control circuits, etc.

Only 3 mils thin. Self-Sticking Markers wrap around

wire fast. Legends imbedded in the foil stay permanently legible. Markers stay on wire under oily conditions — won't discolor at temperatures to 350°F.

NEMA and NMTBA Markers in stock for immediate delivery. Specials made to your order. Write today for free working sample prices, and name of local distributor

W. H. **BRADY** CO.
Est. 1914

783 W. Glendale Ave.
Milwaukee 9, Wis.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

"TORQUE WRENCH" MANUAL

Sent upon request

Formulas
Applications
Engineering data
Screw torque data
Adapter problems
General principles

P.A. **STURTEVANT** CO.
ADDISON **QUALITY** ILLINOIS

Manufacturers of over 85% of the torque wrenches used in industry

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1, 1955

Transistor Heat Sinks Beryllium Copper

Beryllium copper heat sinks enable the transistor to operate at higher levels of dissipation and provide a mounting clamp for the transistor in those cases where the transistor is suspended by its leads and not used with a socket. Model HS-10 is designed for the GT soldered case and Model HS-20 for the GT version of the JETEC 30 case. General Transistor Corp., Dept. ED, 91-27 138th St., Jamaica 35, N.Y.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Epoxy Chokes 1.1 to 120 μ h

Thirteen epoxy encapsulated chokes ranging in values from 1.1 through 120 μ h following preferred values are available. All are 5/16 in. in diam and 1/4 in. long with axial pigtail leads. They are color-coded for value identification. The chokes are constructed so as to have maximum ruggedness and resistance to moisture, temperature and other environmental extremes.

James Thomas Chirurg Co., Dept. ED, 414 Park St. Bldg., Boston 12, Mass.

CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Tube Electrometer Measures 10^{-11} A



The Model VTE-1 Vacuum Tube Electrometer measures direct currents of either polarity from 10^{-3} to 10^{-11} a. The unit features a built-in bucking current source, with range from 10^{-3} to 10^{-9} a for scale expansion. Time constants of 0.1 to 30 sec are available on a single rotary selector switch. Zero drift is 0.1 per cent per day after initial warm-up period. The meter is available with high and low level output trips for process or nuclear control uses.

Tullamore Electronics Lab., Dept. ED, 6055 S. Halsted Ave., Chicago 36, Ill.

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

Bendix Synchro "Supermarket"

also headquarters for

RADAR ANTENNA DEVICES



Doubtless you've learned to depend on the Bendix Synchro "Supermarket" for fast delivery and tremendous selection of precision synchros, servo motors and other vital electronics systems components. But did you know that Bendix is also a prolific producer of radar antenna devices?

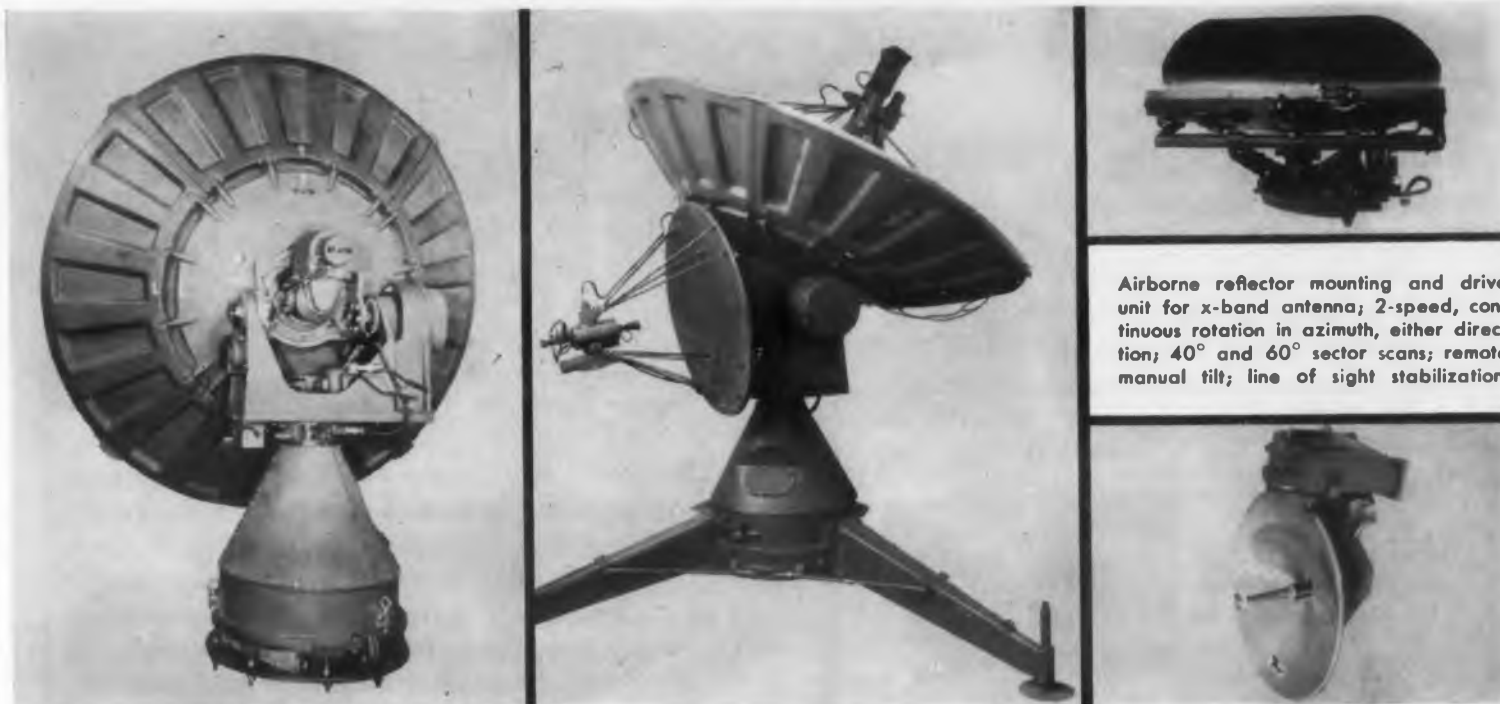
Over the years Bendix airborne and ground-based antenna devices have been successfully designed by our highly specialized staff of radar and servo-mechanisms engineers to meet a wide

variety of exacting requirements. And, of course, world-famous Eclipse-Pioneer precision rotating components are standard in all Bendix radar antenna devices.

When you order from Eclipse-Pioneer, you'll enjoy the advantages of experienced engineering coupled with favorable delivery and prices that result from mass production techniques.

District Offices: Burbank and San Francisco, Calif., Dayton, Ohio, and Seattle, Wash.—Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

TYPICAL EXAMPLES OF BENDIX RADAR ANTENNA DEVICES



Lightweight, ground-based, air-transportable tracking antenna pedestal for mounting 8-ft. diameter, s-band segmented parabolic reflector and rotating scanner; highly accurate 2-speed data systems in elevation and azimuth.

Lightweight, ground-based, air-transportable, dual reflector, multi-band, high gain search antenna and control system; 2-speed data systems and magnetic clutch drives in azimuth and elevation.

Airborne weather radar antenna with line of sight stabilization for x- or c-band; switchable wide fan (coscant squared) beam pattern for mapping or pencil beam for storm detection.

Eclipse-Pioneer Division

TEREBORO, N. J.



CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION



HAVE YOU EVER HAD THIS PROBLEM?



ELIMINATE PRODUCTION DOWN-TIME

When You Need CONTACTS IN A HURRY

Here's how Deringer Delivery saves you time and increases your profits.

Whether the contact you need is standard or special, Deringer delivers in accordance with your needs and in less time than others take to process an order.

Our prices are competitive. You pay no premium for our precision quality and faster delivery.

Write for these FREE CONTACT CATALOGS



If delivery has ever been a problem, try Deringer. You'll be glad you did.

DERINGER Metallurgical Corporation

8117 Monticello Ave • Skokie, Illinois
PHONES: CHICAGO KEystone 9-8502 SKOKIE ORchard 5-1030

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Gearhead Motor
AC, Oil-filled

This oil-filled gearhead motor meets requirements of MIL-M-17059 and MIL-S-901, Class AI shock. It is a 2 speed motor, 2 pole and 6 pole, designed for 220 v ac, 60 cps 3 phase rated at 1/10 hp output at 250 rpm and 84 rpm, intermittent duty at high speed, continuous duty at low speed. It is equipped with an electrically energized brake which will stop motor within 0.2 sec and within 25 deg of output shaft of gear box. The motor is totally enclosed to provide protection against moisture, dust, fungus and salt spray. It is filled with Verselube F-50 silicone fluid for cooling. Ambient temperature: -65 to 200 C, 100 per cent humidity.

Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION



Isolation Amplifier
Selectable Bandwidths

The Model 102B serves as either a general purpose preamplifier or as an isolation amplifier covering both audio and ultrasonic frequencies. It has a 5-v, 50-ohm output to drive oscilloscopes, sound level meters and pen recorder power amplifiers. Frequency response is from 2 cps to 150 kc or to 1.7 mc with selectable bandwidths and accurate decade gains of 0.1 to 1000. Impedance input is 400 megohms, and noise is below 10 μ v with 150 kc response. Two accessory probes for low-capacitance connection to the circuit being measured are included. Typical uses include work with accelerometers and hearing aids, pulse amplification, and vibration and noise studies.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION

Send for FREE SAMPLE PACKET of the three new MUELLER "70 SERIES" ALLIGATOR CLIPS. Low-cost, streamlined clips

with **SNAP!**

THIS IS AN ACTUAL HIGH SPEED SEQUENCE PHOTOGRAPH OF A NEW "70 SERIES" ALLIGATOR CLIP

which is taking 1/2500th second to snap shut upon a wafer. Talk about acceleration!—the upper jaw hits 60 MPH in three-eighths of an inch. The upper jaw and flying wafer fragments have been caught in many images along their paths of movement.

Photographed by means of a special process, it graphically illustrates the "snap" in Mueller's traditionally snappy springs. These springs provide a mean, corrosion-cutting bite for perfect test connections.

THE NEW "70 SERIES" ALLIGATORS FEATURE:

Simple, direct, streamlined design, and lower cost than the famous "60 Series".

Faster, easier connection, whether screw type or soldered.

A new patented hinge, and cord strain relief ears.

WRITE FACTORY TODAY FOR FREE SAMPLE PACKET SHOWN ABOVE



Mueller Electric Co.

1580H East 31st Street • Cleveland 14, Ohio

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW! Syncramental motor provides precise *bi-directional stepping*



ACTUAL SIZE 1.5" DIA. X 2.525"

The Syncramental Motor accurately translates pulses to incremental shaft position . . . rotates potentiometers, counters, rotary switches, control mechanisms. Features a clutch mechanism, rather than ratchets, to index the shaft through action of two LEDEX Rotary Solenoids.

Angular increment per pulse is 36° either direction . . . maximum stepping rate, 15 per second . . . load capacity, up to 2 lb. in. starting torque . . . life expectancy, 2 million steps . . . dimensions, 1.500" dia. x 2.525" long . . . weight, 13 oz. . . standard Servo mounting.

Write today for complete data . . .

G.H. Leland
INC.

SYNCRAMENTAL MOTOR

123 WEBSTER STREET, DAYTON, OHIO
IN CANADA: Marsland Engineering Ltd., Kitchener, Ontario
IN EUROPE: NSF Ltd., 31-32 Alfred Place, London, England

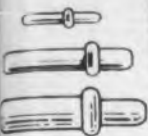
CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

50% SAVINGS

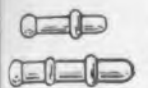
with

BEAD CHAIN[®] Multi-Swage Parts

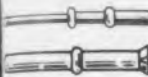
CONTACT PINS



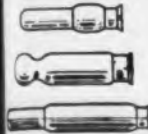
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JACKS



FRICTION CONTACTS



also PRINTED CIRCUIT MINIATURE PARTS

Contact pins, terminals, jacks or any small tubular parts. Maximum 1/4" diameter x 1 1/4" length.

Send sketch for quotations.

BEAD CHAIN DRIVES

Low-speed positive drives or motion transfer ... at far less cost!



Send for Multi-Swage or Bead Chain Drive Catalogs!

THE BEAD CHAIN MFG. CO.

58 Mountain Grove St., Bridgeport 5, Conn.

CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

If it's HOT or DRY

USE 'DIAMOND H' SERIES R RELAYS



Where the temperature hits 200°C ... or drops to -65° ... where a dry circuit is downright arid ... or

power circuit employs 10 amperes (or even 20 amps for a short life need) ... your best bet for reliability is a "Diamond H" Series R miniature, hermetically sealed, aircraft type relay. Their shock and vibration resistance you may take for granted. Variations on the basic 4 PDT Series R relay perform outstandingly over such a broad area that they are frequently used in many different types of jobs in a given application, with resultant savings in spare part inventories. The range of possible characteristics covers:

Various brackets of vibration resistance from 10 to 2,000 G's; coil resistances from 1 to 50,000 ohms, operational shock resistances of 30, 40, or over 50 "G"; mechanical shock resistances to 1,000 "G"; contact capacities from 350 V., D.C., 400 V., A.C. to 10 A., at 30 V., D.C., as well as signal circuits.

For complete information send for a copy of Bulletin R-250.

THE HART MANUFACTURING COMPANY

210 Bartholomew Avenue, Hartford, Conn.

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

Differential Amplifier

Rejects Noise & Hum Pickup



Providing high gain and stability necessary for strain-gage and thermocouple applications, the Model DA-101 wide-band differential amplifier handles low-level signals, including pulse signals, without noise or hum pickup. Noise is 6 mv referred to the input with a bandwidth of 50 kc at the 3 db point and at 20,000 ohms differential input impedance. Static common-mode rejection is greater than 100,000 to 1. Gain is adjustable in steps from 100 to 2000 with a gain accuracy of 0.1 per cent. Linearity is ± 0.05 per cent.

The amplifier is built so that six units can be mounted on a 7-in. relay-rack panel.

Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION



Double Pulse Generator

Variable Delay and
Width

This double pulse generator, Model B-3-2, is capable of generating two pulses both having recurrence rates of 1 mc. The internal oscillator controls both pulses and has repetition rates from 10 cps to 1 mc, or the instrument may be triggered externally at rates up to 1 mc. Each of the two pulses may be independently and continuously delayed from 0 to 10,000 μ sec with respect to the common synchronizing pulse. Each of the two pulses may be continuously varied in width from 0.08 to 10,000 μ sec. The two pulses are available on separate output jacks or may be mixed via a resistance mixing network so that they are both available at a common output. Due to the modular construction of the instrument it may be expanded to furnish greater numbers of pulses.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

SPIROL — the spring pin with Wider Hole Tolerances



With SPIROL PIN, hole drilling is not limited to plus tolerances. Both plus and minus hole tolerances are allowed because the spiral construction permits greater flexibility in expansion and compression. The wider hole tolerances eliminate precision reaming requirements, reduce drilling rejects, and cut costs.

OTHER UNIQUE SPIROL FEATURES

SHOCK RESISTANCE

High resistance to shock and vibration permits use of "medium duty" SPIROL pins in a wide variety of materials with wide range of bearing loads. Heavy and light duty SPIROL pins also available in stock.

MINIATURE PINS

SPIROL is the only spring type pin available in these miniature diameters: 1/32" - .039" - 3/64" - .052". Unique spiral cross-section retains flexibility and strength in smallest sizes. Other standard sizes up to 1/2" diameter.

PERFECT CHAMFER

A. Smoothly rounded radius where chamfer meets shank eases insertion into hole. No sharp break to "bite" and resist insertion. B. Chamfer angle is precisely designed to offer minimum thrust resistance and maximum compression leverage.

NON-HEAT-TREATED METALS can be specified in standard SPIROL pins for extra corrosion-resistance or conductivity. Less resilient metals are usable because stress is evenly distributed throughout the spiral cross-section, giving maximum spring action.

FREE! Write for literature on Spirol Pins.



SPIROL PIN

C. E. M. COMPANY • 86 SCHOOL ST. • DANIELSON, CONN.
CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

FREE SELECTION CHART

for
AGASTAT[®]
time delay
relays



Now you can select exactly the right Agastat time delay relay for your particular timing need—in a hurry. This free selection chart lists data on every popular model in the Agastat line—the most complete line of pneumatic time delay relays in the industry. They're adjustable for timing from 0.1 second to 10 or more minutes, unaffected by voltage variation, dust-proof, light, and mountable in any position. And there's an Agastat model to precisely fit your requirements, including two-step, electrical interlock and double head units. A glance at the free selection chart tells you which model to order.

Write for your free copy to Dept. A26-924

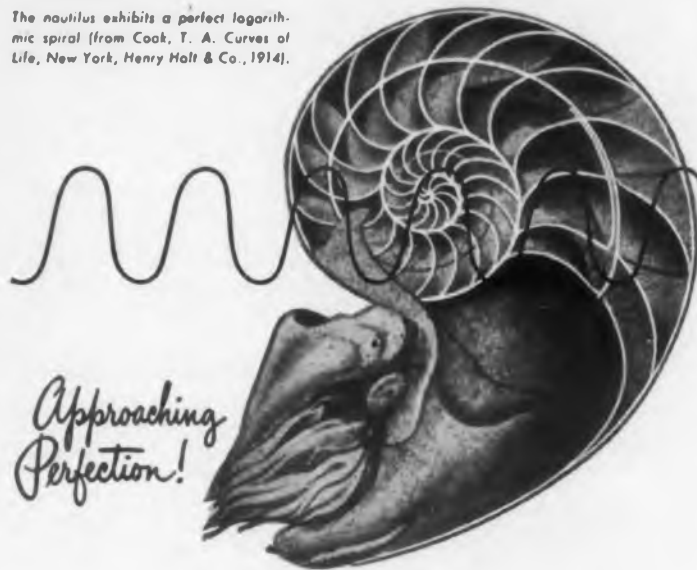
AGA
DIVISION

Elastic Stop Nut Corporation
of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

The nautilus exhibits a perfect logarithmic spiral (from Cook, T. A. Curves of Life, New York, Henry Holt & Co., 1914).



MODEL 1200 SINE WAVE GENERATOR

Less than 0.1% distortion at any amplitude or frequency. 1 cps to 1 mc in 6 decades, plus overlap. 600 ohms constant output impedance. Many other exceptional features. Small, portable — 23 pounds. Complete data on request. \$265.00, FOB Factory.

DONNER SCIENTIFIC COMPANY

3 Galindo Street,
Concord, California



CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Silicon Rectifier Units
Supply 1500 Amp

A line of silicon regulated power rectifiers supply up to 1500 a continuous capacity. The unit proves particularly useful as the dc source for ground support equipment and missile testing. Reliable performance is provided by hermetically sealed silicon diodes which are impervious to humidity, fungus, salt spray, sand and dust as well as ambient temperatures from -55 to $+65$ C. Standard models are available for 1000 a continuous capacity with dc voltage ranges from 6 to 40 v, with dc regulation of ± 0.5 per cent, response of 0.1 sec and ripple of 1 per cent rms. All models are built to meet the requirements of military specifications.

Christie Electric Corp., Dept. ED, 3410 W 67 St., Los Angeles 43, Calif.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION



Fixed Pad Attenuators
10, 20, 30 db

A series of precision fixed pad attenuators have been designed to partially absorb rf power in the 8.2 to 75 kmc frequency spectrum. The pads are useful between klystrons and other elements of a typical waveguide test bench to counteract frequency pulling effects or to reduce by a known amount of rf power flowing in a system. Ratings and general characteristics include a maximum power dissipation of 2 w and nominal attenuation values of 10, 20, and 30 db. The accuracy of attenuation measurement and limits is 1/4 db. The attenuation value and calibration frequency are stamped on each unit. The fixed pads are fabricated from short sections of waveguide in which a lossy element is mounted. Standard cover flanges are used at each end. All surfaces are silver plated throughout. Excepting flanges, external surfaces are finished with blue-gray lacquer.

Microwave Associates Inc., Dept. ED, Burlington, Mass.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION



**SOLENOID
REFERENCE
MATERIAL**

Yours for the asking!

New reference data covering PSP Miniature and Sub-Miniature DC Solenoids are now available to aid you in solenoid selection for valves, computers, memory units, data processing—and avionics applications. Solenoid type, size, voltage range, temperature range, force, weight and similar characteristics of nine units are given. All are produced in accordance with MIL-S-4040A specifications.

Send for this helpful reference material today. And ask also for information about high voltage and high temperature solenoids, high pressure types, co-axial valves and standard PSP Solenoids!



PSP ENGINEERING COMPANY

DIVISION OF INDUCTION MOTORS CORP.
6058 Walker Avenue • Maywood, California

Send for the Informative PSP Catalog

PRECISION SCIENTIFIC PRODUCTS

CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION

SHORT . . .
in size
LONG . . .
in performance



NEW SODECO Type TCeBZ Electric Impulse Counters

The latest in the SODECO line, these new electric impulse counters offer designers a wonderful opportunity to squeeze a high-performance impulse counter into a very limited space.

Look at these features:

- AC or DC Models
- Counters measure as little as 1-3/8" wide x 2-1/16" high x 1-3/4" deep (designed for flush mounting)
- 4 or 5 digit models available
- Fast—can count up to 25 impulses/sec.
- Low power demand—as low as 1 W DC at 10 impulses to 6.5 W AC max. at top speed
- Instantaneous mechanical push-button reset

You'll want more information on these unique counters. Write to—

LANDIS & GYR, INC

45 West 45th Street, New York 36, N. Y.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW—self-locking UNBRAKO socket head cap screws



The Nylok* self-locking feature locks these screws securely in place, seated or unseated, wherever you stop wrenching! They won't work loose. Can be used repeatedly. Tough, resilient nylon locking pellets permanently installed. Successfully withstand temperatures ranging from -70 to 250°F . Familiar UNBRAKO knurled heads for sure finger grip and fast assembly—accurate hex sockets for positive, nonslip internal wrenching. Heat treated alloy steel, controlled fillets, continuous grain flow lines, fully formed Class 3A threads for maximum strength and exact fit. Can be used as adjusting screws. Pellets act as liquid seals. Standard sizes from #6 to 1 in. diameter. Also available in plated finishes and in stainless steel. Write for Bulletin 2193. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 12, Pa.

*TM Reg. U.S. Pat. Off., The Nylok Corporation

STANDARD PRESSED STEEL CO.

UNBRAKO SOCKET SCREW DIVISION

SPS

JENKINTOWN PENNSYLVANIA

We also manufacture precision premium fasteners. Write for free booklet.

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get full PROPERTIES
plus PRECISION
in

TSI* grade

TEFLON ROD
a TRI-POINT exclusive

* A new high-density, uniform rod extruded by Tri-Point to meet strict requirements of precision-machined parts.

NOW AVAILABLE, in unlimited quantities from stock:

- Diameters: .125" to 1.000" and larger
- Tolerances: .001"
- Increments: 1/32" and less
- Lengths: up to 12 feet

DU PONT

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TRI-POINT

Mayfair 1-5801

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SPECIALISTS IN EXTRUDING TEFLON

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION



X-Band Magnetron
40 Watt

A 40 w, MA 215, X-band pulsed magnetron has been developed for operation in the frequency range from 8800-9600 mc. The tube is rated at 40 w peak pulsed power output at a 25 per cent duty cycle for maximum pulse lengths of 5 μsec . Substantially higher peak powers may be achieved with shorter pulse durations and reduced duty cycle requirements. Frequency and amplitude modulation of the magnetron output pulse has been measured at less than ± 30 kc modulation deviation in experimental models. Operating efficiency of the MA-215 is 20 to 30 per cent. A ceramic cathode bushing structure is used for increased reliability. The magnetron weighs approximately 20 oz.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION



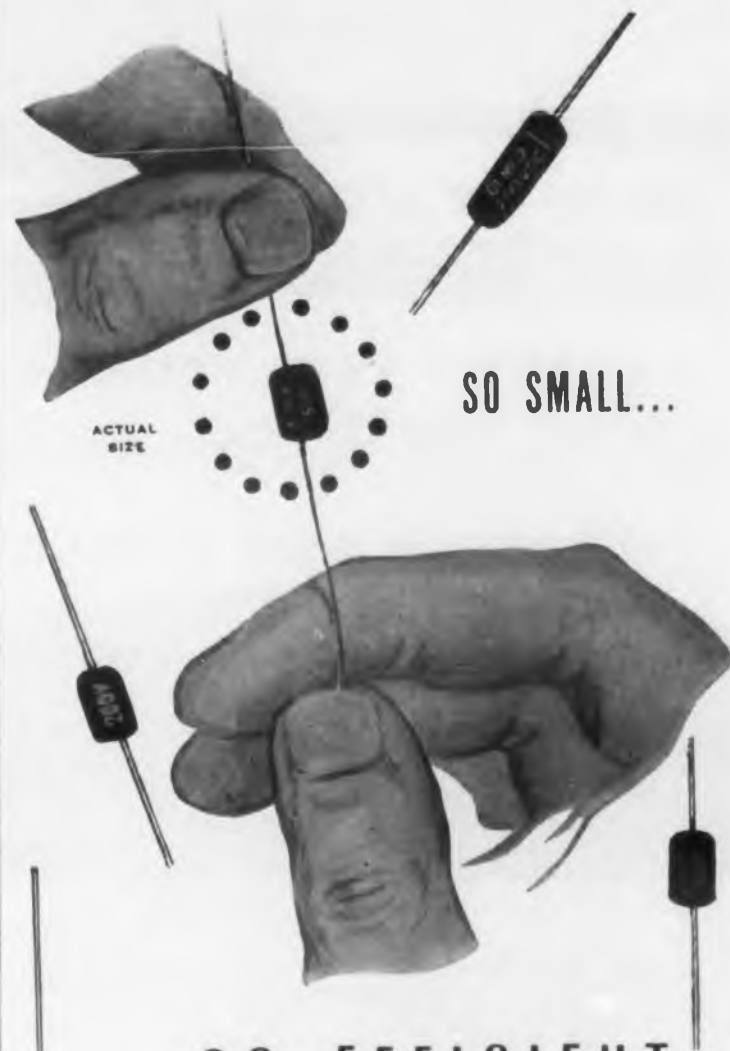
Antenna Matching
Transformer

Minimum Loss from
1 to 50 Mc

The antenna coupling or matching transformer is designed to match a 700 or 200 ohm receiving antenna balanced transmission line to a 72 or 52 ohm coaxial line with a minimum transmission loss over the range of 1 to 50 mc. This transformer employs the use of a core material which extends its frequency response considerably beyond that of former units. The insertion loss has also been kept quite low, less than 1 db at mid-band. A spark gap arrangement has been provided for protection against the effects of lightning. The transformer and circuitry has been arranged to provide dc continuity through the antenna for checking purposes. The transformer has been designed with an octal plug to allow easy replacement. Printed circuitry is used to assure uniformly high performance. The overall dimensions making a compact unit are 5-1/4 x 7-7/7 x 4-1/2 in. It is encased in a completely watertight housing and provided with desiccant.

Nems-Clarke, Inc., Dept. ED, 919 Jesup-Blair Dr., Silver Spring, Md.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION



SO SMALL...

... SO EFFICIENT

For those transistorized circuits and other compact circuitry requirements. They have the desired quality product characteristics of all Hopkins Capacitors.

TEMPERATURE RANGE
The operating temperature range is from -55°C to $+100^{\circ}\text{C}$.

POWER FACTOR
Less than 1% at 25°C and 1,000 CPS up to and including 1.0 M.F.D.

INSULATION RESISTANCE
Will average 500 megohms X microfarads for units less than 1 microfarad, when measured at 200 VDC for 2 minutes at 25°C .

Available in hermetically sealed metal cans or plastic encased.

MICRO
MINIATURE
METALLIZED
PAPER
CAPACITORS



Send For Catalog
TODAY

Write or Wire

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HOPKINS Engineering COMPANY

12900 FOOTHILL BOULEVARD

P. O. BOX 191 • SAN FERNANDO, CALIFORNIA

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW DESIGN MINIATURE RELAY

RESISTS 15 G VIBRATION

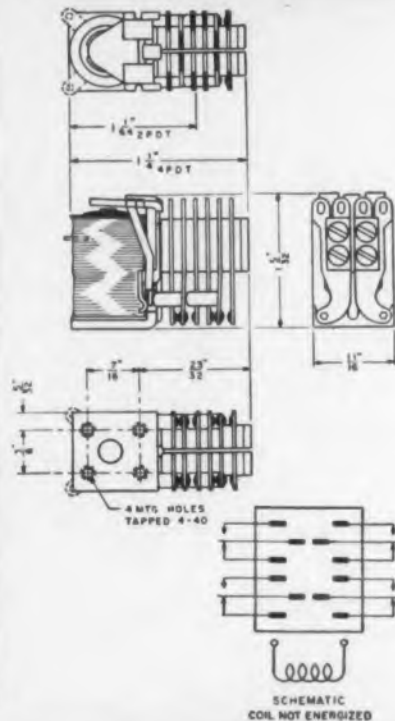
THROUGH 500 CYCLES



Series 5400

The new Series 5400 Husky Miniature Relay is designed for continuous duty, general purpose DC use . . . to give superior performance in aircraft, missiles, communications and other circuit control applications.

- **Vibration Resistance:** withstands 5 to 70 cps at 0.060" double excursion and 15 G from 70 to 500 cps without chatter or transfer.
- **Contacts:** available in arrangements up to 6 Form A or 4 Form C [total of 12 springs]. Standard contact material is palladium, rated at 3 amperes 26.5 VDC or 115 VAC resistive. Can be supplied in ratings up to 10 amperes per contact.
- **Available** in any standard voltage up to 115 VDC. Normally supplied with coil resistance of 280 ohms \pm 10% for operation on 26.5 VDC.
- **Weight** 1.7 oz.
- **Available** hermetically sealed also. Write for Bulletin No. 6.



You can Rely on
HUSKY RELAYS



CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Battery Charger
50 to 200 Ma

A battery trickle charger with continuous adjustment range of 50 to 200 ma is available. The battery charger includes a meter to indicate charging current; output is fused to protect charger components. Output voltages are 12 and 24 v dc with input voltages of 110 to 120 v, 60 cps. A full wave selenium rectifier circuit is provided.

Automatic Switch Co., Dept. ED,
Florham Pk., N.J.

CIRCLE 168 ON READER-SERVICE CARD

Series Summation Amplifier Summation and Isolation



A transistorized summation and isolation amplifier has been designed for eliminating resolver non-linearities. The single channel Model 807 can be used with any standard 400 cps resolver, Mach 4 Mod 0 or equivalent. With an operating life of over 8000 hrs and an accuracy of ± 0.1 per cent the 807 holds phase shift errors to less than 0.15 deg. Operating efficiency is over 90 per cent; temperature range is -55 to $+85$ C.

Maxson Instruments, Dept. ED,
Div. of the W. L. Maxson Corp., 47-37
Austell Pl., Long Island City 1, N.Y.

CIRCLE 169 ON READER-SERVICE CARD

**ONE FLICK RESETS this
HIGH SPEED Electric COUNTER**

Model "YE" by
DURANT

(Test count-life over 70 million)

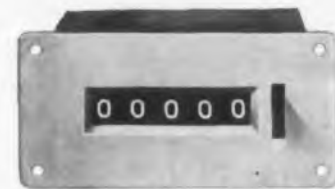
Offered in TWO STYLES:
1. Quick PUSH-BUTTON RESET
2. Electric REMOTE RESET

First high-speed electrically actuated counters with added advantage of electric reset. Clean-cut, legible 3/16" figures, white on black. Ideal for all high-speed electric counting applications — accurate at high, low or intermediate speeds.

DURANT MANUFACTURING CO.
1993 N. Buffum St. 93 Thurbers Ave.
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Representatives in Principal Cities



ALASKA GRAY
AND SEAL BROWN



Compact, with great rigidity — entirely enclosed against dust and moisture. Base or panel mount. Speeds to 1500 C.P.M.

PRODUCTIMETERS
SINCE 1879
Count Everything

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION



Transmission Coupling Flexibility with Positive Action

The Posiflex Coupling for transmission components permits flexibility of deg shaft to shaft angular misalignment and 1/8 in. shaft to shaft parallel alignment with positive action. The unit measures 1 1/8 in. long by 1/2 in. diam with a wide range of sizes. Space saving is made possible by housing the gimbal joints internally in the coupling shell. All parts are of Type 303 stainless steel. Gimbal joints are heat treated for maximum strength and precision ground assuring tight backlash requirements at high speeds and torque.

Fourdee, Inc., Dept. ED, P. O. Box 106, Orlando, Fla.

CIRCLE 173 ON READER-SERVICE CARD



Magnetic Tape Reel Easily Threaded

Called the C-Slot Reel, the design features a curved groove in the hub for threading. Tape is simply slipped into this groove in the opposite direction of reel rotation and the recorder is ready for operation. No kinks or twists are made in the tape and no tape-ends are left sticking up. Since the C-Slot is self-locking, there is no need to turn the reel by hand. Sharp edges have been eliminated, including those on the inner surface where considerable tape wear takes place on ordinary reels. Hub construction provides strong and well-balanced characteristics.

Audio Devices, Inc., Dept. ED, 444 Madison Ave., New York 22, N.Y.

CIRCLE 174 ON READER-SERVICE CARD

in the Spring...



■ A young man looks for high tensile strength, corrosion-resistance and close tolerances... especially if he is a design engineer who plans to incorporate the spring in his own machinery.

■ When you require springs, consult the spring engineers at John Chatillon and Sons. They have over 120 years of experience in designing and manufacturing all types of springs and they can solve *all* your spring problems.

Send specifications and blueprints to Department D-1.

JOHN CHATILLON & SONS

85 CLIFF STREET, NEW YORK, N. Y.

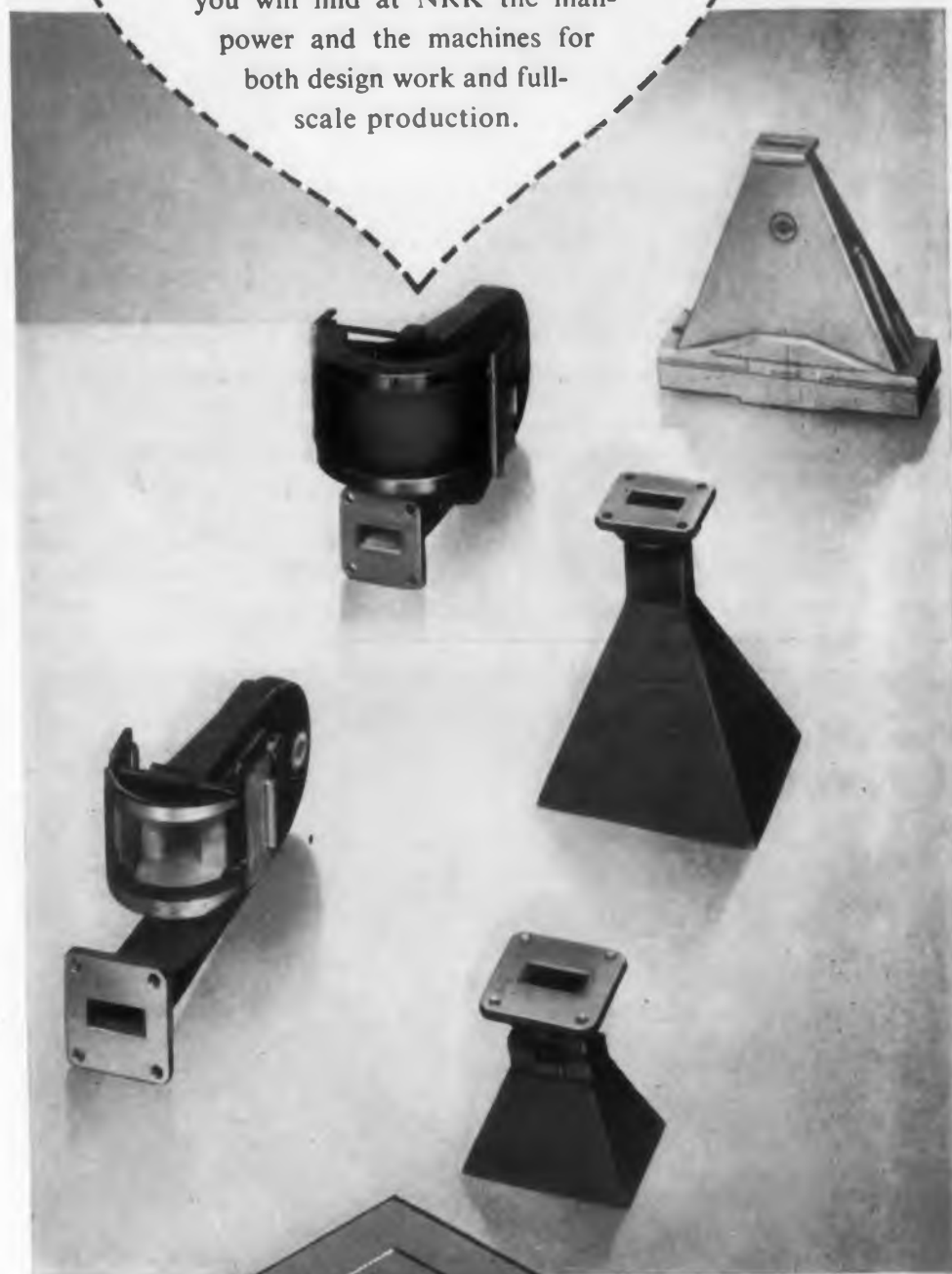
Manufacturers of Precision Springs and Force Measuring Instruments Since 1835.



CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

MICROWAVE HORNS

Products of long experience, these microwave horns are typical of the many that NRK has produced. Whatever your needs for radar or microwave components, you will find at NRK the manpower and the machines for both design work and full-scale production.



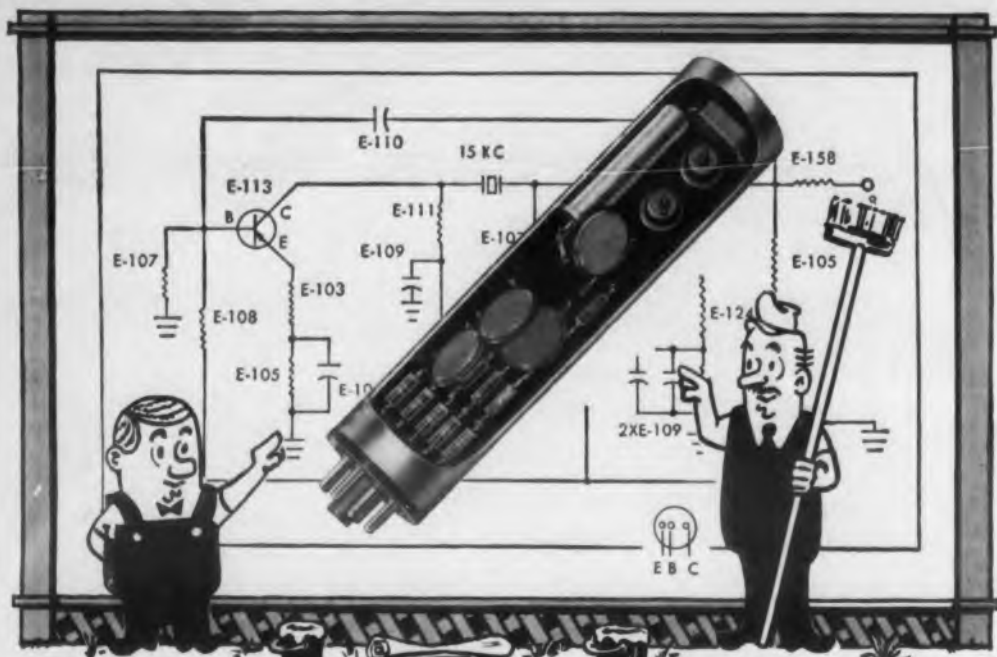
Microwave Assemblies, Radar Components and Precision Instruments... manufactured and designed to your specifications.

N.R.K. MFG. & ENGINEERING CO., 4601 W. Addison St., Chicago 41, Illinois

Eastern Sales Office: Box 445, Westfield, N. J.

West Coast Representatives: Bray and Carter, 2232 W. 11th St., Los Angeles 6, Cal.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION



"They're sure compact, K.C." "You bet, M.C., only 1 1/4 by 6 1/2 inches!"

NEW REEVES-HOFFMAN TRANSISTOR OSCILLATORS

WRITE FOR
BULLETIN RH-OS.



New Reeves-Hoffman oscillators are transistorized for compactness and crystal controlled for unerring accuracy. Each oscillator is produced and tested with exacting care by skilled craftsmen using the most modern equipment and facilities available. Reeves-Hoffman will manufacture these units in volume to your specifications.

DIVISION OF **DYNAMICS CORPORATION OF AMERICA**
CARLISLE, PENNSYLVANIA

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Accelerometers Range of 0.03 to 40,000 G

Series 400 Accelerometers employ barium titanate in compression and have a natural frequency of 75 kc. They operate over an acceleration range from 0.03 g to 40,000 g and over a frequency range from 0.05 cps to 20,000 cps, with a sensitivity of 50 mv/g ± 5 per cent throughout the usable range. Pickups are available in various sizes, weights and mounting configurations.

Columbia Research Laboratories,
Dept. ED, Woodlyn, Pa.

CIRCLE 181 ON READER-SERVICE CARD

Linear Displacement Transducer 1000 Ft Remote Operation



This linear displacement transducer Model LD-20, features an all stainless steel housing and waterproof connector. The unit measures displacement remotely at distances up to 1000 ft or more, employing the variable reluctance principle. It is designed to operate over a linear range of 2 in. With the use of a simple bridge, the transducer may be used at frequencies of 60-100 cps and the output fed to a galvanometer or recorder. Models operating over a linear range of 5 in. are also available.

Jones-Porter Instruments Co., Inc.
Dept. ED, Box 666, Riverdale, N.Y.

CIRCLE 182 ON READER-SERVICE CARD

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to industry

Small in cost but valuable in function—this is the important contribution RELIANCE Mica makes to so many industries. Wherever application requirements call for mica insulation to meet close tolerances and rigid specifications, you can rely on RELIANCE for a high quality product. Take advantage of our design and engineering staff. WRITE TODAY!

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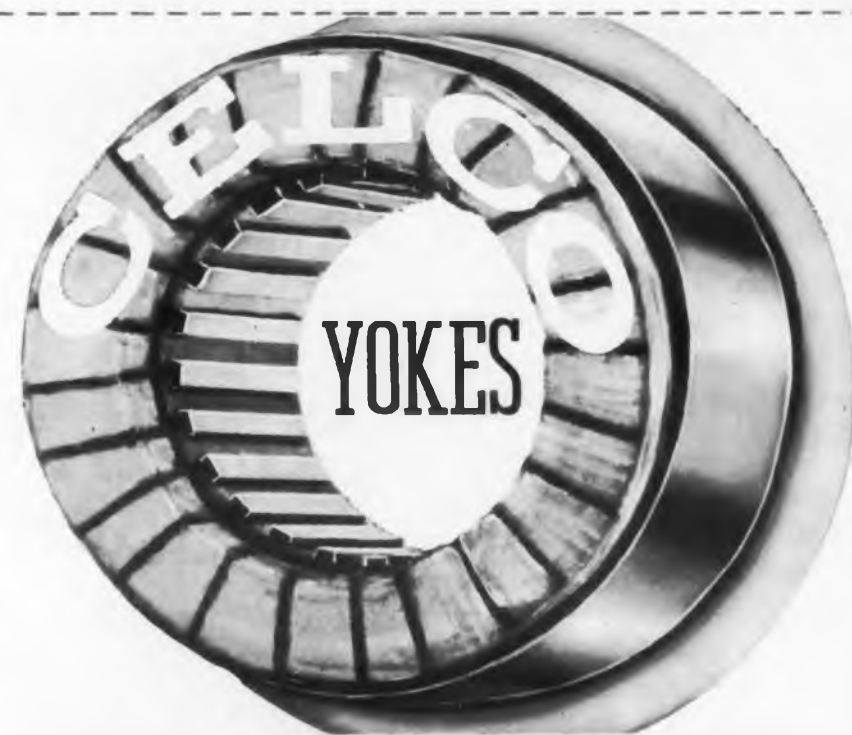
RELIANCE MICA CO., INC.
341 39th St., B'klyn. 32, N. Y.

Gentlemen,
 Please send literature on RELIANCE Mica.
 Please send quotation on enclosed specs.

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RELIANCE MICA CO., INC. 341 39th St., B'klyn. 32, N. Y.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION



FOR HIGH ACCURACY DISPLAY SYSTEMS

We specialize in the design and manufacture of precision deflection Yokes for military and commercial applications. Phone or write for immediate engineering evaluation of your critical display problems—Phone DAVIS 7-1123. MAHWAH, N. J.



Celco Constantine Engineering Laboratories Co.
MAHWAH, NEW JERSEY

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

Balancing Potentiometer 2 W Rating



Model 220 measures 3/16 x 5/16 x 1 in. Mounting is accomplished by means of 2-56 screws through stainless steel eyelets on 3/4 in. centers. Tinned copper leads 1-1/2 in. long by 0.016 in. diam. permit the use of either potentiometer circuit or standard wiring techniques. A 15-turn screwdriver adjustment features a self-locking shaft and an idling wiper assembly to prevent damage from forcing adjustments. Power rating is 2 w. The unit is designed for a maximum operating temperature of 175 C. Model 220 is available in standard resistance values from 100 to 20K ohms.

Bourns Laboratories, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

CIRCLE 186 ON READER-SERVICE CARD

Neutron Detector Tubes For Reactor Control

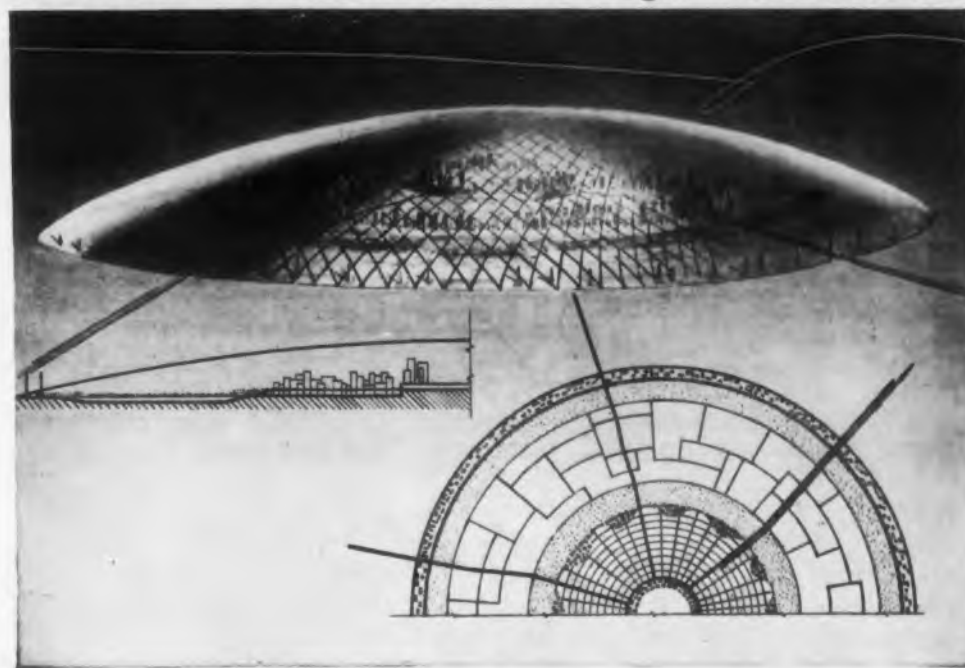


Two new neutron detector tubes for use in reactor control and reactor monitoring systems are announced. Model VXN-1 is an enriched boron trifluoride proportional tube for counting thermal neutrons. It is available in 1, 2, and 2-1/16 in. diam of various active lengths. Nominal operating voltage is 1700 v with a 250 v Minimum plateau having a typical slope of 2 per cent per 100 v. The second type, Model VXN-2, is of the recoil type. It has a polyethylene inner wall and an ethylene filling and is used to count fast neutrons. Nominal operating voltage is 1575 v. It is supplied only with a diameter with length corresponding to standard three-chamber ORNL design.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 187 ON READER-SERVICE CARD

MARS outstanding design SERIES



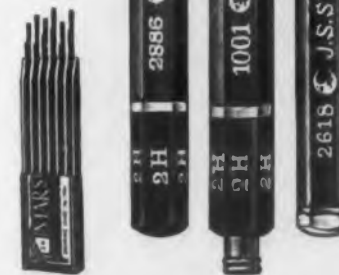
21st century city

The shallow, plastic-faced, Geodesic dome makes this city of the future look strange to 20th century eyes. But designer Philip H. Seligson has combined practical economics with creative thinking in committing his concept to paper. Industries are located at the outer circumference of the city; discharge their smoke through stacks that pierce the dome. Central air conditioning controls the temperature—winter or summer the climate is perfect. Instead of building their own four weather walls and roof, insulating them, heating and cooling them, people can build their walls merely as grilles and curtains.

No matter which of today's ideas become reality, it will be as important tomorrow as it is today to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and—last but not least—the Mars-Lumochrom, the new colored drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.

The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored drafting pencil, 24 colors.

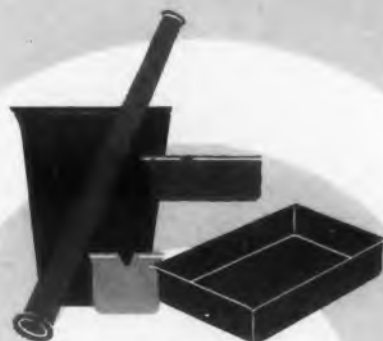


J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

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CENTER FOR HIGH-PURITY FUSED QUARTZ

AMERSIL service is keyed to your requirements. Here, at the primary source for fused quartz and silicaware of critical purity, several specially developed production processes are used—each providing an end product suited precisely to certain types of fabrication and use.

Delivery is prompt. Standard apparatus, crucibles, trays, cylindrical containers and tubing (up to 25" diam.) are available for prompt service. Amersil engineers will be glad to assist in developing special equipment for your requirements. Your inquiry is invited. ★ ★

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COMPANY, INC. FUSED SILICA
AND QUARTZ

685 RAMSEY AVE. ★ HILLSIDE 5, NEW JERSEY

ENGELHARD INDUSTRIES

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New!....

FROM TRANSISTOR CENTER U.S.A.



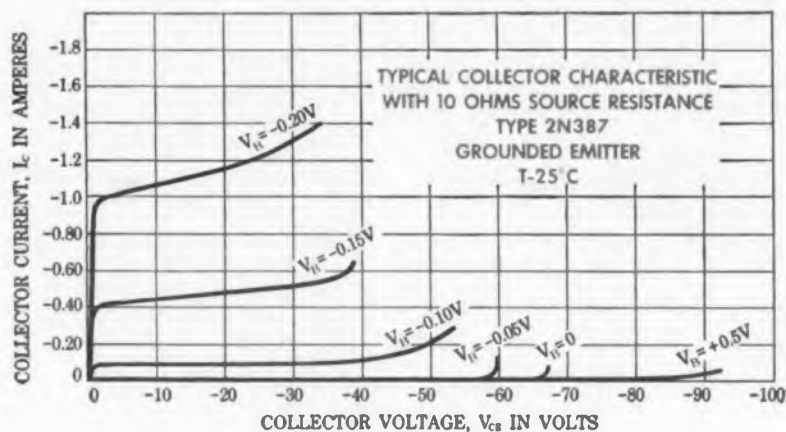
PHILCO 60V and 80V Power Transistors

Designed for servo, control, power converter and power supply applications.

Here are extremely reliable, high voltage power transistors—immediately available in production quantities. These transistors perform with a typical thermal drop of only $1\frac{1}{2}^{\circ}\text{C}$ per watt . . . with storage temperature of 100°C . They have high beta at high currents . . . improved alpha cut-off . . . low surface leakage currents . . . low saturation resistance . . . low distortion. Both transistors operate at power load of 12.5 watts. The unique *knee-action* between the aluminum mounting clamp and the copper mount assures maximum dissipator contact at all times. Recent price reductions make these transistors the greatest value in the high voltage power transistor field.



Philco cold-welding process permits hermetic sealing in controlled atmosphere . . . assuring exceptional transistor life and performance!



Philco transistors, after vacuum baking, emerge into a controlled atmosphere . . . where they are welded to insure perfect sealing for life. This process eliminates contamination of the transistor elements by moisture or atmosphere. Uniformity and quality control are strictly maintained throughout.

Write for complete data, application notes on voltage ratings of power transistors, and new low prices to Lansdale Tube Company, Lansdale, Pa.

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

New Products

Snap-Action Switch Handles 2 Hp

A heavy duty, snap-action switch has been designed to handle up to 2 hp. Called the Duo-Snap, the device comes in four terminal and circuit arrangements, permitting at least six circuit variations. Its snap-action is achieved through the rolling spring principle. The unit is 2 in. in length and has an electrical rating of 2 hp, 230 v ac; 1 hp, 150 v ac; and for pilot duty, 20 a, 250 v ac.

Robertshaw-Fulton Controls Co.
Dept. ED, Acro Div., Columbus, Ohio
CIRCLE 193 ON READER-SERVICE CARD

Miniature Timer Weights 6 Oz

A timer measuring 1-1/2 in. sq and weighing 6 oz is hermetically sealed and designed for 115 v 400 cps, 115 v 60 cps and 28 v dc operation. Its mounting mechanism is internally shock-mounted to meet applicable military specifications on shock and vibration. It operates in a temperature range of -55 to $+125^{\circ}\text{C}$ and to altitudes of 60,000 ft.

The Advanced Products Co., Dept. ED, North Haven, Conn.

CIRCLE 194 ON READER-SERVICE CARD

RF Duplexer 450 to 900 Mc

The Type 149 radio frequency duplexer is a tuned cavity network designed to couple a transmitter and receiver operating in the 450 or 900 Mc bands to the same antenna and transmission line without interaction with negligible loss in efficiency. With the duplexer, one antenna and transmission line are eliminated. High isolation reduces the spurious radiation of the transmitter by at least 20 db and the spurious responses of the receiver by at least 40 db. The duplexer is assembled on a 3-1/2 x 19 in. panel to fit standard relay rack and is normally mounted on the same rack as the radio equipment. All tuning adjustments are made at the factory in accordance with specified frequencies and locked to prevent movement during shipment or under vibration.

Budelman Radio Corp., Dept. ED
375 Fairfield Ave., Stamford, Conn.

CIRCLE 195 ON READER-SERVICE CARD
CIRCLE 196 ON READER-SERVICE CARD

Magnetic Cores

Provide Greater Stability

Magnetic cores for transistorized electronic computers are available which reportedly offer the greatest stability yet achieved for a transistorized core over a wide range of temperatures, currents and other disturbing influences. The result is greater computer accuracy and less downtime for trouble-shooting. The cores can maintain ratios of 3 to 1 or better between a Read 1 and a Read 0. The drive current used with one of the new cores can vary plus or minus 2 per cent in the 300 to 400 ma range, over a range of 50 to 100 F. The National Cash Register Co., Dept. ED, Dayton 9, Ohio.

CIRCLE 197 ON READER-SERVICE CARD

Wire Wound Resistor

Up to 250,000 Ohms

A wire wound resistor, completely encapsulated, measuring 3/16 in. in diameter by 3/8 in. in length and rated at .25 w is available. The maximum resistance on this unit is 250,000 ohms. All requirements of military specifications, except physical requirements, can be met by this resistor. The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 198 ON READER-SERVICE CARD

Missile Tracking Camera

70 Millimeter

A 70 mm data recording camera, Model TIDATA MOD V, specifically designed for missile tracking provides a more detailed record of missile activity. With a weight less than 16 or 35 mm cameras can handle and a larger field of view. With the same focal length lenses, it minimizes the effect of tracking error and helps keep the missile within the camera's 2-1/4 x 2-1/4 in. frame. Registration pins insure precise frame-to-frame alignment. A sturdy transport eliminates vibration and permits high resolution at speeds up to 100 fps and at shutter openings of 1/1000 deg. Two neon lights provide visible recording on both edges of film for exact correlation with time base. Flight Research, Inc., Dept. ED, Diamond, Va.

CIRCLE 199 ON READER-SERVICE CARD

CIRCLE 200 ON READER-SERVICE CARD



TRIPLET

Triplet Electrical Instrument Company
Bluffton, Ohio
53 years of experience.

THE MIGHTY NINE

Only Triplet affords you such a wide choice of VOMs. Whatever your application—broad or limited—there is a Triplet VOM particularly suited for it.

631
Combination
V-O-M-VTVM

630-NA
For Best Testing
Around the Lab,
Production Line
or Bench

630
The Popular
All-Purpose
V-O-M

630-A
A Good Lab and
Production Line
V-O-M

310
The Smallest
Complete V-O-M
with Switch

630-T
For Telephone
Service

666-HH
Medium Size
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Field Testing

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The First V-O-M
with 10,000
Ohms/Volt AC

666-R
Medium Size
with
630 Features



PROJECT AND SENIOR PROJECT
ELECTRONIC

engineers

New Horizons . . . Greater Achievements . . . Challenging, Satisfying, Rewarding Assignments . . . await graduate EEs and MEs with three to ten years directly applicable experience at . . . AC, The Electronics Division of General Motors.

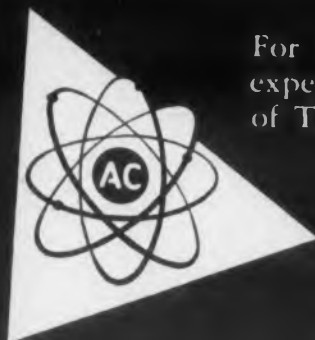
Our ever expanding electronic activities . . .
The finest of facilities and test equipment . . .
Working alongside outstanding pioneers in Electronics . . .
GM's policy of complete decentralization . . .

Provides every qualified project engineer the best of personal development opportunities at AC.

We work in every phase of Research, Design, Development, Reliability and Production in these exciting fields:

AVIONICS	INERTIAL GUIDANCE
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**AUTOMOTIVE - AERONAUTICAL
ELECTRO-MECHANICAL DEVICES**



For immediate interview in your area or in Milwaukee (our expense) send resume *Mr. Cecil E. Sundeen, Supervisor of Technical Employment.

THE ELECTRONICS DIVISION
GENERAL MOTORS Corporation

Flint 2, Mich.

Milwaukee 2, Wis.

CIRCLE 566 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Wire-Wrap Machine Solderless Technique



In this solderless wire-wrap unit, two lateral adjustable wrapping tools are mounted side by side, spaced to accommodate the component used. This new technique designed for the automatic assembly of axial-lead components. Tape-mounted components are fed from a reel to a set of gripper jaws which pluck a single component from the tape into the wrapping position. The component leads are simultaneously placed in a set of "side-loading" wrapping bits, the gripper maintaining contact with the leads at either end of the component body. The "side-loading" bits fold the leads from the tangential position to an axial position in the bits. The assembly (component, gripper jaws and wrapping tools) moves forward to a position where each wrapping bit over a terminal. The wrapping bits then rotate in opposite directions, forming a solderless wrapped connection with each lead of the component. The total cycle time for this operation is two seconds.

The process is designed to use commercial available components. Permanent connections with the lowest known resistance and high reliability are made. The elimination of heat and protection provided by the gripper jaws during the operation gives maximum care to the component. The simplicity of this type of connection results in increased reliability of commercial electrical equipment.

Gardner-Denver Co., Dept. ED, Keller Tool Division, Grand Haven, Mich.

CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1, 1968

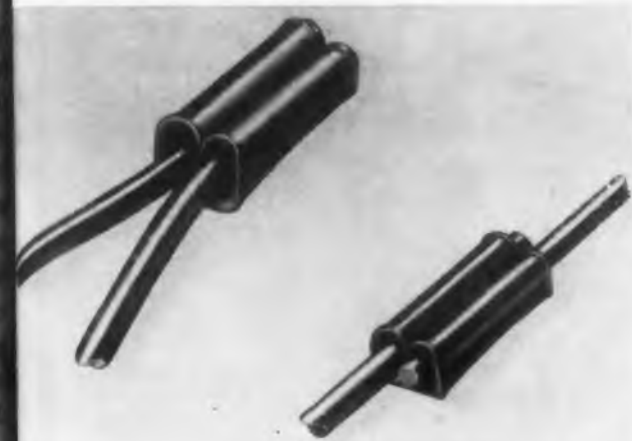


Toroidal Coil Winder 2 to 8 In. OD Coils

This heavy duty toroidal coil winding machine designed to wind medium to large size toroidal coils such as are used in magnetic amplifier and control systems. The unit specifications include: coil size, 2 to 8 in. OD; residual hole, 3/4 in.; speed, maximum of 500 turns per min; winding length, 24 in. diam, 1/2 in. cross section; wire load, maximum 1-1/2 lb per loading. Turns are counted by a system incorporating thyatron pulsing circuit. Donald C. Harder Co., Dept. ED, 3710 Midway Ave., San Diego 10, Calif.

CIRCLE 205 ON READER-SERVICE CARD FOR MORE INFORMATION

Horizontal Splicing Machine Joins Coated Wires



The AMPLI-var splice with its automatic "Horizontal" splicing machine, is designed to produce up to 1200 per hr identical, mass produced splices on enamel, polyvinyl acetal and similarly coated wire. The splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning or other methods of removing insulation. There is no heat damage. The splice, scarcely larger than the wires themselves, is design-engineered to lock the wires and connector into a high tensile strength joint. The joint is hermetically sealed during splicing, thus rendering it corrosion resistant. Soldering material and equipment are unnecessary, less wire and time are required, thereby lowering installed costs. They can be used on solid or stranded conductors or combinations thereof.

AMP Inc., Dept. ED, Harrisburg 13, Pa.

CIRCLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

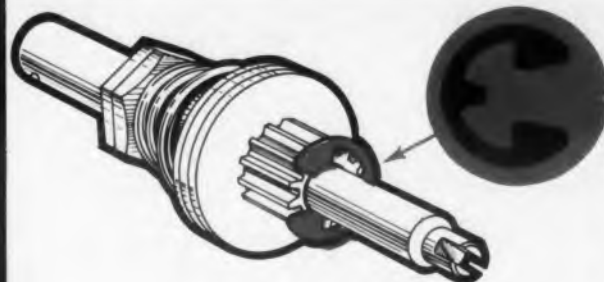
Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator



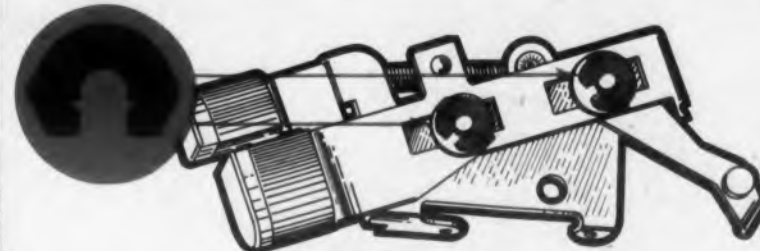
THE NEW MARCHANT DECI-MAGIC
automatic-decimals calculator made by Marchant Calculators, Inc., Oakland, California.



CRESCENT RING SPEEDS ASSEMBLY, DISASSEMBLY
Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.



E-RING SECURES PARTS AGAINST SPRING THRUST. Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.



LOCKING PRONG RINGS PERMIT SIMPLE DESIGN. Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U.S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.



WALDES
TRUARC[®]
RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U.S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U.S. Patents pending. Equal patent protection established in foreign countries.

CIRCLE 207 ON READER-SERVICE CARD FOR MORE INFORMATION

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. (Please print)

Name _____
Title _____
Company _____
Business Address _____
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FD092

Production Products

Transistor Washer Uses Distilled Water



A special apparatus for washing and rinsing transistors and other small electronic parts in hot distilled-demineralized water has been developed. It has been found that rinsing in hot, highly-purified, particle-free water improves quality and reduces rejects. This equipment incorporates continuous repurification of the rinse water by ion-exchange plus activated carbon filtration followed by ultra-fine filtration of submicroscopic particles to 0.45 micron. Washing and rinsing is accomplished in a five stage cascade type rinse tank. Rinse chambers are individually electrically heated and a regenerative heat-exchanger is employed in the circulating system to conserve electricity. Demineralizer and carbon filter are disposable cartridge type. Submicron filter employs replaceable membranes.

The final rinse water is of high electrical resistance, 5,000,000 (18 C) or more ohms, and is also free of organic impurities and submicroscopic particles which often contribute to sub-standard results. Complete unit is mounted on a mobile frame with circulating pump, etc, as illustrated.

Barnstead Still & Demineralizer Co., Dept. ED, 2 Lanesville Terrace, Boston 31, Mass.

CIRCLE 210 ON READER-SERVICE CARD FOR MORE INFORMATION

TAPES YOU CAN TRUST



109—INTERNATIONAL STANDARD—For moderate speeds, tensions, pressures. 1.5 mil cellulose acetate backing. Uniformly accurate because of carefully milled resinous components, rigidly controlled oxide manufacturing process. .55 mil coating of standard output oxide.



108—GENERAL PURPOSE—Uses the same reddish-brown oxide as offered in No. 109 Instrumentation Tape. Because of its dimensional stability, this tape is recommended for multi-track applications. "Weather-balanced", it's ideal in extremes of temperature and humidity.



128 — HIGH OUTPUT — 100% more output (+6db) at 15 mil wave length. This tape is specifically designed for uses where high output, long wave length is required. 1.5 mil polyester base achieves high dimensional stability. .5 mil coating of "High Output" oxide.



159—EXTRA PLAY—50% more recording time on the reel! Made with 1 mil polyester backing, .35 mil coating of high potency oxide. Offers improved high frequency response, improved short wave length output, and better head conformity eliminates signal loss.



148—LONG WEAR—Rugged newcomer! This premium tape gives you 3.5 db greater output at short wave lengths, yet withstands heat-wear in temperatures up to 200°F. and eliminates head build-up. Has 1.5 mil polyester backing, .35 mil coating of "High Output" long wear oxide.



149—LONG WEAR, EXTRA PLAY—Matches 148 for heat-wear resistance and magnetic properties but records 50% longer because of thinner 1 mil polyester backing. Selection for use of this tape should be based on strength versus playing time as the determining factor.

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

Choose from a complete line of "Scotch" Brand Instrumentation Tapes for industry and defense

Whatever your recording requirements, "SCOTCH" Brand has the right magnetic tape for you. Here's the world's fullest line of tapes for exacting instrumentation use — and the most reliable. Every "SCOTCH" Brand Instrumentation Tape meets critical dropout specifications. In pulse recording these tapes average less than 1 error per roll.* In direct recording, these tapes conform to proposed Navy specifications defining dropouts as variations

of 22% or more in signal magnitude, lasting 300 or more microseconds.** All tapes shown are available in standard widths of 1/4", 1/2", 3/4", 1" and 1".

FREE BOOKLET gives you specific engineering data on dropouts plus complete physical and magnetic specifications of these famous "SCOTCH" Brand products. Write: Minnesota Mining and Mfg. Co., Dept. PJ-97, St. Paul 6, Minnesota.

*Measured by recording 200 non-return pulses per inch on a 0.035" track. A reduction to less than 50% normal signal amplitude constitutes a signal error. Two errors are measured by saturating the tape unidirectionally. Each spurious signal greater than 10% of normal signal amplitude constitutes a zero error. Errors per roll based on recording 7 tracks on rolls 1/2" x 2500'.
**Based on a 8750 cps signal played at 7.5 ips.



WHICH MAGNETIC TAPES ARE BEST FOR YOUR INSTRUMENTATION NEEDS?

Tape Number and Description	Stability	Strength	High Temperature Performance	High Speed Performance	Long Wave Length Output	Short Wave Length Output	Recording Time
108 General Purpose	Best	Best	Good	Good	Good	Good	Normal
109 General Purpose	Good	Good	Good	Good	Good	Good	Normal
128 High Output	Best	Best	Very Good	Very Good	Best	Good	Normal
148 Long Wear	Best	Best	Best	Best	Good	Best	Normal
149 Long Wear Extra Play	Best	Good	Best	Best	Good	Best	Extended
159 Extra Play	Best	Good	Good	Good	Good	Best	Extended

All quantities expressed are relative to No. 109

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul, Minn. Export Sales Office: 99 Park Avenue, New York 16, New York. © 3M Co., 1957

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

Automatic Soldering System

For Printed Circuits



This Flowsolder unit is designed to eliminate the difficulties involved in the conventional flat dip-soldering of printed circuits. This unit lifts the molten solder up to the circuit instead of lowering the circuit panels down to the molten solder. The solder wave, 8 in. wide and free from oxide, is produced by pumping molten solder through an elongated spout by a motor driven impeller pump. The circuit panel is passed through the crest of this wave and the joints between the component leads and the copper conductors on the underside of the panel are soldered. Fresh solder is fed to the bath by feeder ingots; as the solder is consumed the ingot is gradually lowered into the bath. The unit is electrically heated and the solder temperature is thermo-statically controlled with normal operating temperature at 250 C.

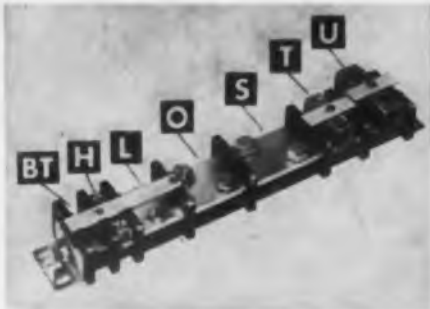
Advantages over the conventional dip-soldering method for soldering printed circuits include: (1) provision for angled entry and exit by the shape of the solder wave, which together with the washing action of the moving solder, prevents trapping of flux or air and assures sound joints; (2) accommodation for panels of any length up to 7-1/2 in. wide; (3) automatic conveying system preventing hesitation or break in the production flow; (4) constant flow of solder which provides a more rapid heat transfer from solder to panel, reducing dipping time and eliminating surface chilling; (5) short panel exposure to heat, diminishing warping of the panel and heat damage to components; (6) continuous flow of clean solder since the molten solder welling up through the nozzle is drawn from below the bath surface; (7) controlled wave level maintained by adjusting the speed of the metal pump which forces the molten solder upwards through the nozzle.

Electrovert Inc., Dept. ED, 489 Fifth Ave., New York 17, N.Y.

CIRCLE 213 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Combination Terminal Block 30 to 250 Amp.



This terminal block allows the grouping of any combination of seven different types of terminals in a single block, as required. Terminals with capacities from 30 amp to 250 amp may be factory assembled in the particular combination required by the user. Since the various components of this combination block are all standard, it can be assembled at the factory with a minimum delay and free of special tooling costs.

Curtis Development & Mfg. Co.,
Dept. ED, 3250 N. 33rd St., Milwaukee, Wis.

CIRCLE 217 ON READER-SERVICE CARD



Miniature Oscilloscope DC to 150 Kc

Designated Mini-Scope, these oscilloscopes feature high deflection sensitivity and minimum pattern distortion. Series 300 Mini-Scopes are supplied in three models with frequency response from DC to 150 kc, 3 db down, usable to 200 kc. Horizontal sensitivity is standardized at 0.5 v per in., with vertical sensitivities ranging from 0.5 v to 1 mv per in. Dimensions are approximately 5 in. cube, and weigh less than 4 lb.

Special Products Corp., Dept. ED,
875 Barbey St., Brooklyn 7, N.Y.

CIRCLE 218 ON READER-SERVICE CARD

CIRCLE 220 ON READER-SERVICE CARD



CAPACITORS

PAPER AND FOIL
WITH SOLID
IMPREGNANT

SOLDER

SOLDER-COATED
LEAD

LEAD CONNECTOR

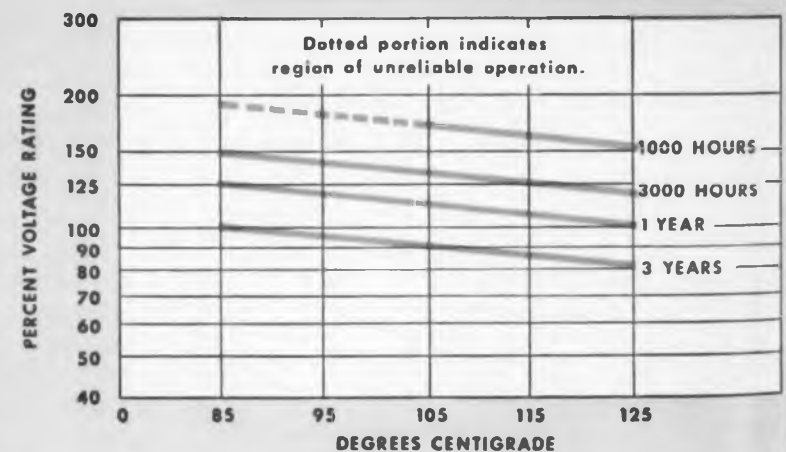
EXPOSED FOIL

COMPRESSION-MOLDED
PHENOLIC CASE

CUTAWAY VIEW OF
PVZ CAPACITOR
ENLARGED 13 TIMES

COLOR CODE

VOLTAGE RATING VS LIFE AT ELEVATED
TEMPERATURE FOR 95% RELIABILITY



GRAPH ABOVE shows outstanding temperature and voltage characteristics for 95% reliability.

PV
len

Solve critical space and temperature problems with subminiature PVZ* capacitors

Low-cost molded units operate from -55 C to $+125\text{ C}$

Now immediately available for exacting applications in commercial and military electronic equipment, these molded paper capacitors meet performance requirements of Characteristic "E" for MIL-C-91A. General Electric's PVZ capacitors are priced substantially lower than comparable metal-clad tubulars. They are designed to operate for a minimum of one year at $+125\text{ C}$ with no voltage derating.

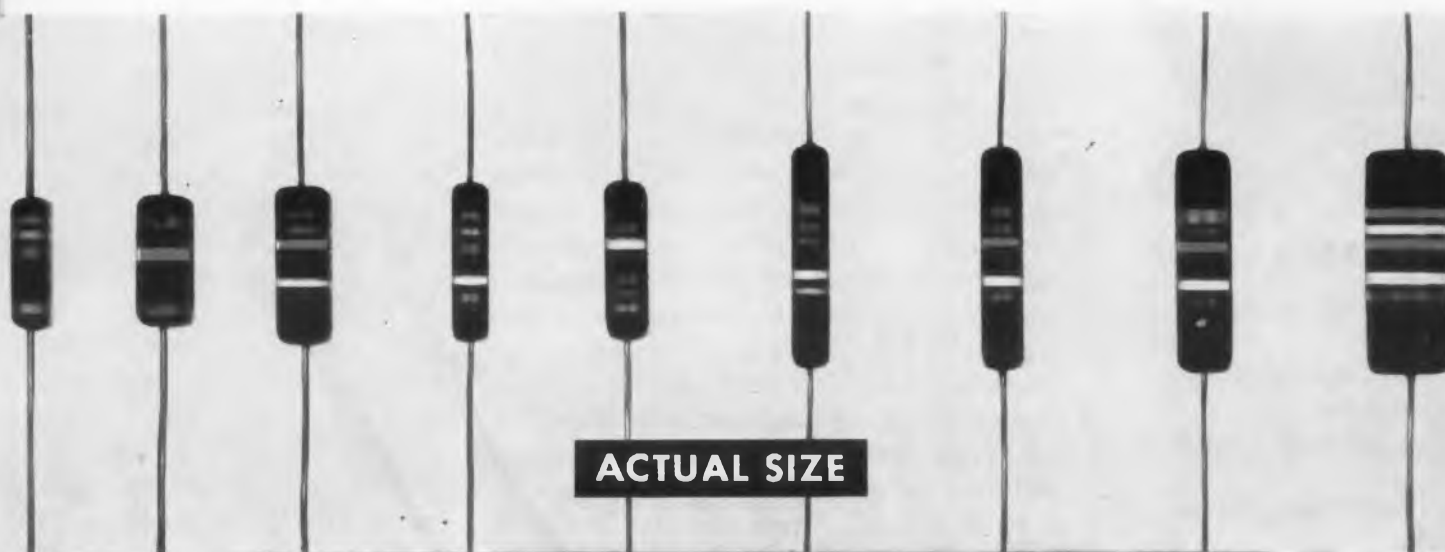
Completely solid after molding, PVZ capacitors feature the following advantages:

- small size
- excellent humidity resistance
- high lead-strength

- insulated body—solid impregnant
- high shock and vibration resistance
- color code for easy identification

General Electric PVZ capacitors are available at 100, 200, 300, and 400 volts. Microfarad ratings range from .00047 to .15.

If you need a capacitor with the characteristics described above, ask your General Electric Apparatus Sales Engineer about PVZ tubulars. He can give you expert application information. He can also arrange for immediate delivery of PVZ capacitors from factory stock in most ratings. For descriptive data write for bulletin GEC-1452 to General Electric, Section 447-2, Schenectady 5, N. Y. *Trademark of the General Electric Co.



PVZ CAPACITORS range in size from .175" diameter by .625" length to .375" diameter by 1.0625" length. Capacitance ratings are available with $\pm 20\%$, $\pm 10\%$, and $\pm 5\%$ tolerances. The color code indicates microfarads, volts, and capacitance tolerance.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Potentiometer and Mv Source

For All Thermocouples



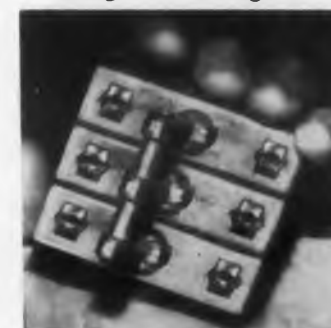
Model P-55 can be used with any thermocouple, and measures any potential in the 0 to 55 mv range. In addition, the instrument will accurately supply the same potential for check-out of recorders and other instruments. The P-55's dual input provides two sets of 55-way binding posts for checking two thermocouples, or one thermocouple against a standard, etc. A thermometer is shock-mounted in the lid, and the instrument is available in a weatherproof aluminum case or in mahogany. It measures $4\frac{1}{8} \times 4\frac{1}{2} \times 7\frac{1}{2}$ in. and weighs $3\frac{1}{2}$ lb.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mountain, Cumberland, Md

CIRCLE 221 ON READER-SERVICE CARD

400 Cps or DC Circuit Breaker

Single or Ganged



The AM17 circuit breaker can function on either 400 cps ac or dc without any change in rating or essential time-delay characteristics. Although manufactured in single-pole form only, the breakers can be readily linked with others to make two- or three-pole units. The only operating connection necessary is a tie rod through the breaker handles; electrical tripping of ping of the other connected breakers. The breaker, which operates on the hydraulic-magnetic principle, does not require derating for either temperature or vibration conditions.

Heinemann Electric Co., Dept. ED, 453 Plum St., Trenton 2, N.J.

CIRCLE 222 ON READER-SERVICE CARD

◀ CIRCLE 220 ON READER-SERVICE CARD

BALLANTINE Sensitive, Wide Band Electronic Voltmeter

measures 1 millivolt to 1000 volts
from 15 cycles to 6 megacycles

Accuracy 3% to 3 mc; 5% above
Input impedance 7.5 mmfds shunted by 11 megs

When used without probe, sensitivity
is increased to 100 MICROVOLTS but
impedance is reduced to 25 mmfds
and 1 megohm



MODEL 314
Price \$285

All Ballantine instruments are

SENSITIVE — ACCURATE — DEPENDABLE

- Same accuracy at ALL points on a logarithmic voltage scale and a uniform DB scale.
- Only ONE voltage scale to read with decade range switching.
- No "turnover" discrepancy on unsymmetrical waves.
- Easy-to-use probe with self-holding connector tip and unique supporting clamp.
- Low impedance ground return provided by supporting clamp.
- Stabilized by generous use of negative feedback.
- Can be used as 60 DB high fidelity video pre-amplifier.

Write for catalog for more information about this and other
BALLANTINE voltmeters, amplifiers, and accessories.

BALLANTINE LABORATORIES, INC.

114 Fanny Road, Boonton, New Jersey

CIRCLE 224 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Silicone

225

Brochure No. 6-206 devoted to the properties and performance of silicone-greases is now released. Developed primarily for high-temperature, slow-speed bearings, it has become an industry standard for uses ranging from worm-and-pinion sets to compressor engine injector valves; from hold-down bolts to plastic extruder nozzles. Dow Corning Corp., Midland, Mich.

Diameter Dilemma

226

Booklet on thread gaging showing that variations in screw thread angle and lead, product misfit fasteners as readily as do deviations in pure diameter dimension itself is now available. The increase can be considerable as shown in charts included in the booklet. Standard Pressed Steel Co., Box 202, Jenkintown, Pa.

Sensitive Relays

227

Sensitive and power type relays are described in 4-page leaflet now available. The illustrated pamphlet gives the specifications and characteristics of each model. Five Star Co. Inc., Plantsville, Conn.

Tubing Prices

228

Prices, properties, and application information are given for a complete line of electrical tubing in a 16-page pricing guide. Included in the guide is a selector chart for plastic tubings. This chart lists application information, maximum recommended operating temperatures, low temperature brittle point, durometer hardness, dielectric strength, dielectric constant, shrinkage, moisture absorption, flammability, fungus resistance, available colors, and applicable military specifications for each available type. A similar chart is provided for various types of coated tubings. The guide also contains data and pricing information on a line of telephone products, among them a wire vibration damper, a filled splice sleeve, and an open splice sleeve. Minnesota Mining and Mfg. Co., Irvington Div., 6 Argyle Terrace, Irvington 11, N.J.

Timers

229

A line of electronic timers is described in 4-page bulletin now available. This bulletin provides specifications, applications and operation of 11 timers of the repeat cycle, interval and delay types. G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va.

Paper Tape Equipment

230

Those involved in tape handling will find the 4-page brochure now available interesting. The illustrated pamphlet describes the construction of the winder and unwinder in simple terms. Whiteford Lab., 258 Broad St., Lynn, Mass.

Liquid Sealant

231

Technical Report No. 5 gives complete information on how to lock threaded fasteners with a liquid sealant. Proper selection of grade is outlined in simple terminology so that predictable results to meet specific locking torque requirements can be easily obtained. Specific uses and methods of application are documented for studs, screws, nuts, and other threaded products. Covered are techniques for sealing and soldering sleeve joints. Fundamental data is given on the basic principles of thread locking with plastics, as well as formulas for torque determination under varying conditions. Physical properties of the sealant, both in the liquid and solid state are given, including cure time, resistance to solvents and chemicals, heat aging, strength, resistance to thermal shock, electrical properties. Drawings and diagrams illustrate the 12-page booklet. American Sealants Co., 103 Woodbine St., Hartford 6, Conn.

Electronics Catalog

232

A 220-page catalog has been issued which contains extensive, detailed listings of industrial electronics and public address equipment as well as other electronic components and equipment. Radio Specialties Co., 456 Charlotte, Detroit 1, Mich.

Plastic Wiring Ducts

233

Low cost plastic wiring ducts for electrical control panel wiring are featured in 4-page folder just released. The folder shows two types of non-flammable vinyl plastic ducts, both with covers that snap on and place directly on the duct. The covers are said to provide quick access to the full width of the duct for quick installation, trouble-shooting and revision. Three methods of mounting are also illustrated: speed mounting with spring steel standard clip; security mounting with threaded studs and standard flush mounting with screw through base of the duct. Panduit Corp., 10132 S. Washtenaw Ave., Chicago 48, Ill.

What Goes On Here?

235

In basic, non-technical and conversational language, the illustrated 8-page booklet describes connectors, terminals, sockets, panels, and components for the electronic, Appliance, Aircraft and Military markets. Burndy Corp., Norwalk, Conn.

Digital VTVM Booklet

236

Full line of digital voltmeters, ohmmeters, ac-dc converters, and complete data logging systems are described in twenty-eight page booklet just released. The booklet is illustrated with charts, diagrams, and photos of instruments. Non-Linear Systems, Del Mar, Calif.

Types for Tape Recording

237

How to Choose the Right Recording Tape," is the name of color pamphlet now released. The illustrated brochure offers general information on magnetic recording and recording characteristics and the electrical requirements, such as Mylar and cellulose acetate, which governs the physical characteristics of the product. The booklet described individual requirements which should be considered in choosing a tape. Reeves Sound-Recording Corp., 10 E. 52nd St., New York, N.Y.

Weld Fasteners

238

Various types of weld fasteners are described in Bulletin No. 58 now released. Among the highlights of the catalog are typical applications . . . methods of improving the products and reducing costs, production economies and others. It is well illustrated and complete information is available on all types of fasteners. Ohio Nut & Bolt Co., 33 First Ave., Berea, Ohio.

Panel-Mounting Units

239

In a 36-page catalog and designers guide an entire line of miniature, panel-mounting electronic instruments are presented. For each instrument photographs, outline drawings, a description, mounting details, complete specifications, and operation theory are given. The catalog, sectioned for ease of reference, includes ac vtm's, dc vtm's, power supplies, and special instruments such as multichannel vtm's, phase meters, and null meters. The designers guide aids in the selection and application of vtm's to measurement or monitoring problems and discusses the how-to phase of building electronic instruments into system equipment. Trio Labs., Inc., 4025 Merrick Rd., Seaford, N.Y.



*to keep ahead,
the leaders rely on leaders*

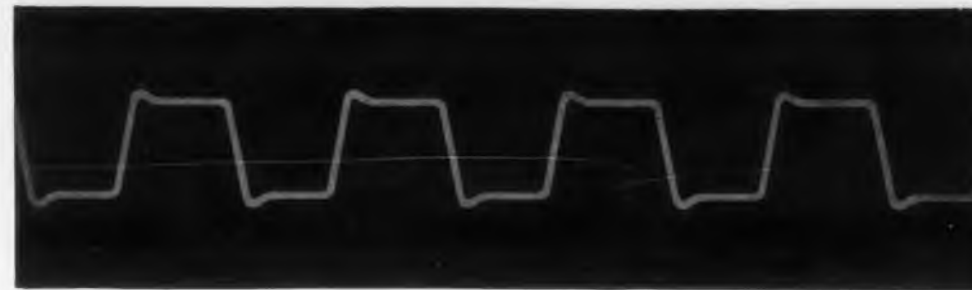
Trio Model D
AC VTVM in
Packard-Bell's
Missile Tester
Construction

PACKARD BELL ELECTRONICS
designs-in with **trio**
panel-mounting miniature
electronic instruments

Write for FREE ENGINEERING GUIDE
on Trio's complete line to Dept. ED-9
Trio Laboratories, Inc., Seaford, N. Y.

when ordinary instruments are
too big or
inadequate . . . **trio**

CIRCLE 240 ON READER-SERVICE CARD FOR MORE INFORMATION



DELAY LINES

standard or specially designed

BY TECHNITROL

These extra-compact delay lines assure a minimum of pulse distortion with maximum stability under ambient temperatures . . . and in a minimum of space. They can be had pencil-thin in plug-in, pig tail or fuse-clip mounting. Available cased or dip-coated in epoxy resin as well as hermetically-sealed units for military application . . . with any desired characteristics of impedance or frequency response. Typical are:



- Delay: 0.01 to 6 μ s
- Characteristic Impedance: 400 to 5600 ohms
- Band Pass Characteristics: Unique windings furnish maximum band width for given delay per inch.

We are prepared to design lumped constant or distributed constant delay lines for your particular circuit applications.



Write today
for Bulletin
ED 174



CIRCLE 241 ON READER-SERVICE CARD FOR MORE INFORMATION

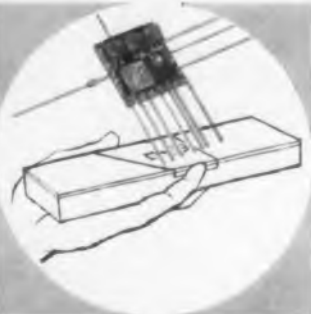


TV SETS—17 PEC's replaced over 100 parts, simplifying assembly and improving performance.

Proof of Reliability and Versatility...



AUTOMOTIVE — PEC provides photo-multiplier tube socket and 20 resistors in one unit.



PORTABLE RECORDER — PEC amplifier provides large recorder quality in miniature tape recorder.

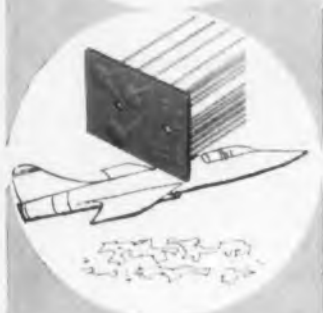
85,000,000 PEC's* used in the past decade...

for these and many other applications

Centralab



ELECTRONIC ORGAN — PEC filter reduces sharp transient of keying to give natural touch response.



JET AIRCRAFT — PEC's simplify assembly of instrument panels... guarantee circuit performance.



ELECTRIC APPLIANCES — PEC in surface burner control enables finer selectivity of temperature.

Centralab PEC's — combining capacitors, resistors, inductors, and wiring in one compact sub-assembly — were originally designed for military applications. And due to their reliability and versatility, more than 85,000,000 have been used during the past ten years to guarantee circuit performance in countless electronic products. New developments promise even greater design flexibility for future applications.

Centralab — originator and undisputed leader in PEC development — offers you modern facilities and 35 years of experience to provide the packaged electronic circuit your product design requires. Write for complete information on products and service.

Centralab

A DIVISION OF
GLOBE-UNION INC.

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In Canada: 804 Mt. Pleasant Rd. • Toronto, Ontario

*Trademark (Packaged Electronic Circuits)

CIRCLE 245 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Hi-Fi, PA, and Ham Products 246

In a complete catalog, electronic products for high fidelity, PA, ham, industrial, and experimental applications are listed. The catalog contains 180 pages, 72 of which are devoted to PA and high fidelity items. Custom Electronics, Inc., 1000 S. Main St., Dayton 9, Ohio.

Design and Production Facilities 247

The facilities of the company's specialized engineering, research and product development facilities, experienced personnel and modern production equipment for the design and manufacture of electronic equipment and components is described in four page bulletin 67-193 now available. Hupp Electronics Co., 743 Circle Ave., Forest Pk., Ill.

5 In. Precision Pot 248

General information and specifications on Series HP1500 5 in. high resolution precision potentiometers are presented in a data sheet of two pages. The literature is illustrated with a photograph and dimensional drawings. De Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N.Y.

Tape Noise

"Sound Talk," Bulletin 34, discusses the problem of noise in magnetic tape recordings. Illustrated with graphs and line drawings, the 5-page text tells what tape noise is and how it is diagnosed on a tape recorder. Among the topics considered are frequency modulation noise, drop-out noise, modulation noise causes, and erasure problems. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn.

Conversion Tables

A series of tables which simplify conversion from decimal to binary numbers, vice versa, have been published in a pocket size folder. The tables should prove useful to those working with coding systems of binary numbers. Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Industrial Tachometers

A variety of generators and indicating recording instruments are described in Bulletin 1258A now released. The illustrated booklet states that the instruments are available for measuring speed of any industrial rotating equipment, including tachometer generators and hand tachometers. General Electric Co., Schenectady 5, N.Y.



NOW...
A Kay Mega-Sweep
With Markers

KAY
Mega-Sweep
MODEL MARKER

SPECIFICATIONS

FREQUENCY RANGE: Two bands; 10-500 mc and 400-950 mc.
SWEEP WIDTH: Continuously variable 50 Kc-40 mc.
SWEEP RATE: Variable around 60 cps. Locks at line frequency.
RF OUTPUT VOLTAGE: High—approx. 0.15 volts rms into nom. 70 ohms.
Low—approx. 0.07 volts rms into nom. 70 ohms.
AMPLITUDE MODULATION: Less than 0.1 db/mc over frequency sweep.
OUTPUT WAVEFORM: Less than 5% harmonic distortion at full output. Less than 2% at half output.
RF OUTPUT CONTROL: Uncalibrated microwave attenuator, continuously variable to 26 db. Attenuation characteristic flat over output frequency range.
FREQUENCY MEASUREMENTS: By use of a precision micrometer-controlled wavemeter, the mid-point frequency of sweep may be pre-set or frequency at any point on oscilloscope display determined to within ± 5 mc.
SWEEP VOLTAGE: Regular sawtooth approx. 20 volts.
DIMENSIONS: 10 1/2" x 18 1/2" x 14 1/2".
POWER SUPPLY: Input approx. 110 watts, 117-V ($\pm 10\%$), 50-60 cps ac. B + electronically regulated.
CRYSTAL CALIBRATOR OUTPUT: Mixed directly with output of Mega-Sweep.
OSCILLATORS: Internally coupled providing a marker demonstration directly on sweep.
STABILITY: Maintained through electronically regulated power supply.
ACCURACY: Crystal— $\pm .01\%$.
CRYSTAL CALIBRATOR FREQUENCY: Fundamental at 5 mc and 50 mc.
HARMONICS: Over whole of usable swept range of Mega-Sweep.
PRICE: \$745.00 F.O.B. Pine Brook, N. J.

For Details on the Complete Line of Kay Instruments, Write:

KAY ELECTRIC COMPANY

Dep't. ED-9

14 Maple Avenue, Pine Brook, N. J.

CAldwell 6-4000

CIRCLE 252 ON READER-SERVICE CARD FOR MORE INFORMATION

Timing Device

255

Additions and replacements are easily made in a recent loose leaf catalog and reference manual on timing devices. The 128 pages of data, color coded for convenience, are divided into six major categories: relays; repeat cycle timers; time delay relays; elapsed time indicators and stop clocks; ac, dc and chronometrically governed timing motors; and miscellaneous information and application data. The descriptive matter is supported by 60 photographs, 30 dimensional drawings, and 50 charts and diagrams. There are approximately 600 catalog item part numbers. The W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

Electronic Data Processing Systems

256

Individual business applications of the transistor electronic data processing system are described in a series of brochures now available. The pamphlets document specific solutions to computational problems in payroll processing, invoice billing, parts inventory controlling, accounts payable processing, utility billing, and life insurance re-rating. Burroughs Corp., Div. Electronic Data, 460 Sierra Madre Villa, Pasadena, Calif.

Servomotor-rate Generator

257

Complete specifications, characteristics, 3-view drawing, and schematic of servomotor-rate generator, Model II is described in Data Sheet 872 now released. The sheet states that the unit provides fast response, low power input, oscillation damping, signal-to-noise ratio of 25:1 and linear torque-speed curve. Beckman/Helipot Corp., Newport Beach, Calif.

Variable Transformer

258

Double wound powerstat with an isolated secondary on a single core is described in 4-page bulletin L 3578 now available. Connection diagrams and ratings are given as well as illustrations, outline drawings and technical rating data on this variable transformer. Superior Electric Co., 83 Laurel St., Bristol, Conn.

Klystron Facts

259

"Klystron Facts Case No. 4" is a 24-page brochure summarizing recent developments in the field of klystron design. The illustrated booklet contains information on depressed collector operation, use of klystrons in high power uhf SSB service, and shaped pulse applications. Eitel-McCullough, Inc., San Bruno, Calif.



FOR
SEMICONDUCTOR
APPLICATIONS



DOPED GOLD PLATING PROCESSES

Co-deposits 24K Bright Gold and closely controlled percentages of Antimony, or other Group 3 or 5 elements,—developed specifically for Germanium and Silicon semiconductors. Bath operates at room temperatures and produces dense, fine grained, uniformly thick "Doped" Gold Plate precisely to your specifications. Write for technical data.

Precious Metals Division

SEL-REX CORPORATION

Dept. ED-9, Nutley 10, New Jersey

(Offices: Detroit, Chicago, Los Angeles)

Manufacturers of Exclusive Precious Metals Processes, Metallic Power Rectifiers, Airborne Power Equipment, Liquid Clarification Filters, Metal Finishing Equipment and Supplies.

CIRCLE 260 ON READER-SERVICE CARD FOR MORE INFORMATION

Looking for a Gang-- **OF POTS?**



If you are in the need of miniature, precision potentiometers with a built-in affinity for each other, you need the MODEL 319 by Daystrom Pacific Corporation, Potentiometer Division.

GANGED IN ALMOST ANY NUMBER, THIS UNIQUE DESIGN OFFERS:

- ★ Independent phasing
- ★ Smallest cup depth, lightest weight on the market
- ★ No clamp rings
- ★ Excellent performance under extreme conditions

Each wiper can be independently phased without interfering with the phasing of the other cups in the gang, and without rotating case or terminals, so that pre-assembled wiring harness can be used. Individual cups are one-half the length of any other similar potentiometer, and the high-strength, heat-resistant body reduces weight and eliminates insulation problems.

Available with panel or servo mount, and with ball or sleeve bearings. **WRITE FOR COMPLETE SPECIFICATIONS.**



Challenging openings exist for highly-qualified engineers

DAYSTROM PACIFIC CORPORATION

A Subsidiary of DAYSTROM, INC.

POTENTIOMETER DIVISION

11150 La Grange Avenue, West Los Angeles, California

CIRCLE 261 ON READER-SERVICE CARD FOR MORE INFORMATION

D-B SUB-CHASSIS REGULATED POWER SUPPLIES

— compact, rugged
units for
original equipment
and lab. work
— all low priced.

model 4-200X



400 VDC — 200 MA
— excellent regulation

This is a versatile unit built for highly dependable operation. Regulation—for 105 to 125 V line: 100 MV change; NL to FL: 100 MV change. Adjustable by factory from 250 to 420 VDC.

bulletin 1025

model 5-300XA



500 VDC — 300 MA
— adjustable, regulated

Adjustable from 250 to 500 VDC by simple internal changes. Regulation—for 105 to 125 V line: .05% change; NL to FL: .05% change. Size—W: 5"; L: 12 1/2"; H: 5 3/8" above deck.

bulletin 1017

model 3-150XHS



300 VDC — 150 MA

— Mil. Spec components
Dependable power for mobile computers and amplifiers. Excellent regulation and low ripple. Factory adjust 250-425 VDC; pot range 50 volts. Withstands high humidity.

bulletin 1023

model .28-2MX



28 VDC — 2 Amps

A compact, unregulated source of power for operating relays, motors, switching circuits, etc. Size: W: 3 1/2"; L: 9 1/2"; H: 4 1/2" above chassis, 1" below chassis.

bulletin 1026

models 1.5-70X, 2.5-70X, 3-70X



Exceptionally Small Types

—W: 4 1/8"; L: 5"; H: 4 1/4" above chassis; 1 3/4" below chassis. Ripple below 4 MV RMS.

outputs:

150 VDC—70 MA, fixed (model 1.5-70X)
250 VDC—70 MA* (model 2.5-70X)
300 VDC—70 MA** (model 3-70X)
*adjustable at factory: 220-260V
**adjustable at factory: 240-350V

bulletin 1028

models 1-20X, 1.5-20X, 2-20X



Octal plug-in units

—only 2 1/2" wide; 2 3/8" long; 4 1/4" high. Ripple below 5 MV RMS.

outputs:

105 VDC—20 MA (Model 1-20X)
150 VDC—20 MA (Model 1.5-20X)
210 or 105 VDC @ 20 MA (Model 2-20X)

bulletin 1027

models .28-5MX; .28-5MXR



28 VDC—5 Amps—adjustable
Transformer taps on Model .28-5MX permit adjusting to 28 volts for variations in line and load.

28 VDC—5 Amps
—regulated by mag. ampl.

Model .28-5MXR—regulation for 115V ±10V line: ±0.25V; NL to FL: 0.5 V.

bulletin 1018

bulletin 1019

With the wide range of voltages and currents offered by these units, design engineers can quickly find a model compatible with their needs. Each unit features simplified design, highest quality components, easy-to-trace wiring, and high reliability.

dressen-barnes

DRESSEN-BARNES CORP.
250 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 265 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Extruded Acrylic Sheets

266

Complete information on the handling, machining, forming, cementing and annealing of low-cost Cadco extruded acrylic sheets is given in a 12-page bulletin now available.

Table of properties and four pages of light transmittance charts, including comparison with cast sheet are also included. Cadillac Plastic & Chemical Co., 15111 Second, Detroit 3, Michigan

Ceramic Capacitors

267

Ceramic capacitors are described in a six-page catalog now available. Disk, tubular, and plate types of ceramic capacitors are illustrated with charts and diagrams. Each application for temperature compensating, stable capacitance, high voltage, printed circuitry is discussed, with complete specifications and properties of the ceramics listed. Special customized applications are mentioned. Skottie Electronics Inc., Peckville, Pa.

Brass Fittings

268

Recently issued is a 48-page brass tube fittings catalog. It lists all available sizes and types, and has a section showing a complete line of drain and shut-off cocks. Other subjects covered in the catalog are push-pull controls, complete assembly instructions on all brass fittings, data on right and wrong ways for tubing a system, tube fitting data and tools. The Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.

Analysis and Test Instruments

269

In an eight-page catalog digest of all standard devices, instruments are grouped by type and application. Depicted and described with specifications are subsonic, sonic and ultrasonic waveform analyzers; rf, vhf and uhf spectrum analyzers; special and accessory instruments; and telemetering test instruments. A summary list of applications and a detailed table of contents help to locate equipment of specific interest. Panoramic Radio Products, Inc., 10 S. 2nd Ave., Mount Vernon, N.Y.

Motors, Fans and Blowers

270

Fourteen-page catalog, No. 83 describing motors, fans and blowers, has been released. This informative catalog offers full details, physical specifications and electrical characteristics on complete line of synchronous, torque, induction and gear motors, centrifugal blowers and axial fans. Both standard and custom models are available to order for commercial or military applications. Ashland Electric Products Inc., 32-02 Queens Blvd., Long Island City 1, N. Y.

Microwave Products Catalog

273

Short form Catalog 57-BG describes all of the products manufactured. Among items included are pulsed and CW magnetrons, TR and ATR duplexing tubes, microwave silicon diodes, silicon power rectifiers, flange-mounted and solderable waveguide pressure windows, waveguide components, and test equipment.

Operating characteristics are tabulated for a majority of the products. Microwave Assoc. Inc., 22 Cummington St., Boston 15, Mass.

Efficiency Poster

274

An unusual training poster has been released recently. It is an attractive, colorful 18 x 24 in. sheet, addressed to assembly line operators, and illustrating dramatically how to do a more effective soldering job, eliminating costly rejects and adding to production efficiency. The poster is designed to be useful in any plant, posted along the assembly line. It is an appeal to the employee's pride of accomplishment. Multicore Sales Corp., 80 Shore Rd., Pt. Washington, N.Y.

Automatic & Semi-Automatic Machines

275

Four specification sheets describing special automatic and semi-automatic machines have been issued. These sheets describe Machine No. 1507, glass tubing cutting machine; Machine No. 2070, automatic bulb blowing machine; Machine No. 1416, high-speed pneumatic base filling machine; and Machine No. 1708, an automatic neck sealing machine. Kahle Engineering Co., 1400 Seventh St., No. Bergen, N.J.

Resistance Elements

276

Three bulletins of interest to industrial companies dealing in electronics are available. One bulletin describes the highly-individualized engineering manufacturing and marketing services offered; second bulletin deals with revolutionary line of resistance elements known as RdF Stikons; and third describes development of miniaturized high-temperature resistance thermometer probe. Arthur C. Ruge Assoc., Inc., 733 Concord Ave., Cambridge 38, Mass.

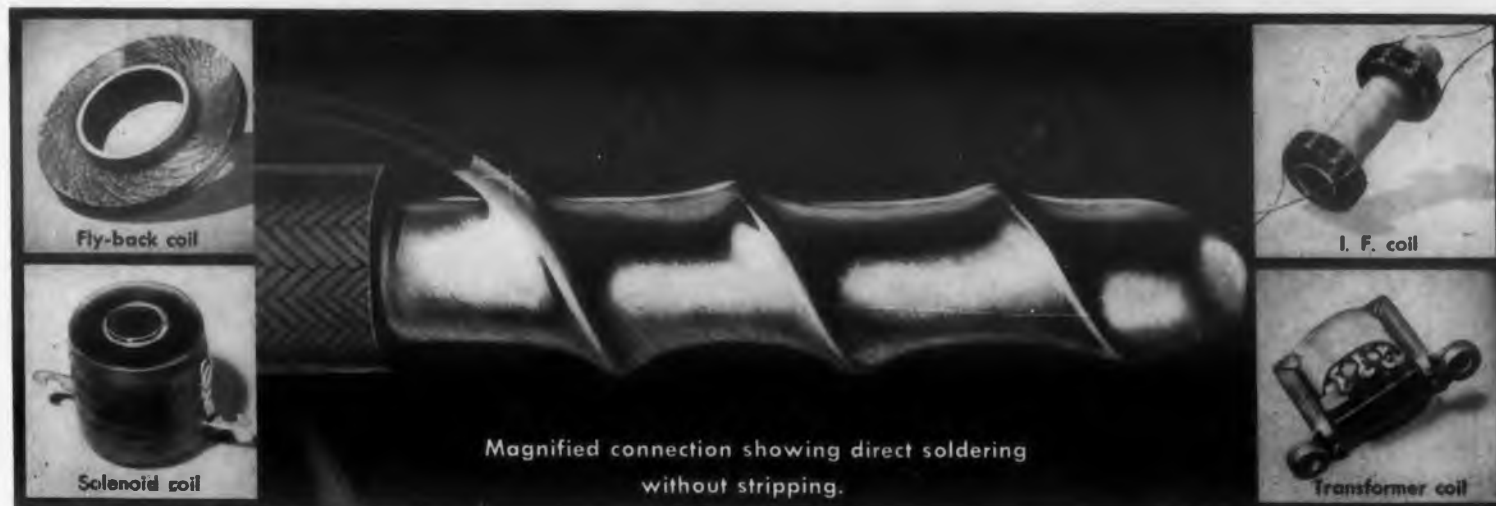
Instrumentation Tape for Telemetry

277

Type B Instrumentation tape designed specifically for telemetry is described in a booklet recently released.

The multi-colored booklet completely describes operating characteristics of the Type B tape for carrier-type recording, including specifications and magnetic properties. The booklet covers use of the tape for FM/FM or FM/PM, PDM/FM, or PDM/PM. Reeves Soundcraft Corp., 10 E. 52nd St., New York, N.Y.

PHELPS DODGE SODEREZE® ENDS STRIPPING, CLEANING— CUTS SOLDERING COSTS!



Magnified connection showing direct soldering without stripping.

Sodereze*—Phelps Dodge polyurethane magnet wire—provides:

1. Low temperature soldering—no damage to copper conductor.
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3. Resistance to heat and solvent shock for safer wax or varnish treatment.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

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YOU GET
Lighter Operating Pressure
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NEW ACRO
PRECISION SWITCHES

NEW MODEL CM Snap Action

The big features of this new, small Acro precision switch are long life and light operating pressure—lighter than any other switch of its type. Having snap action parts of beryllium copper and contacts of fine silver, the CM offers extremely good repeatability and will deliver millions of actuations *without failure*. It can be ganged for multi-pole applications, will operate in a temperature range of 160°F., and is designed for use where positive control is required and slow actuation inherent.



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Operation of the Acro CS switch is through rotary motion (either clockwise or counter-clockwise), with a spring bias provided for quick return. Available in normally open and normally closed models, this new switch also operates by very light pressure and will give extra long mechanical and electrical life. It's designed for use where rapid actuation is inherent and contacts are protected against vibration or shock in the "at rest" position.



Both the Acro CM and CS Switches are furnished with a choice of integral actuators to suit individual applications!

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Columbus 16, Ohio

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Trends in Components

Sub-Miniature Metallized Paper Capacitors

Peter P. Grad
 Aerovox Corp.
 New Bedford, Mass.



A major modification of the metallized paper capacitor has resulted in a 50 per cent volume reduction of the smallest available units of this type. The insulation resistance and temperature coefficient characteristics have been improved over the best commercial subminiature paper capacitors. The small size and high precision of this component make it suitable for transistor circuitry. Although the capacitor is not yet available on the market, this preview should be useful to the design engineer.

Aside from constructional details, the impregnant and the method of impregnation employed are most important in the manufacture of metallized paper capacitors.

It was found that a liquid impregnant—polysiloxanes—is the most successful for high reliability subminiaturization, and for heretofore unobtainable electrical characteristics. Although liquid impregnants were generally considered unsuitable for metallized paper capacitors because of the conductive particles resulting from the self clearing burn-out, a newly developed impregnation technique coupled with the properties of methyl polysiloxane changed this misconception.

This liquid impregnant has many advantages. Inherent in their chemical structure the silicone oils

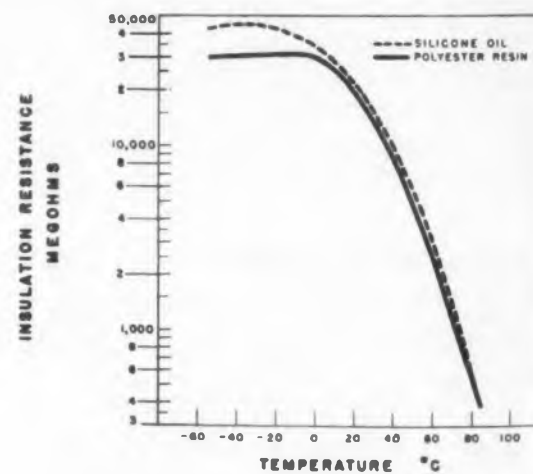


Fig. 1. Graph of insulation resistance vs temperature. 1.0 µf subminiature metallized paper capacitors impregnated with silicone oil and polyester resin.

hibit a high degree of stability. Their resistance to heat and oxidation is high, and relatively slight changes in viscosity and dielectric properties take place with temperature changes. Added factors are the high degree of water repellency and availability in viscosity ranges.

Experimental evidence indicates that methyl polysiloxanes partially polymerizes under the stress of arcing which occurs when the metallized paper undergoes self-clearing. The resultant small gummy masses occlude any conductive decomposition particles as a consequence of the paper pyrolysis. This is a partial explanation for the puzzling phenomenon that silicone oil does not cause breakdowns whereas mineral oil, for example, is unsuitable as a metallized paper impregnant. The good performance of the silicone oil impregnant is predicated, however, on its complete penetration into the fibrous structure of the paper.

The development of the subminiature metallized paper capacitor has resulted in the following:
Insulation resistance values attained at 25 C (10,000 meg- μ f) and at 85 C (300 meg- μ f) are better than the highest values for commercially available metallized paper capacitors. See Fig. 1.

The volumes are an average of 55 per cent smaller than the volumes of the smallest commercially available metallized paper capacitors. A completely assembled 1 μ f unit has a total volume of 1.1 cu in.

A low capacitance change with temperature has been obtained: -2, +0.3 per cent. See Fig. 2.

Power factor values are equivalent to present commercial and military standards for metallized paper: 0.55 per cent at room temperature.

Tolerance on capacity can be kept within ± 10 per cent.

Life expectancy is 7.5 years at 85 C and 25 v.

Large scale production is feasible without major tooling or large equipment investment.

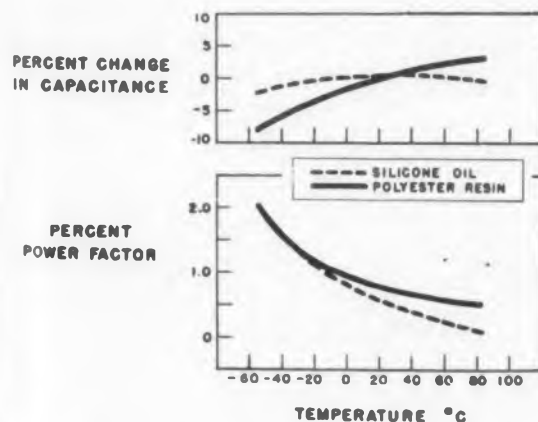


Fig. 2. Graph of capacitance and power factor vs temperature. 1.0 μ f subminiature metallized paper capacitors impregnated with silicone oil and polyester resin.

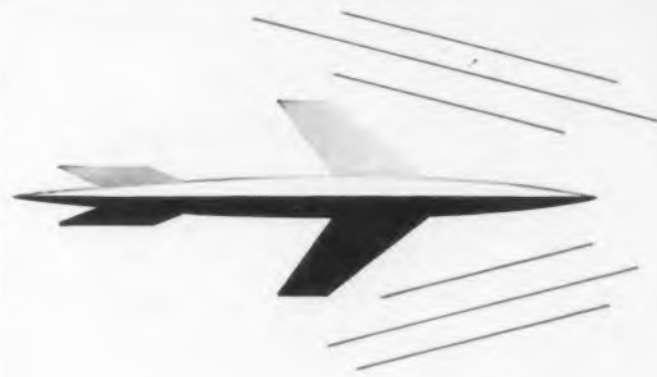
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Mincom pioneered and perfected tape recording techniques for the radio and recording industry

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Mincom pioneered the recording and reproduction of off-the-air television from magnetic tape

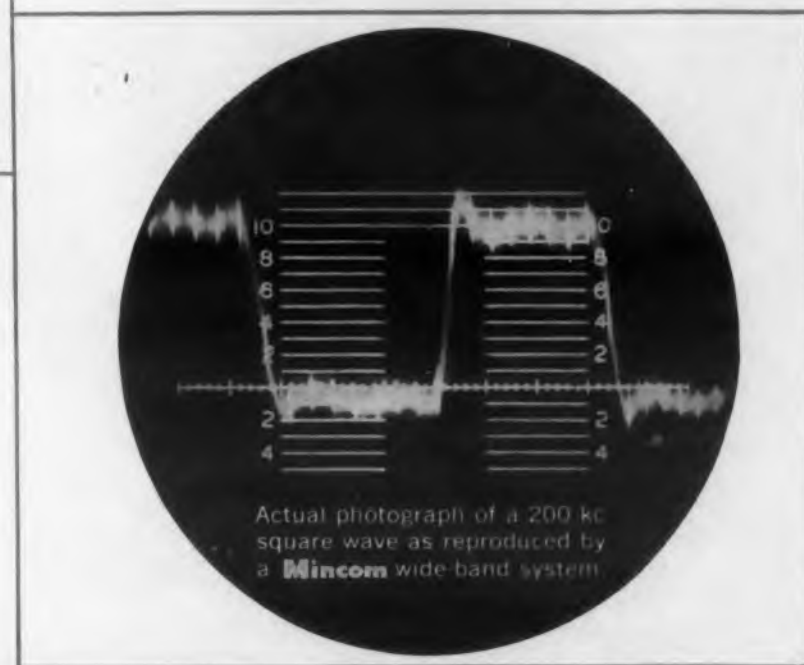
...First Demonstration of Video Tape Recording... November, 1951

Mincom pioneered and perfected the tight-loop drive for instrumentation recording on magnetic tape

...First Tight-Loop Drive Recorder... August, 1952

And now— Mincom has perfected wide-band magnetic tape systems which can be used for: Radar Recording • Wide-band Telemetry • Waveform analysis • Spectrum Monitoring and Closed Circuit Television Recording

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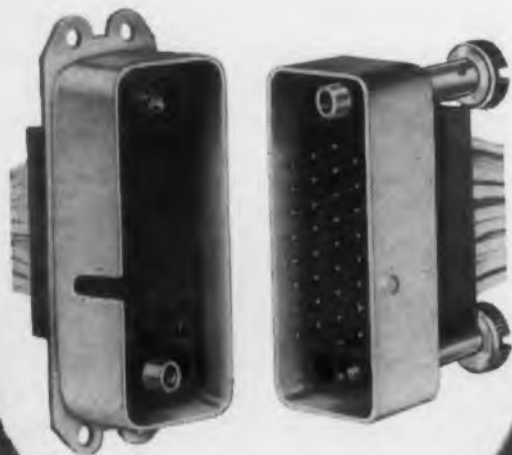
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West Coast Branch: 1218 Fifth Street, Santa Monica, Calif.

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Ideas for Design

Measuring AC Currents in Transistor Circuits

OWING to the nature of audio vacuum tube circuits, it is possible to make fairly complete analysis of an experimental circuit by measuring stage-by-stage voltage gains using conventional equipment. In transistor circuits, it is also desirable to ascertain current and power gains. Once knowing these additional facts, it becomes possible to calculate actual stage-by-stage impedances.

Since most small laboratories are not equipped with low impedance ac microammeters, it is possible to measure signal currents as low as 0.1 μ a by using the circuit shown in conjunction with a vtm.

Requirements

The requirements for an ac microammeter should include the following: 1. it should not increase the impedance in the circuit being measured; 2. input terminals must be above ground; 3. the frequency response should be flat over the ac frequency spectrum to be applied; 4. it should be convenient and easy to use.

In the circuit, a Triad type HS-52 transformer was used, having the following specifications: frequency response—20 to 20,000 cps; impedance ratio—62.5 ohms to 20,000 ohms (1.320); turns ratio—1:17.9; dc resistance of primary—3.6 ohms; dc resistance of secondary—780 ohms. Because the vtm is actually measuring the current in the

SZ Switch Position

	1	2	3
Secondary Impedance	180 ohms	1.8 K ohms	18 K ohms
Primary Impedance	.563 + 3.6 ohms	5.63 + 3.6 ohms	56.3 + 3.6 ohms
Multiplying Factor	0.1	1.01	0.001
Min. Detectable Current*	10 μ a	1 μ a	0.1 μ a

* Based on Minimum of 0.1 mv on Ballantine Model 310 A vtm

secondary, the dc resistance of the secondary has no effect on the accuracy of the measurement; although it does decrease the sensitivity somewhat.

The 3.6-ohm dc resistance of the primary does not affect the accuracy, but in a low-impedance circuit—such as a 50 ohm common-base input circuit—it will reduce the input current by approximately 5 per cent.

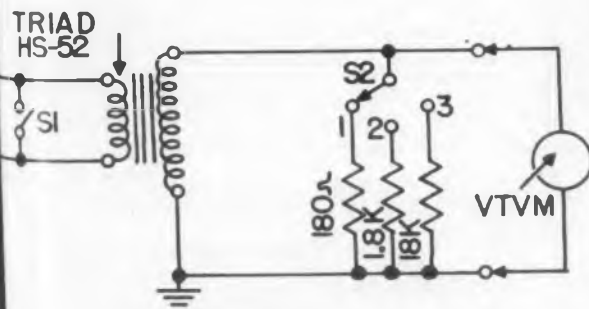
The multiplier resistances in the secondary were chosen so that the switch positions vary the current ranges in powers of 10. The voltmeter reads directly in current, by mentally multiplying the scale reading by the proper power of 10.

Switch *S1* is used to check the effect of inserting the device in the circuit to be measured. This is done by noting any change in the output of the test circuit when *S1* is alternately opened and closed. With *S1* opened, *S2* is stepped until a loading effect is noticed by a slight decrease in the output voltage of the test circuit. The voltage loading is then noted and by means of the multiplying factor is converted directly to current. If a fourth step were added to *S2*, its resistance could be 180 K ohms. Because the maximum specified secondary impedance is 20 K ohms, the 180-ohm resistor would seriously degenerate the frequency response. Frequency response is as specified by the transformer manufacturer, provided the 20 K ohm impedance rating is not exceeded.

Accuracy

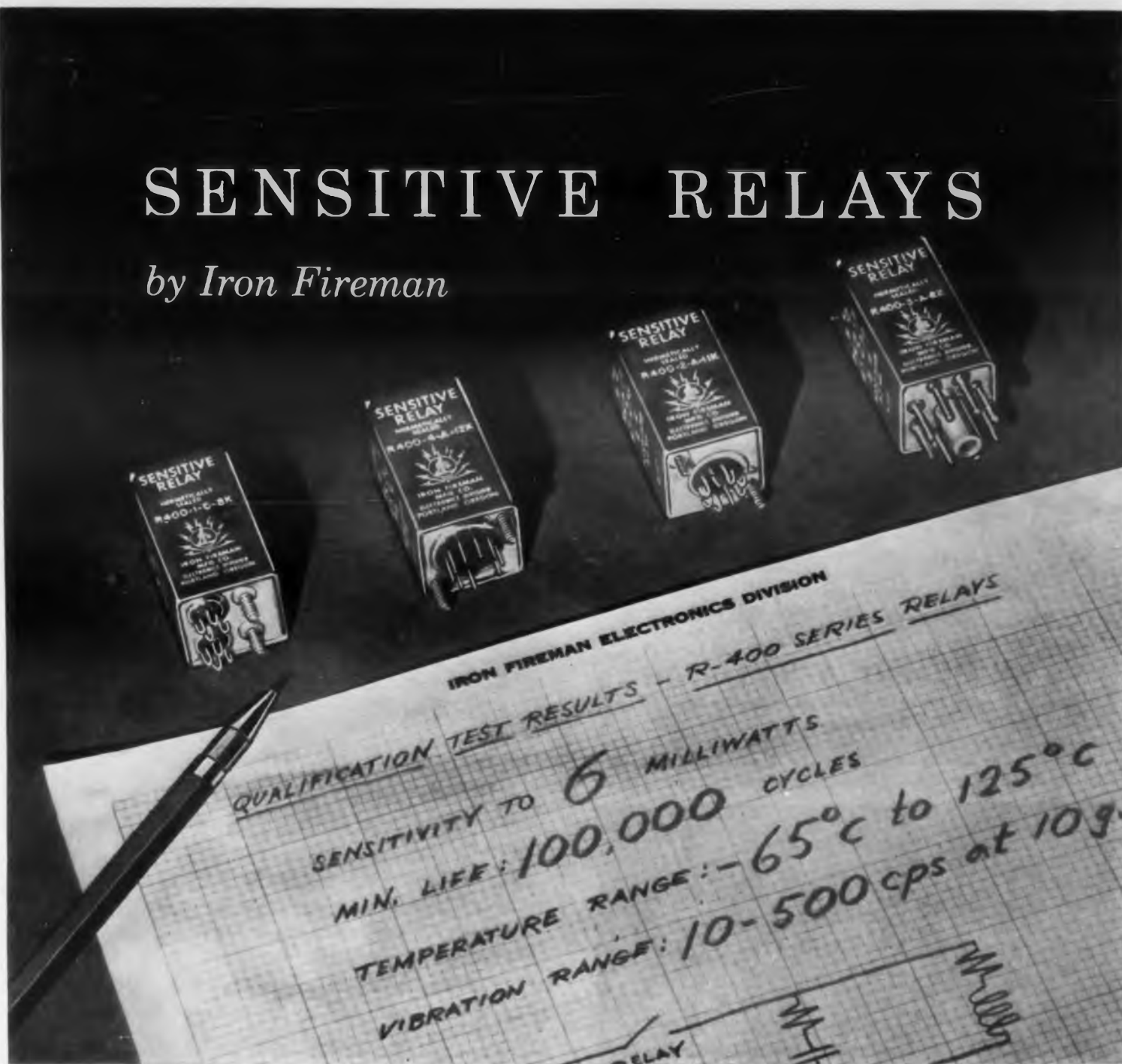
The circuit shown is adequate to measure radio current to at least 3 per cent, which is the limit of the Ballantine vtvm. Further improvement can be obtained using a transformer of lower dc resistance and higher inductance.

Due to temperature effects and transistor parameter variations, most high quality transistor circuits make use of multiple ac and dc feedback loops to improve stability and linearity. This circuit has been especially useful in measuring currents and impedances in these closed loop circuits. *John W. Sullivan, Northrop Aircraft, Experimental Flight Test, Development*



SENSITIVE RELAYS

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Qualified to MIL-R-5757

These balanced-armature relays meet or exceed rigid military specifications. They combine extreme sensitivity with rugged resistance to a wide range of vibration, shock and temperature.

This is why Iron Fireman sensitive relays are used

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Ideas for Design

Low Cost Speaker Horn

A plant loudspeaker paging system was needed. A low-cost solution was found by improvising for loudspeaker enclosures as follows:



Surplus metal spheres were purchased which had been used to hold gyros in transit. These were cut as shown; then the speakers were mounted in the half spheres, resulting in very efficient radiating horns.

These horns were then mounted from the ceiling with a resultant saving in amplifier cost because of the increased efficiency brought about by the horn effect.

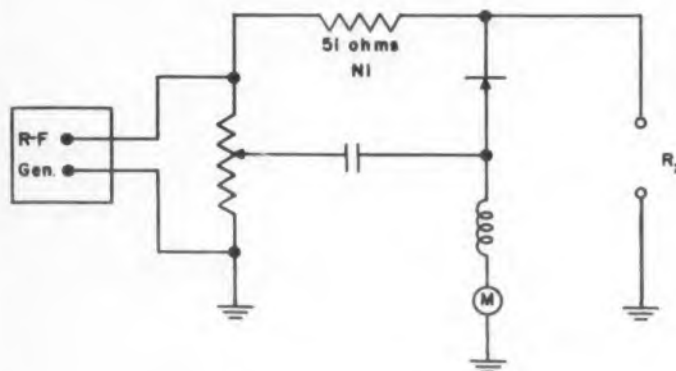
Herbert Piller, National Electronics, 451 Thieriot Ave., N.Y. 72, N.Y.

Antenna Impedance Measurements

The solution shown here increases the utility of existing antenna impedance measuring equipment (Heathkit, etc.). It results in 1. greater frequency range; 2. avoids scale compression at low R readings and extend range to ∞ , and 3. gives more uniform loading of the generator.

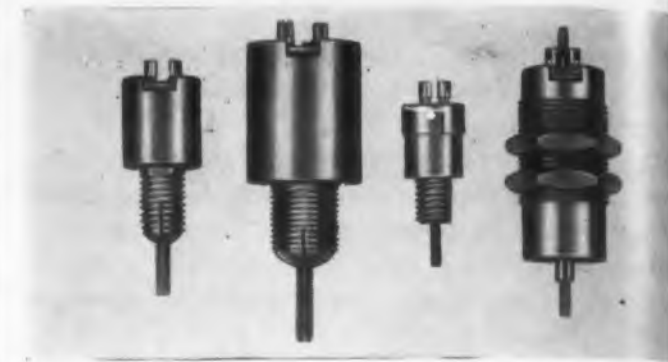
The variable series resistor has been replaced by one of fixed composition having superior frequency characteristics. The variable resistor is now used as a slide wire voltage divider across the source, as shown.

The bridge now balances at mid scale with a 51 ohm R_x and gives a range of 0 to ∞ ohms. The generator load varies from approximately 33 to 100 ohms. A. H. Nichols, Sr. Staff Eng., Hughes Aircraft Co., Culver City, Calif.



Modified impedance measuring circuit

Miniaturized . . . Ruggedized . . .
And whether you buy one or thousands
of these Shielded Coil Forms you get
CTC Reliability



Shown approx. 4/5 actual

Shielded Coil Form Data: Highly shock-resistant, mechanically enclosed. Mount by single stud. Single layer or pie-type windings to your specifications. LS-9, $1/16'' \times 1/2''$; LS-10, $5/8'' \times 15/16''$; LS-11, $15/16'' \times 17/32''$; LS-12 (square for printed circuit), $1/2'' \times 1/2'' \times 1/2''$; LS-14 (double-ended version of LS-9, with separate tuning slugs), $1/2'' \times 15/64''$.

Ideal for use in IF strips, or as RF coils, oscillator coils, etc.

For samples, information, prices write Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Mass.

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Does your lead go



or is it held in the
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LOCKTITE

Three things make LOCKTITE Holder tower over other holders on the market:

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2. Push-button control advances the lead without touching fingers, thus avoiding graphite smudges.
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Imported Castell Leads

For supreme satisfaction use LOCKTITE with imported CASTELL 9030 lead in 19 degrees, the same quality lead that made CASTELL wood pencil famous in every civilized country in the world. Call your Dealer today.

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REGULATED POWER SUPPLY

0.001% Regulation and 0.1 Millivolts Ripple



MODEL UHR-220

The KROHN-HITE Model UHR-220 is a compact POWER SUPPLY for applications requiring up to 0.2 ampere of d-c at 0 to 500 volts with ultra-high regulation, extremely low ripple and unusual stabilization under severe input line voltage transients. The internal impedance is less than 0.01 ohm for low frequencies and d-c, and less than 0.1 ohm for frequencies as high as 100 kc. Stabilization for $\pm 10\%$ change

line voltage is 0.003%. Transient response is 0.001 microsecond and typical 10-hour drift is 300 ppm. A 0-150 ma, bias supply with 0.05% stabilization and 0.2% ripple is available in addition to two 6.3 volt unregulated a-c outputs of 5A capacity. Price \$390.00, f.o.b. factory.

For Further Details Write

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Improved Harness Layout

A simple method for the layout of wiring harness assemblies, that lends itself to the accurate duplication of two or more harness boards for higher production rates, has been developed at the Columbus Division of North American Aviation, Inc.

General practice has been to paste down on plywood boards paper blackline prints made from the original layout tracing. Errors occurred because paper prints—however accurate the original layout may have been—are stretched or shrunk during printing, developing, or mounting on the wood. Errors as much as 1/2 in. in 6 ft—and more in longer boards—have been measured.



In the Radio-Electric Department at the Columbus Division of North American Aviation, Inc., a Master Stabilene Film layout is being compared to a duplicate copy which is printed on plywood. The plywood forms a jig used for the manufacture of wiring harness assemblies.

The new method uses a stable base material—Keuffel & Esser's 130 H Stabilene Film, a re-stabilized Mylar, with a pencil and ink surface—for the preparation of the master layouts for wiring harnesses. Stabilene Film comes in thickness of 0.003, 0.005 and 0.0075 in., has a dimensional stability that averages 0.000006 in. per in. in both directions at temperatures from 80 to 220 F, and from 0 to 98 per cent relative humidity.

Once the master layout has been completed on Stabilene Film, the layout is printed directly on plywood that has first been coated with white shellac and sanded smooth and then sensitized with a daylight type diazo emulsion. Printing is done by contact to insure accuracy in a contact printer 6 ft wide and 30 ft long. If more than one harness board is required, additional sheets of plywood can be printed. There is no limit as to the number of reproductions that can be made.

Once printing has been done, the Stabilene Film can be rolled for storage to save space. It contains no plasticizer and will not deteriorate in storage.

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WILL NEVER SHORT OUT
OR BURN UP

Davohm Series 850 Hermetically Sealed Metal Film Resistors

Extensively used in critical applications where severe line overloads might burn up conventional resistors or cause them to short out and overload other components. While Davohm Series 850 can momentarily withstand large overloads, extreme overloading will open circuit them; but they cannot short out or burn because there are no organic compounds in this resistor which might carbonize or burn. Typical present applications—fuel gauges in jet planes—line terminations in telemetering circuits.

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Custom-Tailored
to your requirements
... for better fit
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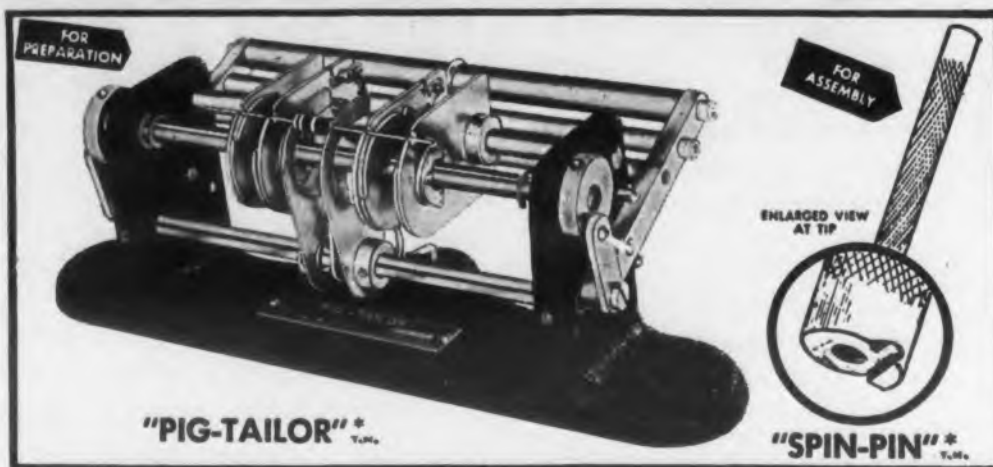
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The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

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2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
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7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
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3. Operator judgment.
4. 90% operator training time.
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6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
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10. Haphazard assembly methods.

* PATENT PENDING

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Report Briefs

Radar Screen Diffraction

This report describes the results of tests to determine the effectiveness of shielding screens surveillance radars in reducing the strength of ground-clutter signals in critical areas. Although the scope of the experimental tests was very limited, it was found that properly designed screens can provide a worthwhile reduction in ground-clutter signal strength in areas where the subclutter visibility performance of the radar is inadequate. PB 1219 Diffraction and shielding effects of radar screens. A. W. Randall and Roger L. Williams. U.S. Office of Aeronautics Administration, Indianapolis, Ind. Office of U.S. Dept. of Commerce, Washington 25, D.C. Mar. 1957, 12 pp, \$0.50.

Light Magnetic Cores

A method of calculation useful wherever weight is a factor in the design of magnetic amplifier components has been devised at the Naval Research Laboratory. The method enables calculation of the configuration of the magnetic core, case and winding yielding minimum weight for a given volt-second capacity of a magnetic core and coil. The analysis is very general and takes into account limiting quantities such as winding resistances and magnetizing currents. It can be extended to include weights of other related components such as associated batteries merely by the addition of appropriate terms to the total weight equation. PB 121776 Design of Minimum Weight Magnetic Cores, J. W. Kallander, NRL, OTS, U. S. Dept. of Commerce, Washington 25, D. C., Jan. 1957, 8 pp, \$0.50.

Log Recording System

A logarithmic recording system was designed to provide information concerning the side-lobe structure of the radiation pattern of an antenna. The system is not limited to use with antenna patterns, but will plot any function that can be expressed as a voltage. The system obtains the logarithm of the input voltage by electromechanical servo techniques. A comprehensive description of the system is given, including derivation of the necessary design equations, a step-by-step outline of the design procedure, and diagrams and parameters for one of the SRI-built recording systems. PB 124296 Economical Logarithmic Recording System. Lloyd A. Robinson, Stanford Research Institute, Menlo Park, Calif., Library of Congress, Washington 25, D.C. June 1956, 40 pp. Microfilm \$3.00, photostat \$7.80.

PROBLEM #4

Design a miniature audio input transformer for airborne operation. Transformer to operate in an ambient temperature of plus 85°C, and to conform to the applicable parts of MIL E-5400 and MIL T-27. Duty cycle to be continuous with a minimum life of 1000 hours. Transformer to couple a 300 ohm source to a tube grid. Step-up turns ratio to be 1:17 minimum, with the maximum possible desired. Frequency response to be flat within 0.75 db from 20 cps to 7,000 cps, and flat within 1.2 db from 15 cps to 10,000 cps. Maximum signal level to be 500 mv @ 20 cps in 300 ohm primary. Electrostatic shield required between primary and secondary. Electromagnetic shielding to be 40 db minimum. Size to be kept minimum but must not exceed 1 1/8" x 3/4" x 1 1/4" high.

SOLUTION BY PEERLESS

Audio Transformer, low level input, miniaturized.
Construction: Grade 1, Class A, MIL T-27
Duty Cycle: Continuous
Life: Greater than 1,000 hours.
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Boron is found to be strongly bonded to the tungsten substrate as indicated by activation energies of 2.8 electron volts for surface migration and 2.2 ev for disappearance. The activation energy of molybdenum for surface migration is 3.1 ev and for the silicon deposit 2.5 ev for surface migration and about 4.0 ev for evaporation. *Field Electron Emission*, Russell D. Young and Earl C. Cooper, Pennsylvania State University, PB 123961, July 1956, 91 p, Microfilm \$4.80, Photocopy \$13.80. Order from Library of Congress, Washington 25, D.C.

Backward Wave Amplifier

A new form of microwave amplifier known as the backward-wave amplifier has recently become possible due to new discoveries. This electron tube is capable of covering a wide band of frequencies, but is actually a narrow band filter which is tunable by varying the anode voltage. In addition to the filtering effect, the tube can have as much gain in its pass band as the better known traveling-wave amplifier. The history of the backward-wave amplifier is briefly discussed, its present status is outlined, and possibilities for future work are suggested. PB 121797, *Backward-wave amplifier, a tunable micro-wave amplifier*, Daniel G. Wright, Wright Air Development Center, Dayton, Ohio. OTS, U.S. Dept. of Commerce, Washington D.C., Sept. 1955, 16 pp, \$0.50.

Electric Panel Design

This report contains a series of graphs of phase retardation design curves for solid lossless flat dielectric sheets. The thickness of the flat dielectric sheets is plotted as a function of incidence angle for perpendicular and parallel polarization and the following constant phase retardation values: 90, 135, and 180 deg. The curves are plotted for a series of dielectric constants. For reference purposes on the same graphs the thickness of the flat dielectric sheets are plotted as a function of incidence angle for the following cases: (1) with the electrical thickness equal to 90 deg, the transmission efficiency is a maximum for both polarizations, (2) with the electrical thickness equal to 180 deg, the transmission efficiency is a maximum for both polarizations, (3) with the electrical thickness equal to 135 deg, the transmission efficiency is again a minimum for both polarizations, and (4) with the electrical thickness equal to 360 deg, the transmission efficiency is again a maximum for both polarizations. The graphs are included for use as a design tool by radome design systems. PB 121783, *Phase retardation design curves for solid lossless dielectric panels*, Eino J. Luoma, Wright Air Development Center, Dayton, Ohio. OTS, U.S. Dept. of Commerce, Washington 25, D.C., Feb. 1956, 27 pp, \$0.75.

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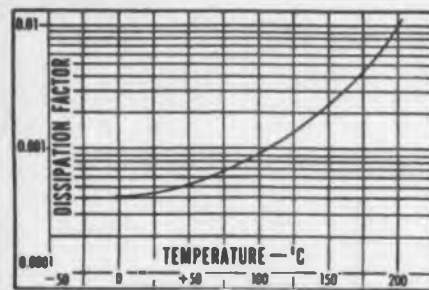
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Patents

Magnetic Device

Patent No. 2,794,164. Shou-Hsien Chow. (Assigned to Burroughs Corp.)

A sub-harmonic generator of the magnetic type uses a single magnetic core having a substantially square hysteresis loop. The core has a first winding and a capacitor in series with the winding to form a charging and discharging path. An alternating current source is in series with the capacitor and the first winding for charging the capacitor. A resistor shunts the first winding and capacitor and lies in the discharge path for the capacitor. A biasing magnetic flux is induced in the magnetic core through a circuit inductively coupled to the core.

Stabilized Two Stage Oscillators

Patent No. 2,792,498. B. D. Pewitt. (Assigned to Radio Corp. of America)

A sine wave oscillator is described which uses a first and a second tube each having input and output electrodes. A regenerative oscillation amplifying loop includes a coupling from an output electrode of said first tube to an input electrode of the second tube and a coupling from an output electrode of the second tube to an input electrode of the first tube. A circuit is coupled to the input electrode of the second tube which develops a gain-limiting self bias voltage. A portion of this bias voltage is applied through a suitable coupling to an input electrode of the first tube.

Gain-Modulated Amplifier

Patent No. 2,974,077. C. L. Olson. (Assigned to Radio Corp. of America)

The amplifier described uses an amplifying tube having an input grid to which the input signals are applied and an anode. A pair of series connected controllable-resistance tubes have a unidirectional supply voltage applied to the anode of one of these tubes. A direct current connection is made between the common cathode anode junction of the pair of tubes and the anode of the amplifier tube. Other signals such as modulating signals are applied to the control grids of the pair of tubes with the same phase which signals control the resistance of these tubes.

Stabilized Direct Current Setting Apparatus

Patent No. 2,792,496. R. N. Rhodes. (Assigned to Radio Corp. of America)

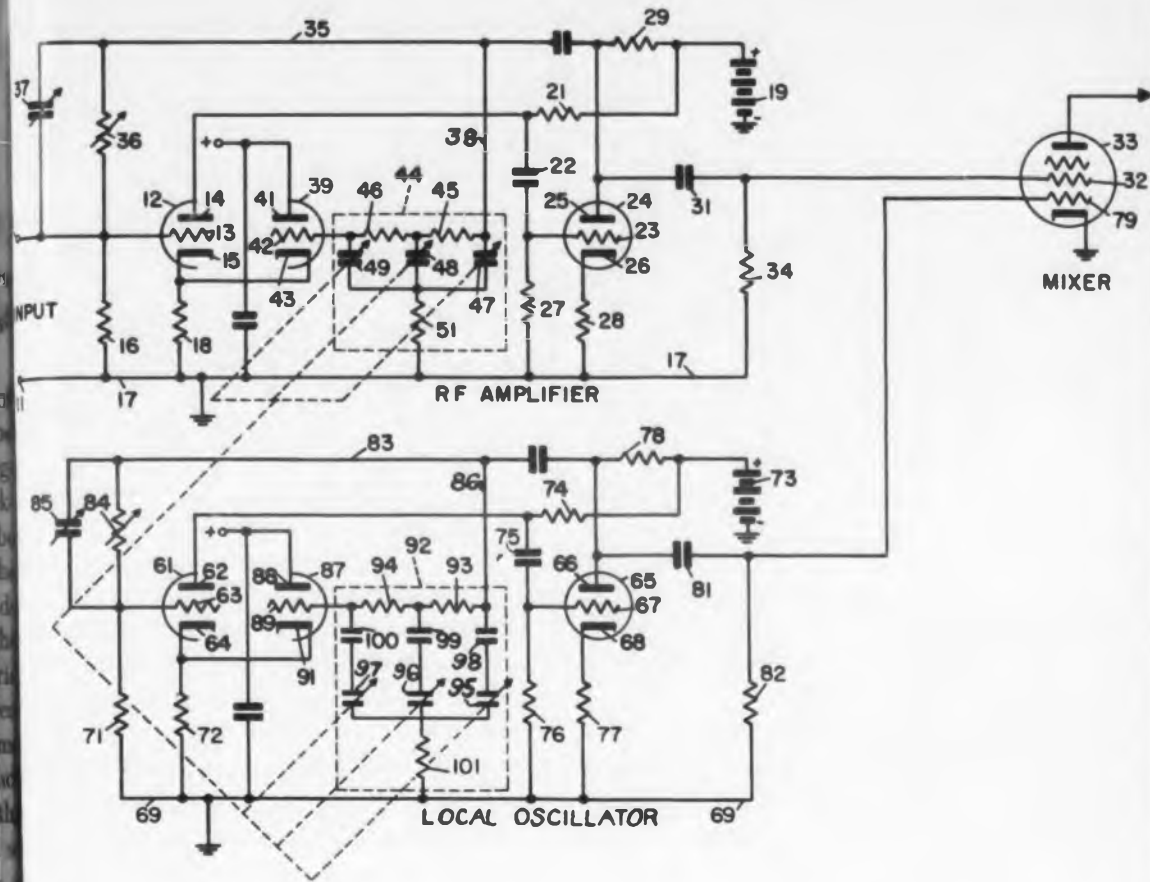
It is desirable to control the level of conduction of an electron discharge tube which is supplied with a signal having regularly recurring reference portions but lacking its direct current component. The tube has a first and a second grid such that the difference in potential between the grids determines the level of conduction of the tube. A circuit is connected to the first grid for clamping the regularly recurring reference portions of the signal to the same voltage level. A direct current path including an impedance is provided from the second grid to a point of fixed potential such that the voltage across the impedance is proportional to the degree of conduction of the tube.

A normally conducting electronic switch and an isolating device connects a source of reference potential and a point of fixed direct current path for the second grid. This switch is periodically opened coincidentally with the recurring portions of the signal to produce a control signal which is proportional to the difference between the reference potential and the voltage across the impedance. The control signal is measured and applied to the clamping circuit to establish the clamping level.

Forcible Reversion Of Magnetic Amplifier

Patent No. 2,792,507. J. P. Eckert Jr. (Assigned to Sperry Rand Corp.)

A control system of the magnetic amplifier type is described. The amplifier has a core of magnetic material and a control winding on the core. A first circuit is responsive to the input for selectively affecting a current flow through the control winding so that the output of the amplifier changes from a predetermined non-saturated state to a secondary output state. A second circuit is coupled to the amplifier winding and is responsive to the output state of the amplifier for reverting the amplifier from the secondary output state to a first signal output state upon cessation of the input signal.



Superheterodyne Receiver Using Resistance-Capacitance Tuning in Local Oscillator and Radio Frequency Stage

Patent No. 2,783,373. C. J. Fowler. (Assigned to United States of America)

Superheterodyne receiving circuits have been tuned by using inductances and capacitors which rendered exact tracking difficult. The inductances also have to be adequately shielded to avoid undesired feedback and in addition they are relatively susceptible to damage because of the fine wire used in the windings. The circuit described here uses resistors and capacitors in the tuning unit.

In the circuit illustrated, the amplifier consists of two amplifying triodes 12 and 24. Positive feedback is provided through the wire-wound resistor 36 which is adjusted so that the feedback is insufficient to produce oscillation. Negative feedback to the triode 12 is provided through the tuning network consisting of resistors and capacitors and a wire-wound resistor 38. The current flowing through a triode 39. The tuning network functions as a band-pass filter which passes signals other than those in the narrow band of frequencies. In this narrow band the impedance of the network 44 is balanced and the current does not pass the frequencies within the narrow band. Control of the current through the triode 39 controls current through a cathode resistor 18 which is in series with the cathode resistor for the amplifier

tube 12 and hence cancels out the positive feedback to amplifier tube 12 excepting those frequencies within the rejection band of the network 44.

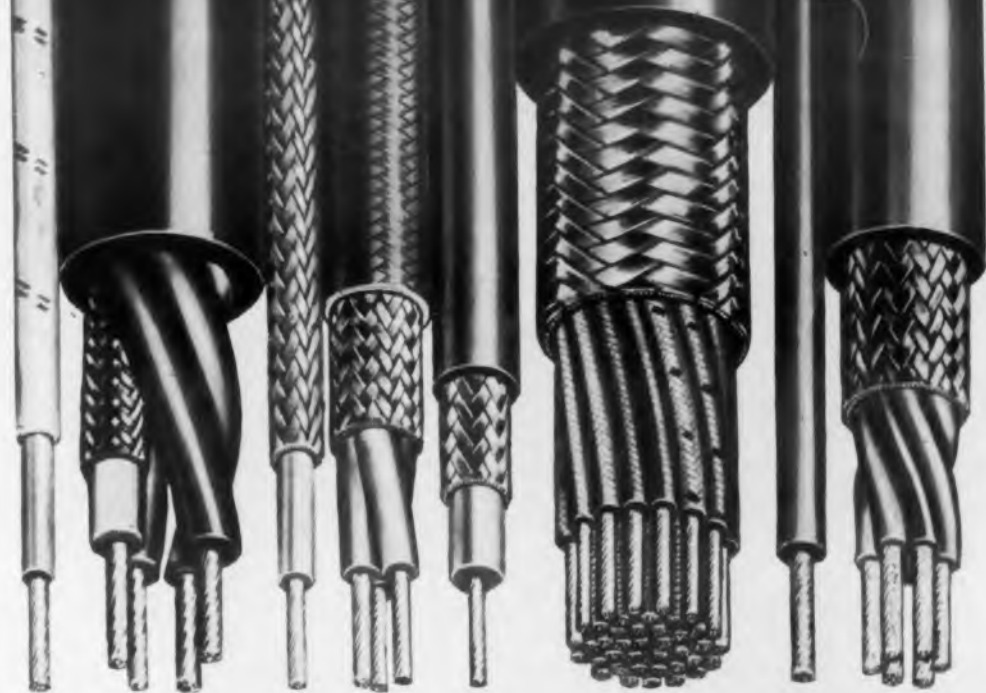
The local oscillator of the circuit is essentially the same as that of the amplifier excepting that the resistor 84 is adjusted so that the feedback sets the oscillator into oscillation. The tuning capacitor for both the amplifier and the oscillator are ganged together.

Sweep Generator Using Nonlinear Sweeps

Patent No. 2,791,688. B. Cutler and G. B. Crane. (Assigned to Gilfillian Bros., Inc.)

The sweep generator includes an amplifying discharge tube which is controlled by recurrent sawtooth waves. A source of substantially continuous voltage is applied to the anode of the tube through a series circuit including an impedance and an inductive load. A capacitor is coupled to the junction point of the load and impedance. It is charged by the potential through the impedance. The voltage developed on the anode of the tube controls means which effectively decrease the magnitude of the impedance in accordance with decreased current flow through the tube. The impedance has a finite impedance value at all times and provides a charging circuit for the condenser when and as the condenser is discharged through the tube.

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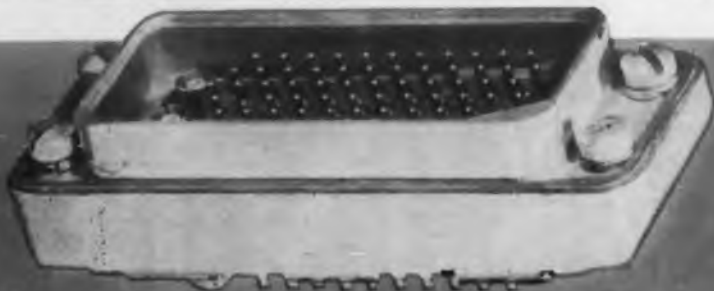
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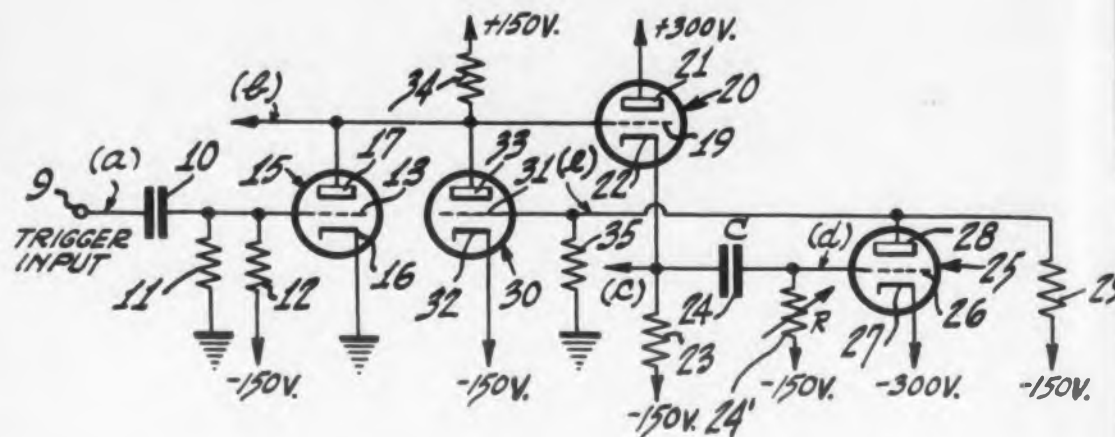
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Patents



Monostable Multivibrator Circuit

Patent No. 2,784,309. J. D. Sable. (Assigned to Radio Corp. of America)

Multivibrators in their simpler form include two vacuum tubes cross coupled so that when one tube is conducting the other is non-conducting. A monostable multivibrator is one in which one tube is normally conducting and a second tube is normally non-conducting. Upon application of an input pulse the condition of conduction is reversed for a period determined by

circuit values whereupon the initial condition is restored. When this type of multivibrator is used with a radar system it is particularly desirable that the circuit has as short a recovery time as possible in order to secure a wide range for the system.

In the multivibrator illustrated in the figure, the first multivibrator tube 21 is normally conducting and the second multivibrator tube 30 is normally non-conducting. The buffer tube 15 is normally non-conducting and upon the application

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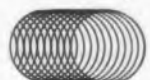
positive input trigger pulse at the terminal 9, this tube becomes conducting. The cathode follower tube 20 also is normally non-conducting. When the tube 15 becomes conducting the potential on the plate of this tube is lowered, due to the increased current through resistor 34. As a consequence, the potential of the control grid of the cathode follower tube 20 is decreased below cut-off so that this tube becomes non-conducting. With the tube 20 becoming non-conductive, a negative pulse of substantial value is generated at the cathode which is transmitted through the capacitor to the control grid of the first multivibrator tube 25 and this tube is biased to non-conduction. The plate voltage of tube 25 increases which increases the potential on the control grid of the second multivibrator tube 30 so that it is biased to non-conduction. The circuit is now in its "on" condition.

Rapid transition of the circuit from "off" to "on" condition is secured through the tight feedback connection between the cathode of tube 25 and the control grid of the second multivibrator tube 30. This direct connection is available because the normal current supply potentials to the multivibrator tubes 25 and 30, as shown in

the figure, have values which permit this direct connection.

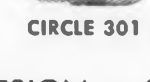
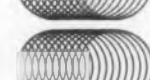
This "on" condition, that is of non-conduction of the first vibrator tube 25 and conduction through the second multivibrator tube 30 continues for a period dependent upon the time constant of the capacitor 24 and the resistor 24'. The negative charge on the capacitor 24 discharges through the resistor 24' until the potential on the control grid 26 reaches a value above cut-off whereupon the tube 25 again begins to conduct current. Conduction increases rapidly through the first multivibrator tube 25 which quickly lowers the potential on the control grid of the second multivibrator tube 30 below cut-off and it is restored to non-conducting condition. The circuit is restored thereby to its initial or "off" condition to receive a second input pulse.

The rapidity with which the transition is made from "off" to "on" condition is dependent upon the rapidity with which the capacitor 24 is charged after tube 25 begins to conduct. Since this charging occurs through the very low impedance of the cathode follower tube 20, charging time and hence recovery time is very short. The patent gives specific values which may be used for the resistors and capacitors.



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BY JACK GILBERT
Norden Laboratories Division,
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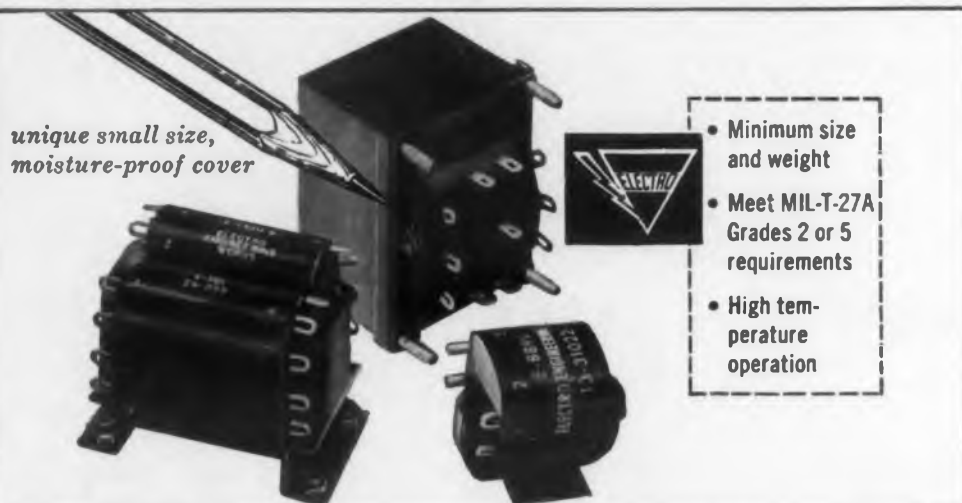


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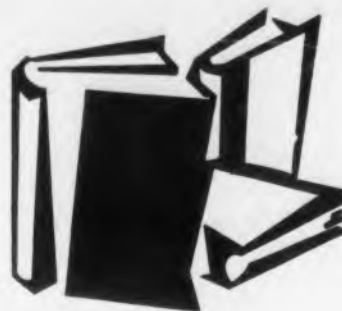


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Books

Proceedings of the 1956 National Electronics Conference

Conference, Volume XII, 1095 pages, \$5.00.

Proceedings of the 1956 National Electronics Conference are available in book form. 105 technical papers, and three luncheon addresses presented at the 12th Annual Meeting in Chicago make up the book. Papers are grouped and indexed in the table of contents to provide easy access without laborious title searching.

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Proceedings of the Sixth Weather Radar Conference

Cambridge, Massachusetts, 1957, 372 pages, \$10.00.

Microwave engineers should find the Proceedings of the Sixth Weather Conference interesting and informative. The 55 papers included in the proceedings constitute a representative cross-section of current research in the field of radar meteorology. The text of most papers is well illustrated with graphs and photos. A list of symbols and abbreviations recommended by the AMS is given at the beginning of the text.

Engineering Electronics

John D. Ryder, McGraw Hill Book Co., Inc., 330 West 42nd Street, New York 36, N.Y. 666 pages, \$9.50.

Fundamental concepts of electronics—particularly the areas of instrumentation, computation and general industrial usage—are projected to industrial applications and completed systems. Without letting his treatment become an instruction book in the operation or maintenance of a particu-

lar piece of apparatus, Dr. Ryder discusses operating principles important to computers, industrial control, and servomechanisms.

The emphasis throughout is on understanding principles and basis circuits applicable to various electronic devices and equipment. Mathematics and circuit theory are emphasized only when they are necessary for a lucid description or advantage of completely analyzing a system.

In the chapter on semi-conductors, Mr. transistors, Ryder treats the four-terminal network theory for transistor equivalent circuits. This chapter is probably the "strongest" in the book. Fundamental analog and digital computation and circuits common to both computers are treated in chapters 8 and 9. Material is included on the frequency response of amplifiers both a sinusoidal and a pulse standpoint.

The portion of electronics which is exclusively "radio" is not discussed in text.

Advanced Calculus

R. Creighton Buck, McGraw-Hill Company Inc., 330 West 42nd Street, York, N. Y., 423 pages, \$8.50.

R. Creighton Buck believes in applied mathematicians—not applied mathematics. With this conviction, he has directed treatment toward a development of the fundamentals of analysis, simultaneously one variable and multi-variable functions. Both are regarded as functions of a point. Because of the tendency in American colleges to present Elementary Calculus from a purely theoretical point of view, certain topics are often slighted. The subject is neglected because of this type of treatment is theory of function of several variables.

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Transmission Circuits

Williams and J. B. Woodford, Mac-
 variab Co., 60 Fifth Ave., New York 11,
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Transmission line parameters and the
 theory of generalized transmission circuits
 are discussed in chapters 1 and 2. The sig-
 nificance of "times" peculiar to transmission
 circuits is presented in a lucid manner. The
 remaining four chapters of the book are so
 organized that a portion or chapter can be
 omitted without impairing the flow of
 thought. Subject matter is straightforward
 and rich in basic fundamentals. The engi-
 neer wishing to acquire a background in
 transmission circuits can use this text as a
 stepping-stone to more detailed treatments.

Relatively little on "technique" is in-
 cluded by the authors when they give
 practical applications of the theory. The
 omission of semi-empirical "aids" will un-
 doubtedly be praised by some as a thought
 provoking stimulus for the student. Others
 will view it as a foolish denial of practical
 information used by all engineers. A special
 appendix is included with the text on "Sol-
 ution of Transmission Circuit Problems by
 means of Electro-magnetic Theory".

The Electrical Production of Music

Alan Douglas, Philosophical Library, Inc.,
 15 East 40th Street, New York 16, N.Y., 223
 pages, \$12.00.

Advantages and limitations of the elec-
 trical production of music are treated in
 simple and interesting terms by Mr. Doug-
 las. Only an elementary knowledge of
 music and electronics is assumed. The
 book travels the practical middle road be-
 tween academic treatises on vibrating sys-
 tems, and personal opinions which tend to
 be too traditional.

The experimenter or potential designer
 of electrical musical instruments is often at
 a loss to decide whether the strong pecu-
 liarities of the traditional instruments are
 really material to tonal effect or whether
 they are due to some limitation of design.
 At times these peculiarities are the result of
 a conflict between theoretical capabilities
 of the instrument and the effect attempted.
 By treating music as frequencies or bands
 of frequencies, which can be adjusted for
 pitch, reinforcement by harmonics, attack,
 vibrato, reverberation and phase relation-
 ship to form a tone-colour, the author pre-
 sents his reader with a clear cut definition
 of tone-colour.

Treatment of the subject matter is simple
 without becoming trite. Adequate refer-
 ences are given for those who feel they
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 material.

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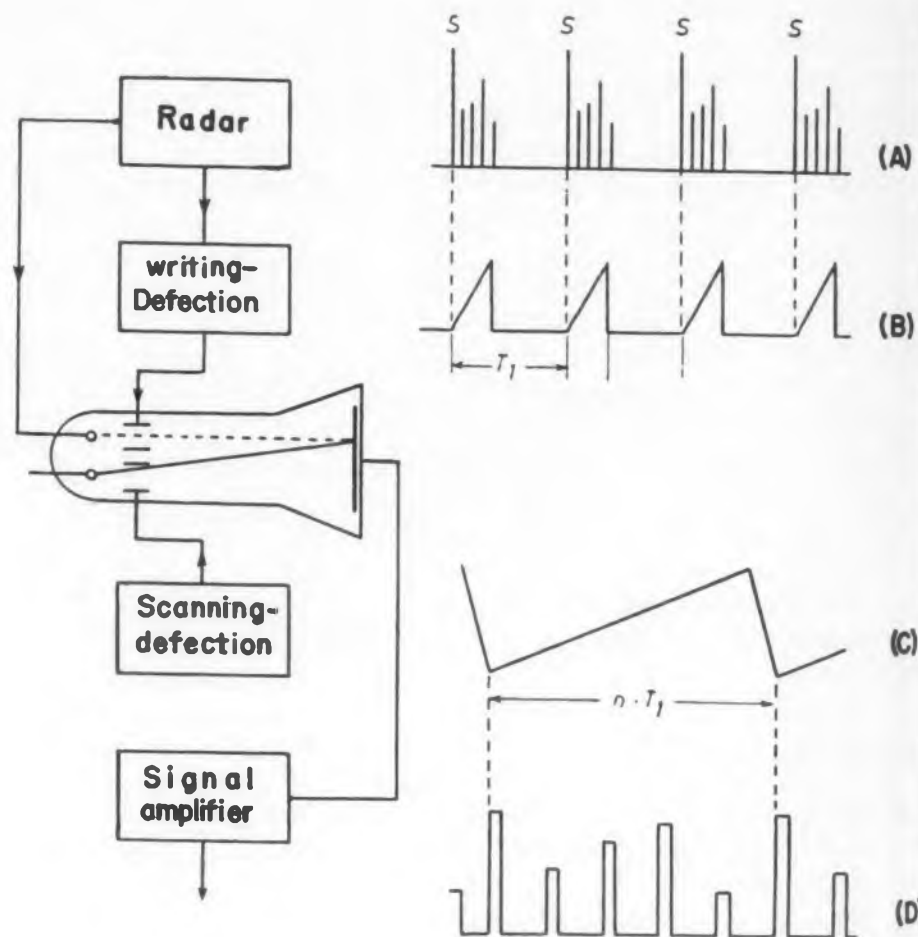
CIRCLE 307 ON READER-SERVICE CARD FOR MORE INFORMATION

German Abstract

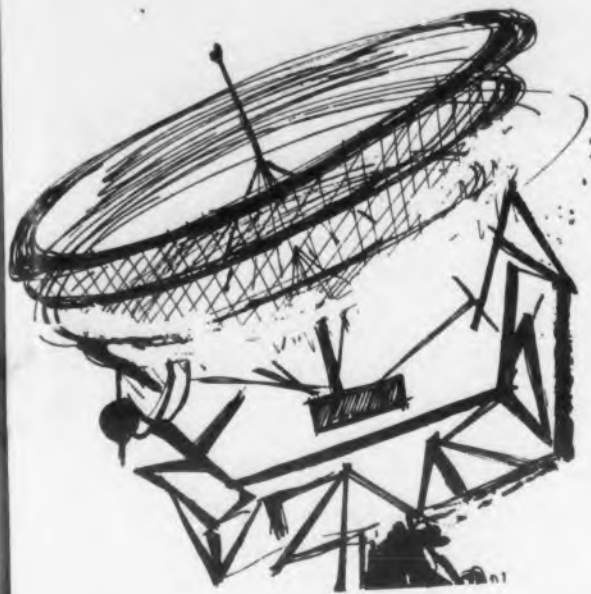
Frequency Compression of Radar Image

E. Brenner

FOR the transmission or recording of radar pictures on magnetic tape frequency compression is almost always desirable because the bandwidth (which lies between 5 and 20 mc) can be compressed by a factor of 20 to 500 without loss of information. This reduction is possible because of the low information content of radar pictures.



Block diagram and examples of waveforms for frequency compression by means of a storage tube. The four signal pulses (S) are shown together with their echos (A). The original signal is shown in line (B), the deflection voltage of reading beam in (C), and line (D) the scanned signal.



frequency compression method was used successfully of harbor-traffic radars.

The basis of the frequency compression results from the following considerations: If the highest frequency component of 20 mc corresponds to the shortest echo-pulse duration of about 0.05 μ sec, then the number of distinguishable echos is 400 (or smaller if the range is less than 3 km). The azimuth resolution may be taken as 0.5 degrees so that the typical radar picture consists of about 720x400 or 288,000 distinct points. At an antenna speed of 20 rpm the entire picture content must be transmitted every three seconds so that a maximum bandwidth of 288,000/3 = 96 kc is required.

For frequency compression a storage tube which has a dual beam system is used. The "writing" beam, whose deflection is synchronously controlled by the original radar pulse, has its intensity controlled by the amplitude of the echo and charges an insulating layer, controlled by the video signal of the radar apparatus, along a line. The "reading beam," which has constant intensity scans the same line and provides for the discharge of the charging produced by the "writing" beam. These changes in charge produce the output signal of the storage tube on the metal plate which is located behind the insulating layer. Since the deflection of the "reading" beam is slower than that of the writing beam, the output signal has wider pulses and consequently requires smaller bandwidth for transmission. If n is the number of echos which are reflected from a target then the scanning frequency of the "reading beam," f_2 is related to the repetition frequency of the original radar pulses f_1 by the ratio $f_1/f_2 = n$.

A simplified block diagram of the system is shown in the figure. As an example four signal pulses (S) are shown together with their echos (a). The writing beam is shown in line (b); the deflection voltage of the "reading" beam is shown in line (c). The factor 3 is used in the example. Line (d) shows the compressed signal. (Abstracted from an article by H. Will, K. Dinter, and K. Lange, *Elektronische Rundschau*, Vol. 12, No. 5 May 1957, pp. 155-157.)



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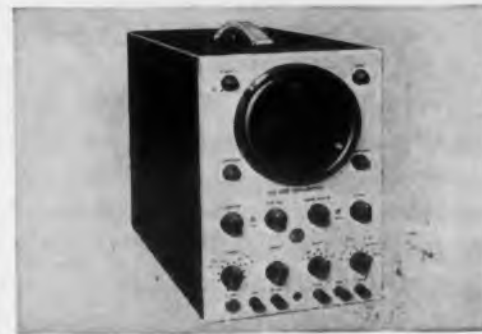
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Improved Transistor Biasing

AN AMENDED transistor bias arrangement offers advantages over the conventional circuit in normal as well as critical applications. During the design of a transistorized servo-amplifier intended for airborne applications, it was found that the stabilization of the output stage needed careful attention. The resistance of the input transformer secondary winding, usually considered negligible, had an adverse effect on the bias stabilization. The influence of this resistance, and a means for overcoming it,

are indicated here.

In Fig. 1 the usual arrangement of a Class B output stage is shown. The transformer secondary resistance is denoted by $4R_t$. This resistance acts in series with the base of the transistor, and degrades the stability factor. In practical designs, it is difficult to achieve a stability factor

$$S = \frac{\partial I_c}{\partial I_{co}}$$

of less than about three without enlarging the in-

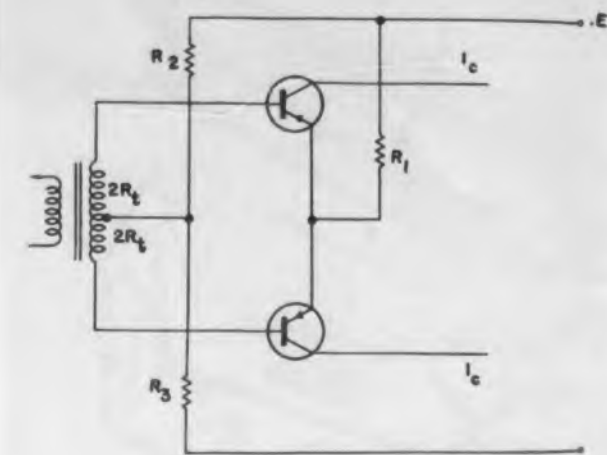


Fig. 1. Schematic diagram, normal Class B output stage.

put transformer to obtain a lower resistance, or increasing R_1 . Both these steps are undesirable, as the first wastes space while the second causes a loss of gain and maximum power output. In any case, the power dissipated in the bias network, denoted by P_b , is unnecessarily large.

The circuit of Fig. 2 overcomes these difficulties by using the transformer resistance as an active part of the bias network in place of R_2 . The design equations used for the two circuits are given in the table.

Comparative Design Formulas for Two Methods of Transistor Biasing

Parameter	Circuit of Fig. 1	Circuit of Fig. 2
$S = \frac{\partial I_c}{\partial I_{co}}$	$\frac{1 + \frac{R_1}{R_t + R_2 R_3 / (R_2 + R_3)}}{(1 - \alpha) + \frac{R_1}{R_t + R_2 R_3 / (R_2 + R_3)}}$	$\frac{1 + \frac{R_1}{R_3} + \frac{R_1}{R_t}}{(1 - \alpha) + \frac{R_1}{R_3} + \frac{R_1}{R_t}}$
R_3	$\frac{E \left\{ (S - 1) - \frac{R_t}{R_1} [1 - S(1 - \alpha)] \right\}}{2(I_c - S I_{co})}$	$\frac{E(S - 1)}{2(I_c - S I_{co})}$
R_2	$\frac{R_3 \{ (S - 1) R_1 - R_t [1 - S(1 - \alpha)] \}}{(R_3 + R_t) [1 - S(1 - \alpha)] - (S - 1) R_1}$	—
R_1	Determined from allowable gain and voltage loss.	$\frac{R_3 R_t}{R_3 + R_t} \cdot \frac{1 - S(1 - \alpha)}{S - 1}$
R_t	—	$\frac{R_1 R_3 (S - 1)}{\alpha S R_3 - (S - 1)(R_1 + R_3)}$
P_b	$\frac{E^2}{R_3}$	$\frac{E^2}{R_3}$

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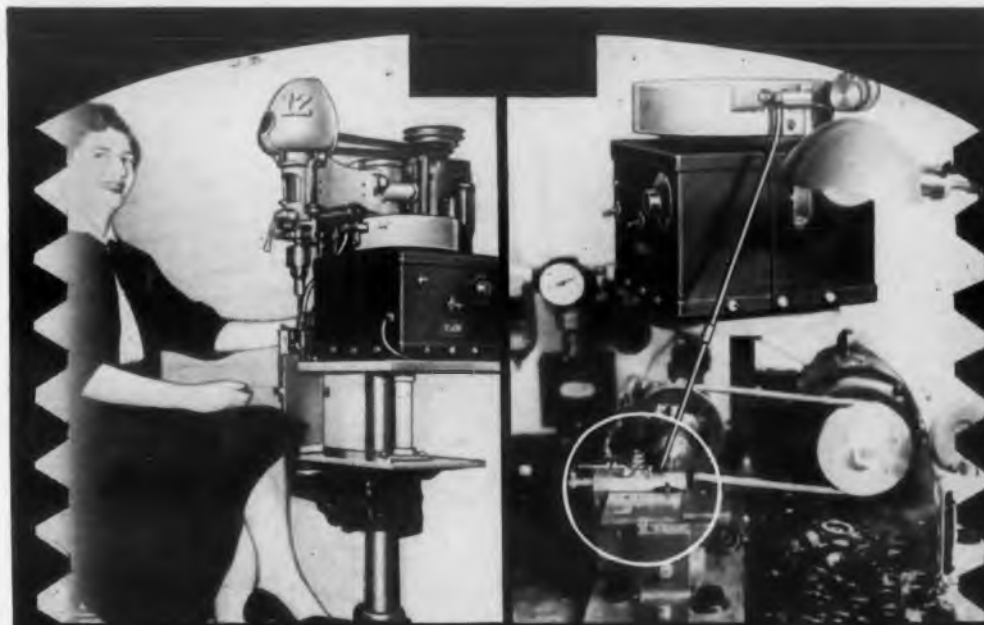
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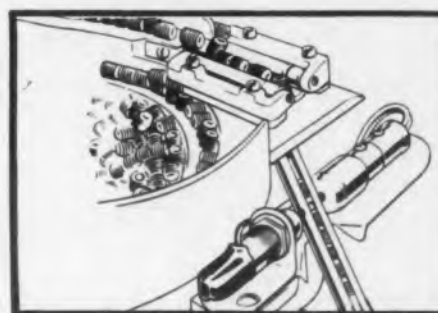
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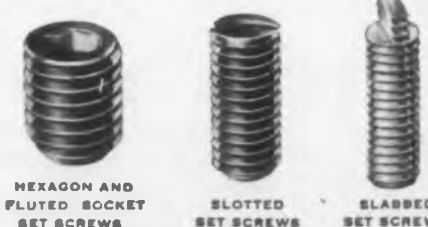
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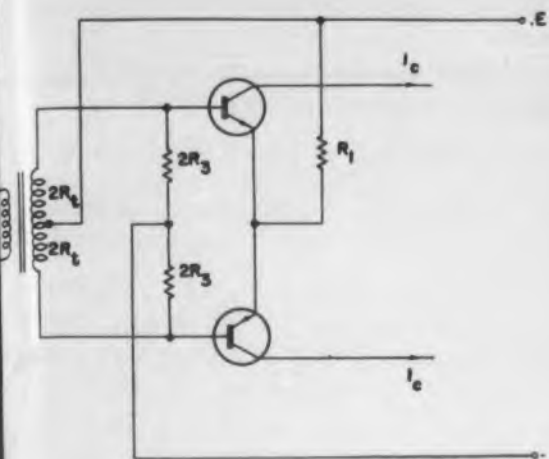


Fig. 2. Schematic diagram, improved output stage circuit.

The following example will illustrate the superiority of the amended circuit.

Data: α = current gain of transistor, common case = 0.92

I_c = required collector current per transistor = 10 ma

I_{co} = collector cut-off current of transistors ≈ 0

E = supply voltage = 28 v

S = bias stability factor = $\frac{\partial I_c}{\partial I_{co}} = 3$

Typical value for the transformer resistance $R_1 = 48$ ohms.

In the case of Fig. 1, an acceptable value for R_1 is 10 ohms. We then have:

$$R_3 = 1530 \text{ ohms}$$

$$R_2 = 14.3 \text{ ohms}$$

$$P_b = 0.52 \text{ w}$$

In the case of Fig. 2 the same transformer is used, and

$$R_3 = 2800 \text{ ohms}$$

$$R_1 = 4.6 \text{ ohms}$$

$$P_b = 0.14 \text{ w}$$

The new arrangement gives the same stability with only 25 per cent of the power loss. It also yields more gain and maximum power output owing to the lower value of R_1 .

With the data given in this example, it is possible to reduce the S factor to two if the power and the value of R_1 remain at the original values. A value of S as low as this cannot be achieved at all with the original circuit.

Note that the dc in the transformer secondary remains balanced and will not alter the transformer design except for the small heating effect.

This article originally appeared in Electronics Engineering of Canada, Vol 1, No. 1, May 1957. Author is Maurice Price, P.Eng., of Computer Devices of Canada Ltd.

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J. George Adashko

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika, No. 1, 1957)

DISTRIBUTED AMPLIFIER ANALYSIS

Distributed Amplifier as a System of Multi-Terminal Networks, Yu. N. Prozorovski, (8 pp, 7 figs).

In conventional analysis the distributed amplifier is represented as two equivalent long lines formed by the input and output capacitances of the tube and by the inductances of the added coils. (See, for example, Ginzton, Hewlett, Jasberg, and Noe, Distributed Amplification, Proc. IRE, 1948, vol 36, p 956). This approach is satisfactory only at relatively low frequencies, breaks down near the critical frequencies of the elements comprising the lines, and makes no provision for unequal individual sections, complex loads, and other factors. The author proposes a method where the amplifier is considered as a system of a finite number of multi-terminal networks (Fig. 1) and derives matrices for the individual sections of the amplifier and for the amplifier as a whole. Any irregularities in the distributed parameters of the amplifier can be accounted for in the pertinent matrix element.

The matrix element for sections I (and V) is:

$$A_I = A_V = \begin{bmatrix} 1 & 0 & R_{oa} F_a & 0 \\ 0 & 1 & 0 & R_{oc} F_c \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & R \\ 0 & 1 \end{bmatrix}$$

where R_{oa} and R_{oc} are the ohmic resistances of the coils and F_a and F_c are coefficients characterizing the dependence of the losses on the frequency. Similar matrices can be written for the other elements, and the matrix of the entire amplifier is merely the product of the individual matrices.

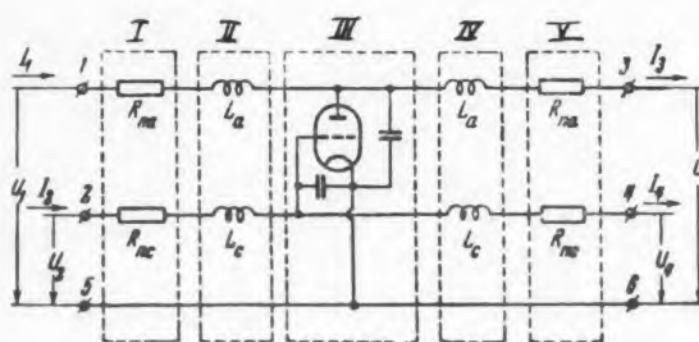


Fig. 1. Section of a distributed amplifier, broken up into several multi-terminal networks. (R_{na} = resistive loss in plate circuit, R_{nc} = resistive loss in grid circuit.)

PULSE BANDWIDTH

Bandwidth Occupied by Transmitted Pulses, M. S. Gurevich (6 pp, 4 figs).

An "ideal" pulse shape was derived by the author in a previous article ("Signals of Finite Duration,

Containing the Maximum Energy Fraction in a Specified Frequency Band," Radiotekhnika i Elektronika, March 1956, ED December 15, 1956). In this article he determines the frequency bandwidth occupied by several standard pulse shapes, arriving at the interesting results given in the following table:

Pulse Shape	Bandwidth (bauds)
"Ideal"	2.5
Rectangular	20.6
Trapezoidal ratio of parallel sides 0.8	6.5
ratio 0.5	3.9
Triangular	2.6
Cosine	2.6
Cosine-squared	2.8

WAVEGUIDE DESIGN

Variational Method for Design of Waveguides with Periodic Irregularities, I., Sh. E. Tsimring, (112 pp, 2 figs).

The Ritz method is used for the analysis of the propagation of electromagnetic waves in a periodically-corrugated waveguide. A decelerating system with rectangular corrugations is used as an example.

UHF TROPOSPHERIC PROPAGATION

Effect of the Form of the Structural Function of Irregularities in the Dielectric Constant of Air on Long-Distance Tropospheric Propagation at UHF, V. N. Troitski, (4 pp, 1 fig).

Continuing his work on this subject (earlier articles appeared in the May and September 1956 issues of Radiotekhnika, ED December 1, 1956 and June 15, 1957), the author derives equations for the median value of field intensity and for the possible bandwidth of waves propagated in air subject to specified variation of the dielectric constant.

MAGNETIC FIELD MEASUREMENT

Instrument for Relative Measurements of Alternating Magnetic Fields, I. S. Shpigel', M. D. Rayzer, E. A. Miae, (9 pp, 7 figs).

Most instruments designed for the purpose (ballistic, electronic integrators, etc.) do not take into account the residual magnetization. This instrument, developed to measure the field of the injection electromagnetization of the 10 Bev synchrotron of the USSR Academy of Science employs nuclear magnetic resonance and is free of this shortcoming.

PULSE SYSTEM STABILITY

Stability of Linear Pulse Systems with Variable Parameters, G. P. Tartakovski, (8 pp, 4 figs).

The author continues his investigations of the characteristics of linear pulse systems with variable parameters (an article on the theory of such systems was published in the November 1956 issue of *Elektrosviaz'*, ED July 15, 1957, and a discussion of their time and frequency characteristics appeared in the December 1956 issue of *Radiotekhnika i Elektronika*, ED August 1, 1957). The stability analysis is based on the derivation of an equation for the transfer function of the system, and the illustrative example used is a frequency-pulse modulated system with pulse feedback.

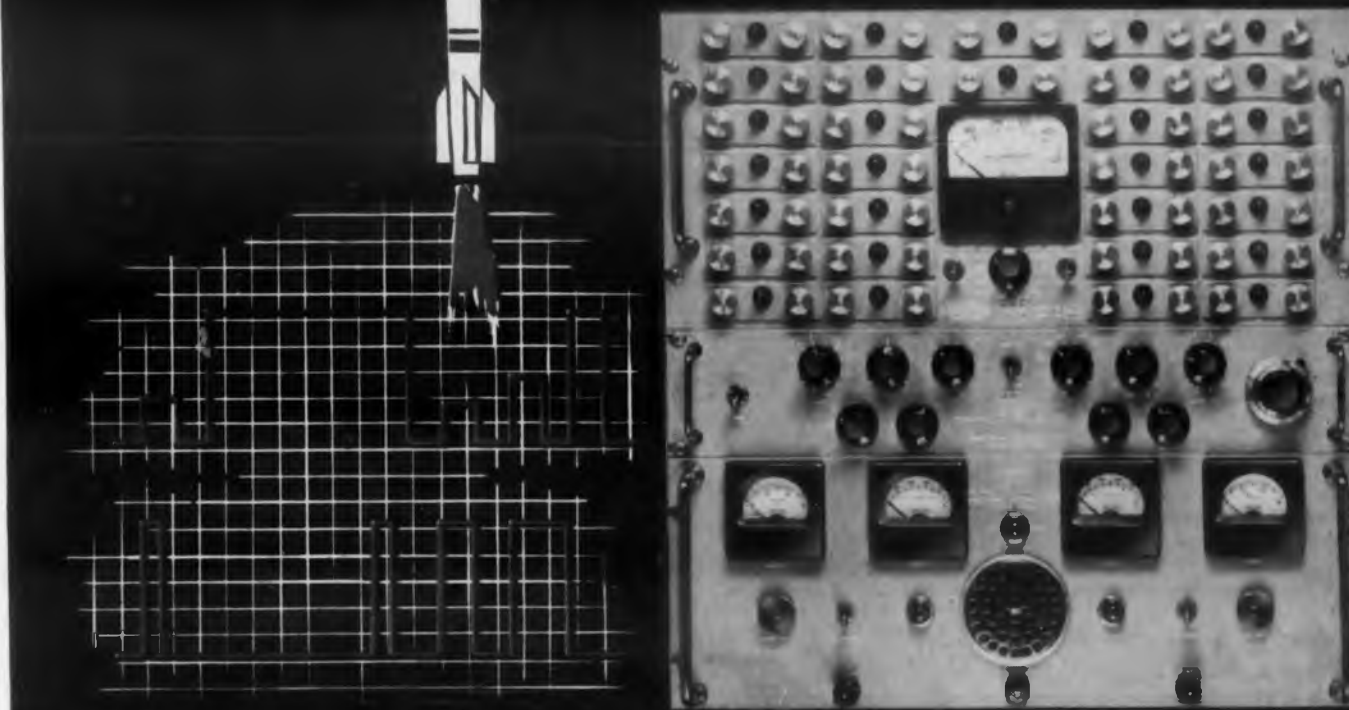
WIDE EAM AMPLIFICATION

High Frequency Oscillations in Electron Beams with Periodically-Varying Velocities, P. V. Bliokh, (12 pp).

There has been considerable recent interest in the possibility of amplifying radio waves by periodic variation of the parameters of an electron beam, so as to dispense with the decelerating system employed in travelling-wave tubes (see, for example articles by Birdsall in *Proc. IRE*, 1954, vol 42, p 628 and Peter-Bloom-Ruetz, *RCA Review*, 1954, vol 15, p. 113). In principle, unlike the situation in a traveling wave tube, it is possible here to effect

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amplification even in an infinitely wide beam, with only the thermal motion of the electrons imposing an upper limit on the frequency.

The author uses kinetic theory to derive a dispersion equation (in the small signal approximation) with which the stability conditions in the beam are established.

DIRECTIONAL COUPLER

H_{01} Wave Directional Coupler for Round Waveguide, M. V. Persikov, (10 pp, 9 figs).

Description of an azimuthal system of rectangular waveguides, coupled to a round waveguide by a longitudinal system of apertures (Figs. 1 and 2). Several modes propagate in the round waveguide, but the rectangular guide is single-mode. A model of this coupler was used to indicate the presence of the H_{01} mode, to measure low reflection coefficients (on the order of 30 to 40 db) in the round waveguide, and to measure the power flowing past a given section of the guide. It also measured the attenuation of the H_{01} wave in the individual waveguide elements and the losses involved in the transformation of the H_{01} wave into other modes. A theoretical analysis of the coupler is given.

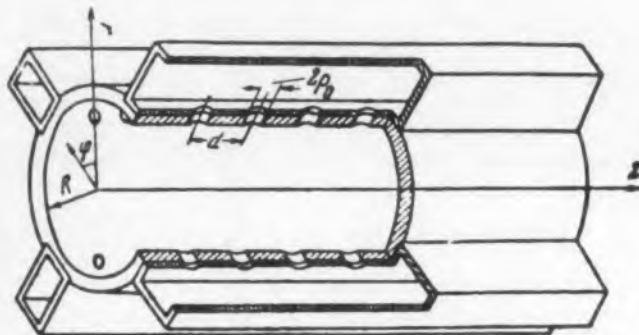


Fig. 1. Cutaway isometric view of the rectangular waveguide coupled to the round waveguide. (Note the longitudinal system of apertures.)

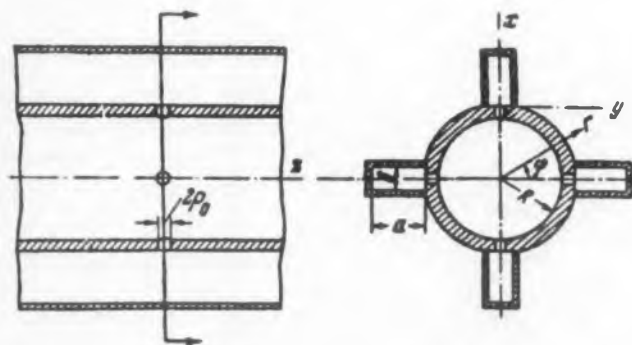


Fig. 2. Cross sections of the waveguide.

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ELECTRONIC DESIGN • September 1, 1955

SYNCHRONIZATION

Mutual Synchronization of Self-Excited Generators at Multiple Frequencies, G. M. Utkin, (13 pp, 6 figs).

It is customary in the literature to treat this topic in a highly simplified manner, and to neglect the reaction of the "synchronized" oscillator on the "master" oscillator. Actually, however, this reaction is quite substantial over a certain band (synchronism zone), the width of which is determined in this article as applied to both frequency multiplication and frequency division.

SELF EXCITED OSCILLATIONS

On the Transformation of Fluctuations of the Amplitude and Phase of Self Excited Oscillations in Resonant Systems. G. S. Gorelik, G. A. Elkin, (6 pp, 2 figs).

A signal with random phase and amplitude fluctuations is traced theoretically through a circuit comprising a linear (resonant) and non-linear (detector) element. Equations are derived for the statistical nature of the phase and amplitude of the output of such a system, given the statistical characteristics of the input amplitude and phase variations. Refers to work by R. Mueller, G. Dalman & A. Rhoads, W. Gottschalk, D. Middleton (all in Trans. IRE, Electron Devices, vol 1, 1954), and several other American investigators.

ENERGY INTERACTION

Analysis of Interchange of Energy between an Electron Stream and an Electromagnetic Wave. V. N. Shevchik, (7 pp, 4 figs).

Certain problems in the interaction between an electron stream and a traveling electromagnetic wave are analyzed in this kinematic approximation. The grouping of electrons in the traveling wave, identical with the grouping process in a klystron, is analyzed and other factors such as maximum current, efficiency and synchronization are discussed. The calculations are extended to include traveling-wave tubes and the optimum operating modes of backward wave oscillators at low amplitudes.

Other Articles In This Issue-

"Emission of Electrons from Complex Surfaces," p V. Timofeev (7 pp, 2 figs). "Concerning the Mechanism of Electron Emission from Thin Dielectric Layers under the Influence of a Strong Electric Field Malter (Malter effect)," M. I. Elinson, D. V. Zernov, (10 pp, 4 figs). "Influence of Differentiation and Integration of Fluctuations on the Average Number of Swings," V. I. Tikhonov, (5 pp, 1 fig.) (Statistical discussion.)



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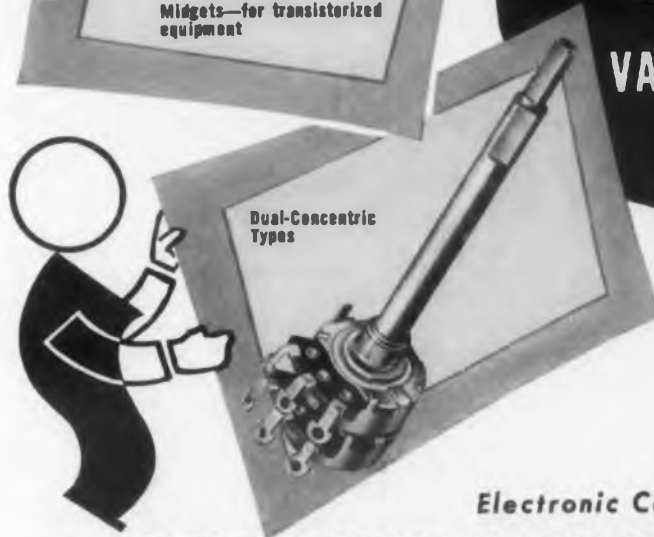
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Standards and Specs

Sherman H. Hubelbank

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NBS CIRCULAR 581, METROLOGY OF GAGE BLOCKS, APRIL 1, 1957

By far the most widely used precise standards of length in the mechanical industry are precision gage blocks which by nature of their accuracy, range of sizes, and relatively low cost have been made available to even the smallest industry. This circular presents the 15 papers presented at the Symposium on Gage Blocks, held at the National Bureau of Standards in August 1955. This 119-page publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for \$1.50 per copy.

Tubes

RETMA RS-190, NEMA 502-D, PIN STRAIGHTENERS AND WIRING JIGS FOR ELECTRON TUBES, JUNE 1957

This standard covers miniature button 7 pin and 9 pin straighteners, T-3 subminiature pin straighteners, locking-in pin straighteners, and wiring jigs for miniature tubes. Copies of this standard are available from the Radio-Electronic-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for 50 cents per copy.



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RETMA RS-187, VIBRATORS FOR AUTO RADIOS, JUNE 1957

Standards are established for vibrators having a nominal input voltage of 6.3 volts dc at 115 cycles and 12.6 volts dc at 115 cycles. Included are the mechanical and electrical standards, incoming inspection tests, interrupter vibrator test circuit, and method of vibrator transformer buffer capacitance determination. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for \$1.65 per copy. This standard is a revision of REC-113-D.

Sockets

RETMA RS-185, DIMENSIONAL AND ELECTRICAL CHARACTERISTICS DEFINING MINIATURE RECEIVER-TYPE TUBE SOCKETS FOR PRINTED CIRCUITS, JUNE 1957

This 42-page standard includes data sheets for twenty 7-pin miniature (molded phenolic) and twenty 9-pin miniature (molded phenolic) receiver-type tube sockets for printed circuits. A typical type number for a socket meeting this standard is TSE7R102. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for \$2.80 per copy.

Automation Dimensions

RETMA RS-188, STANDARD DIMENSIONAL SYSTEM FOR AUTOMATION REQUIREMENTS, JUNE 1957

A series of dimensional systems and nomenclature to serve as a guide in the coordination of equipment design, component design, and the design of machinery for automatic manufacture are established by this standard. In the design of electronic equipment which may be built on automatic machines, it shall be standard to make all dimensions, which must be controlled for automation purposes, to be multiples of 0.025 inch. This modular dimension shall apply to all three axes of Cartesian coordinates. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y., for 25 cents per copy.

Capacitors

MIL-C-3871, CAPACITORS, FIXED, ELECTROLYTIC (A.C., DRY-ELECTROLYTIC, NONPOLARIZED), AMENDMENT 3, 6 JUNE 1957

The list of referenced specs and publications, the requirements for packing, packaging, and marking for shipment have been revised. The time limit for shelf life has been changed to 18 months.

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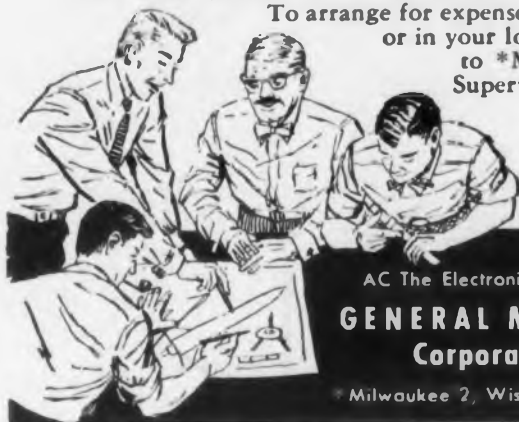
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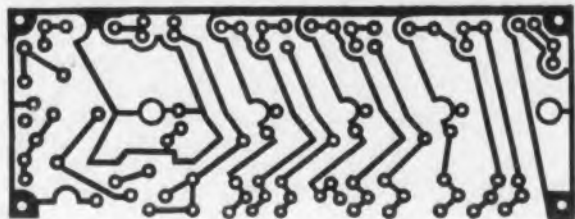
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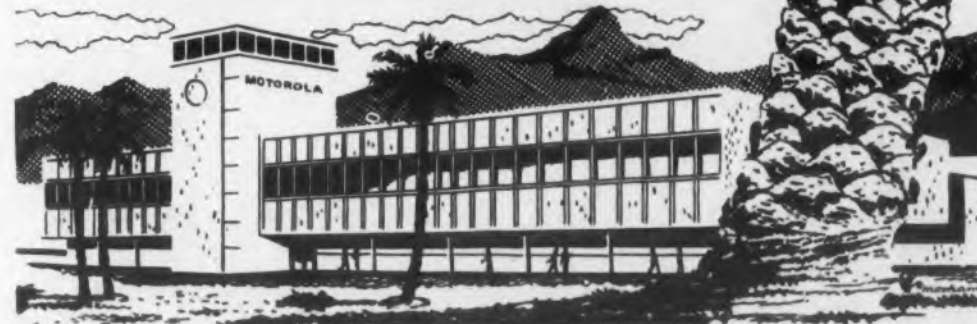
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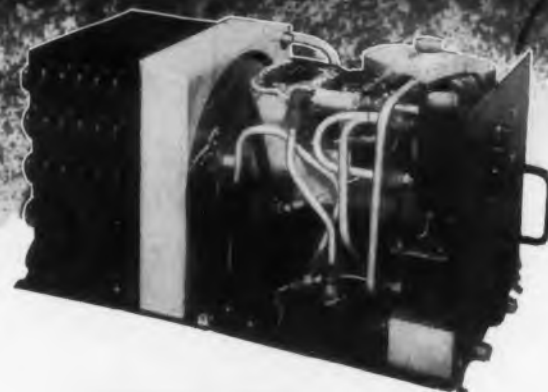
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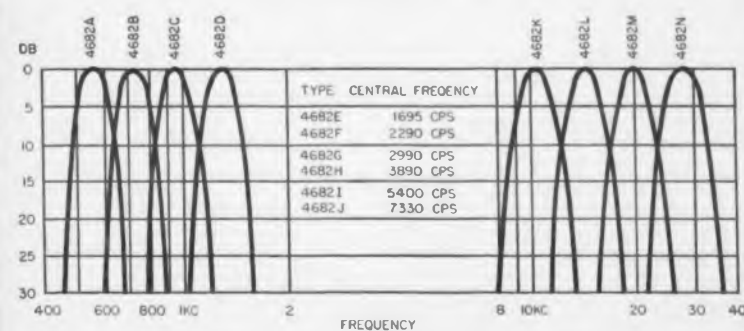
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FILTERS

FOR EVERY APPLICATION



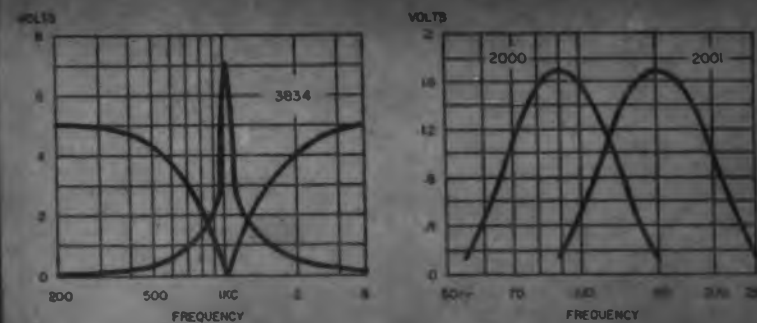
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Dimensions:
(4682A) 1½ x 2 x 4"



Dimensions:
(3834) 1¼ x 1¼ x 2-3/16"
(2000, 1) 1¼ x 1¼ x 1½"



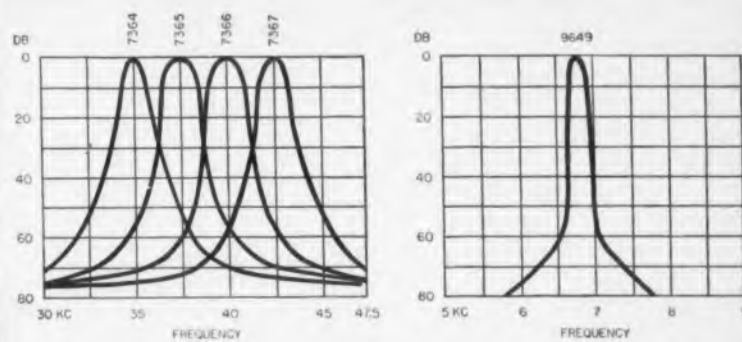
AIRCRAFT FILTERS

UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

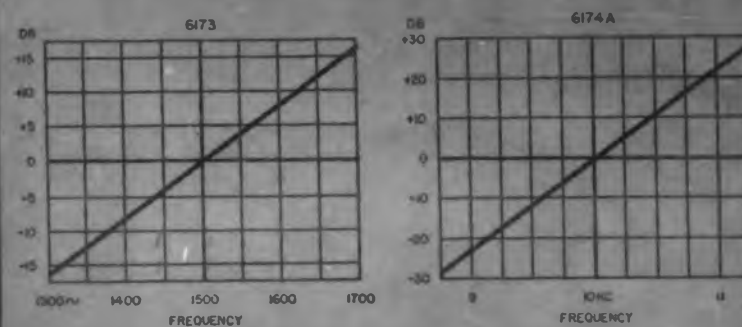
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For data sheets on any of these new types, or for information on other well-known RCA "audio" tubes, such as the 12AX7 and 6L6-GB, write to RCA Commercial Engineering, Section I-18-Q-1, Harrison, N. J.

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