

ELECTRA DE



The Microscopic World of a Larva of Can. . . p. 21

CONGRESS SIGN

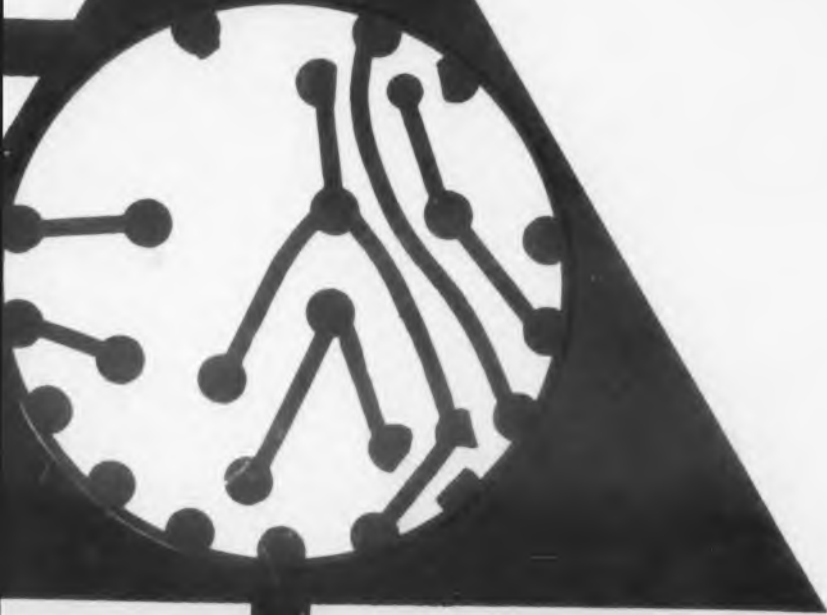
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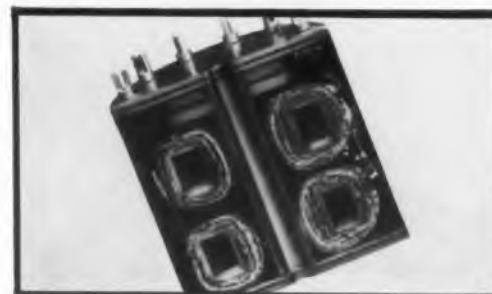
Laminating . . . Epon resin, laid up with inert fibrous fillers, produces laminates with superior dielectric properties and moisture resistance. Epon resin laminates can be dip soldered, sheared, punched and drilled, and provide excellent dimensional stability.

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Can Epon resins solve a production problem for you? For assistance and technical literature, write us now.



These miniature electronic components potted in Epon resin will withstand solder bath temperatures and retain excellent dimensional stability.



Sections of magnetic amplifier coils, when embedded in Epon resin, have exceptional resistance to solvents and chemicals

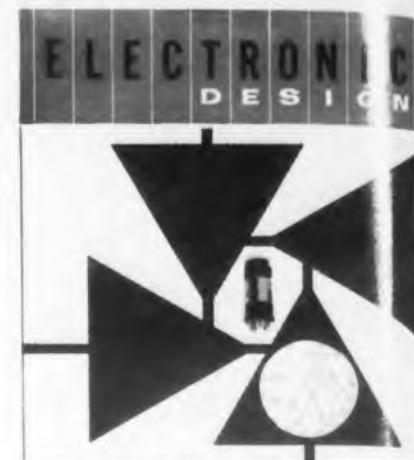
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CIRCLE 1 ON READER-SERVICE CARD



HIGHLIGHTS OF THE ISSUE



Two Watt Amplifier in a Size 8 Can (Cover) p 32

In diameter, no larger than a size 8 servo motor, this new servo amplifier packs a lot of power for its size. To achieve an 85 per cent space factor, it uses a very novel packaging technique.

Graphical Method Simplifies Wien Bridge Oscillator Design p 20

Here is a reliable, effective, design procedure for Wien Bridge oscillators. It gives better and faster results than the more common trial-and-error approach.

Overlap Method Makes Fast Pulses In Transistor Circuits p 44

By taking a pulse as the overlap between a positive and negative step, displaced by the desired pulse width, Mr. Mark Smith has achieved unusually fast, flat-topped pulses in transistor circuits. His peculiar use of logical diagrams suggests many ways to obtain the overlap.

Optimum Design of Power Transformers and Saturable Reactors, Part 2 p 48

Here's the concluding part of Mr. Nisbet's article on how to design the most efficient transformer. In this part, he presents some nomograms that solve some very messy equations.

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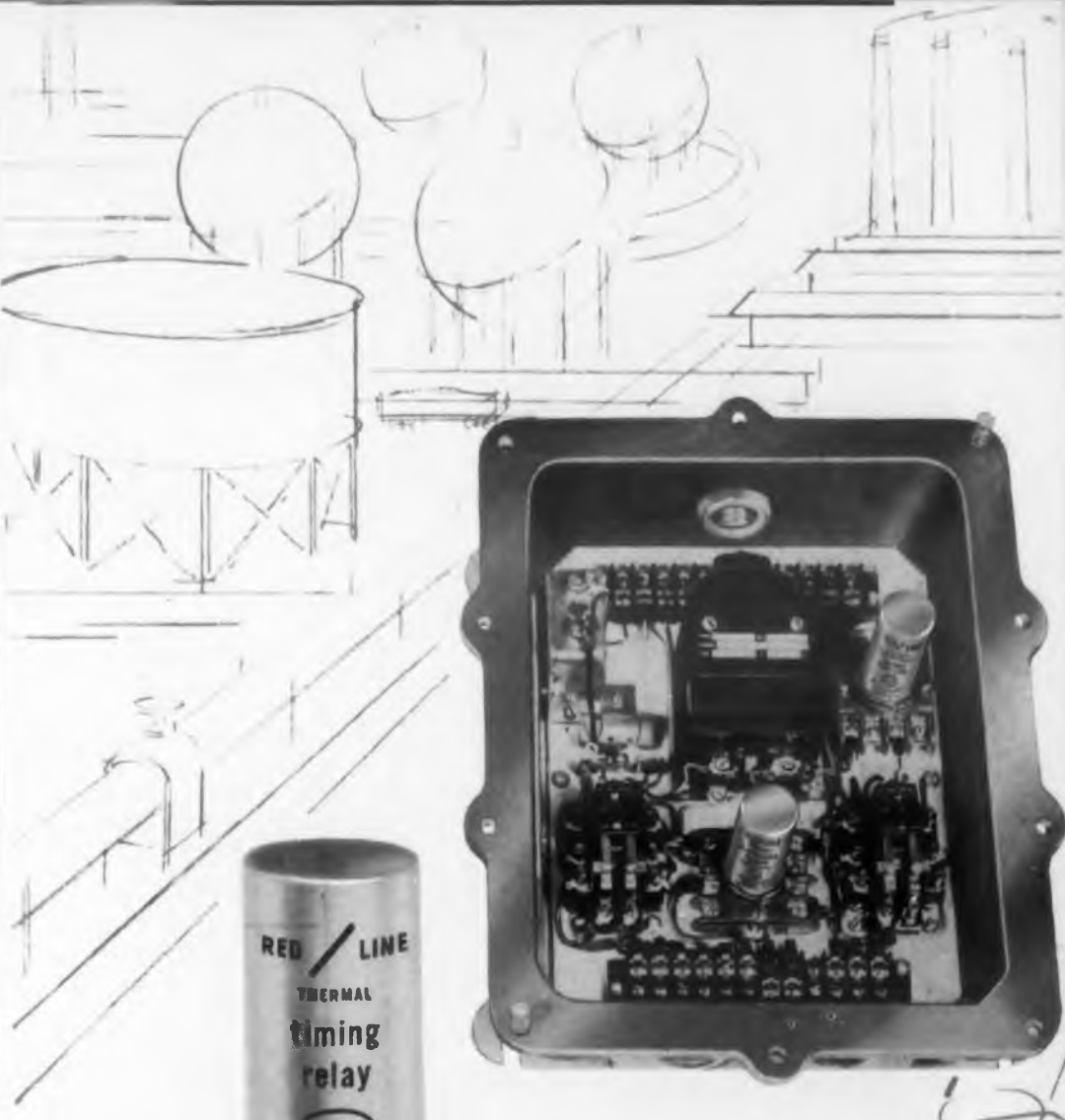
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Robertshaw-Fulton

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harmful vibration...

Abnormal and persistent vibration in rotating equipment usually means costly trouble. Robertshaw-Fulton's Vibraswitch Detectors and Model 651 control units detect vibration and shut down valuable equipment before damaging trouble develops.

Two G-V Red Line Thermal Time Delay Relays are used in each control unit. One blocks out the vibration detector while the protected equipment is starting up. The second times the duration of vibration and permits shut-down only if trouble persists.

Absolute reliability of every component is vital in a protective system of this sort. G-V Red Line Delay Relays meet this requirement for reliability ... at surprisingly low cost. Apply them in your equipment and be safe.

Write for Publication 131.

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2N658	-24	5	50	40	2.5	60	12
2N659	-20	10	70	55	2.5	65	12
2N660	-16	15	90	65	2.5	70	12
2N661	-12	20	120	75	2.5	75	12
2N662	-16	8	25 min.	50	2.5	65	12

Typical values at 25°C unless otherwise indicated

Dissipation Coefficients: In air $0.35^{\circ}\text{C}/\text{mW}$; Infinite Sink $0.18^{\circ}\text{C}/\text{mW}$

These new PNP Germanium Computer Transistors made by Raytheon's reliable *fusion-alloy* process add to the already comprehensive line of Raytheon Reliable Computer Transistors which include several in the *Submin* (0.160" high, 0.130" dia.) package. Write for Data Sheets.

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CIRCLE 3 ON READER-SERVICE CARD

ENGINEERING REVIEW

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

Open-Shut Case

Radome on Lockheed's prop-jet Electra swings open on top-mounted hinges for easy maintenance of C-band weather radar unit. Radome consists of a 1/2 in. honeycomb core covered with laminated plastic. Support braces on each side, at the mid-section, hold unit away from joint. It is fastened in place by four quick-disconnect latches.

Approximately 4 ft deep, the 76-in. diam radome is covered with a high-grade rubber foot to prevent rain erosion. Thoroughly checked in static tests, it withstood maximum aerodynamic strains anticipated in actual flight, Lockheed engineers said.

The radome was manufactured by H. I. Thompson Fiber Glass Co., to design specifications by Lockheed Aircraft Corp., 745 Chrysler Building, New York 17, N.Y.





Developmental high-temperature gallium arsenide microwave diodes are examined by Dr. D. A. Jenny of RCA who developed new semiconductor device.

Diode, Rectifier Point To Smaller Missile Controls

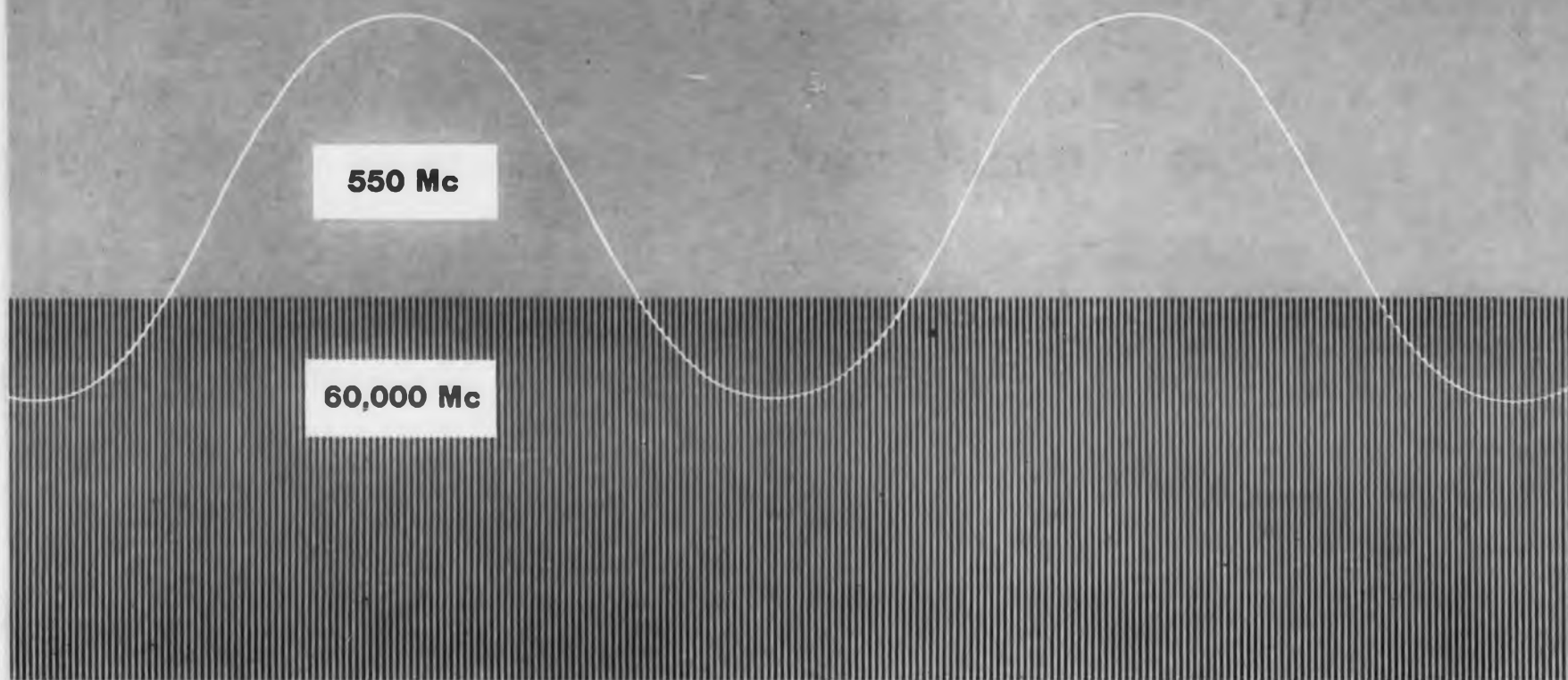
Two new RCA-developed high-temperature semi-conductor devices use gallium arsenide. They may pave the way to smaller, more compact radar equipment, electronic computers, and control systems for aircraft and missiles.

High temperature characteristics of gallium arsenide have made possible the construction of a number of microwave diodes and power rectifiers. These devices are capable of operating efficiently at temperatures substantially higher than those at which present germanium or silicon devices will function. The developmental rectifier will operate effectively at temperatures above 572 F, as compared to a maximum of about 392 F for silicon rectifiers.

The microwave diode, developed by Dr. D. A. Jenny has been operated at a frequency of 6000 mc and has been raised to temperatures of 200 C. This device, however, reportedly has an optimum temperature "way beyond this figure" but higher temperature operation has been restrained by the temperature

(Continued on following page)

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons



RAYTHEON REFLEX KLYSTRONS from 550 to 60,000 Megacycles

More than 70 Raytheon reflex-type klystrons for local oscillator, signal generator and transmitter applications.

Raytheon produces more reflex klystrons than all other manufacturers in the world combined . . . one important reason why Raytheon klystrons have established a matchless record for reliability and

proved performance in thousands of installations. Equipment designers are welcome to call on our Application Engineer Service. Write for consolidated data booklet presenting comprehensive characteristics of the complete line of Raytheon klystrons, magnetrons and special tubes. There is no cost, or obligation.

3 TYPICAL RAYTHEON REFLEX KLYSTRONS

RK-5721 — Velocity variation oscillator designed for use with a coaxial cavity in CW or pulsed operation over the 4290 to 11,000 Mc range for signal generator and special local oscillator applications.



Heater Input @ 0.58 A 6.3 V
Reflector Voltage Transit Mode 2 1/4 cycles
Frequency Range 4290-8340 Mc
DC Resonator Input @ 20 mA 1000 Vdc
DC Reflector Voltage -50 to -625 V
Electronic Tuning (Half Power) Frequency Change 12 Mc min.
Reflector Modulation Sensitivity (8340 Mc) 0.1 Mc/volt
Power Output (Average CW) 160 mW

RK-6116 — A ruggedized thermally tuned oscillator of the integral cavity type designed for CW operation in the 8500 to 9660 Mc range with an average power output of 30 mW.



Heater Input @ 0.52 A 6.3 V
Tuner Heater Current 0.80 A
Frequency Range 8500-9660 Mc
Resonator Input @ 25 mA 300 Vdc
Reflector Voltage (max. Po @ 8550 to 9660 Mc) -60 to -145 Vdc
Thermal Tuning Time
8500-9660 Mc 2 seconds
Electronic Tuning Range @ 9080 Mc 100 Mc
Power Output
8500-9660 Mc 26 to 34 mW

QK-422 — A mechanically tuned velocity variation oscillator designed for CW operation in the 7125 to 8125 Mc range in microwave relay systems.



Heater Input @ .44 A 6.3 V
Frequency Range 7125 to 8125 Mc
DC Resonator Input @ 32 mA 300 Vdc
DC Reflector Voltage (max. Po @ 7125 to 8125 Mc) -130 to -210 Vdc
Power Output 7125 to 8125 Mc 100 mW min.
Electronic Tuning (to half power points) @ 7600 Mc 25 Mc min.
Modulation Sensitivity @ 7600 Mc (10 V pk. to pk. mod. volt.)5 Mc/V min.

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Division, Section PF-25, Waltham 54, Mass.



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in Electronics

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ENGINEERING REVIEW

limitation of supporting equipment. Diode application is foreseen in ultra-high-speed switching operations and radar system hf detection.

According to RCA officials, these and other new semiconductor devices presently under development, will reduce substantially the problem of cooling in the design of many electronic systems, permitting close packaging of components or higher power level operation of present equipment. Substantial advances also are being made at RCA Laboratories in the application of gallium arsenide to transistors. In addition, new ground is being broken in the growth and processing of gallium arsenide in the pure crystal form.

Multi-Channel SSB System Operates at 900 Mc

A multi-channel single-sideband radio system operating in the 900 mc region has been successfully produced and tested by Federal Telecommunication Labs., Nutley, N.J. Although designed primarily for line-of-sight transmission, the single-sideband equipment is adaptable to over-the-horizon microwave radio through the use of bigger antennas and larger power amplifiers. Proposed development plans will push the operating frequency up to 2000 mc.

The system will accommodate up to 120 telephone channels within a 500 kc bandwidth, allotting just over 4 kc to each channel. Present systems using other types of modulation, such as frequency or pulse modulation, are characterized by bandwidths, of the order of 30 to 40 kc per channel.

The new equipment was loop-tested over a 4 mile experimental circuit with losses inserted to simulate a normal 30-mile line-of-sight circuit. Total power required to light all the filaments and operate both transmitter and receiver is about 65 w.

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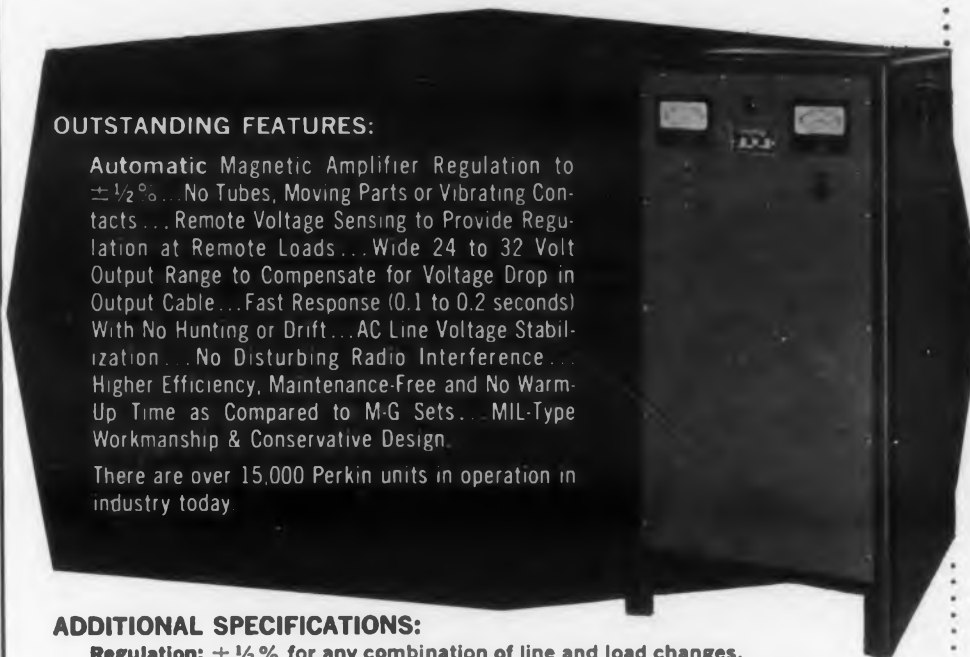
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- Aircraft Engine "Soft" Starting and Testing.
- Battery Charging & Standby Service
- ... and other heavy duty 28 volt DC Power applications.

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OUTSTANDING FEATURES:

Automatic Magnetic Amplifier Regulation to $\pm 1/2\%$... No Tubes, Moving Parts or Vibrating Contacts... Remote Voltage Sensing to Provide Regulation at Remote Loads... Wide 24 to 32 Volt Output Range to Compensate for Voltage Drop in Output Cable... Fast Response (0.1 to 0.2 seconds) With No Hunting or Drift... AC Line Voltage Stabilization... No Disturbing Radio Interference... Higher Efficiency, Maintenance-Free and No Warm-Up Time as Compared to M-G Sets... MIL-Type Workmanship & Conservative Design.

There are over 15,000 Perkin units in operation in industry today.

ADDITIONAL SPECIFICATIONS:

Regulation: $\pm 1/2\%$ for any combination of line and load changes.
AC Input: 208, 230 or 460V, $\pm 10\%$, 3 phase, 60 cps. Ripple: 1% RMS.
All units available with dollies for mobility.

AVAILABLE MODELS:

MR2432-200A, 200 amps • MR2432-300A, 300 amps • MR2432-400A, 400 amps
MR2432-500A, 500 amps

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CIRCLE 5 ON READER-SERVICE CARD



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	$\pm 1/2\%$	100-125 V 1 phase	1%
MR532-15A	2-36V	15	$\pm 1/2\%$	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	$\pm 1/2\%$	100-125V 1 phase	1%
28-50WX	24-32 V $\pm 10\%$	50	$\pm 1/2\%$	230 V* 3 phase	1%
MR2432-100XA	24-32V	100	$\pm 1/2\%$	208/230V* 3 phase	1%
MR2432-200	24-32 V	200	$\pm 1/2\%$	208/230V* 3 phase	1%
MR2432-300	24-32 V	300	$\pm 1/2\%$	208/230V* 3 phase	1%
MR2432-500	24-32 V	500	$\pm 1/2\%$	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-SWX	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	$\pm 1/2\%$	95-130 V 1 phase	1%
MR15125-5	15-125	5	$\pm 1\%$ †	95-130 V 1 phase	1%††
6125-25**	115-125	25	$\pm 1/2-4\%$	230/460 V 3 phase	5%

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



This continuous seam welding machine can turn out 300 parts in one hour when hand loaded.

Continuous Seam Welder Seals Transistors

A welding machine has been developed for sealing semi-conductor devices. The new technique eliminates presoldering preparation and all cleaning. It also stops high-temperature penetration of the working parts and prevents glass breakage.

A specially constructed hollowed ring surrounds the glass stem of the transistor. One electrode is applied to the inner portion of the ring and one to the outer by means of which a continuous seam weld is accomplished. The machine weighs 30 lbs and requires 1 kva. Power is supplied from any standard 110 v ac outlet. Production rates of 300 per hour are possible with hand loading of parts. The machine which has undergone two years of successful tests at RCA was developed by Sidney S. Steriess, 1307 Edward L. Grand Highway, Bronx, N.Y.

Transformers Rated at 150 Kva Easy on the Ears

Dry-type transformers rated through 50 kva single-phase and 150 kva three-phase having low-noise sound levels of 45 db or below are being built by General Electric, Fort Wayne, Ind. Noise analyses are made by sealing the transformers in a laboratory which has an ambient noise level of less than 10 db measured on NEMA specified equipment. It is a five field chamber that exceeds NEMA's recommended specifications. The sound level of a transformer is determined by taking the arithmetic average of five measurements. One each is taken at intervals of approximately 90 deg around the transformers. One measurement is taken above the transformer on the vertical axis.

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Reliability—

miniaturized

Magnetic Modulators

All Magnetic Modulators strictly conform to MIL T 27A. Some typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.



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NEGLIGIBLE HYSTERESIS
EXTREME STABILITY
(Ambient Temp. Range from -65°C to $+135^{\circ}\text{C}$)
COMPACT SIZE
LIGHTWEIGHT
INFINITE LIFE
COMPLETE RELIABILITY



Miniaturization of the new Magnetic Modulator makes it possible to incorporate this component into wafer type structures and transistorized printed circuit assemblies without sacrificing ruggedness or reliability.

CONSULT GENERAL MAGNETICS on magnetic amplifier components for automatic flight, fire control, analog computers, guided missiles, nuclear applications, antennas, gun turrets, commercial power amplifiers and complete control systems. Call or write for Catalog B on miniature and standard components.



Magnetic Input Modulator



Magnetic Input Modulator



Magnetic Thermocouple Converter

TYPE NUMBER	IMM - 436 - 2	IMM - 436 - 3	MTC - 435 - 2
Excitations Frequency—Carrier	400 cps	400 cps	400 cps
Signal Winding DC Resistance	1000 ohms $\pm 15\%$ each signal winding	1000 ohms $\pm 15\%$ each signal winding	10 ohms $\pm 15\%$
AC Excitation Volts	5.5 V. @ 400 cps	2.5 V. @ 400 cps	6 V. RMS
Input DC Signal Range	0 to $\pm 100 \mu\text{a.}$	0 to $\pm 80 \mu\text{a.}$	0 to $\pm 10 \text{mv.}$
AC Output Range	0 to 2.2V. @ 400 cps (sine wave)	0 to 1.5V. @ 400 cps (sine wave)	0 to 2.7V. @ 400 cps (sine wave)
Overall Dimensions (Inches)	27/32x27/32x1 5/16	27/32x27/32x1 3/16	1 1/4x7/8x5/8
Null Amplitude (Noise Level)	20 mv. RMS	15 mv. RMS max.	25 mv. RMS max.
Output Impedance	7000 ohms	7000 ohms	10,000 ohms
Null Drift (In terms of Input signal) -65°C to $+100^{\circ}\text{C}$	$\pm 0.5 \mu\text{a. max.}$	$\pm 0.5 \mu\text{a. max.}$	$\pm 0.1 \text{mv. max.}$
Hysteresis — % of maximum input signal	0.5% maximum	0.5% maximum	0.5% maximum
Type of Mounting	Male Stud	Female Insert	Male Stud
Maximum % Distortion in Output	25%	15%	20%
Weight Ounces	1.3 oz.	1.2 oz.	1.5 oz.



ENGINEERING REVIEW

BuShips Picks Ungrounded Electrical Systems

Ungrounded neutral electrical systems are chosen over the grounded systems on naval ships where the voltage is 600 v or less and where continuity of power supply is vital. This policy was discussed in a paper delivered at a Middle Eastern District AIEE meeting by E. W. Lusby and C. L. Straub of the Bureau of Ships, U. S. Navy Department. Ground faults are the most common cause of power failure, they pointed out. The ungrounded system requires more maintenance, however, it was said, and additional facilities and personnel must be provided. The grounded system, which has less maintenance requirements, can be used "on those ships that do not depend on continuity of power supply." The grounded system is also better where there are abnormal voltages to ground, the authors said but "test results and analytical investigations have indicated that abnormal voltage to ground occur infrequently on Naval ships."

Heat Energy Converted Directly to Electricity

Heat is being converted directly to electricity with a new engine designed at the Massachusetts Institute of Technology.

The device, called the thermoelectron engine, consists of two plates, one hot and one cold. Electrons possessing sufficient energy to overcome a potential barrier stream from the hot plate which is at a temperature of perhaps 2000 F, to the cold plate.

The model built at MIT by Dr. Joseph Kaye and Dr. George N. Hatsopoulos is based on a report made by Dr. Hatsopoulos two years ago. It appears that an efficient power plant could be built to yield 5000 to 15,000 w in each cu ft of plant volume.

◀ CIRCLE 6 ON READER-SERVICE CARD

New Collision Avoidance System Unveiled

A new collision warning and anti-collision command computer for piloted aircraft has recently been devised. The operation of this equipment is based upon the principle that the relative velocity vector between two aircraft must coincide with the line-of-sight between them in order for a collision to occur. The relative velocity between two aircraft which are near enough the same altitude to collide potentially is computed from altitude, speed and heading information exchanged between airplanes. Line-of-sight between the two aircraft is determined by direction finding equipment. When the relative velocity is found to lie within a few degrees of the line-of-sight, warnings are given that a collision with the other airplane may be imminent. It is only necessary for the pilot to maneuver according to the steering command given to eliminate the collision threat. This device does not measure range since it is not required in the computation. Nor does it require an operator's attention. Designed by the Aerostronics Corp., Los Angeles, Calif., the system is expected to weigh approximately 30 lbs and occupy about 1 cu ft.



Escape Velocity Exceeded

Upstream view of Hotshot II shows technicians preparing to fire the electric arc-driven wind tunnel in which escape velocity has been exceeded at the Arnold Engineering Development Center near Tullahoma, Tenn. Man in foreground sights high-speed camera on test object in 50-inch-diameter test section while another technician works on arc chamber. Unipolar generator, beyond and to left of arc chamber, builds up electrical energy in inductive coil (out of picture at right) until level required for test run is reached. Test flow at escape velocity lasts about 1/10th of a second. The arc which produces the airflow creates pressures of more than 15 tons per sq. in. Friction of air flow past the test object produces temperatures exceeding 40,000 F.

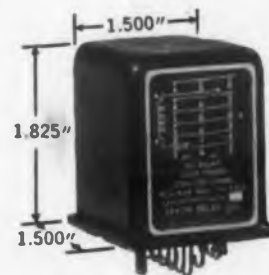
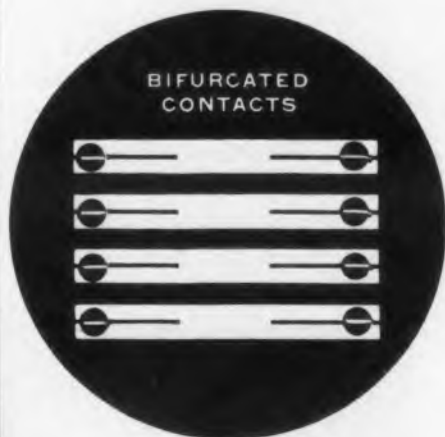


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6 PDT
Normal operating voltages—6-115 vdc—115 vac (400 cycle).
Contact ratings @ 28 vdc or 115 vac, single phase
Resistive—3 amp @ 125°C
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Inductive—1.5 amp @ 85°-125°C
Motor Load—1.5 amp @ 85°-125°C
Rated duty—continuous
Minimum cycles—100,000
Weight—0.3 lbs. max.
Shock—50 G's
Vibration—15G's—2000 cps
Applicable specifications
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MIL-R-5757B
Class A & B

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ENGINEERING REVIEW

Nuclear Instrumentation System Built

Instrumentation for nuclear reactors has been shipped to the Atomic Energy Commission's Knolls Atomic Power Lab in Schenectady, N.Y. Designed to serve as control and safety equipment in either land or marine installations, the equipment is to be used in a land-based prototype of a nuclear powered submarine. The nuclear instrumentation system is capable of measuring from one to 10 billion units of neutron flux per sec. The reactor is constantly monitored by the system which gages and indicates the density and rate of change of neutron flux of the atomic reactor from "start up" to "full power."

The system basically consists of three channels of reactor monitoring equipment: source range channel; intermediate range channel; and a power range channel. All channels are provided in duplicate as an additional safety precaution. Each channel is built into a separate, interchangeable drawer, allowing quick replacement without plant shut down.

Device Prevents "Shorts" Up to 100,000 A

A current limiting fuse, which protects circuit components having available currents as high as 100,000 a, was described during the Great Lakes District Meeting of the AIEE.

In his paper, Norman Shackman of the Bulldog Electric Products Co., Detroit, Mich., explained that the current limiting fuses are used in fusible devices, in series with circuit breakers, or as a part of a circuit breaker to protect individual loads and groups of loads. The device, which increases short circuit energy by limiting the magnitude and duration of fault current, is constructed to be dependable and permanent.

There's a "one-best voltmeter" for every job... and you'll find it here!

Makeshift measurement—where you *stretch* a faithful but out-moded instrument to or beyond its limitations—this takes time. Save engineering time by choosing and ordering now the "one-best" *-hp-* voltmeters fitting your measurement need. *-hp-* offers a complete array of precision, dependable voltmeters, each specifically suited to a given type of voltage measuring job. Check the brief data here, then ask your *-hp-* representative for demonstration—*on your bench and on your problems!*



WIDE RANGE—10 cps to 4 MC

-hp- 400D, probably the best *-hp-* voltmeter ever built. Covers all frequencies 10 cps to 4 MC. Extremely sensitive, accurate within $\pm 2\%$ to 1 MC, measures 0.1 mv to 300 v. Direct reading in dbm. 10 megohm input impedance insures negligible loading on circuits under test. New amplifier circuit with 56 db feedback insures maximum stability and freedom from change due to external conditions. \$225.00.



MULTI-PURPOSE to 600 KC—\$200

-hp- 400AB, unique value, broad utility and long-term dependability in a low cost laboratory instrument. Covers 10 cps to 600 KC, measures from 0.3 mv to 300 v in 11 ranges. High stability, high sensitivity, accuracy $\pm 2\%$ full scale from 20 cps to 100 KC. 10 megohm input impedance; 25 μ f shunt. Meter reads direct in volts and dbm. \$200.00.



EXTREME ACCURACY of 1%

-hp- 400H, designed for users who need highest accuracy within $\pm 1\%$ to 500 KC, $\pm 2\%$ to 1 MC and $\pm 5\%$ full range. Covers frequency range 10 cps to 4 MC. Has 5" meter with mirror scale, measures voltages 0.1 mv to 300 v. High 10 megohm resistance minimizes circuit disturbances; amplifier with 56 db feedback insures lasting stability. Direct reading in db or volts. Extremely high quality throughout. \$325.00.

-hp- also offers a broad variety of voltmeter accessories including voltage dividers, connectors, shunts and multipliers to extend the useful range of your equipment. Details on request from your *-hp-* representatives or direct; or see page 46 of current *-hp-* catalog.



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test instruments
for science,
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**STANDARD OF INDUSTRY—
20 cps to 700 MC**

-hp-410B, perhaps the most widely used of all precision voltmeters. In addition to 20 cps to 700 MC ac coverage, serves as a dc voltmeter with over 100 megohms input impedance. Also is ohmmeter for measurements 0.2 ohms to 500 megohms. For ac measurements, input capacity 1.5 μf , 10 megohms input impedance, employs radical *-hp-* developed diode probe which virtually eliminates circuit loading. \$245.00.

NEW!

-hp- 400L Logarithmic Voltmeter

High accuracy

10 cps to 4 MC

5" true log voltage scale

Linear 12 db scale

10 db range steps

Generous scale overlap



New, convenient *-hp-* 400L is a unique instrument combining a specially designed logarithmic meter movement with the many desirable features of *-hp-* 400D and 400H voltmeters.

Model 400L's logarithmic voltage scale plus unusually long scale length provides an instrument of maximum readability and an accuracy which is a *constant percentage of the reading*. Voltage scales are more than 5" long, with a 12 db scale spread across the full scale length. The meter is mirror backed for maximum accuracy. A range switch changes voltage sensitivity in 10 db intervals. This feature, together with the 12 db scale, provides generous overlap and is of particular convenience in work involving decibel levels.

Other features of the new 400L include exceptional long term stability, high sensitivity, high input impedance, large overload capacity, compact size and highest quality construction.

Model 400L may also be used as a stable amplifier.

SPECIFICATIONS *-hp-* 400L

Voltage Range:	0.3 mv to 300 v, 12 ranges, 1-3-10-30 sequence.
Frequency Range:	10 cps to 4 MC
Accuracy:	$\pm 2\%$ of reading, or $\pm 1\%$ of full scale, whichever is more accurate, 50 cps to 500 KC; $\pm 3\%$ of reading, 20 cps to 1 MC; $\pm 5\%$ of reading, 10 cps to 4 MC (Includes line voltage changes 103 to 127 volts.)
Long Term Stability:	G_m reduction in amplifier tubes to 75% nominal causes less than 0.5% error, 20 cps to 1 MC
Calibration:	Calibrated in RMS value of sine wave. Log voltage scale, 0.8 to 3 v and 0.3 to 1 v. Db scale — 12 to + 2 db. 10 db intervals between ranges.
Input Impedance:	10 megohms shunted by 15 μf , 1 to 300 v. 25 μf shunt on 0.001 to 0.3 v range.
Amplifier Usage:	Output terminals permit 400L to amplify small signals or monitor waveforms with an oscilloscope.
Power Supply:	115/230 v $\pm 10\%$, 50/1,000 cps, approx. 100 watts.
Price:	<i>-hp-</i> 400L (cabinet) \$325.00. <i>-hp-</i> 400LR (rack) \$330.00.

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

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FIELD ENGINEERS IN ALL PRINCIPAL AREAS

Rectifier Operates At 1300 F

Silicon carbide rectifiers have been made to operate at temperatures up to 1300 F. This marks the highest temperature yet achieved at which solid state rectifiers will perform, according to scientists at Westinghouse, Pittsburgh, Pa. The grown junction silicon carbide crystals are prepared in a specially designed furnace operating at temperatures higher than 4500 F. The furnace contains an atmosphere of pure helium or argon to prevent contamination of the crystals as they grow inside the furnace. Once the crystals are prepared, they are cut, etched, and otherwise treated for fabrication.

Drone Guidance System Tests Air Defense

An electronic guidance system designed to help the Air Force test U. S. defenses against the most modern air weapons available to an enemy has been successfully demonstrated, the U. S. Air Force and Sperry Gyroscope Co. announced. The microwave command guidance system was specifically engineered for use with Q-4 and Q-5 supersonic drones. It now is being considered as a universal system for controlling other target drones for test purposes, pilotless aircraft, and missiles.

The system enables a control team anywhere on the ground—or in the air—to track a drone, command its engine and flight controls, and receive flight data. All three functions of the system are carried out on a single radar frequency band. The system also is the first to provide remote control of aircraft at low altitudes and great distances, because it incorporates use of an air director (control aircraft) which, like the master ground control station, is fitted out completely with radar range, tracking, command, plotting, and data receiving equipment.

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Now there is a way to make a really portable power tool! Redesign with exciting, new YARDNEY SILCAD® Silver-Cadmium batteries that are far lighter, smaller and much more powerful than nickel-cadmium and conventional lead-acid batteries.

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pensively, too, for added economy. Its voltage output remains constant throughout discharge. The YARDNEY SILCAD® will operate at peak efficiency under a wide variety of adverse environmental conditions such as shock, vibration, moisture and wide temperature ranges. And they are available in a wide choice of capacities from .1 ampere-hour to 300 ampere-hours and larger.

Remember the exciting advantages of this new battery when designing portable power equipment. No other portable power source offers so many opportunities for imaginative application. Write for complete technical data today.

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WASHINGTON REPORT

Herbert H. Rosen

Cockpit Instrumentation Declassified

The Office of Naval Research has unwrapped more details on its Army-Navy Instrumentation Program—ANIP. Described were the functions of two black boxes—a central control computer and a contact analog generator. The pilot of a jet airplane will watch an instrumented TV screen. On display will be the averaged data from the ILS, Doppler radars, Tacan, Omni, Vortac, or any other navigation aids—or combination of aids, coming from the control computer. It will even operate on dead reckoning data and feed it into the analog display. Superimposed on the position data will be graphic information on fuel consumption, flight path or plan, present position, destination, and Tacan stations.

Cmdr. G. W. Hoover, ANIP project officer, predicted the whole system will be in production within two years. Although the first systems will use a standard CRT display, later models will incorporate an improved version of the Ross Aiken flat CRT.

Besides the flat tube, the ANIP program has been responsible for other significant developments. One member of an unique service-industry team, VARO Manufacturing, has come up with some very clever techniques called micro-circuitry. This is microminiaturization carried another step. It utilizes an atmospheric evaporation technique to place circuits on dime-sized ceramic pallets.

The analog display system developed by Kaiser Electronics also represents a novel departure. A picture is presented to the pilot which gives him just the right feel to confidently guide his craft down the "highway" displayed before him.

Departure from convention is standard operating procedure for the ANIP. When Litton Industries needed a new kind of material to store its computer logic, it called on fellow team member, Servomechanisms, to find the material.

Rather than modify existing materials and possibly come up with a marginal answer—a staff of eight researchers decided to tear oxygen atoms apart. As a consequence, they have come up with insulating and semiconducting materials, such as $TiO_{1.95}$ and call them suboxides. Breaking into the atomic and molecular lattice is easy now. Servomechanisms has done so to all kinds of metallic oxides—zirconium, nickel, chromium, molybdenum, cesium, manganese, and others.

Prime contractor for the fixed wing part of the ANIP is Douglas Aircraft. They are now flying

a Navy T2V with the system (and a flat CRT) installed. Douglas has also built a simulator on which tentative solutions to problems were tested before hardware was developed.

Teaming with Litton, DuMont, Bendix Pacific, and the Franklin Institute, is Bell Helicopter, which is dealing with helicopter instrumentation. Fortunately, ONR demands that all members of all the teams get together and crossfertilize. Thus in five years, a whole new concept of cockpit instrumentation has become a reality.

DOD To Monitor Missile Reliability

After a year of studying what could be done to improve reliability specifications in military contracts affecting guided missiles, the Department of Defense has come up with an interim plan. According to D. H. Patterson, of DOD's Guided Missiles Office, a reliability monitoring program will be attempted.

"The proposed reliability assurance program," as Patterson calls it, "begins when the contract is awarded and continues through the phases of design, development, production, and major product improvement in the life cycle of the missile weapon system." Stages at which reliability is to be predicted, assessed, or measured have been formulated to provide a basis for the monitoring program. These are: detailed design study; breadboard; prototype; preproduction demonstration; demonstrations of service readiness; service evaluation; full-scale production; and demonstration of major product improvement.

Obviously, reliability will have to be written into the very first guided missile system contract and progress with the system up to the point of "correcting for obsolescence" in a modification contract.

Patterson and his *ad hoc* committee have not set up this program unilaterally. More than 200 replies from industry association members have been received in answer to a request for comments on the first draft of the proposal. A final draft reflecting some of the replies will be submitted to the Military Services "for consideration and comment on how it may be incorporated into future guided missile weapons systems contracts."

Patterson cautions that the monitoring program is designed to "permit a minimum of interference with the contractor's work and to be compatible with the Military Services' specifications and practices in progress reporting."

And, as in the form of a prayerful hope, Patterson adds, "I hope the time will be short when we will think no more of specifying and achieving reliability than we do of specifying and achieving performance factors such as altitude or range."

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CORMAG® PROTECTION! Weston's famous Cormag mechanism permits close grouping of instruments on magnetic or non-magnetic panels. No special adjustments need be made. There's no danger of magnetic intereffects.

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For accuracy, appearance, readability and cost, your best buy is CROWN. Your local Weston representative will be glad to quote on your requirements and arrange prompt delivery of prototypes. Contact him for full information, or write to Weston Instruments, Division of Daystrom Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

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Speech Worth Applauding

Dear Mr. Lippke:

Your editorial in the April 16, 1958 issue of *ELECTRONIC DESIGN* is much appreciated. For years my wife has been very emphatic on the poor quality of presentation made by engineers at technical meetings.

Our ISPE [Illinois Society of Professional Engineers] just completed their annual convention at Decatur where four out of five general meeting speeches were “read.” It took a member of the faculty of the Business School from the University of Illinois to give the key speech in such a way that 200 men and 200 women were sitting on the edge of their chairs. His topic, “Inflation, Deflation, and Flation,” included conversation on business statistics. His style of presentation was amazing and, even though he had reference sheets on the speakers stand, you never felt he was “reading.”

Dr. Robert O. Harvey, Professor of Business Administration, could certainly be looked at as an example. He took a subject in which the usual “professor” would go down deeper, stay down longer, and come up drier than any other individual and held his combined audience in humorous stitches for more than 45 minutes. He was able to impress his points on economic changes and still leave you with a feeling that you would like to hear him continue.

Could you please send further information on the new Professional Group on Engineering Writing and Speech referred to in the last paragraph of your editorial.

Warner A. Johnson, P.E.
Micro Switch
Freeport, Ill.

► Information about the Professional Group on Engineering Writing and Speech may be ob-

LETTERS

ained from Eleanor McElwee, Secretary, PGEWS, Commercial Engineering, RCA Tube Div., Harrison, N.J. For membership, write to PIRE headquarters at 1 E. 79th St., New York, N.Y.

Uniterm Filing System

Gentlemen:

Congratulations to an article which may help all a crying need.

We've started a similar system on our own, but find it is beyond our resources of time and secretarial help. Perhaps by publishing this letter we may find a like-minded company in our own area which would like to join in a cooperative effort.

Stephen V. Hart, Vice-President
Electronic Control Corp.
Detroit, Mich.

Dear Sir:

I have read with interest Mr. Bell's article in the April 16 issue concerning the Uniterm system of filing.

There is no doubt that the article is a step in the right direction on a problem that has vexed us considerably in the past; a problem that is, no doubt, shared by most engineers.

My suggestion at first thought is that each article in a periodical has already been Unitermed by the author. This information can be printed in a box in the upper right hand corner of the title page of the article with a space reserved for the appropriate filing number as determined by the reader or filing clerk.

Joseph Salvatore
Control Systems Lab.
University of Illinois
Urbana, Ill.

Now, Tung-Sol offers designers a complete line of high reliability Germanium PNP Transistors!



Tung-Sol types and ratings are listed below with the types they replace. From these, spot your needs! Then, for long-life operation, specify Tung-Sol!

TYPE	APPLICATION	MAXIMUM RATINGS (25° C)					TYPICAL VALUES (25° C)				SIMILAR TYPE REFERENCE
		Pc mw	Vce volts	Vcb volts	Ic ma	Tj °C	MAX. Icbo µa	Hfe	fab mc	Ge db	
MEDIUM POWER AUDIO TYPES (To-9 Outline)											
2N381	Output Amplifier	200	25	25	200	85	20	36	1.2	31	2N61, 2N186/A, 2N187/A, 2N266, 2N60, 2N180, 2N181, 2N185, 2N188/A, 2N226, 2N311, 2N403, 2N408
2N382	Output Amplifier	200	25	25	200	85	20	54	1.5	33	
2N383	Output Amplifier	200	25	25	200	85	20	72	1.8	35	2N59, 2N224, 2N241/A, 2N265, 2N270
2N460	General Purpose Industrial	200	—	45	400	100	15	25	1.5	39	2N44
2N461	General Purpose Industrial	200	—	45	400	100	15	50	1.5	41	2N43
HIGH FREQUENCY TYPES (To-9 Outline)											
2N404	Computer	100	24	30	400	85	5	30	12	—	2N581
2N425	Computer	100	20	30	400	85	5	30	4	—	2N394, 2N578
2N426	Computer	100	18	25	400	85	5	40	6	—	2N269, 2N395, 2N579
2N427	Computer	100	15	20	400	85	5	55	11	—	2N123, 2N315, 2N396, 2N580
2N428	Computer	100	12	15	400	85	5	80	17	—	2N316, 2N397, 2N582
2N413	RF Amplifier	100	15	—	200	85	5	—	3	—	2N111, 2N135, 2N410
2N414	RF Amplifier	100	15	—	200	85	5	—	5	—	2N139, 2N112, 2N136, 2N218, 2N412
2N416	RF Amplifier	100	15	—	200	85	5	—	10	—	2N113
2N417	RF Amplifier	100	15	—	200	85	5	—	20	—	2N114
HIGH POWER TYPES (To-3 Outline)											
2N242	Audio Amplifier	15	45	—	2	85	1.0	50	0.4	34	2N155, 2N176, 2N250, 2N257, 2N301/A, 2N350, 2N351, 2N554, 2N555
2N378	Power Switch	15	20	40	3	85	0.5	35	0.3	24	2N255
2N379	Power Switch	15	40	80	3	85	0.5	30	0.3	23	2N158/A, 2N251, 2N296, 2N297
2N380	Power Switch	15	30	60	3	85	0.5	60	0.4	29	2N156, 2N256, 2N387
2N459	Power Switch	15	60	105	3	85	0.5	40	0.3	24	2N375

NOTE: Similar type references are listed at time of printing and should be interpreted as approximate equivalents. This reference does not necessarily imply exact electrical or mechanical interchangeability.

To fill your special transistor requirements or for full facts on any of these standard Tung-Sol types, write or phone: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey. Sales Offices: Atlanta, Ga., Columbus, Ohio, Culver City, Calif., Dallas, Tex., Denver, Colo., Detroit, Mich., Irvington, N. J., Melrose Park, Ill., Newark, N. J., Seattle, Wash. . . . Canada: Toronto, Ont.

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MEETINGS

June 5-6: 2nd National Symposium on Production Techniques

Hotel New Yorker, New York, N.Y. Sponsored by PGPT. For information write John W. Tripp, Sperry Gyroscope Co., Great Neck, N.Y.

June 8-12: National Association of Electrical Distributors

San Francisco, Calif. For more information about the convention write to the National Association of Electrical Distributors, 290 Madison Ave., New York 17, N.Y.

June 9-13: 6th Annual Technical Writers' Institute

Rensselaer Polytechnic Institute, Troy, N.Y. For details contact William E. Price, News Bureau, Rensselaer Institute, Troy, N.Y.

June 9-13: 4th International Automation Exposition and Congress

Coliseum and Barbizon-Plaza Hotel, New York, N.Y. Included in this exposition and congress will be over 100 clinic sessions, 15 technical sessions, plus the Military Automation Exposition. Conferences on "Human Factors in Systems Engineering," and "Plant Layout for Automation" will also be held in connection with the exposition and congress. For further information write to Harrison Gilmer, Director of Public Relations, 4th International Automation Exposition and Congress, 845 Ridge Ave., Pittsburgh 12, Pa.

June 15-19: Semi-Annual Meeting of the ASME

Detroit, Mich. Write to ASME, 29 W. 39th St., New York 18, N.Y., for further information about the meeting.

June 16-18: 2nd National Convention on Military Electronics

Sheraton Park Hotel, Washington, D.C. Sponsored by PGMIL. Contact Dr. J. McLaughlin, Naval Research Labs., Washington 25, D.C.

June 18-20: Statistical Methods in Radio Wave Propagation

University of California, Los Angeles, Calif. Sponsored by the University of California En-

Engineering Extension. Participants from England, France, India, and the United States will present papers in three major fields, statistical theory and techniques of use to scientists and engineers, phenomenological investigations with both statistical and physical structure, and instrumentation for the rapid reduction of large quantities of radio data. Inquiries should be addressed to Dr. W. C. Hoffman, Engineering Building, Room 3116, University of California, Los Angeles 24, Calif.

June 22-27: AIEE Summer General Meeting
Buffalo, N.Y.

June 23-27: ASTM 61st Annual Meeting
Hotel Statler, Boston, Mass. Highlighting the meeting will be the 12th Technical Photographic Exhibit of the ASTM. Entries will be accepted from members of ASTM, employees of company members, and engineering students. For further information, contact E. W. Walsh, Chairman, Narragansett Electric Co., 15 Westminster St., Providence, R.I.

July 24-25: 5th Annual Symposium on Computers and Data Processing
Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute, Electronics Div., University of Denver. Symposium will consist of technical papers on basic problems in the field of data processing, particularly in the areas of formalized analysis techniques, logical design techniques, automatic programming, systems organization, digital communications, and components and devices. Queries concerning the symposium may be addressed to C. A. Hedberg, Head, Electronics Div., Denver Research Institute, University of Denver, Denver 10, Colo.

Aug. 6-8: Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers
Hotel Statler, Los Angeles, Calif. Sponsored by AIEE. The four technical sessions will include technological and theoretical aspects of non-linear magnetics and magnetic amplifiers, computer applications, special purpose devices and applications, and "new frontiers" in the field. Exhibits will be displayed by 40 manufacturers selected for their contributions to the industry. For more information about the conference write AIEE, 33 W. 39th St., New York 18, N.Y.

Aug. 13-15: Conference on Electronic Standards and Measurements
NBS Boulder Labs., Boulder, Colo. Sponsored

5-megawatt ferrite isolator for high-power radars

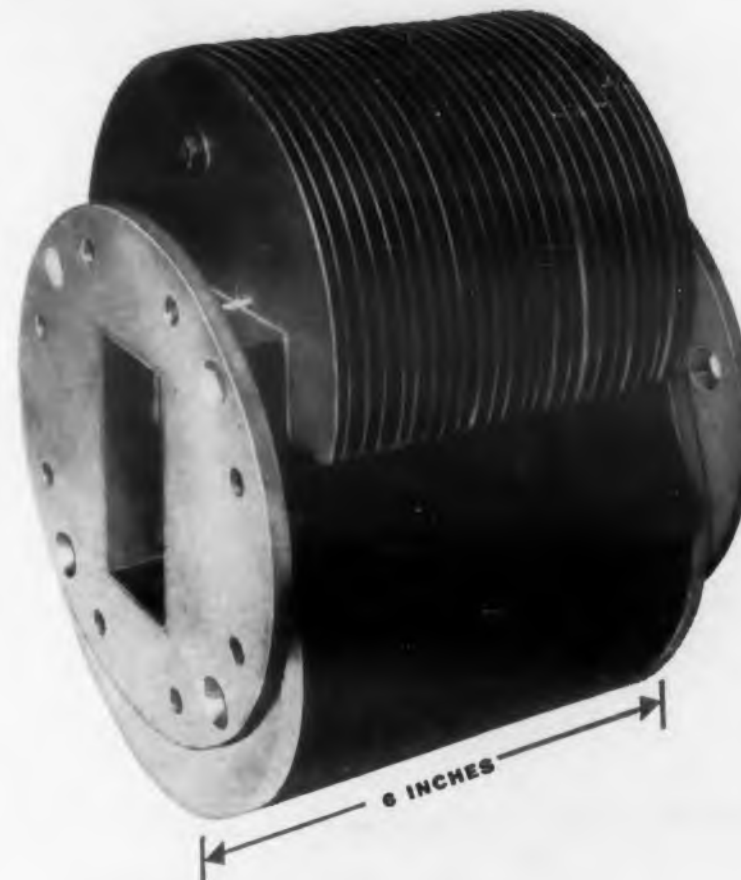
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Another Sperry contribution to improved performance of radar systems is this new Model D44S1 ferrite isolator. It boosts efficiency of S-band radars by allowing optimum operation of high-power tubes.

In addition, this isolator protects high-power tubes from load mismatches, and eliminates frequency and power variations due to changing load impedances. It is rated at 5 megawatts peak, 5 kilowatts average, and features insertion loss of less than 0.3 db. Compact and small, the Model D44S1 measures only 6 inches in length and 8 inches in diameter. And its air-cooled design eliminates the extra expense and weight of liquid-cooling accessories.

Currently Sperry has under development or in production a wide variety of ferrite devices in addition to those shown here. These include megawatt duplexers, coaxial duplexers, octave-plus bandwidth isolators and attenuators, high-speed switches, modulators and choppers.

Sample quantities of the listed units are available immediately from our stock for test and evaluation in your system, with a view to production tailored to your specific requirements. Contact our nearest district office for further information.



MODEL D44S1 SPECIFICATIONS

Power: 5 mw peak, 5 kw average
Frequency: 2700-2900 mc
Insertion loss: less than 0.3 db

Isolation: 10 db min.
Cooling: Forced air



COAXIAL FERRITE ISOLATORS

MODEL	USE	FREQ. RANGE	MAX. AV. POWER	INSERTION/ISOLATION	DIMENSIONS
A44L1	Radar	1250-1365 mc	400 w	1 db 10 db	3" dia. x 13.25"
A44S1	Radar	2700-3100 mc	10 w	1 db 10 db	1.5" dia. x 5"
D44L1	Relay	1700-2400 mc	30 w	1.5 db 21 db	3" dia. x 13.25"
A44S4	ECM	2000-4000 mc	400 w	1 db 10 db	3" dia. x 13.25"



X-BAND FERRITE COMPONENTS

MODEL	USE	FREQ. RANGE	MAX. AV. POWER	INSERTION/ISOLATION	DIMENSIONS
A44X1	Isolator	8200-12400 mc	400 w	1 db 10 db	1.5" dia. x 5"
A43X1	Variable Attenuator	8500- 9600 mc	10 w	1 db 30 db var.	1.5" dia. x 2"

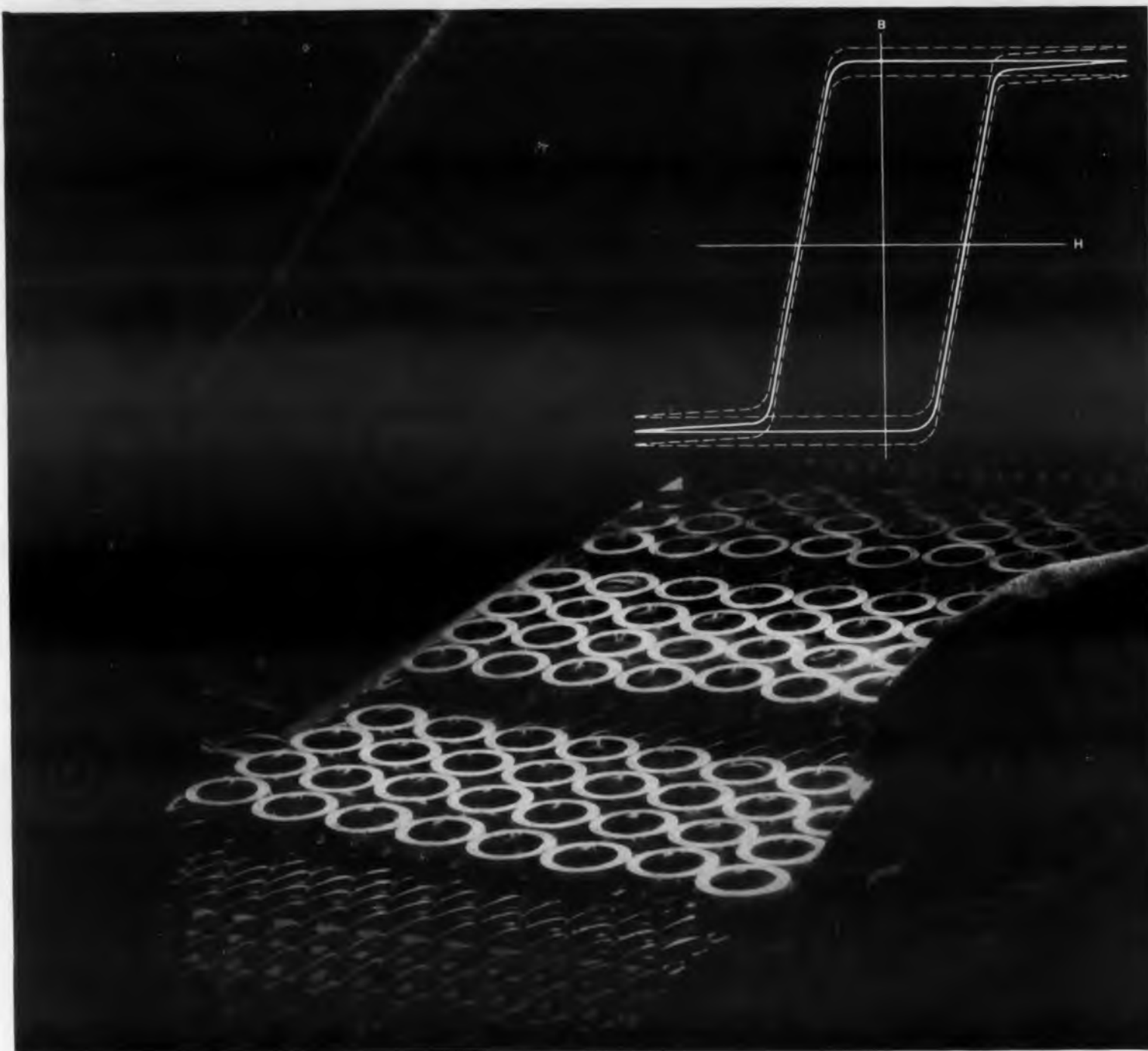
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*Paper No. TWC-45, Winter General Meeting, AIEE, February, 1958. Flux Reset Test is one of two tests proposed for standardization

CIRCLE 15 ON READER-SERVICE CARD

MEETINGS

by the Professional Group on Instrumentation of IRE, Electronic and High-Frequency Instrumentation Committee of AIEE, and the Radio Standards Lab. of the National Bureau of Standards. Six technical sessions will cover the following subjects: The Relationship of Standards to Physical Constants; Frequency and Time Interval Standards; Direct-Current and Low-Frequency Standards; Radio-Frequency Standards (Measurement of voltage, current, power, impedance, attenuation, phase shift, field strength); Microwave Standards (Measurement of power, impedance, attenuation, noise), and The Organization and Operation of Standards Laboratories. Write James F. Brockman, National Bureau of Standards, Boulder Labs., Boulder, Colo.

Aug. 19-22: Western Electronic Show and Convention

Los Angeles, Calif. Details will be announced later. For more information write Western Electronic Show and Convention, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Paper Deadline

June 25: Deadline for papers to be presented at the 1958 National Simulation Conference. The conference, sponsored by the IRE, is planned for October 23-25 in Dallas, Tex. One hundred words abstracts and 500 word summaries of technical papers in the general field of simulation should be transmitted in duplicate to D. J. Simmons, Rt. 8, Box 447, Ft. Worth, Tex.

Courses—Seminars

Aug. 4-15: Special Summer Program on Microwave Ferrites. Massachusetts Institute of Technology, Cambridge 39, Mass. Topics will include Electromagnetic Theory of Fields in the Presence of Ferrites, Measurements of Ferrite Characteristics, and Linear and Non-linear Ferrite Devices: Theory and Application. Write to Dr. Herman A. Haus, Assistant Professor, M.I.T. Department of Electrical Engineering for information.

Aug. 4-15: Summer Study Course in Microwave Theory and Technique. Case Institute of Technology, Cleveland, Ohio. The course will be directed toward the engineer in industry who has found a growing need for training in the methods of measuring and analyzing with microwaves. Requests for additional information on the course should be directed to the Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

EDITORIAL

ELECTRONIC DESIGN Breakthrough

Last month, after advertising lineage was counted, **ELECTRONIC DESIGN** moved into first position in display advertising among electronics technical publications. In 64 months, **ELECTRONIC DESIGN** has outpaced all electronics magazines—a record unparalleled among some 1200 business magazines. We're in first place because you, the reader, said we were the most helpful to you in giving you ideas to do your job better.

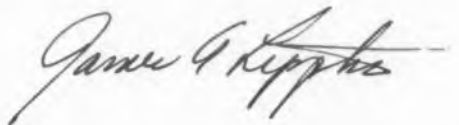
Being first in advertising makes our publishers and sales force jubilant. We editors don't deny we're pleased, but the fact is almost anticlimactic. We have for some time carried more engineering design information than other publications. It has been our goal to give you the best in helpful, practical design information. Whether we are first in advertising is immaterial except as it affects total space available for editorial.

As of last month, we were the only principal magazine, serving the electronics industry exclusively, with a square format. To you, the reader, this has meant attractively laid out articles, easy to read and to follow. The magazine lies flat on your desk. (Of course, we know the shape makes it more difficult to remove articles for filing, but we feel that quantity and quality are more important.) To the advertiser, the square format has meant editorial next to every page of advertising. If the editorial is interesting, his ad will be exposed to readers. Your response to his advertising has made him aware that **ELECTRONIC DESIGN** is read. He gives us more advertising, we have more room for editorial—a happy cycle.

What makes being first even more significant is that our audience, exclusively design engineers, is not as wide as that of other publications. This goes to prove that you, the design engineer, are the key man. In this time of general recession, **ELECTRONIC DESIGN**, which goes to design engineers with a design engineering message, is growing. Others are off.

Of course, much of the credit should go to our engineer-authors. It has been their desire to pass along helpful information that has enabled us to become so successful. It has not been easy for some authors—we have many times asked them to rewrite their material so that we could pass along only essential-to-know information in as short a space as possible. We trust the results of writing for us have been rewarding. One bit of satisfaction to the author comes from knowing that he is being exposed to the greatest number of design engineers.

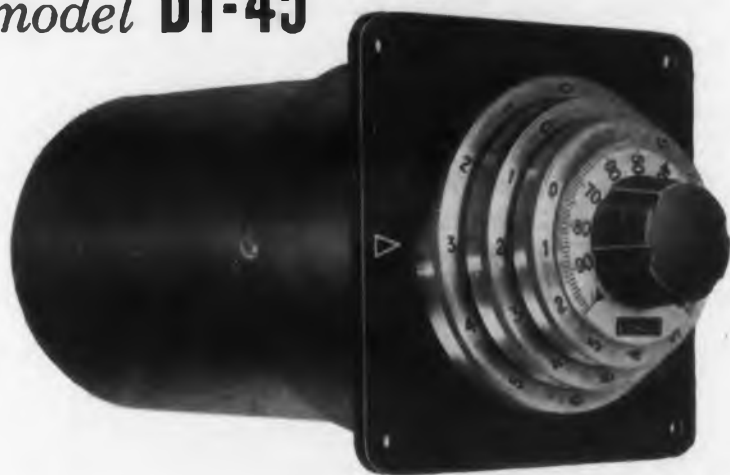
As we toast the success of the magazine, we toast you, the reader, for the support and words of encouragement that you have given us as we were growing.



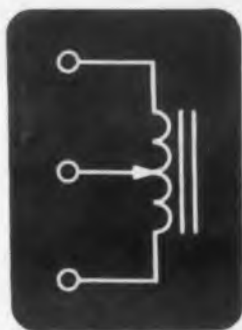
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Graphical Method Simplifies Wien Bridge Oscillator Design

Earl D. Grim

Radio Corporation of America
RCA Victor Div.
Camden, N.J.

Here's a simple graphical method for the analysis and design of Wien Bridge oscillators. It avoids the "dogwork" of the rigorous mathematical design and the sloppiness of the trial and error method.

TOO OFTEN, Wien Bridge oscillators have been designed by the "hit and miss and try again" method. This has resulted in oscillators with poor waveform or unstable operation. This article describes a reliable, effective design procedure. Curves are presented to enable the design engineer to outline the requirements for the feedback network and amplifier parameters to produce circuit oscillation at the desired frequency.

Basic Wien Bridge Oscillator

A simplified schematic of the oscillator is shown in Fig. 1. The gain of the amplifier is symbolized by $|G|$. The symbol A is defined as the ratio of R_1/R_2 and C_2/C_1 , and T is defined as $R_1C_1 = R_2C_2$ where the R 's and C 's are defined in Fig. 1.

In Figs. 2 and 3, ϕ_H , the phase of H (the transfer function of the feedback network) is plotted against generalized frequency coordinates. Fig. 3 is an enlarged section of Fig. 2 in the region near $\omega = 1/T$.

Fig. 4 presents $|H|$, the gain factor of H , plotted against A , the feedback network parameter. This gain factor varies also with the phase shift through the network. Hence, three curves are plotted, with phase shifts corresponding to zero, ± 20 and ± 40 degrees.

There are two main points to note with these curves.

1. As A increases, the feedback network has a larger gain factor. As A gets very large, the gain factor approaches unity.

2. If the phase shift through the network is not zero, the gain factor is always smaller than the corresponding zero phase shift gain factor.

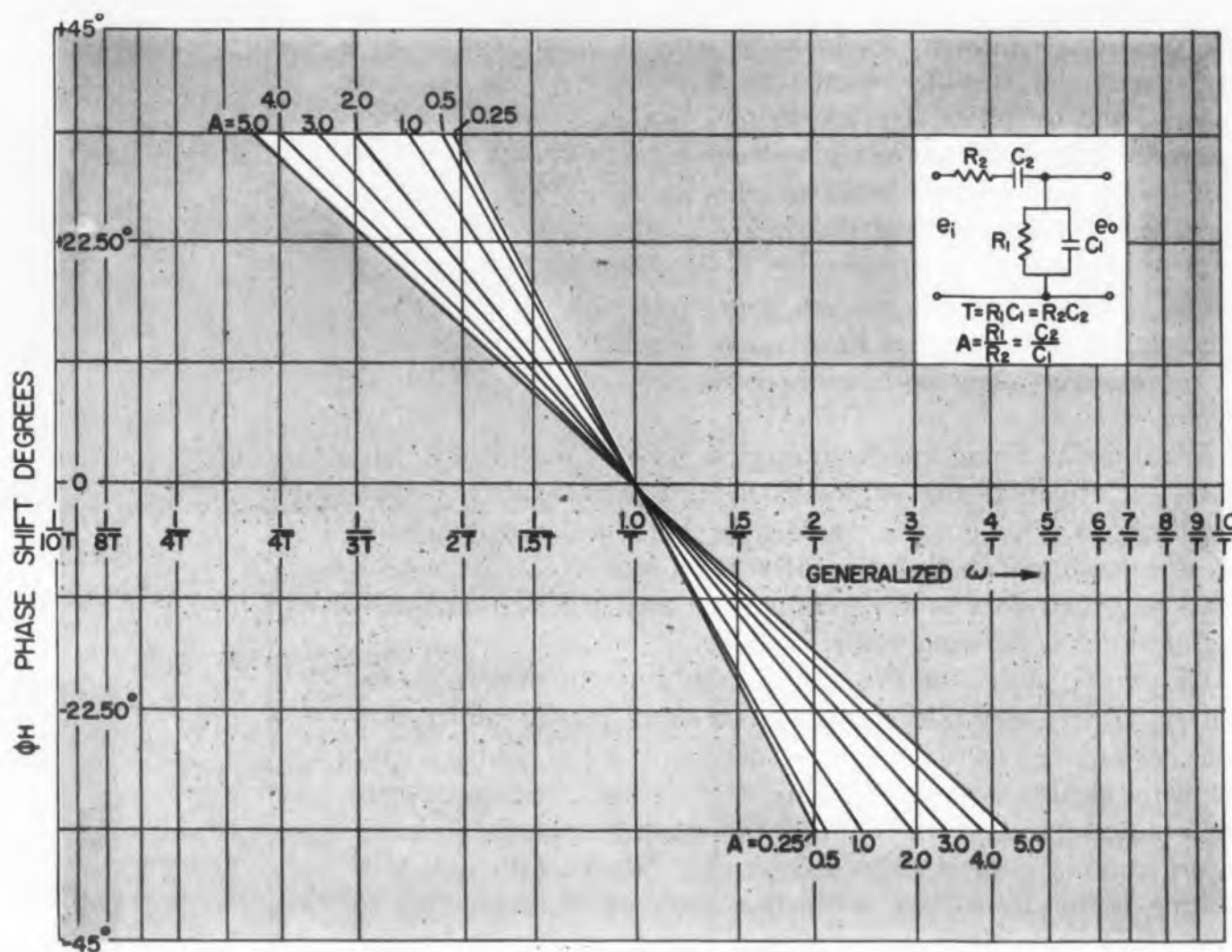


Fig. 2. The network phase shift is plotted here against generalized frequency (in radians per second) for various values of the parameter A .

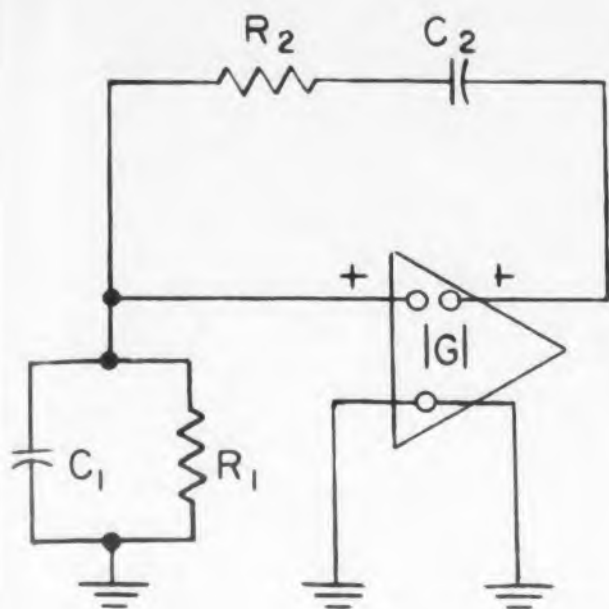


Fig. 1. Basic Wien Bridge oscillator. The ratios $R_1/R_2 = C_2/C_1$ are symbolized by A . The time constant $T = R_1C_1 = R_2C_2$. C_1 includes amplifier input and stray capacity and R_1 includes the amplifier grid resistor.

If the closed loop representing the amplifier and feedback network is broken at the input to the amplifier, and if a voltage is fed to that input, then the closed loop will oscillate if the voltage at the output of the feedback network has the same phase and equal or greater magnitude than the amplifier input voltage.

Expressed mathematically:

$$\phi G + \phi H = 0$$

$$|G| |H| \geq 1$$

where ϕG and ϕH are the phase relationships of the transfer functions of the amplifier and feedback network respectively. $|G|$ and $|H|$ are the absolute values of their magnitudes. With these criteria, one can design an oscillator.

5 kc Oscillator Design

Feedback Network: For a 5 kc oscillator

$$\omega = 2\pi \times 5 \times 10^3 = \pi 10^4$$

$$T = 1/\omega = R_1C_1 = R_2C_2 = 10^{-4}/\pi$$

In setting the impedance level of the feedback network, a compromise must be effected between the desirable high impedance which minimizes amplifier loading, and the equally desirable low impedance which minimizes the effects of changes in circuit capacity due to tube changes.

In this spirit of compromise, a value of 56 K is chosen for R_2 . Then

$$C_2 = \frac{1}{5.6 \times 10^3 \pi} = 560 \mu\mu f$$

Now a value for A must be chosen. Notice in Fig. 2 that for values of A less than 0.25, the curve would have substantially the same slope as for $A = 0.25$. Values of A greater than 5 are not

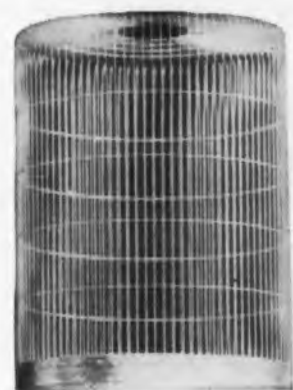


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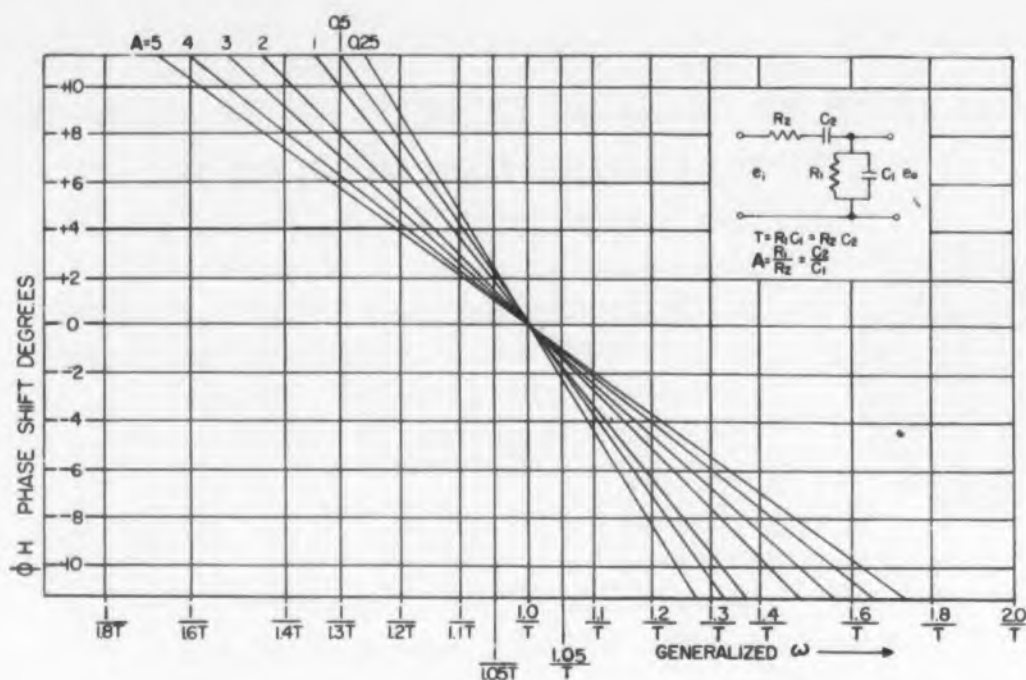


Fig. 3. This is an expansion of Fig. 2 in the vicinity of $\omega = 1/T$.

too practical since they result in severe frequency changes for small phase changes. Again, in a spirit of compromise, a value of $A = 2$ is chosen. Then

$$R_1 = AR_2 = 112 \text{ K}$$

$$C_1 = C_2/A = 280 \text{ } \mu\text{f} \text{ (which must include amplifier input capacity)}$$

This completes the design of the feedback network. The required gain and phase shift characteristics of the amplifier must now be determined.

Amplifier Phase Shift and Gain: Referring to Fig. 3, and recalling that $\omega = 1/T$ and $A = 2$ were chosen as parameters to determine the feedback network characteristics, it can be seen that ϕH must be zero at the point defined by the values of ω and A .

Since $\phi G + \phi H = 0$ as an oscillation requirement, then ϕG must equal 0.

Thus one amplifier requirement is that its phase shift at 5 kc must be zero. Of course, this may be 360 deg or multiples of 360. Phase shift in the amplifier can often be found conveniently by plotting the break points in the amplifier frequency gain curve and computing the phase shift. (See the reference.)

The gain requirement of the amplifier can be found by referring to Fig. 4. This presents $|H|$ as a function of A with ϕH as a parameter. When ϕH is 0 and A is 2, then $|H| = 0.5$.

Since for oscillation the product of $|G|$ and $|H|$ is equal to or greater than 1, then $|G|$ must be equal to or greater than $1/0.5 = 2$.

Thus the amplifier must have a gain of two or slightly greater for oscillation. This gain should

be measured with the feedback network and any other load impedance that might be present.

A 5 kc Oscillator

Fig. 5 shows a workable design for a 5 kc oscillator using a 12AT7. The actual amplifier design procedure will be covered in a forthcoming article.

Briefly, a few points in the schematic are worthy of note. C_1 had been calculated to be 280 μf . In the schematic, however, C_1 consists of two capacitors having a total value of 259 μf . The difference is accounted for by the input capacity of the amplifier. The first triode has a 100 K plate load to provide high gain, while the second triode has a total plate load of only 8.2 K to minimize the loading effect of the feedback network and reduce the gain to 2. The 7.5 K, 1.8 K combination provides negative feedback to reduce gain and minimize changes in the open loop gain. The tap in the second triode's plate load is to compensate for variations in the amplification factor from tube to tube. The values of the coupling capacitors are chosen to balance lagging and leading phase shifts and to provide zero phase shift at 5 kc.

Output is taken from the cathode of the second stage of amplification so as to maintain a low impedance to minimize loading. Where severe loading is anticipated, this output should drive another cathode follower.

High and Low Frequency Oscillators

In designing very high or very low frequency oscillators, it is difficult to obtain zero phase shift

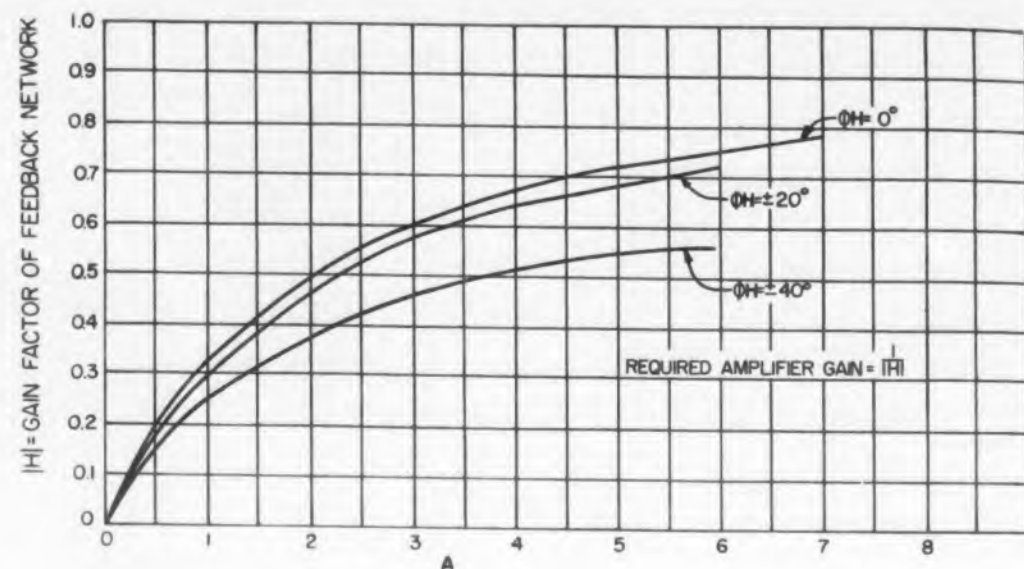


Fig. 4. These curves are used to determine the required amplifier gain and feedback network gain, knowing A . They are especially useful for high and low frequency design.

through the amplifier with any reasonable gain. In these cases, a design can be completed with phase shift.

Suppose an amplifier design has a gain of 3.5 with 20 degrees of lagging phase shift at the desired frequency of oscillation. Since the sum of the phase shifts of the amplifier and feedback network must be zero, and the amplifier has a phase shift of -20 deg, the feedback network must have a phase shift of $+20$ deg.

Also, since the product of the gain factors of the amplifier and feedback network must equal or be greater than 1, $|H|$ must equal or be greater than $1/3.5 = 0.286$.

Referring to the ϕH curve of Fig. 4, one can produce oscillation with a value of A of about 1 or greater. In general, the lowest value of A should be chosen to provide the most stable circuit operation. This can be observed in Fig. 2. The slope of the curves increases as A decreases, which indicates that a smaller frequency change in the closed loop will occur for a given change in amplifier phase shift with smaller values of A .

Therefore the value $A = 1$ is a good choice for a feedback network parameter. Now the two parameters, $A = 1$ and $\phi H = +20$ define a point on Fig. 2 from which ω can be found. This value is $\omega = 1/1.75 T$. Then $T = 1/1.75 (2\pi f) = R_1 C_1 = R_2 C_2$.

Since f is known, T is defined by this equation and R and C can be found. Again these values should be chosen as a compromise between stray capacity effects and amplifier loading. After R_1 and C_1 are known then R_2 must equal R_1 and C_2 should equal C_1 since A was chosen equal to 1.

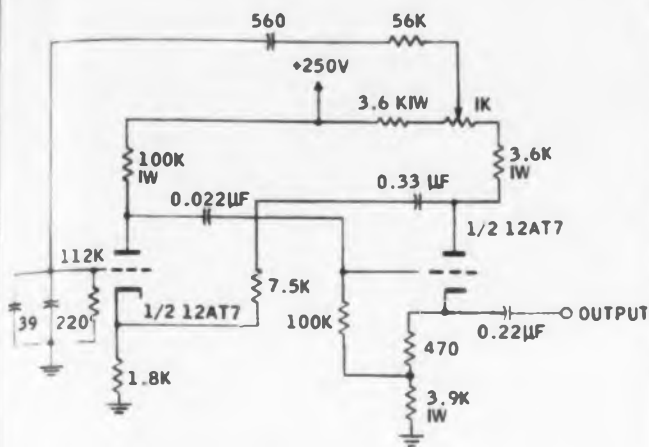


Fig. 5. A 5 kc Wien Bridge oscillator. Capacitor values are in μf unless otherwise designated.

Knowing the expected variation in the phase shift and gain of the amplifier, one can predict the frequency variation and the capability of oscillation. With A known, a given variation in amplifier phase shift will cause a specific frequency shift which can be found from Fig. 2 or 3. The oscillation capability can be determined from Fig. 4. If the gain $|G|$ is less than $1/|H|$ at the chosen A value at any limit point, the circuit will not oscillate. If $|G|$ is much greater than $1/|H|$ the output waveform will be distorted.

Since zero or 360 degrees of phase shift is required, two stages are generally necessary if the common cathode connection is used. However, one can get gain and the required phase shift in one stage if the common grid connection is used, or in the transistor, the common base connection. An obvious difficulty with this type design is the very low input impedance of the cathode or emitter circuit. Nevertheless, if this is taken into account an oscillator can be built with only one amplifier stage.

Variable Frequency Design

A variable frequency oscillator can be designed if, for example, C_1 and C_2 are varied simultaneously. The frequency of oscillation is:

$$\omega = 1/T = 1/R_1C_1 = 1/R_2C_2$$

But this is true only if the phase shift through the amplifier is zero. If there is phase shift, then the actual frequency of oscillation can be found from Fig. 2 or 3. Thus the designer can predict deviations from linearity in the variable capacitor vs frequency relationship and establish specifications for the amplifier phase shift according to his design requirements.

Reference

Servo-mechanisms and Regulating System Design, Vol. I, Chestnut and Mayer. John Wiley, New York, N.Y., 1951, pp. 309-310.



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Using Transistors in Demodulator Circuits

Albert N. DeSautels

Minneapolis-Honeywell Regulator Co.

Minneapolis, Minn.

Part 1

Phase discriminators with dc output are used extensively in control circuits. Transistorized discriminators have the advantage of small size and low power consumption. They provide amplification with good reliability over a wide temperature range.

This article discusses half-wave and full-wave phase discriminators using transistors and diodes to produce output capable of driving magnetic amplifiers, saturating relays, loading coils, and hydraulic valves.

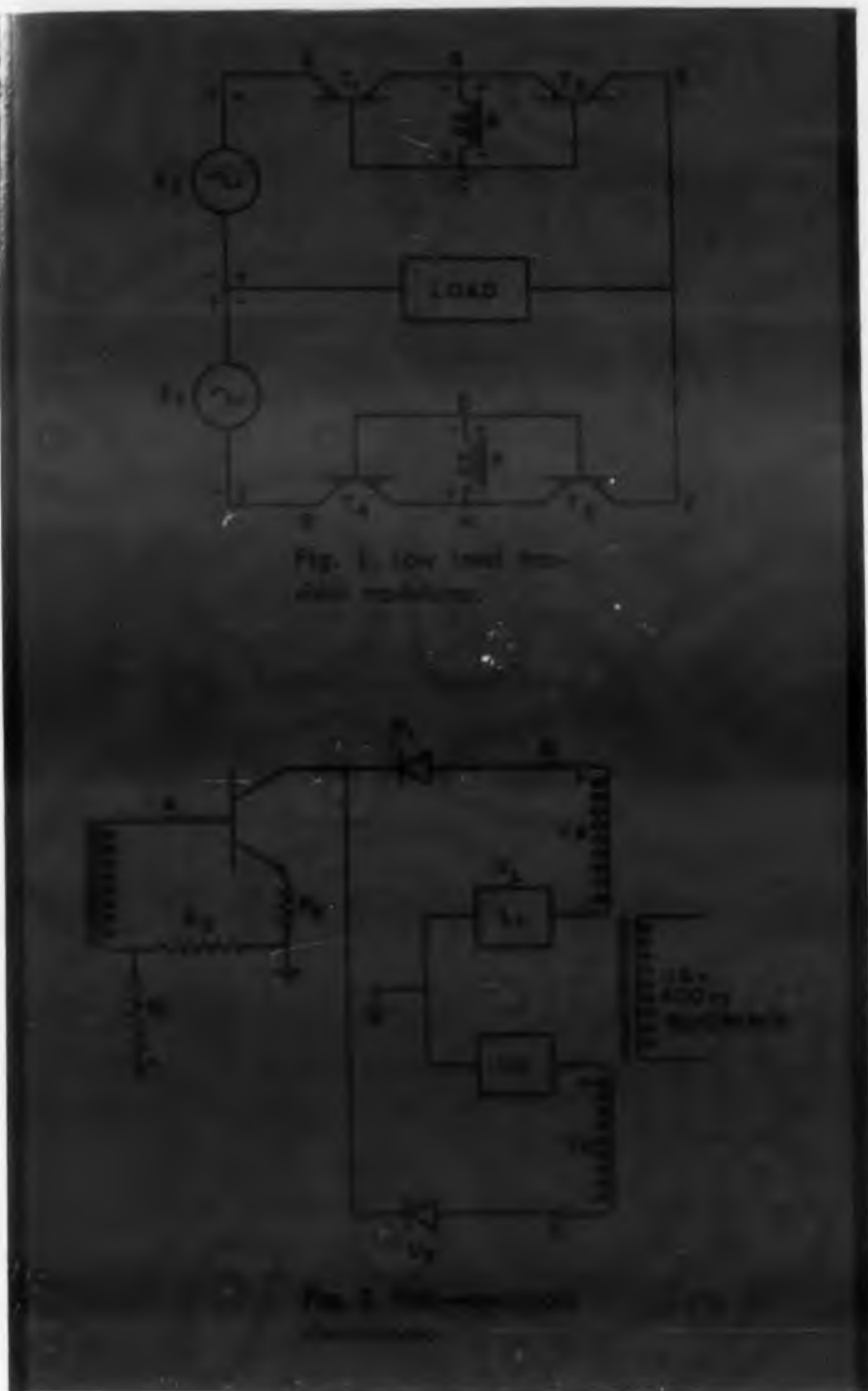
Part 2 will analyze operating characteristics and discuss power considerations and limitations.

DEMODULATOR circuitry uses the switching characteristics of the junction transistor. A transistor demodulator (Fig. 1) can be combined with a magnetic amplifier or transistor amplifier to produce an effective unit in a synchro-controlled system.

In essence, when the base is positive with respect to both emitter and collector, the transistors will act as open switches with very low leakage. When the base becomes negative with respect to either, the transistors will act as closed switches with very little voltage drop.

When transistors are acting as switches rather than amplifiers, their characteristics are not critical and no need exists for matching. Low gain transistors can also be successfully used.

The demodulator (Fig. 1) is a stable device



capable of operating at as low as 20 millivolts of signal. However, a fairly large signal is required to achieve respectable values of current through a load. In an experimental setup, an E_s of 1/2 v produced 50 μ amp of dc.

Phase Discriminators

A half-wave phase discriminator (Fig. 2) is capable of furnishing much higher levels of dc current to a load. Transistors and diodes are combined to provide amplification, demodulation and discrimination with reliability and stability over a wide temperature range. Power handling capabilities are extensive and are limited primarily by maximum voltage and current rating of the transistors.

The circuit shown in Fig. 2 will produce half-

wave differential dc current into a three-terminal or split load such as is found in the activating coils for hydraulic valves in automatic flight control systems. Discriminator action is furnished by the diodes D_1 and D_2 . Considering the NPN transistor shown, when the points A and B are becoming positive at the same time, T_1 will conduct and current will flow through D_1 and one-half of the load L_1 . On the negative half-cycle, T_1 is cut off and no current will flow.

If the signal phase at A is reversed and points A and C are becoming positive simultaneously, T_1 will again conduct with current flowing through D_2 and the other half of the load L_2 . Once again on the negative half-cycle, T_1 is cut off and no current will flow.

The resistance R_e may be added to improve transistor interchangeability and performance with temperature variation. The ratio R_1/R_2 would be independent upon the amplitude of the dc power supply and the amount of quiescent current acceptable in the load. It is necessary that the diodes D_1 and D_2 be matched for balanced phase response.

When one diode is conducting, a back voltage appears across the other equal to twice the peak reference minus the voltage drop in the load. Therefore, the nonconducting diode should have an inverse voltage rating in excess of $2\sqrt{2}V_R - V_L$.

When the transistor is nonconducting, the collector emitter junction is subjected to an inverse voltage equal to the peak reference voltage. Therefore, the maximum collector voltage rating should be greater than the peak reference voltage value.

Often it is advisable to use full-wave rather than half-wave discrimination. The large fundamental ripple on the half-wave dc output may necessitate use of shunting capacitors in hy-

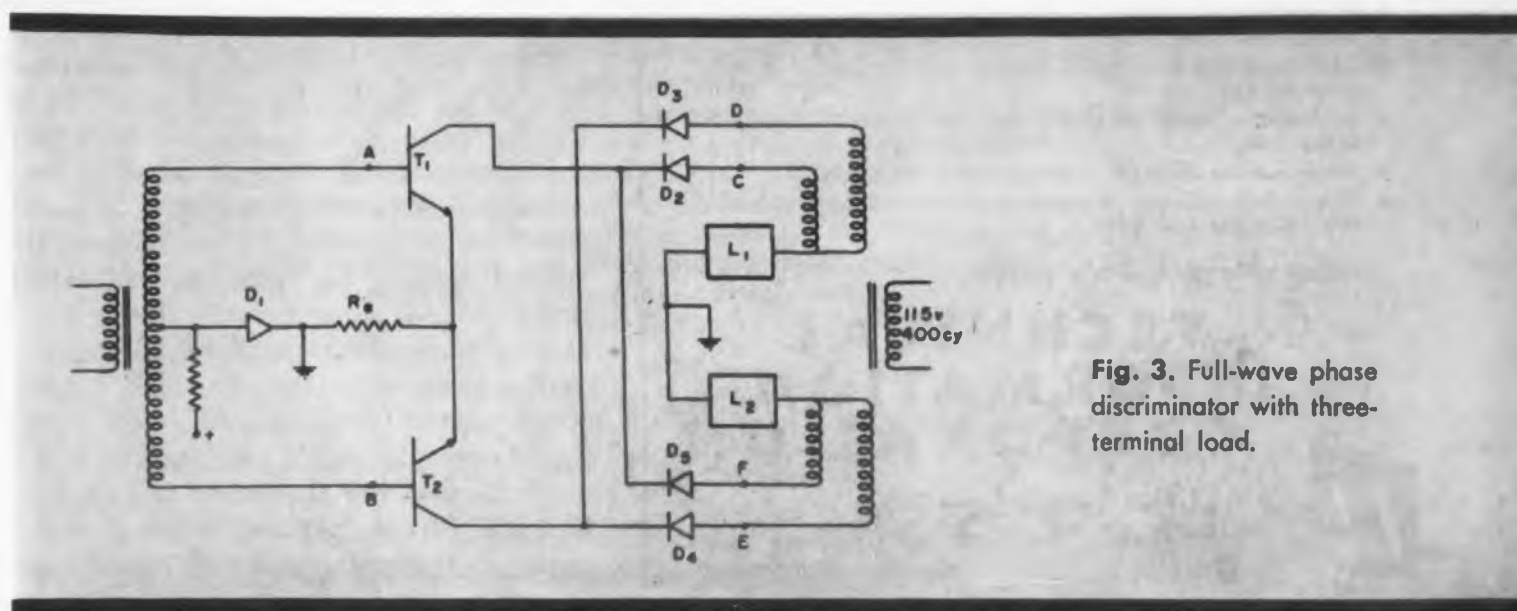


Fig. 3. Full-wave phase discriminator with three-terminal load.



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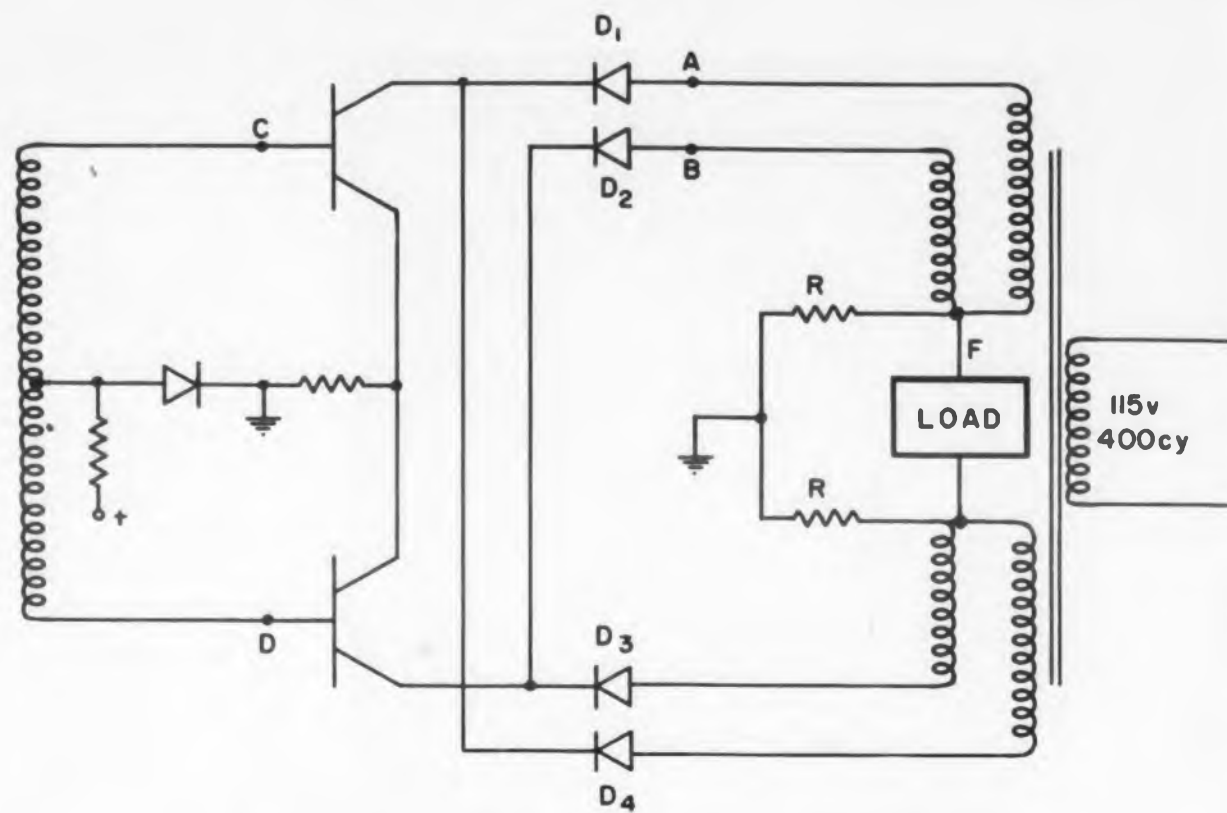


Fig. 4. Full-wave phase discriminator with two-terminal load.

draulic valve or relay drive applications. Full-wave discrimination would eliminate the need for any capacitor in most instances.

Half-wave magnetic amplifiers will present more stable performance with full-wave dc controls. More efficient control of the full-wave magnetic amplifier can be obtained with full-wave through the control windings.

Transistors can be used as well in full-wave discriminators as in half-wave.

The half-wave discriminator can be adopted to full-wave output into a three-terminal load (Fig. 3). Full-wave output is obtained through the summing of two half-wave actions.

When A and C become positive simultaneously, T_1 conducts through D_2 and the load L_1 . During this half-cycle, T_2 is cut off because of the negative signal at B. On the second half of the cycle, A and C become negative cutting off T_1 while B and D become positive. T_2 then conducts through D_3 and the load L_1 . Thus, the load experiences two half-wave current pulses during the cycle, or a full wave of current. For a 180-degree phase change in the signal, points A and F would become positive simultaneously, and conduction would occur through T_1 , D_5 , and the load L_2 for one half-cycle. For the second half-cycle, A and F would become negative while B and E become positive and T_2 would conduct through D_4 and L_2 , completing the full wave of current.

Since both transistors conduct during the cycle to provide an average or effective current, the transistors need not be matched. The same inverse voltage considerations associated with the half-wave circuitry will apply to full-wave circuitry. For balanced phase response, the diodes may have to be matched.

Constant bias voltage for the transistors is provided by D_1 . Control of forward current through D_1 establishes a desired transistor bias voltage related to the forward diode voltage drop. Bias voltage is selected in accordance with the amplitude of quiescent load current permissible for a particular application.

An additional function of D_1 is to provide some compensation for temperature changes. Transistor characteristics are such that with temperature decrease, an increase in bias voltage is required to maintain constant collector current conditions. Conversely, with temperature increase, a decrease in bias voltage is necessary to maintain constant collector current. The temperature characteristics of the bias diode are such that the forward resistance increases with decreased temperature and decreases with increased temperature. Therefore, with a constant current source to the diode, the forward voltage across the bias diode D_1 would increase with lower ambient and decrease with higher ambient. In this manner, the drop across the diode would

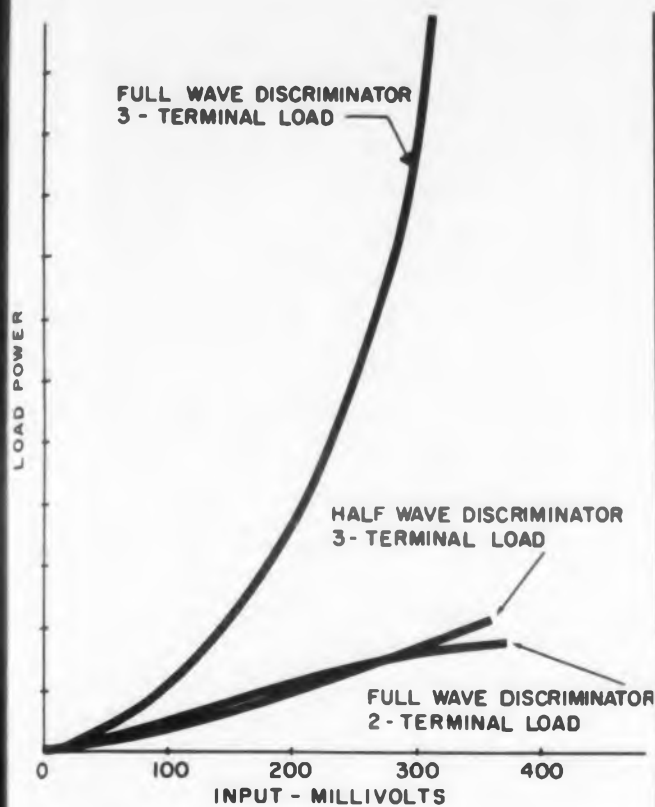


Fig. 5. Load power vs input voltage

tend to compensate for the changing bias requirements of the transistor. R_c may be added to improve transistor interchangeability.

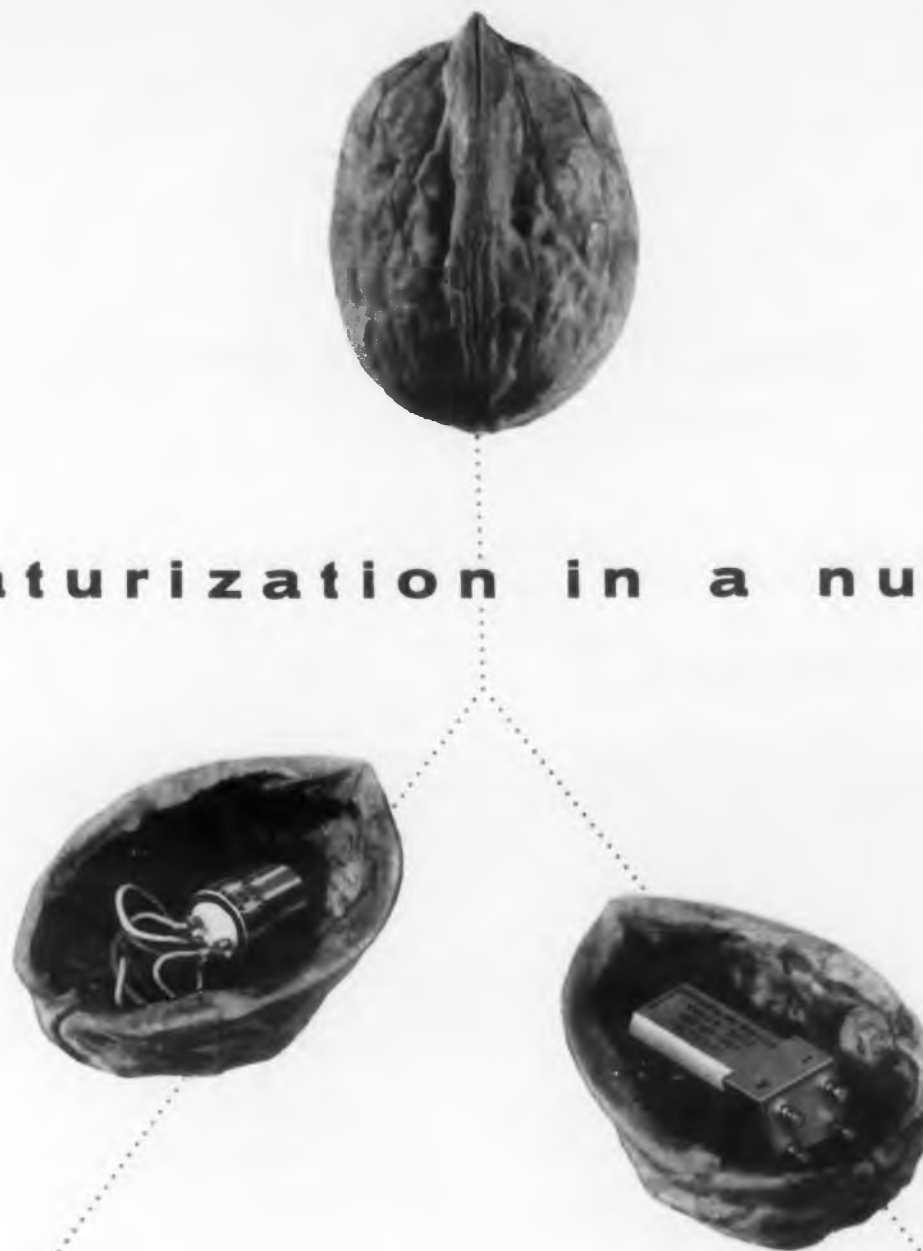
A two-terminal, phase-sensitive dc output from the full-wave discriminator can be obtained by adding bleeder resistors and connecting the load as shown in Fig. 4.

For best power transfer to the load, R is approximately equal to the load resistance. One-sixth of the output power is dissipated in the load; the remainder is lost in the bleeder resistors. Thus, this configuration is considerably less efficient than the three-terminal usage.

Current through the load will be full-wave with direction related to signal phase. When point C becomes positive, T_1 conducts through D_1 ; and the current takes two paths, one through the load and the other through R . On the next half-cycle, points D and B become positive, and T_2 conducts through D_2 and completes the full wave of current through the load. With reversed signal phase, conduction would be through D_4 and D_3 with a reversal of current direction through the load.

Fig. 5 compares load power for half-wave, full-wave three-terminal, and full-wave two-terminal transistor phase discriminators as a function of input voltage. These curves show a favorable comparison between half-wave three-terminal output and full-wave two-terminal output.

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High Voltage Semimetal Thermocouples

Robert W. Fritts
Assistant Director of Research
Baso Inc.
Milwaukee, Wis.

Editor's Note: The semimetals discussed in this article were originally developed by Dr. Fritts for use outside the electronic industry. A semimetal thermocouple heated by a gas pilot light, was designed to provide direct control of a safety valve. ELECTRONIC DESIGN feels that semimetals, which lie between metals and semiconductors in respect to electrical properties, have potential applications in electronics. The manufacture, properties, and new applications for the material are discussed.

THERMOELECTRIC materials, which generate enough power to operate relays, valves, and small motors, make possible the operation of equipment directly from a thermocouple junction. Composed of lead telluride (PbTe) modified by alloying agents, the new materials can generate power ten times more efficiently than conventional metallic thermocouples. They exhibit electrical properties between metals on the one hand and semiconductors on the other. The material used in the elements is called a semimetal to distinguish it from high resistance germanium and silicon devices.

Semimetal thermocouple elements are alloys composed principally of crystals of PbTe with minute concentrations of bismuth or sodium alloying agents to overcome the naturally high resistivity of the lead telluride. Desired electrical properties of the elements are obtained by varying the concentration of the alloying agent. The thermocouples can be manufactured at low cost since there is no need to prepare them in single crystal form, or with the high purity necessary for germanium and silicon. The elements are produced by casting ingots in carbon molds in a reducing atmosphere. They can be made with either positive or negative polarity depending on the kind of alloying agents used. Ready machinability is a further factor in low production and fabrication costs.

Positive and negative polarities in semimetals are obtained by varying the lead content in relation to the tellurium and by the addition of elements called positive promoters or negative promoters. In semimetals of positive polarity, P-type alloys, the amount of lead in the PbTe alloy ranges from 59 per cent to 61.8 per cent by weight, the positive promoter being less than 1 per cent. Semimetals of negative polarity, N-type alloys have a lead content of 61.95 per

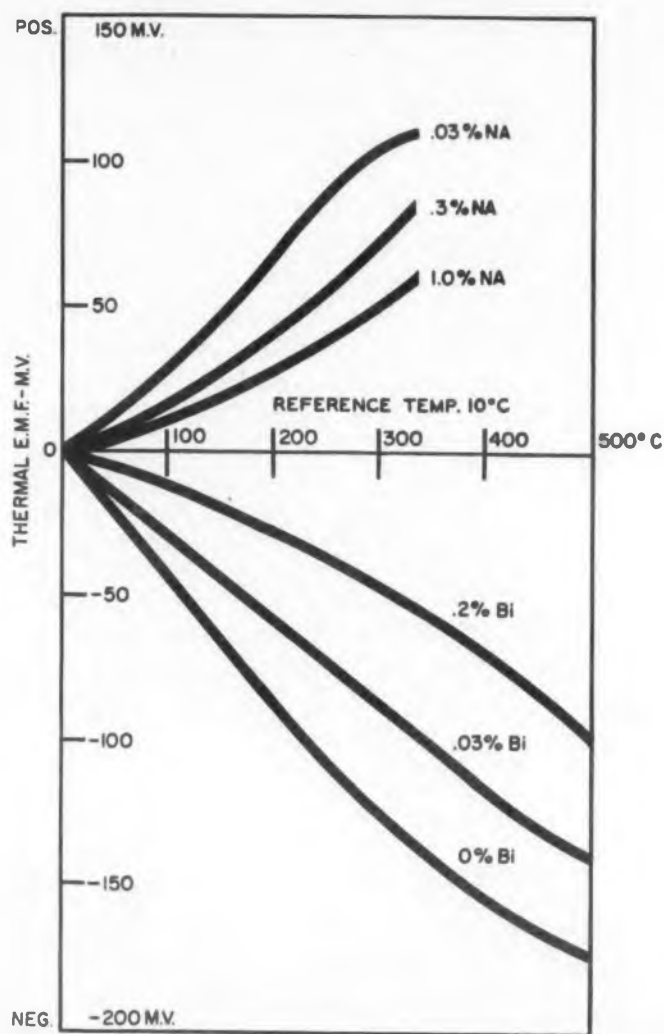


Fig. 1. Thermal emf for several specific pbTe alloys indicate the temperature and voltage ranges possible with various compositions.

ent to 63 per cent with a negative promoter gain of less than 1 per cent. Conductivity of both materials can be varied over wide ranges by changing the amounts of the promoters added. Variations of the lead content within the ranges specified has negligible effect upon the conductivity.

Operating Conditions

Both *P* and *N* ingots can be used in open air up to the melting point of tin (230 C). Above this temperature oxidation of the alloy becomes significant and hermetic sealing is necessary. The *P*-type alloy is sufficiently stable for long time service up to 350 C when operated in a non-oxidizing atmosphere. The *N*-type alloy can be used for extended service up to 600 C.

For lower temperature applications, both the *P* and *N* alloys may be soldered with tin or lead in eutectic solders. For higher temperatures, special electrode alloys have been developed to provide physically bonded ohmic contacts with a negligible contact resistance.

New Applications

Sensitive relays have been operated directly from a single *P-N* thermocouple from a temperature difference of only 85 C. Accurate control of long time delay relays can be effected by externally heating the hot junction of the relay op-

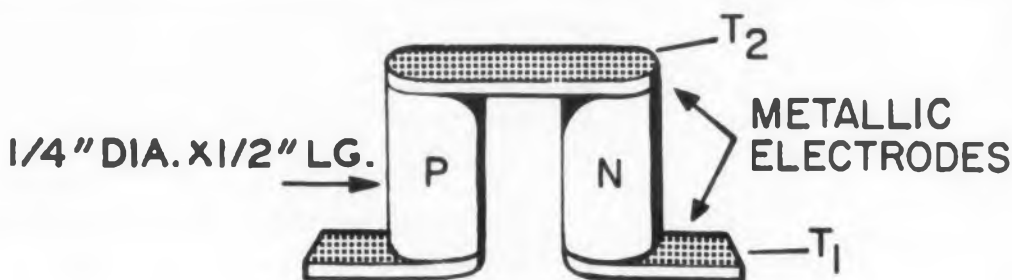


Table 1. Electrical properties possible for various alloys. Voltage sensitivity and maximum power into a matched load depend upon different choices of *P* and *N* alloys.

For High Voltage Sensitivity

T_2 °F	T_1 °F	<i>E</i> mv	<i>R</i>	<i>I</i>	Matched Load Power mw	<i>N</i> alloy	<i>P</i> alloy
550	50	197	0.12	0.82	81	.01 wt. % Bi	.002 wt. % Na
350	50	116	0.07	0.83	48	"	"

For Maximum Power To Matched Load

550	50	117	.0148	3.95	230	.10 wt. % Bi	.035 wt. % Na
350	50	65	.0106	3.06	99.7	"	.021 wt. % Na

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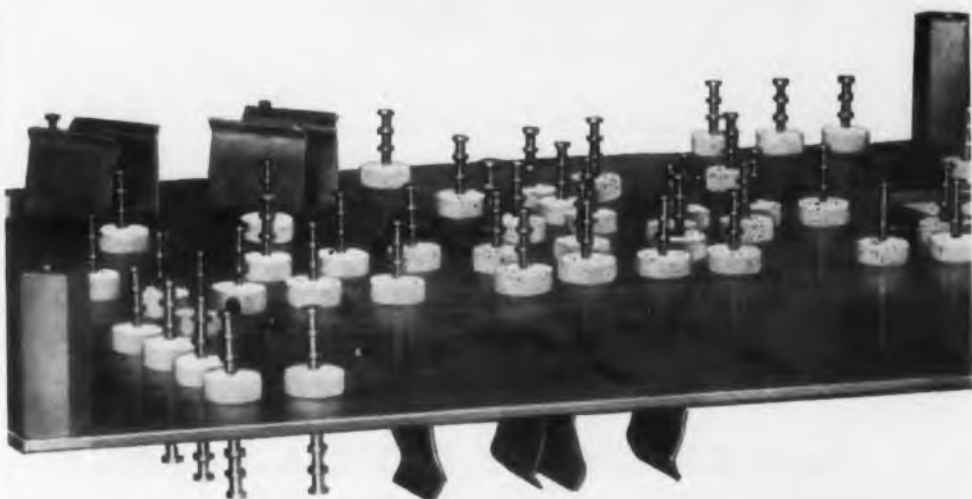
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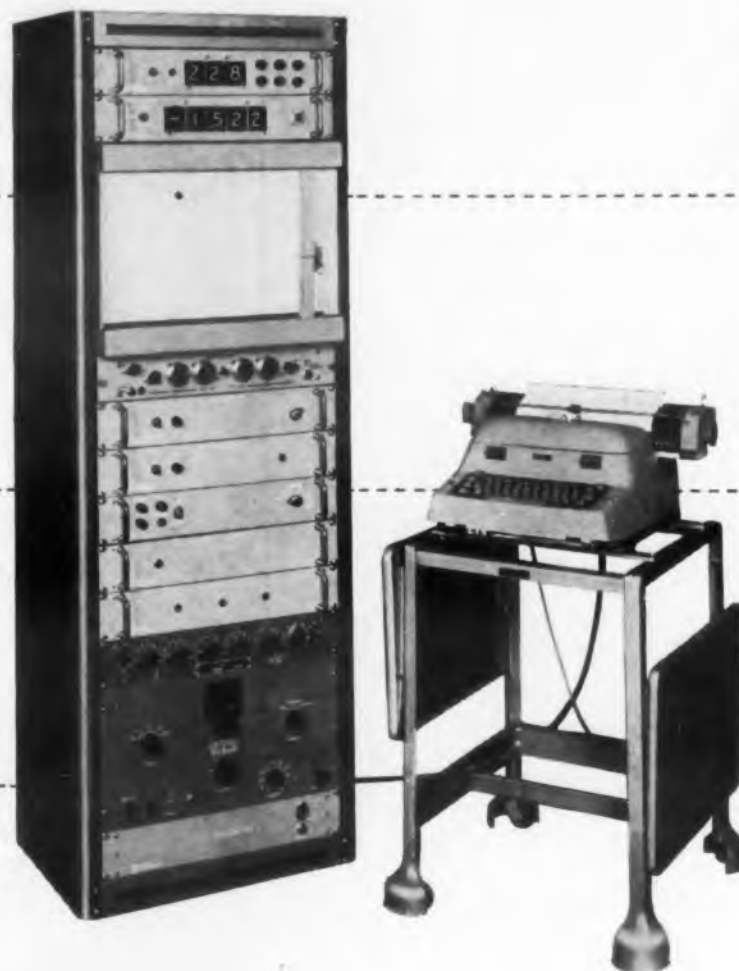
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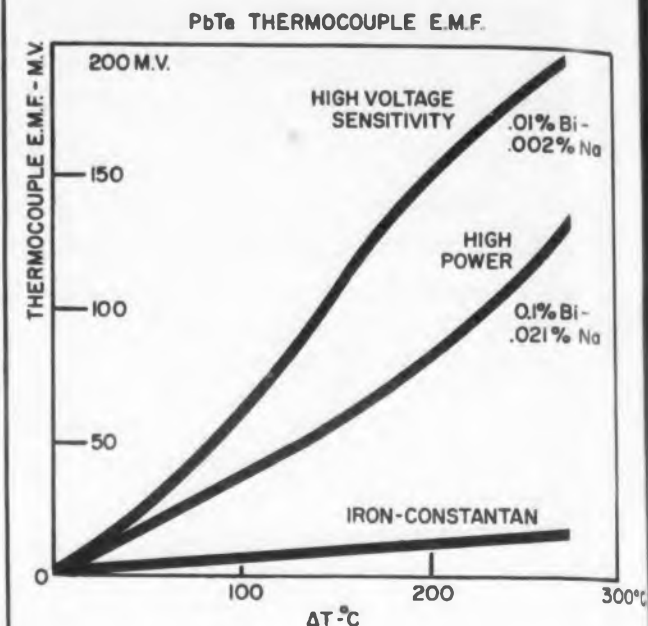


Fig. 2. Voltage composition time than an thermoc

erating thermocouple to raise its temperature slowly to the point where sufficient current is developed to actuate the relay.

One high temperature application of the N-type alloy has been the operation of valves and safety shutoff devices in the gas controls industry. The thermocouple, when heated by a small pilot flame, provides enough power to operate the safety valve. A thermopile of twelve such thermocouples has driven a small air-circulating fan from the heat of a laboratory Bunsen burner. The same thermopile operated a lamp-bank of six penlight bulbs at full brilliance. With focussing means, infrared radiation can be used as a source of electrical power.

Because of the ease with which these alloys can be fabricated, many other applications are contemplated.

Physical and Electrical Properties

When cast and hydrogen annealed, a semimetal has these physical properties:

Tensile strength	—greater than 1000 psi
Compressive strength	—greater than 10,000 psi
Young's modulus	— 2×10^6 psi
Density	—8.15 g/cc
Thermal expansion coefficient	— 18×10^{-6} /deg C
Thermal conductivity	—0.02 watts/cm/deg C

Complex relationships exist between thermal emf, resistivity, and temperature in a semimetal thermocouple. The composition for positive and negative thermocouple elements is governed by the desired function of the thermocouple and the temperature range in service. The thermal emf for several specific PbTe alloys are shown in Fig. 1. These emf's are taken with respect to cop-

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Fig. 2. Semimetal high voltage and high power compositions have up to ten times more output than an iron-constantan thermocouple.

per. When positive and negative PbTe elements are used in a single thermocouple, the thermal emf developed is the sum of emf's for the two components or the ordinate differential between the two curves. The electrical resistivity of these materials exhibits a large positive temperature coefficient at ordinary temperatures, but at elevated temperatures this coefficient becomes negative.

The shape of the resistivity-temperature curves of semimetal materials depends strongly upon the degree of alloying with negative or positive promotor. Some examples of composition and properties are shown in Table I.

A comparison of the data in Table I shows that high voltage sensitivity and maximum power delivery to a matched load cannot be obtained with a single choice of *P* and *N* compositions. High voltage sensitivity is obtained with *P* and *N* elements doped with small amounts of sodium and bismuth. High matched load power is obtained with elements doped with relatively higher amounts of these additives. The data for thermocouples designed for maximum power delivery to matched load illustrates how the selection of composition depends upon the temperature ranges to be encountered. A comparison of the voltage sensitivity of semimetal materials with conventional thermocouple alloys is shown in Fig. 2. Thermal emfs for two semimetal combinations are plotted with the voltage output of an iron constantan couple.

As is shown, semimetal high voltage sensitivity and high power compositions have up to ten times the output of the iron-constantan thermocouple.

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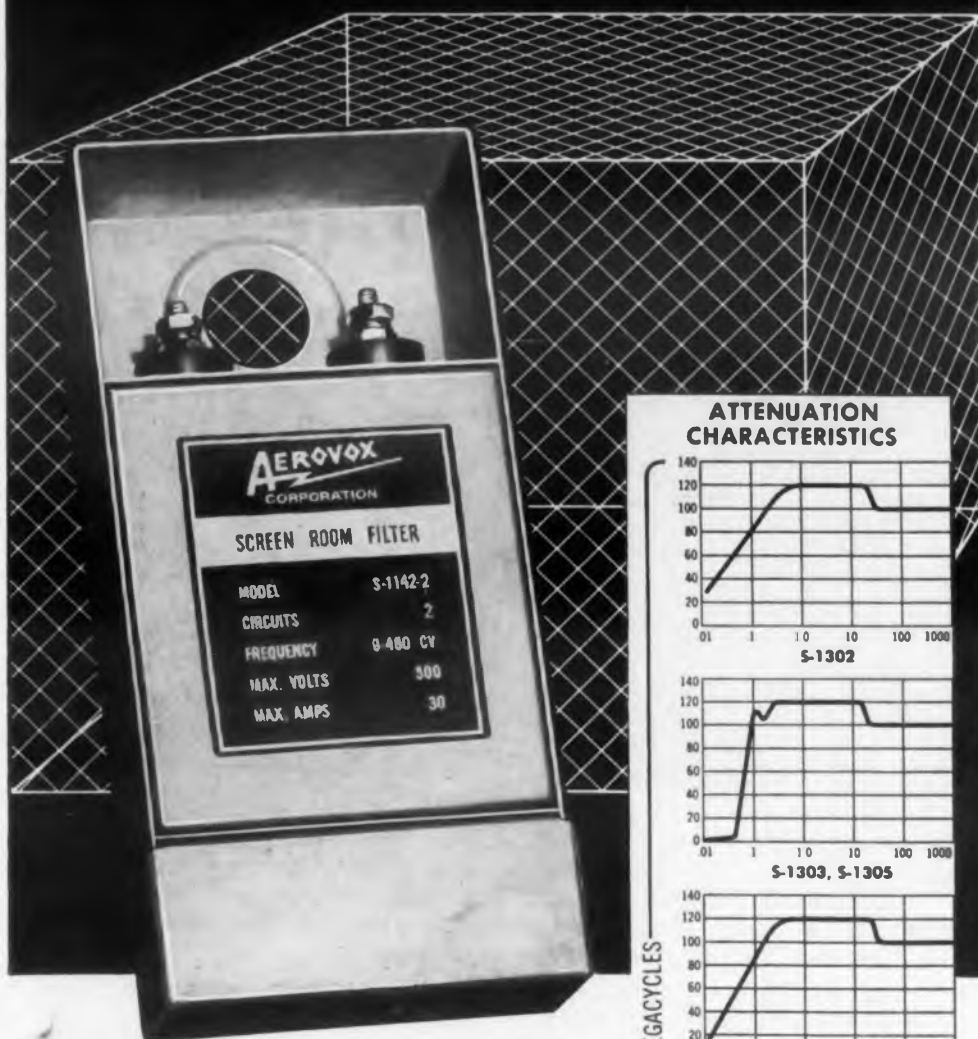
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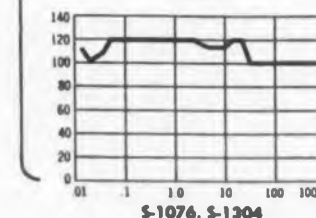
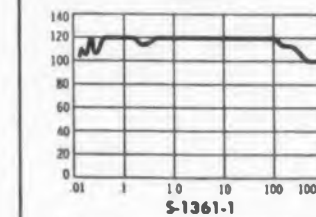
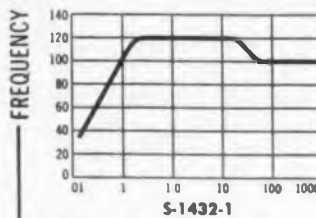
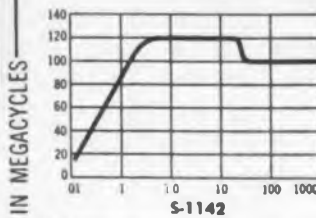
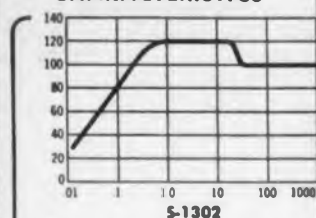
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Two Watt Amplifier In A Size 8 Can

IT'S HARD to believe that anybody could build a two watt amplifier in a size 8 shell. It's harder still to believe the amplifier could deliver two watts of 400 cycle power continuously in a 100 deg C ambient—and with no heat sink.

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impedance is 5000 ohms.

Its gain can be adjusted from 200 to 1000 with an external resistor. The entire assembly weighs only an ounce and occupies only 0.8 cubic inch.

The Precision Components Div., of Norden-Ketay Corp., of Commack, N.Y., wanted this miniature amplifier to resemble a servo motor as nearly as possible. To pack so much power capability in so small a space required a novel packaging technique.

The result was a sandwich type struc-



Size 8 motor and amplifier to drive it.

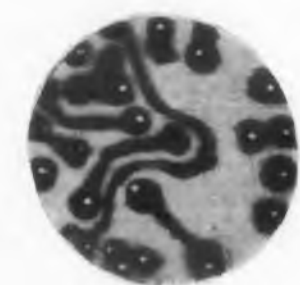


ure, easy to assemble, and very rugged. The construction uses five printed circuit boards, each 1/16 in. thick with a 3/4 in. diameter. A standard header and case, and standard resistors, capacitors, and transistors (four of them) are used. The arrangement embodies parallel sets of printed circuit boards with circuit components between. The sandwich modules are assembled first. The fifth board brings connections to the header pins. The amplifier assembly is then completed by feeding peripheral leads through outer holes at the edge of the boards for interconnection between boards and connections to the header.

The entire assembly is then resin clipped, evacuated and filled with a Monsanto liquid coolant. Finally, it is sealed in its case.

The cylindrical package lends itself ideally to the use of standard resistors and capacitors, and to the use of the standard JETEC-30 transistor case.

For more information turn to the Reader-Service card and circle 27.



Printed circuit wafers help unusual packaging technique provide 85 per cent space factor.

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W&D 5333



Radar Reflectors of Reinforced Plastic

Ralph L. Mondano
Raytheon Manufacturing Co.
Waltham, Mass.

The application of reinforced plastics in the fabrication of radar reflectors can be primarily traced to the facility with which glass-resin layups can be accurately shaped to a compound curvature. Radar reflector designers were immediately intrigued by the idea of being able to make an accurate male form upon which they could position some woven glass fabric, paint it with the new magic liquid thermosetting resins and obtain a good mechanical structure.



... as they come from the mold

PROPERTIES not obtainable or economically unobtainable in metal radar reflectors are now available in reflectors made of reinforced plastic. At Raytheon Manufacturing Company's Plastic Research Division, practical plastic reflectors have been produced which resist corrosion, are easily reproduceable, can be molded with good surface finish and are dimensionally stable. But the one most important feature is *light weight*. Yet, the strength-weight ratio is comparable to or better than for metal reflectors.

Development of a reflector in reinforced plastics, which would have all the desirable properties indicated above plus reasonable cost (competitive position cost-wise will depend on quantity), required the solution of a number of formidable problems.

Problems Encountered

In the design of plastic radar reflectors, the following questions had to be answered:

- How would the necessary metallic reflecting surface be obtained?
- Would this structure have enough rigidity when mounted and gimballed at high accelerations?
- What are the aging characteristics as well as creep problems?

- How should metal attachments be made to these reflectors?
- Is a sandwich construction more desirable than a single laminate?
- How close could these reflectors be held to the mold?
- What would be the actual tolerances of reproducibility to the mold with respect to each reflector?

Design Evolution

To make a reasonably inexpensive mold having a compound curvature with a tolerance of plus or minus 0.003 in.—and able to withstand the handling and usage encountered in making a reinforced plastic part—phenolic tool resin was decided upon. This mold was hand worked and completed to required tolerances by the use of several sets of accurately finished metal templates. But, in trying to get a reinforced plastic piece reproduced from this mold resulted in disaster. An attempt was made to fabricate the reflector by laying up and curing the outside skin, the honeycomb, and the inside skin on the mold all in one step. The approach was to use a rubber blanket technique, put the sandwich construction assembly in an autoclave, subject it to the steam temperature and pressure and, presto, complete the part. This proved a costly venture. The large heat differential caused by the rapid introduction of heat to the outside surface of the mold caused it to shatter and to fracture into many pieces. Further afterthought suggested that more reinforcement should have been used in the fabrication of the plastic mold.

A second plastic mold was fabricated and a reflector made using the vacuum-bag technique. The assembly was laid up in steps and each layup was cured under heat lamps. Dimensions of the plastic mold changed from week to week, however, distorting under average atmospheric conditions. Changes were not on the order of thousandths but *tens* of thousandths of an inch.

By natural sequence, an all-metal mold was built. Most reinforced plastic manufacturers have concluded, and in some cases the hard way, that a good reinforced plastic part requires a well-designed metal mold. This holds true regardless of the process, whether it be press molded or vacuum-bag formed.

On this metal mold it was possible to successfully fabricate the first sandwich reinforced plastic reflector, but, unfortunately, not suitable to the radar people. Polyester resin, glass skins, and polyester glass-based honeycomb were used. Mechanical checks were run on the completed reflectors to compare them to the molds. It was found that the plastic reflectors were out as much as 0.030 in. This again was in no way uniform and resembled a distorted effect. Several

polyester-glass honeycomb sandwich reflectors were fabricated, each of which exhibited poor performance when subjected to radar tests. At this time aluminum wire screening was being used, embedded in the face laminate of the reflector for the necessary radar reflecting surface. Every effort was made to avoid using epoxy resins to make radar reflectors—mainly because of the difficulties encountered in handling and releasing of the epoxy part from the mold.

But, eventually it proved necessary to fabricate an epoxy resin reflector using aluminum screening as the reflector face. This reflector performed better electrically than any of those previously made, apparently due to lower shrinkage and better stability of epoxy resins. Further work with epoxy resins made it clear that a need existed for accurately controlled curing temperature and time schedules in order to obtain a minimum of distortion.

Reinforcing Considerations

Up to this point no consideration was given to internal and external ribbing and reinforcing. A honeycomb sandwich was made with an epoxy front skin involving a special edge reinforcement, glass polyester honeycomb and a top skin of epoxy and glass, the reflector face being aluminum screening. In some reflectors, especially the airborne ones, the requirements of weight and space dictated that, if possible, no ribbing



Fig. 3. Removing parabolic-reflector sections from the mold and checking for blemishes.

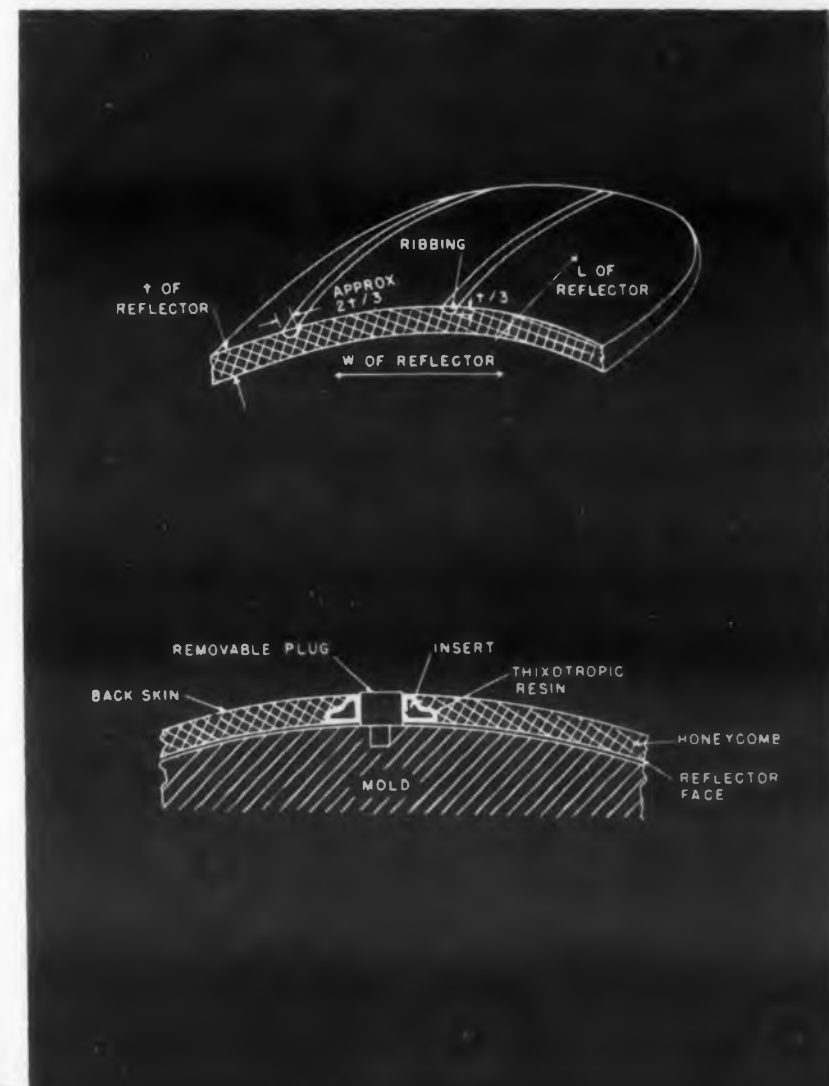


Fig. 1. How internal ribbing can be used to strengthen a reflector. The stiffening members are applied between the two skins. They are glass rovings which give unique unidirectional reinforcement.

Fig. 2. How inserts are installed. Pins and plugs are designed to hold the inserts in place during lay-up.

or build-up should be employed beyond reasonably thin honeycomb sandwiches. This led to consideration of internal ribbing (fig. 1). This consisted of adding stiffening members between the two skins, and was found to be extremely satisfactory. This produced the first suitable plastic reflector. External ribbing that would increase the thickness of the plastic reflector structure could also give added rigidity and resistance to distortion.

Production Problems

One problem that would be faced in production would be the shaping and positioning of the aluminum screening. Therefore, consideration was given to the use of other types of conductive coating. Several techniques such as conductive lacquers, electrodeposition, electroless plating and metal spray appeared feasible. A recent development is a laminating resin sufficiently dc conductive to be suitable for a radar reflective surface.

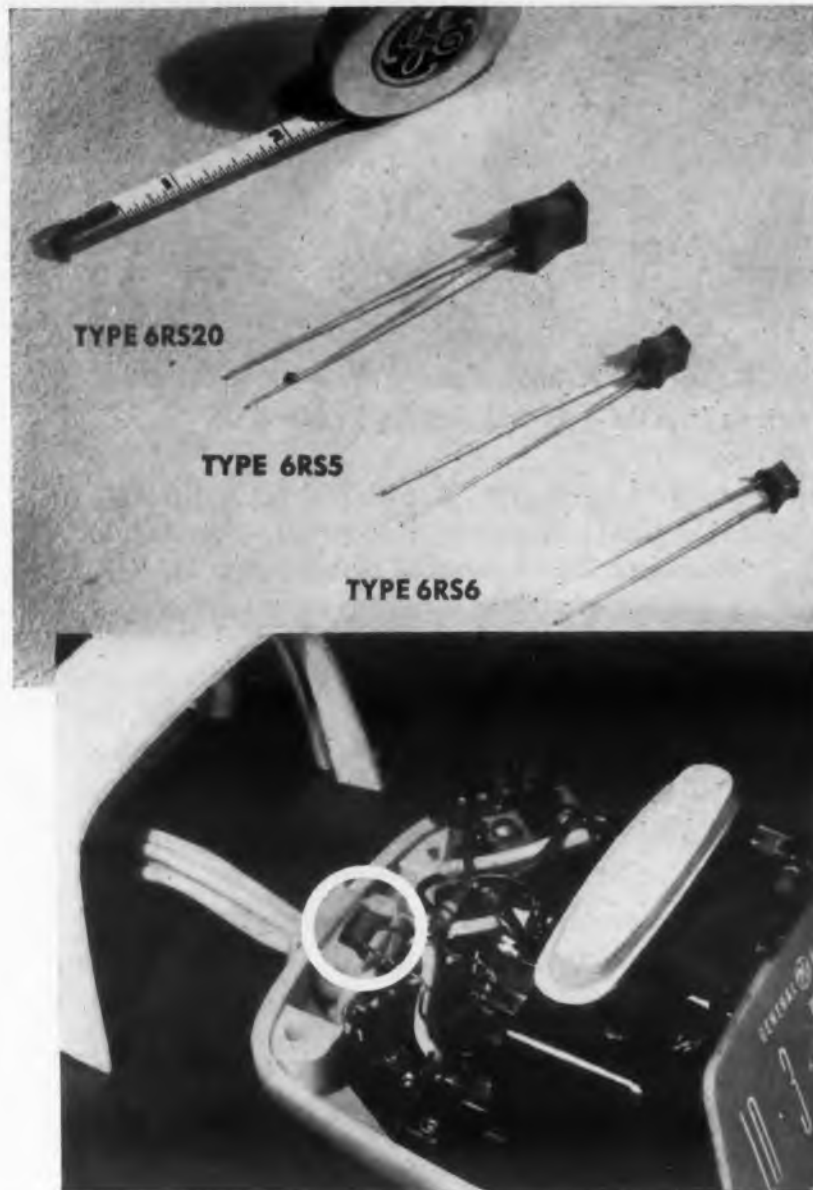
Performance Tests

One glaring obstacle at present is the temperature performance limitation. Plastic reflectors have been built and tested which have suitably performed up to temperatures of 275 F. Higher

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The advantages of Vac-u-Sel rectifiers lie in General Electric's precision vacuum process for obtaining a pure, more even deposition of selenium over the entire cell surface. This results in longer life—even at high operating ambients and better-than-normal rated current. Performance can be reliably predicted from unit to unit.

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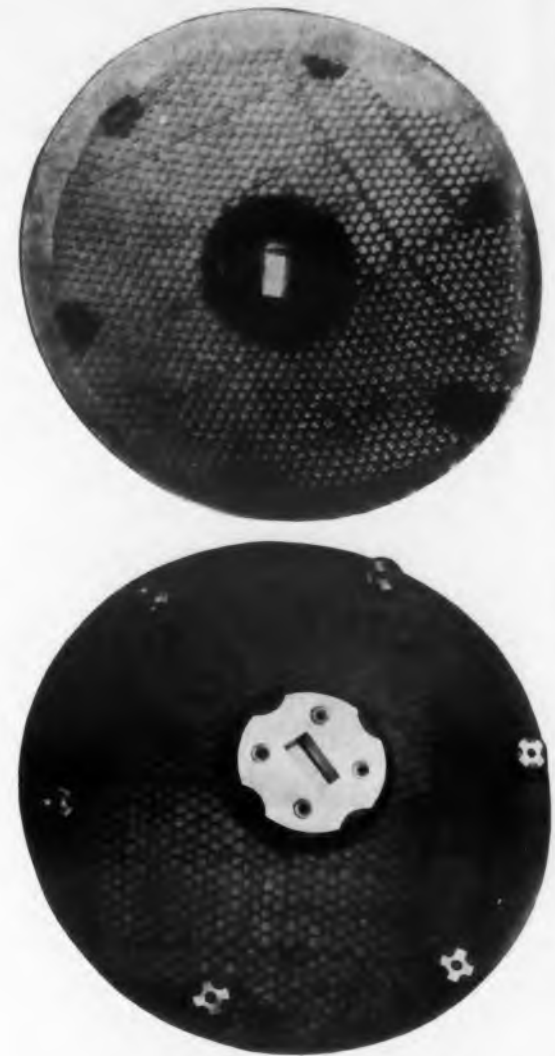


Fig. 4. Plastic-sandwich-type parabolic reflector. Front view, above and rear view, below.

temperature resins, stable at 500 F, offer promise of overcoming the present temperature performance limitation.

The structure proved to have enough rigidity at high accelerations when mounted and gimbaled. In very rigid drop tests the equipment attached to the reflector was severely damaged, while the reflector showed no visible signs of damage. All indications are that the epoxy-glass reflectors are remaining within operational tolerances, on creep and distortion with aging which would indicate the retention of mechanical tolerances. Some of the reflectors have been on test for three years.

The reflectors have successfully passed all environmental tests to which they have been subjected. One of these tests consisted of keeping the reflector at a temperature of -62°C for 48 hours and then raising the temperature to -54°C for an additional 24 hours. After being brought to room temperature, mechanical inspection for delamination, appearance, fraying, color change, contour change and loosening of hardware revealed no effect of low temperature on the reflector. Another test required that the reflector be held at its resonant frequency for 6 hours. Again there was no mechanical damage. Drop testing at 8 g and 15 g did not damage the re-

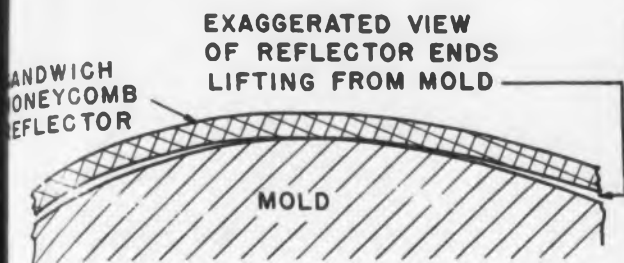


Fig. 5. How the edges of the sandwich honeycomb tend to lift away from the mold on curing. This tendency must be accounted for in mold design but is accurately reproducible from reflector to reflector.

reflector. Electrical pattern checks have shown that the plastic reflector compares favorably with an all-metal reflector in beam width and side lobe characteristics.

Metal Attachments

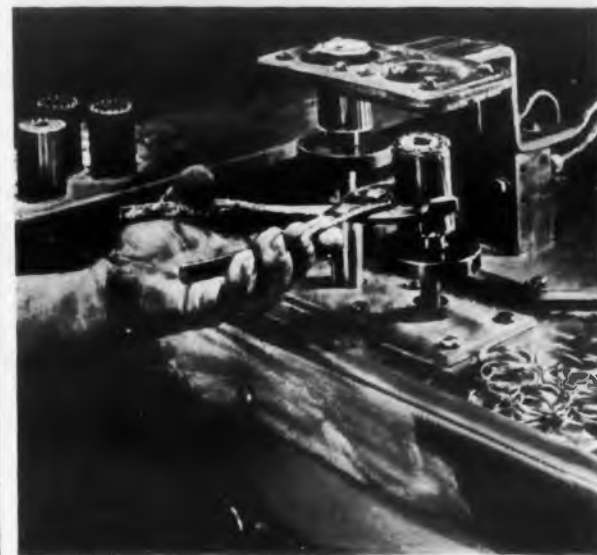
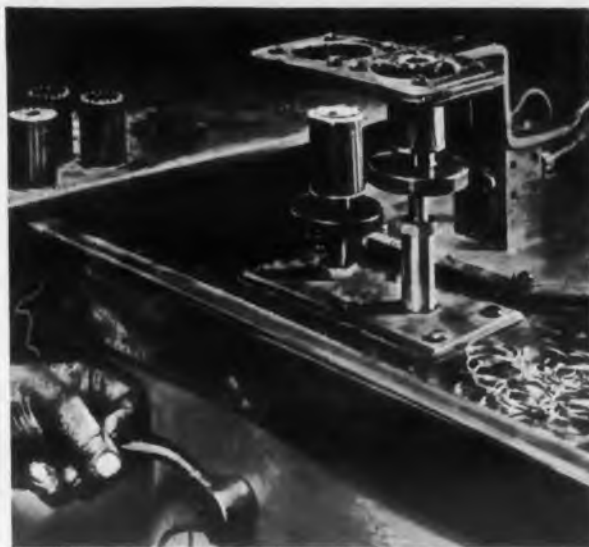
Metal attachments can be easily fastened to molded-in inserts. Including inserts in the mold decreased the time and effort of locating and positioning attachments and allowed through holes for wave-guide horn feeds—a valuable innovation to the manufacturing technique. Pins and plugs could be designed to hold inserts that would remain an integral part of the sandwich structure similar to that shown in fig. 2.

A sandwich construction was found to be much more desirable than a single laminate mainly because it proved to have the best weight-stability factor. Reflectors were fabricated up to a laminate thickness of 3/8 in., mainly, to study the dimensional stability possible. An attempt was made to obtain the best possible solid laminate reproduction of the mold by utilizing staggered orientation of glass fabric and a slow, low temperature cure technique. Even so, the laminate structure proved less satisfactory than the sandwich structure.

Tolerances

The actual degree to which the best sandwich structure reflectors can be held to the mold varies with reflector size, design, and shape. A simple parabolic reflector, fig. 4, displayed exceptionally good reproducibility, yet, it defied techniques to establish tolerances. Mold tolerance reproducibility of the parabolic section reflector in fig. 3 also proved a difficult job. With reflectors approximately five feet long, the tips of the reflector showed a slight tendency to lift off, as shown in fig. 5. However, the reproducibility of one reflector to the next proved excellent by actual performance tests.

Extensive work has been done with plastic and metal reflectors involving fiberglass, CTL honeycomb and magnesium skins, and aluminum honeycomb and magnesium skins, making use of high-temperature plastic interface bonding.



FIRST, BULLETIN 20

This informative booklet will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. A copy awaits your request.

Induction Motors Corp. of Westbury, New York, and Maywood, California, has built an outstanding reputation as a designer and manufacturer of sub-fractional horsepower motors...for 5427 high performance reasons.

This large variety of motors, blowers and fans for an equally large variety of applications, stems from 15 basic motor frame sizes, depending on length, pole materials, windings, groove angles and the like.

Handy & Harman silver alloy brazing is concerned with brazing the rotors. Each rotor (whatever the size) is joined by a preformed ring of Handy & Harman SIL-FOS, by induction heating — at an alloy cost that is reckoned in pennies. For example, the alloy cost per 7/8" frame is two cents per joint, or four cents per complete assembly.

That's an example of the economics of silver alloy brazing. Performance requirements are quite another thing — and they are unquestionably stringent. Many of these motors are used in aircraft and missile work and must, of course, meet the most extreme environmental conditions.

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discuss the merits of silver alloy brazing... and to point out as a reason for its wide acceptance throughout industry. The facts are that there are many more benefits; gas- and leak-tightness, thermal and electrical conductivity, ductility, and production economy — are all *joint qualities* of silver alloy brazing. At any time, we will be happy to discuss any or all of these qualities (and others), as applied to your product or production method. The benefits are large and you can enjoy them.

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New Delay Line

triples delay/rise-time ratio

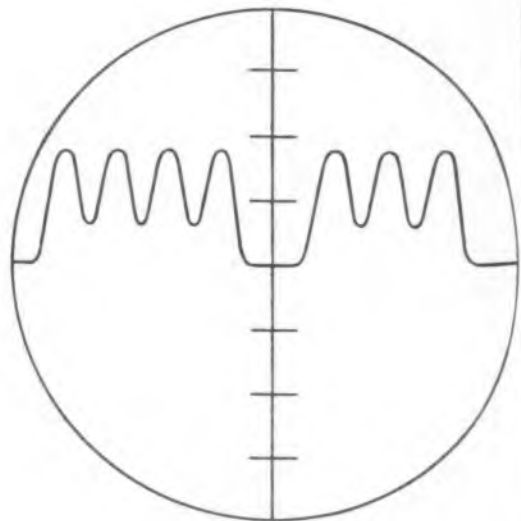
DESIGNERS of radar recognition systems can do a better job of encoding and decoding information, thanks to a new lumped constant delay line. With no sacrifice in reliability, this line performs three times better than older lines.

Its figure of merit, or delay to rise time ratio, is 145, compared with 50, formerly considered the practical upper limit. This enables computer engineers to design delay line memories with 72 bit storage capacity rather than 25.

Engineers at ESC Corp., in Palisades Park, N. J. feel their new family of delay lines with their faster rise times, better figures of merit, and greater bandwidth, can encompass applications previously beyond the scope of a delay line.

Radar engineers have been using delay lines for their high reliability, long term accuracy, thermal stability, and simple circuitry. But these lines limited the amount of information radar systems could handle.

The number of codes they can handle and their ability to distinguish code groups depend on system bandwidth.



Pulse train after transmission through a delay line with a delay-to-rise-time ratio of 50 to 1.

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But former lines, with their relatively long rise times, narrowed the bandwidth. (Bandwidth is inversely proportional to rise time.)

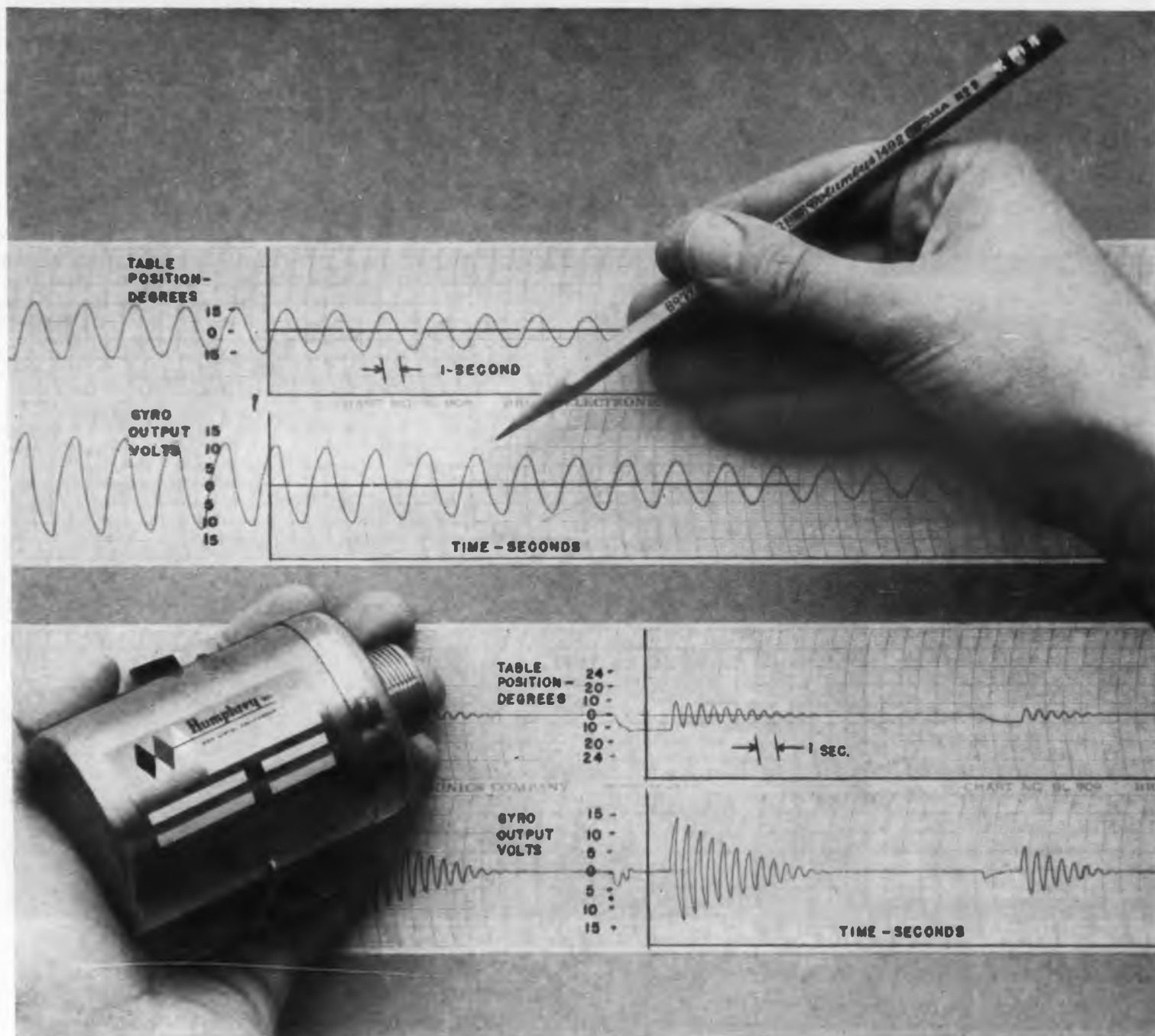
With older lines, engineers were forced to resort to additional circuitry to boost system performance. One approach used pulse shaping circuits at discrete time intervals along the delay line. This improved the situation, but at the expense of circuit simplicity—hence reliability.

It is theoretically possible to make delay lines with any delay to rise time ratio by cascading low pass filter sections with the desired phase and frequency characteristics. But practical delay lines cannot realize the ideal because of the limits imposed by their components, particularly inductors, with low Q's on the order of 50 or 100.

ESC's new lines use advanced design techniques and higher Q inductors to reach their unprecedented figure of merit. The only sacrifice they've made is size, and not much of that. Lines with the figure of merit of 145 measure 3 x 4-1/2 x 8-1/2 in. compared with the 2 x 4 x 8 dimensions for similar lines with a merit figure of 50.

Like former lines, their temperature coefficient of delay is less than 65 ppm per deg C, and can be improved considerably. They can be tapped to within 0.1 per cent of total delay, while former lines could be tapped only to 0.5 per cent.

For more information, turn to the Reader-Service card and circle 32.



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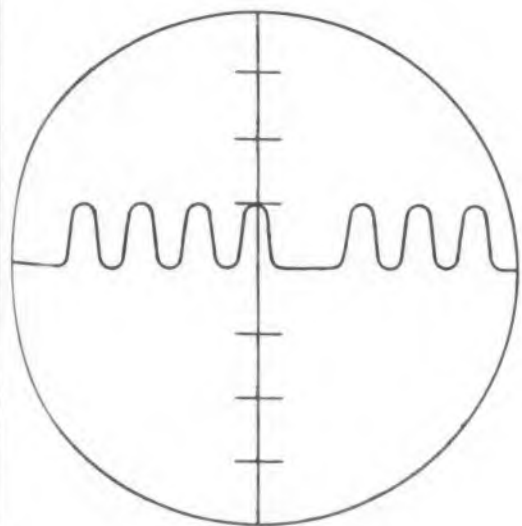
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CIRCLE 34 ON READER-SERVICE CARD

Pitfalls in Precision AC Measurements

Dr. H. A. Poehler
Section Head
General Precision Lab., Inc.
Pleasantville, N. Y.

Part 1

THE MOST common pitfalls in ac high precision measurements can be attributed to ground loops; loading effects; improper connections of shielded cables; harmonics in the null; calibration at an impedance different from that used in the measurement; and cancellation of errors in an overall measurement. Errors created by ground loops, loading effects, and harmonics in the null are examined and illustrative examples of typical circuit errors are presented.

A subsequent article will consider the remaining sources of error outlined above.

Ground Loops

Lack of attention to grounding connections can lead to appreciable errors in precision measurements. The errors lie in the difference in potential which may exist between different grounds. A circulation of current, therefore, takes place through the "ground loops" and results in unrecognized IR drops.

An example of a ground loop is given in Fig. 1 in the circuit used to measure the output voltage of a tachometer. The loop is set up by double grounding at points A and B. Since the power source is generally located at one end of the equipment and the tachometer to be tested is located at the other, the existence of the double ground is not always as obvious as it appears in the figure. The error in this measurement is the potential drop produced by the ground current in flowing from C to B. Removal of the ground at A will free the circuit from this current.

Loading Effects

The input impedance of the null detector is also frequently neglected. Fig. 2 shows a typical circuit for the measurement of the voltage ratio of a transformer. The input capacity of the null detector, and the capacity of the ground terminal of the null detector with respect to ground are

(Continued on page 43)

The problems encountered in high precision measurements are in some ways analogous to those encountered in high frequency measurements. It is, therefore, possible to draw from the techniques used in the h-f fields to analyze these problems. This article discusses the commonly incurred errors in precision ac measurements and some corrective techniques.

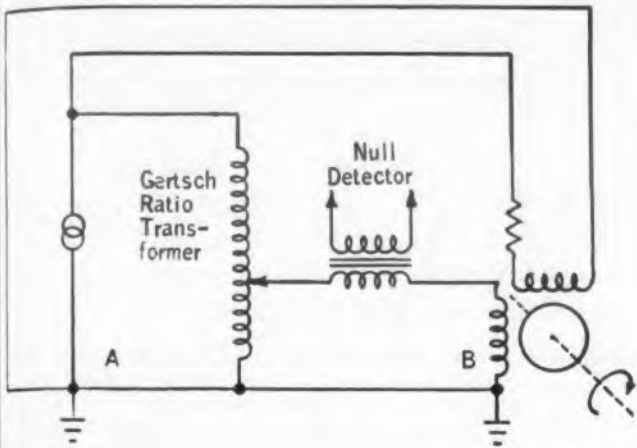


Fig. 1. Ground loop in the circuit for the measurement of the output of a tachometer.

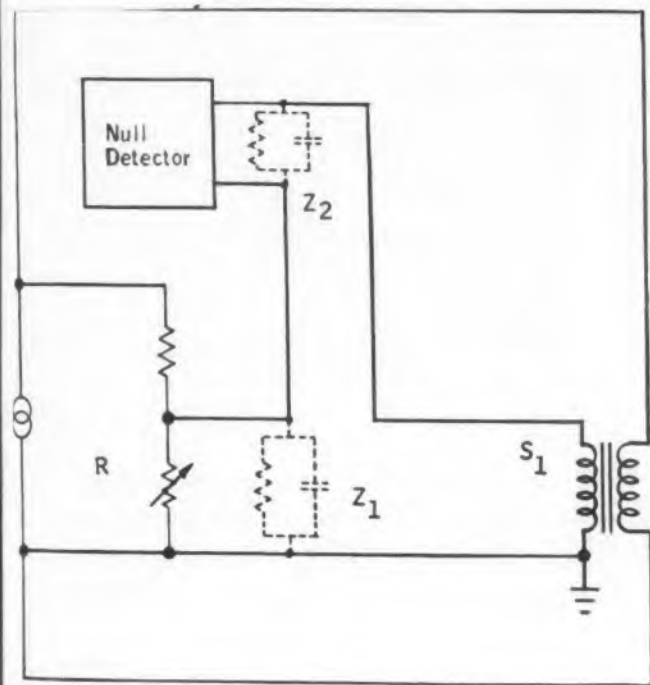


Fig. 2. Circuit for measuring the output ratio of a transformer. Error is introduced by the loading effect of the null detector.

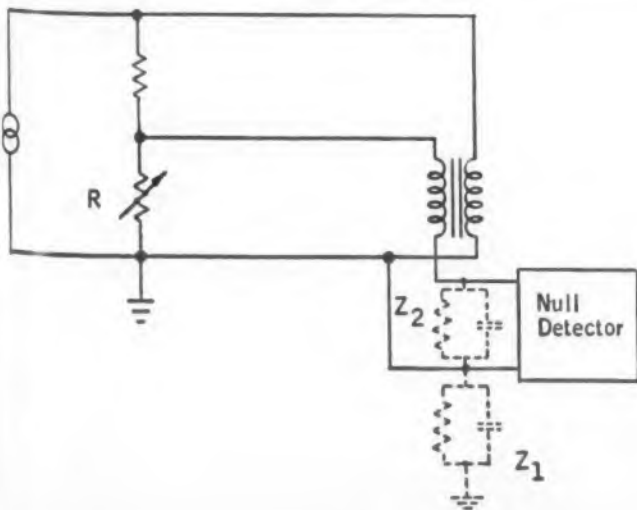


Fig. 3. The Null Detector is properly connected. There is no loading effect.

Quiggley's

Breakfast

Brainstorm



...or the case of the sub-miniature toroids

Major Quiggley, DC, AC, etc. banged his fist on the table and stared with fascination at the breakfast cereal before him. "Eureka! I've got it!" he bellowed with enthusiasm. "Sub-miniature toroids, just the size of these Cheerios* to solve our limited space problems!"

The major beamed with satisfaction. "Great idea!" he purred. "I'll call B & W and get them to develop it!"

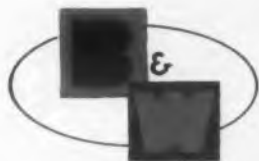
Major Quiggley rushed to the office, put through a call to Barker & Williamson, and rapidly outlined his earth-shaking idea. "It will revolutionize the industry!" he concluded with final triumph.

Tactfully, the harassed sales manager explained that B & W had not only been manufacturing toroids the size of Cheerios for many years, but also have available a complete line of sub-miniature as well as larger types. He indicated that many of the toroids were so small that the center hole was only $\frac{1}{16}$ " in diameter! Quiggley sputtered, "You should let a feller know, old chap! Send one of your sales engineers right over!"

Here's What Major Quiggley Learned About Toroids from the B & W Sales Engineer:

- *Sizes*—B & W manufactures a complete range of standard and special toroid coils and related networks.
- *Tolerances*—5% for standard types and as close as 1% for specials.
- *Finishes*—plain—waxed—tape wrapped—encapsulated, or hermetically sealed to MIL-T-27A Specs where required.
- *Delivery*—To meet your requirements in time and quantity.

*Reg. Trademark—General Mills



Barker & Williamson, Inc.

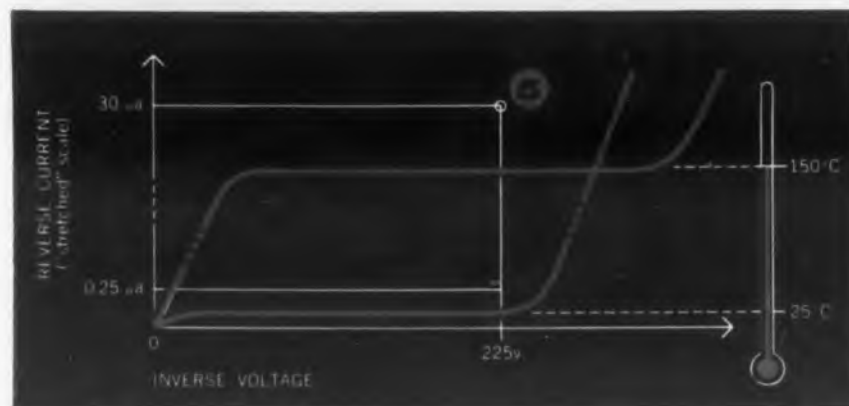
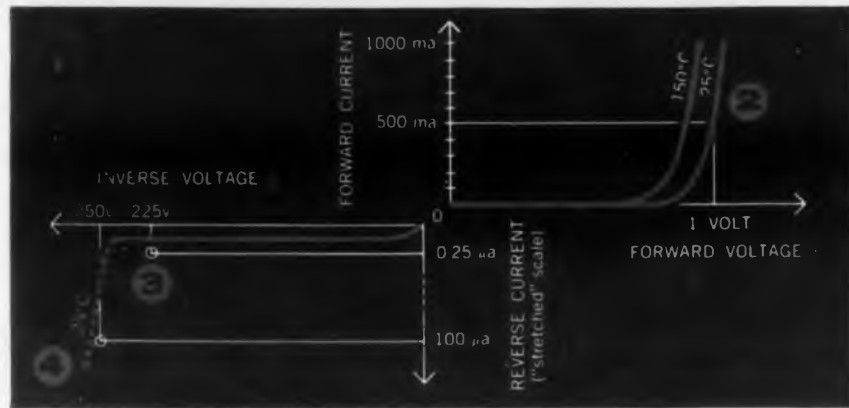
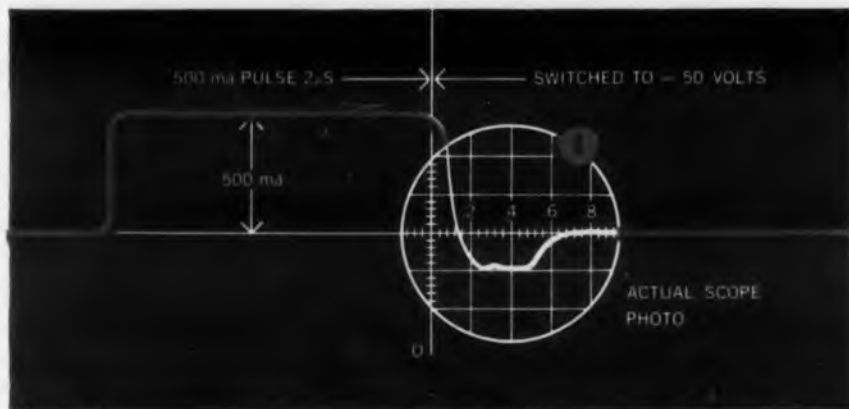
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● **HIGH FORWARD CONDUCTANCE.** The forward current specification is 400 ma at 25° C with 1.0 volt maximum drop under static (d-c) conditions. Conductivity increases with temperature — diagram shows typical "x-y" plots at 25° and 150° C.

● **LOW LEAKAGE** at high inverse voltage. Specification at 25° C is maximum 0.25 μa at rated voltages.

● **HIGH INVERSE VOLTAGE.** Saturation voltages can be supplied in a range from 40 to 200 volts for this high current series.

● **HIGH-TEMPERATURE OPERATION.** Typically, leakage current is no greater than 30 μa at working inverse voltage and 150° C. Diodes are rated for both operation and storage at temperatures from -65° to +150° C.

SPERRY SEMICONDUCTOR DIVISION
SPERRY RAND CORPORATION
South Norwalk, Connecticut

ADDRESS ALL INQUIRIES: Marketing Department, Great Neck, N. Y., or Sperry Gyroscope offices in Brooklyn, Cleveland, Seattle, San Francisco, Los Angeles, New Orleans, Boston, Baltimore, Philadelphia.

CIRCLE 36 ON READER-SERVICE CARD

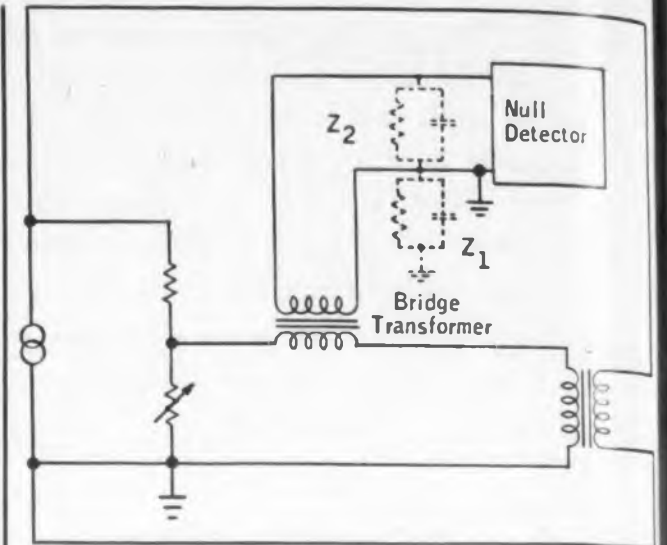


Fig. 4. The use of a bridge transformer permits the known and unknown voltage to have one side grounded. The null detector is properly connected and no loading error is introduced.

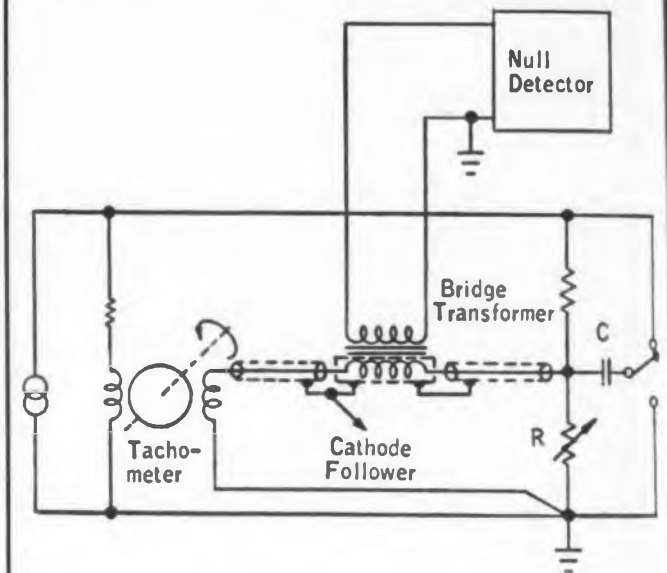


Fig. 5. Circuit for the measurement of the output voltage of a tachometer where errors arise from the presence of harmonics in the null.

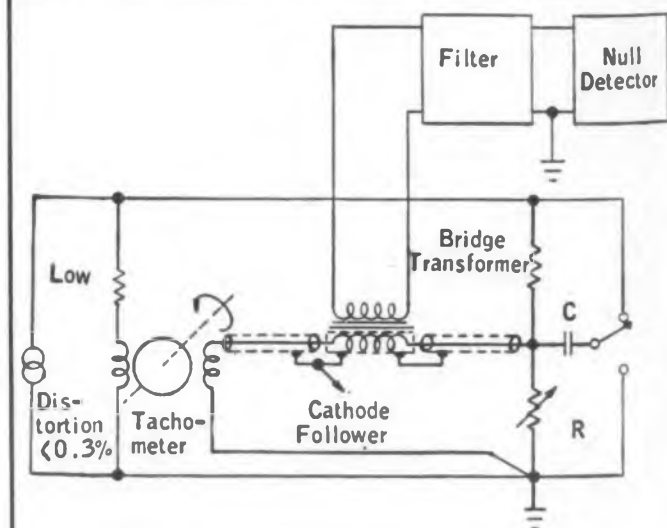


Fig. 6. Errors arising from the presence of harmonics in the null have been eliminated by a suitable filter and by reduction of the distortion in the power supply.

shown. The capacities of the null detector will cause appreciable errors unless the impedances Z_1 and Z_2 are negligible compared to the impedance R and the output impedance at S_1 .

A circuit which avoids these pitfalls is shown in Fig. 3. Note that the impedance Z_1 is shorted out, and that Z_2 has zero voltage applied to it at null.

The latter principle can be applied quite generally. Whenever a disturbing impedance cannot be eliminated in a measurement circuit, the circuit may be arranged so that the voltage across this impedance is zero at the null.

In cases where it is necessary to ground both the resistance divider and the output winding of the transformer a bridge transformer may be used as in Fig. 4. The disturbing effects of Z_1 and Z_2 are here eliminated.

Harmonics In the Null

Considerable errors in measurement may result when the effect of the harmonics and pickup on the null detector are ignored.

A typical example is shown in Fig. 5 where the output voltage of a tachometer is measured. Suppose R and C are adjusted for a balance as indicated by a phase-sensitive voltmeter, such as a Phazor. In a practical case where the output of the tachometer is 6000 mv and measurements are desired to ± 0.5 mv, harmonic errors of as much as 6 mv have been observed. The difficulty arises since the phase-sensitive voltmeters are not insensitive to harmonics pickup in the null.

For precision measurement harmonics should be less than 10 times the desired minimum-detectable signal. In a case where it is desired to measure within 0.5 mv, the maximum permissible harmonic level in the null is 5 mv.

It is common practice, unfortunately, to attempt a measurement of a 1 mv in-phase signal in the presence of harmonic residuals of 200 mv.

At least two means of reducing the harmonic content of the null signal are available:

- The distortion in the supply voltage should be reduced by reducing the distortion at the output of the oscillator feeding the amplifier, or by reducing the distortion in the amplifier;
- The null signal at the null detector should be filtered.

For precision measurements, the distortion in the output voltage should not exceed 0.3 per cent total. Phase shift in the filter will not affect the accuracy of the measurement, provided that both the in-phase and the quadrature components of the null are adjusted to zero. It is inconvenient, however, to use filters with too large a phase shift, since an in-phase adjustment of the null causes changes in both the in-phase and the quadrature components.

The circuit of Fig. 6 indicates application of these principles to avoid harmonics in the null.

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(B) Boiled-down version of popular $\frac{1}{4}$ " control, Series 44 is no bigger than a dime! 0.2 watt rating. 0.015 lb. 500 ohms to 5 megohms. With or without switch. Popular in hearing aids, pocket radios and other compact assemblies.

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CIRCLE 37 ON READER-SERVICE CARD

Overlap Method

Makes Fast Pulses

In Transistor Circuits

Mark Smith
Bogue Electric Mfg. Co.
Paterson, N.J.

Overlapping a pulse and a delayed pulse can provide very high pulse repetition rates with very steep rise and fall times. The technique employs delay lines to provide very high quality pulses.

CONVENTIONAL transistorized pulse generators usually cannot provide fast, flat-topped pulses. Where repetition rates and amplitudes must be very high, and rise and fall times must be very low, the overlap technique may be just what the doctor ordered.

This technique involves more elaborate circuitry. It consists in taking the pulse as the overlap between a positive and negative step, displaced by a time interval equal to the desired

pulse width. Though this technique is not new (see Ref. 1), its description with logical diagrams suggests many circuits by which the overlap can be obtained.

Logic

In Fig. 1, the arrow-headed lines may have one of two possible values, "0" or "1." Electrically, these values are represented by a high and a low voltage respectively. The "NOT" block in Fig. 1a

inverts its input, so that if its input, X_d , is a "0," its output, X_d' , is a "1." A plate amplifier can perform this inversion nicely.

The "AND" block provides a "1" at its output only when both inputs are "1." The expression, XX_d' , signifies X "AND" X_d' . One type of "AND" circuit has two plate amplifiers with a common load resistor, followed by a second plate amplifier. The second amplifier has a "NOT" function, and is needed because the first two plate ampli-

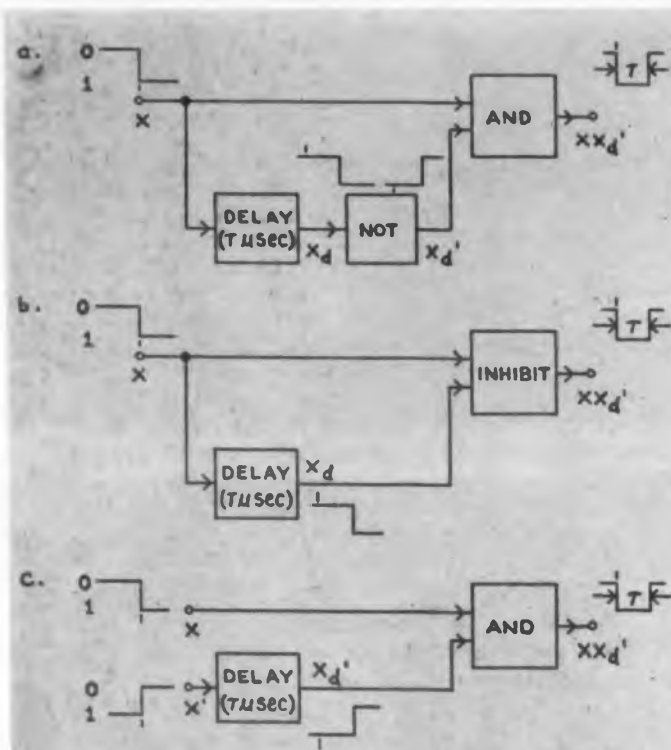


Fig. 1. Logical diagrams show many ways to produce overlapped pulses. Note the shift of the pulses with respect to the timing marks.

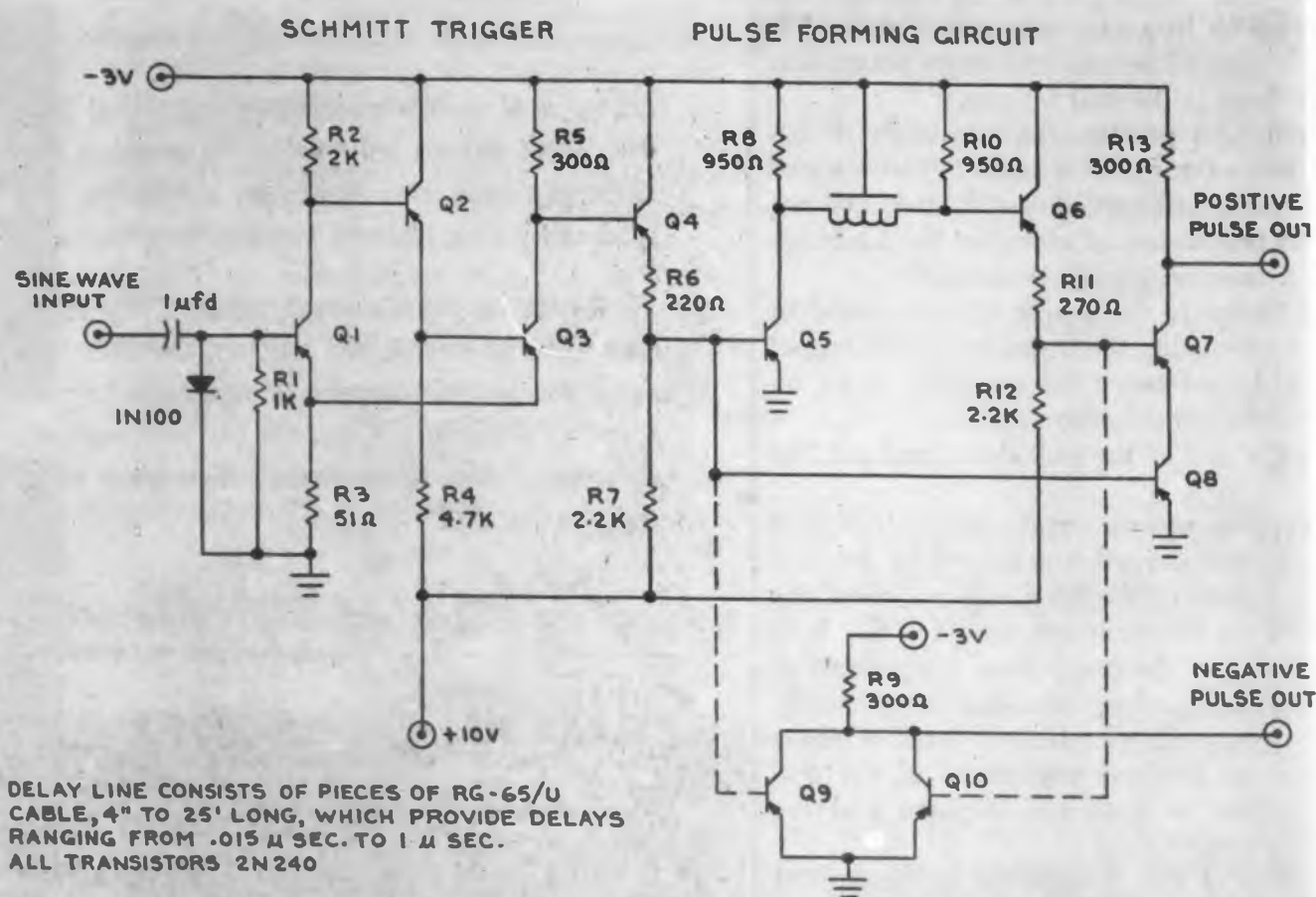


Fig. 2. This circuit, described in the text, provides unusually fast, high quality pulses.

ers invert the signal. The "DELAY" block reproduces the input signal at a later time, as shown by the shift in the pulse with reference to the timing mark.

Fig. 1 shows how logical building blocks may be used to generate pulses. Many circuits are available to produce the simple logical functions, "AND," "OR," "NOT," and "INHIBIT."

Fig. 1b shows an "INHIBIT" block which simply combines the functions of the "NOT" and "AND" blocks. The level of its output is at "1" only when one of its inputs is a "1" and the other is a "0."

Fig. 1c shows the overlap method applied where both the positive and negative steps are available. Both steps are available from multivibrators, Eccles-Jordan flip-flops, or Schmitt triggers. The overlap method is suitable when these circuits provide leading and trailing edges which are short enough for the desired pulse.

This technique is particularly useful as a substitute for R-C differentiators in circuits like binary counters. It has three main advantages:

1. The counter output has pulses only of the polarity selected;

2. There is no trailoff;

3. Nonlinearity of the edges of the flip-flop output is not emphasized.

A Fast Pulse Generator

How It Works. Fig. 2 shows a Schmitt trigger driving a pulse forming circuit which uses the overlap technique. The Schmitt trigger delivers a negative going step across R7. This causes Q5 to swing from cutoff to saturation. Since a negative input provides a positive output, Q5 has provided the "NOT" function.

At the time Q5 is driven into saturation, current is driven into the base of Q8. Since Q7's base is also negative at this time, both Q7 and Q8 saturate, bringing Q7's collector to about zero volts.

After a time equal to the electrical length of the delay line, the collector voltage of Q5 appears at the input of the emitter follower Q6. Its output, taken across R12, cuts Q7 off, so Q7's collector returns to -3 v.

The result of all this is a positive pulse at Q7's collector as wide as the length of the delay line. The Schmitt trigger which drives this pulse-former must have a positive going edge which is faster than the electrical length of the delay line.

Q7, Q8, and R13 do not provide the "AND" function referred to in Fig. 1a. "AND" may be performed by applying the positive pulse to a grounded emitter amplifier. However, if a negative pulse is needed, it may be obtained at the collector of Q10 when the connections indicated by the broken lines are made.

(Continued on page 47)

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Insulation Resistance: See curve reproduced below for typical performance.

Lead Pull Test: Steady force of 10 lbs. applied axially for 60 seconds.

Life Test: 250 hours at 85° C and 125% of rated voltage.

Capacity Tolerances to ± 1%.

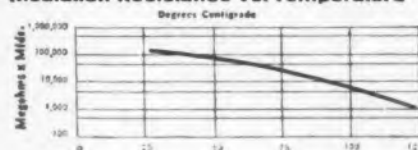
Humidity Resistance: Far exceeds requirements of RETMA Apec. REC — 118 — A.

Temperature Range: Operation at rated voltage from -60° C to +85° C; and to +125° C with 50% derating.

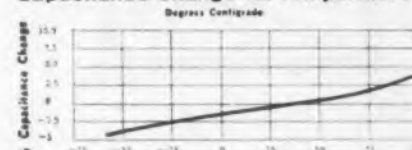
TYPICAL SIZES

Capacity	100 Volts	200 Volts	400 Volts
.001	.156 x 1/2	.156 x 1/2	.156 x 3/8
.0047	.156 x 1/2	.156 x 1/2	.186 x 3/8
.01	.156 x 1/2	.171 x 3/8	.250 x 3/8
.047	.234 x 3/4	.296 x 3/4	.343 x 7/8
.1	.281 x 7/8	.375 x 7/8	.421 x 1
.47	.468 x 1 1/4	.546 x 1 1/4	.671 x 1 1/4

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Capacitance Change vs. Temperature



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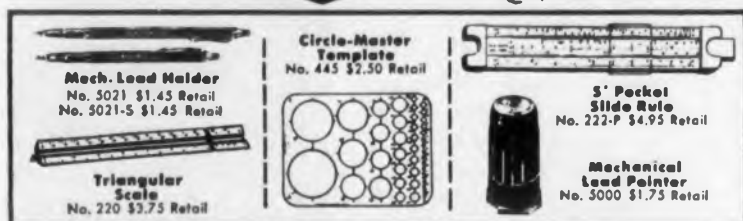


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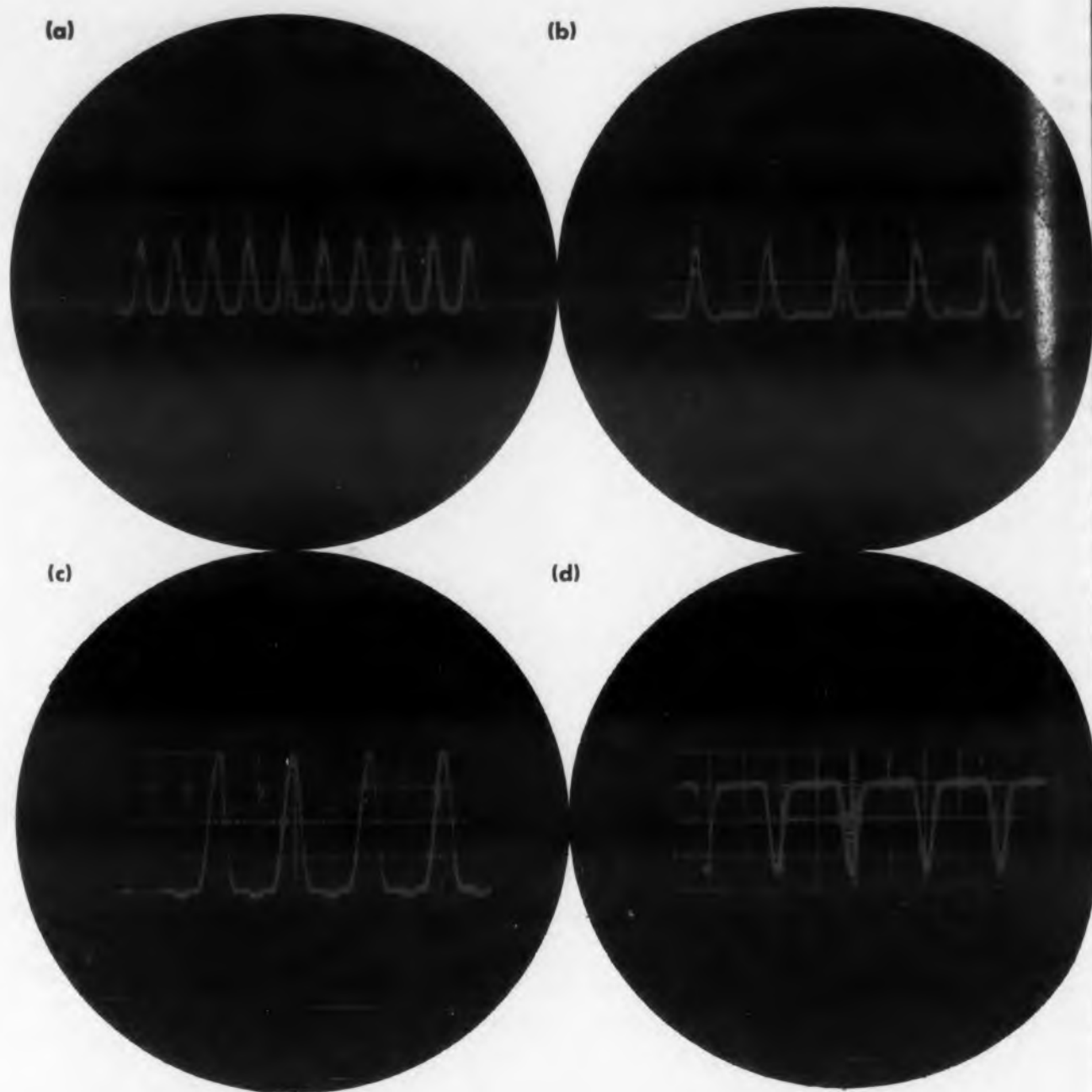


Fig. 3. Wave forms for the circuit of Fig. 2. The time base is set at 0.1 μ sec per major division. The delay line in **a**, **b**, and **d**, was a 4 in. length of RG-65/U. A 12 in. length was used in Fig. 3c. **a**. Taken at Q7 collector. Same as Fig. 2. Input was 3 v peak to peak at 10 mc. Amplitude is 0.5 v per major division. **b**. Same as Fig. 3a, but with 4 v peak to peak input. **c**. Same as Fig. 3b, but with 4 v p-p input. **d**. At collector of Q10. Input is 3 v p-p at 5 mc. Amplitude is 1.0 v per major division.

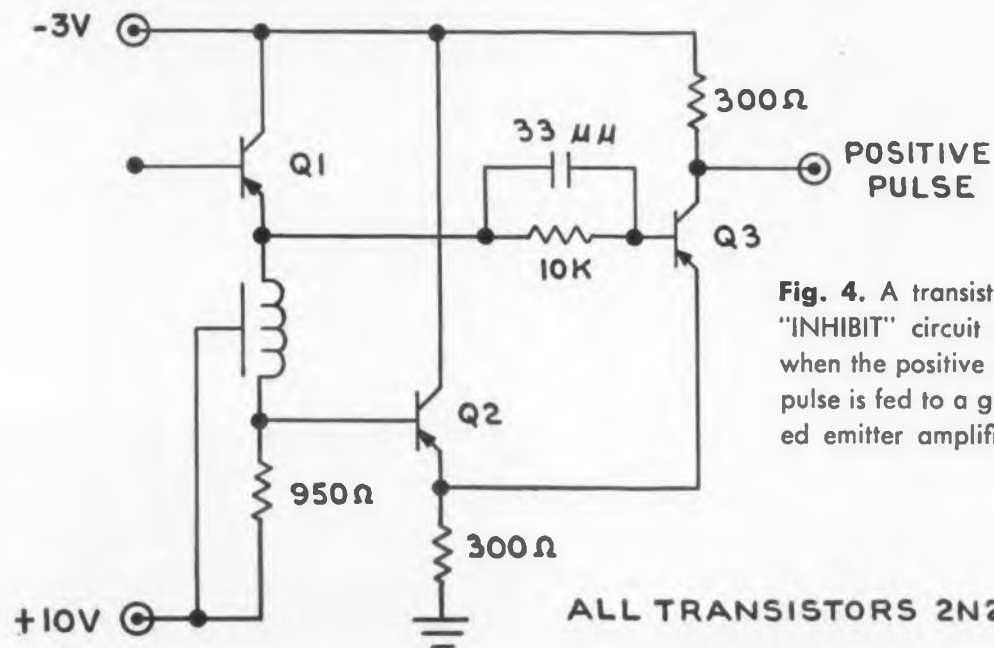


Fig. 4. A transistorized "INHIBIT" circuit results when the positive output pulse is fed to a grounded emitter amplifier.

ALL TRANSISTORS 2N240

Well It Works. Fig. 3 shows the wave-
forms obtained from the circuit of Fig. 2.
High and low frequency limits could not be de-
termined due to the limitations of the test equip-
ment. The sine wave oscillator could not provide
a sine wave slower than 10 cps, and the scope,
Tektronix 545 with a 53/54B pre-amp had a
time of 0.015 μ sec.

Though this scope is one of the fastest avail-
able, it was still not fast enough to pass the fre-
quencies available from this pulse generator
without distortion. The rise times shown in the
oscillograms are for the CRO, not the pulse cir-
cuit.

Since the test equipment was the limitation,
effort was made to improve circuit perform-
ance with peaking coils, speed-up capacitors,
point-to-point wiring without sockets, and spe-
cial delay lines or resistors. Nevertheless, the
amplitude vs time relationship was the same
from 10 pulses per second to 5 million, with duty
ratios available to 40 per cent.

At the time the circuit was developed, in the
spring of 1956, the 2N240 was considered the
best suitable transistor. Since then the 2N393
has become available. It has higher power and
current ratings, so it should permit much higher
output voltage and current with no sacrifice in
high frequency performance.

The Inhibit Circuit

The "INHIBIT" function, which combines
"NOT" and "AND," lends itself to transistoriza-
tion. In Fig. 4, when the base of Q1 is at 0 v, its
emitter voltage keeps Q2 and Q3 cut off. Q3's
collector is then at -3 v. A negative step, fed to
Q1 causes Q3 to saturate, so its collector goes to
-1.5 v. After a time equal to the length of the
delay line, Q2's base conducts heavily and back
with biases the emitter-base diode of Q3, cutting Q3
off. Its collector swings back to -3 v, providing
a positive pulse. To complete the "INHIBIT"
function, this pulse can be applied to the base of
a grounded emitter amplifier.

Logic Conventions

The convention wherein "0" is represented by
high voltage, and "1" by a low voltage, was
adopted here because the circuits use pnp tran-
sistors. When npn's are used, the convention is
usually reversed so a given logic circuit provides
the same logic whether it uses pnp's or npn's.

References

Radiation Laboratory Series, Massachusetts Institute of
Technology, Vol. 19, pp 244-245.
Transistor Switching Circuits, M. Smith, ELECTRONIC
DESIGN, Oct. 1, 1957.

For a reprint of this article turn to Reader-
service card and circle 41.



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Applications: Full wave rectifier—bridge rectifier—modulator—demodulator—phase detector—and many others.

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CIRCLE 42 ON READER-SERVICE CARD



Optimum Design of Power Transformers and Saturable Reactors

Part 2

T. R. Nisbet
Alto Scientific Co., Inc.
Palo Alto, Calif.

Here, in the concluding part of Mr. Nisbet's article, he presents useful nomograms and a procedure for optimizing transformer designs. The nomograms remove a great deal of the drudgery normally involved in transformer and saturable reactor designs.

MANY of the equations which arise in this work are of the form^{*} $a e^6 + b e^4 - c e^2 - d = 0$. The conventional method of solving them is very time consuming. Since great accuracy is not normally required, a simple trial and error method was first attempted, but even this was quite laborious.

Cubic Equations

The nomogram of Fig. 6 enables good approximate solutions (to two or three significant digits) for a cubic equation of this form. In effect, the first two terms are considered as $(e')^4 (ae^2 + b)$. The nomogram is used to find the value of e' which makes the equation true. Successive approximations are discarded until $e' = e$, that is, until the original value of e is reached.

Another type of cubic equation arises in the evaluation of v^* . The coefficients in this case have similarities which enable the nomogram of Fig. 7 to be simpler to operate than Fig. 6.

Regulation

The calculated value of total wire loss can be visualized as a resistance in series with the secondary of a perfect transformer. The voltage drop which would be caused by the secondary current flowing through this value of resistance makes possible a quick check on the anticipated transformer regulation.

* e =side of core area=tape width=inches of build-up;
 v =ratio of window sides= g/f . See ED, Apr. 16, pp 27-28, figs. 3, 4.

Leakage Inductance

Regulation is affected by leakage inductance. By interleaving sections of the primary and secondary, the leakage inductance can generally be reduced significantly. For the type of transformer described, the leakage inductance effectively present in a winding of N turns is approximately

$$L_L = 5.3 N^2 (MLT) (2 - S_w) v^{-1} 10^{-6} \text{ mh} \quad (15)$$

where

$$MLT = \text{mean length of turn} = 4(e + f) \quad (15a)$$

Eq (15) is based on the assumption that half the primary and half the secondary are wound on each of the two bobbins. If the windings are further split, so that each bobbin contains a fraction of one winding sandwiched between fractions of the other winding, the leakage inductance is multiplied by approximately n^{-2} , where n is the number of boundaries of insulating material between sections of the windings.

It is important to note that it is possible, in most cases, by interleaving sections of the windings, to make the leakage inductance small enough to be represented by a 5 per cent increase in the calculated value of resistance.

Maximum VA Rating

The core loss is a function of the peak flux density. It is important, therefore, to have a method for determining the optimum value of flux density.

If published graphs of core loss vs peak induc-

Table I. Differential Logarithmic Core Loss

Material	n	Frequency of Measurement
Ferrite	.438	100 kc
Grain Oriented Steel	.527	" "
Silicon Iron	.485	" "
Grain Oriented Steel, 2 mils	.5	10 "
Silicon Iron, 1 mil	.434	" "
Ferrite (Ferroxcube III B)	.41	" "
Grain Oriented Steel, 5 mils	.575	400 cps
Silicon Iron, 4 mils	.51	" "
High Perm 49, 6 mils, at 15 kilogauss	.64	" "
High Perm 49, 6 mils, at 1 kilogauss	.34	" "
Silicon Iron, 14 mils, at 14 kilogauss	.535	60 "
Silicon Iron, 14 mils, at 1 kilogauss	.38	" "
Grain Oriented Steel, 14 mils, to 15 kilogauss	.527	" "
Mumetal, 14 mils, at 2 kilogauss	.725	" "
Mumetal, 14 mils, at 8 kilogauss	.493	" "

(Source — graphs published in "Reference Handbook for Radio Engineers")

tion are studied, it will be seen that in the majority of cases the "curve" is a straight line when ordinates and abscissas are plotted on logarithmic scales. From any such graph, a constant, n , can be derived, representing the differential logarithmic core loss, a property of the material. As B varies from B_1 to B_2 kilogauss, the core loss,

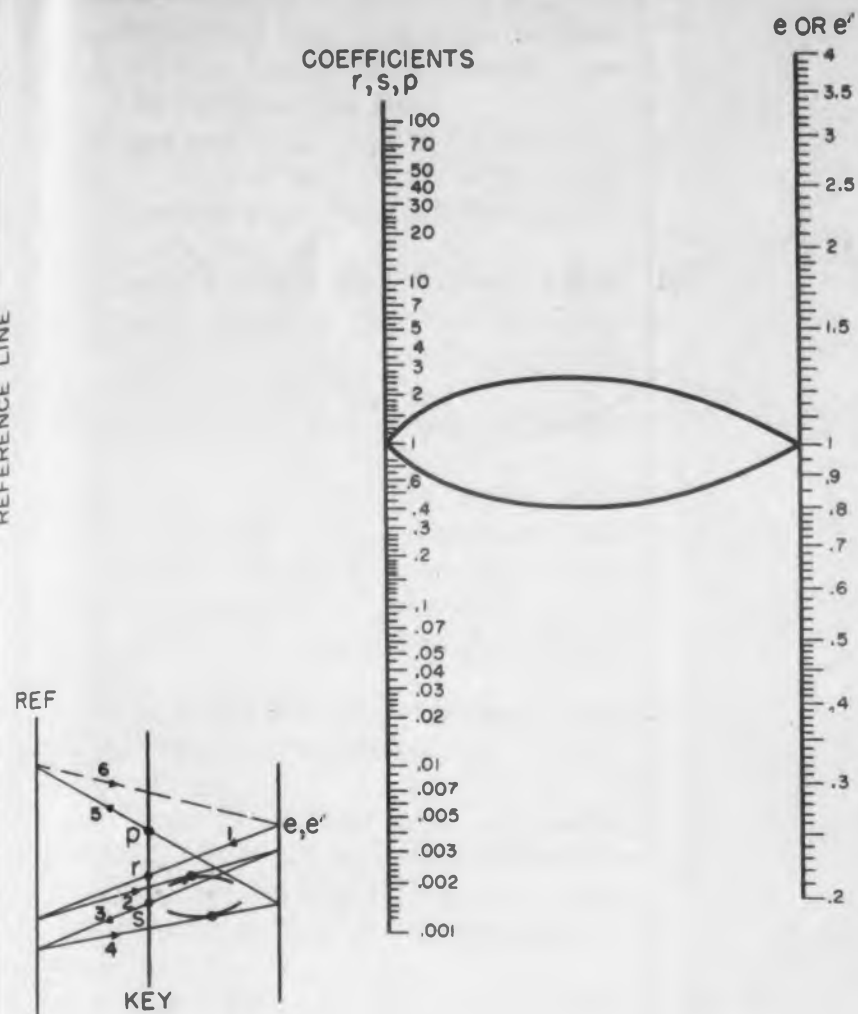
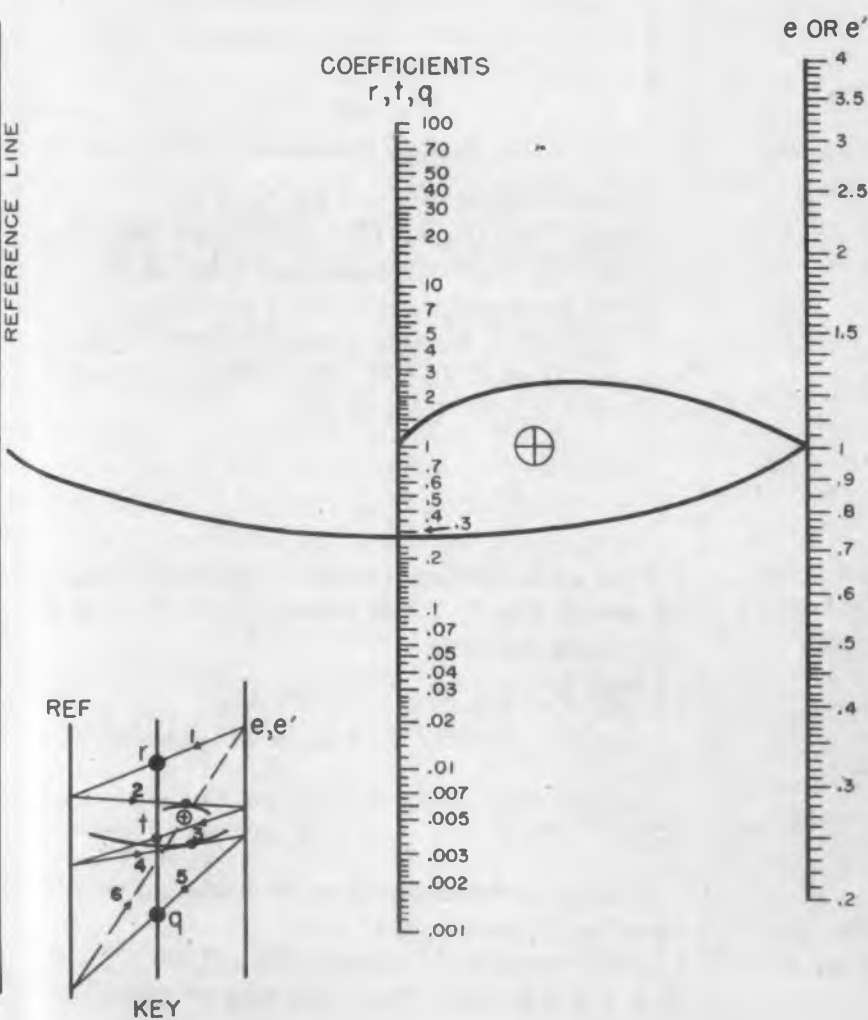


Fig. 6. Nomograms for cubic equations.

a. To find e from $ae^3 + be^2 - ce - d = 0$. Calculate $r = b/a$; $s = (da/bc) - 1$; $p = c/a$. Pick a point on the e scale and traverse the scales as shown in the key. In the sixth traversal, follow the sloping lines to plot a point on the right scale corresponding to one on the left. Note the point of intersection on the e scale after the sixth traversal. With this point, repeat from the start till the sixth traversals cut the e scale at the same point twice.



b. This solves for e also, but in this case, $r = b/a$; $t = 1 - (da/bc)$; $q = a/c$. Start with any point on the e scale. Follow the key, repeating the first traversal from the point on the e scale where the sixth traversal finishes. Repeat till the sixth traversal cuts the e scale twice at the same point.

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advancement
in instrument
design

**INDUCTION
SOLDERING
UNIT**



Model PM 1

FOR SMALL PARTS AND ASSEMBLIES

Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. $15\frac{3}{4} \times 21\frac{1}{2} \times 15$ ". 150 lbs. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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"WHERE ELECTRONICS MEETS THE EYE"
meters

CIRCLE 43 ON READER-SERVICE CARD

**BOOST INSTRUMENT SENSITIVITY ...
with MIN-AMP**



HIGH INPUT IMPEDANCE
LOW NOISE LEVEL
STABILIZED GAIN (x10, x100)
WIDE FREQUENCY RANGE
HI- and LO-PASS FILTERS
AC LINE OPERATION

Miniature, low-noise pre-amplifier (Model 201 illustrated) extends oscilloscope and voltmeter sensitivity by factors of 10 or 100. Two-stage amplifier readily removed from power unit and "plugged-in" to instrument input terminals without wiring, connecting links or other accessories. Compact assembly requires minimum bench space. Normal frequency range; 5 cycles to 1 mc. Switch-controlled filter circuits limit amplifier pass band; improve signal/noise ratio. Wide dynamic range; over 10 volts maximum output.

Write for technical bulletin: MIN-AMP

ELECTRONICS, INC.
MOUNTAIN LAKES, NEW JERSEY

CIRCLE 44 ON READER-SERVICE CARD

P , varies from P_1 to P_2 watts per lb. Hence

$$\frac{\log B_2/B_1}{\log P_2/P_1} = n \quad (16)$$

a constant for the core material.

For maximum volt-amperes

$$P_c/P_w = 2n \quad (17)$$

This relationship should be observed in a design where the ultimate limiting factor is the temperature rise. Values of n for different core materials are shown in Table I. It should be noted that unlike the core loss itself, n is substantially independent of frequency.

By inserting the expanded formulas for core loss and wire loss in eq (17), an equation can be written for setting a maximum VA rating.

Optimum Design

For minimum weight

$$\frac{d}{de} (P_w) = - \frac{Q}{P \rho_w S_w} \frac{d}{de} (P_c) \quad (18)$$

For maximum efficiency

$$\frac{d}{de} (P_w) = - \frac{d}{de} (P_c) \quad (19)$$

For maximum efficiency and minimum weight

$$P = \frac{Q}{\rho_w S_w} \quad (20)$$

This offers a useful starting point in design, provided that flux densities approaching saturation are not involved. From P , the manufacturer's data gives a value of peak induction B , which is necessary for the calculation of c in eq (1a).

Where saturation densities are involved, (when P becomes fixed at its maximum permissible value), it can be shown that

$$Q \approx \frac{P \rho_c S_c}{(6n - 1) M} \frac{e^2 (v + 1)}{v^{1/2}} \quad (21)$$

and n is assumed at 0.5.

Window Shape

The window shape factor, v , has heretofore been assumed. It can now be evaluated.

If a design has been calculated for an assumed value of v , a value is obtained for the two sides, f and g . If f is multiplied by a correction factor z , and g is divided by the same amount, the window area remains the same but the distribution of weights and losses is changed.

To find the window shape which yields the lowest combined core and wire loss, the combined loss is evaluated. The window side g is retained as a separate entity, to enable it to be di-

vided by z while f is multiplied by z . Equating the differential with respect to z to zero gives

$$v' = \frac{v}{z^2} = 1 + \frac{Q M^2}{P \rho_c S_c e^4} \quad (22)$$

In this equation, v is the ratio g/f which was assumed in order to enable the first calculation to proceed. Since z has changed the ratio g/f , the new value v' is the old value divided by z^2 . This new value is used as v in the next calculation.

Comparison of eq (21) and (22) shows that v depends on Q , and Q on v . The equations must therefore be solved simultaneously. The solution is a cubic equation for which the nomogram of Fig. 7 was constructed.

The presence of the variable M/e^2 in (21) and (22) requires that, after solving for v and Q , the design procedure must be continued, at least until e and M are evaluated. By a repetitive process (or by intelligent anticipation of a suitable value of M/e^2) a final design can be arrived at. Fortunately, stability is reached quickly, usually after two successive corrections to an assumed value of v .

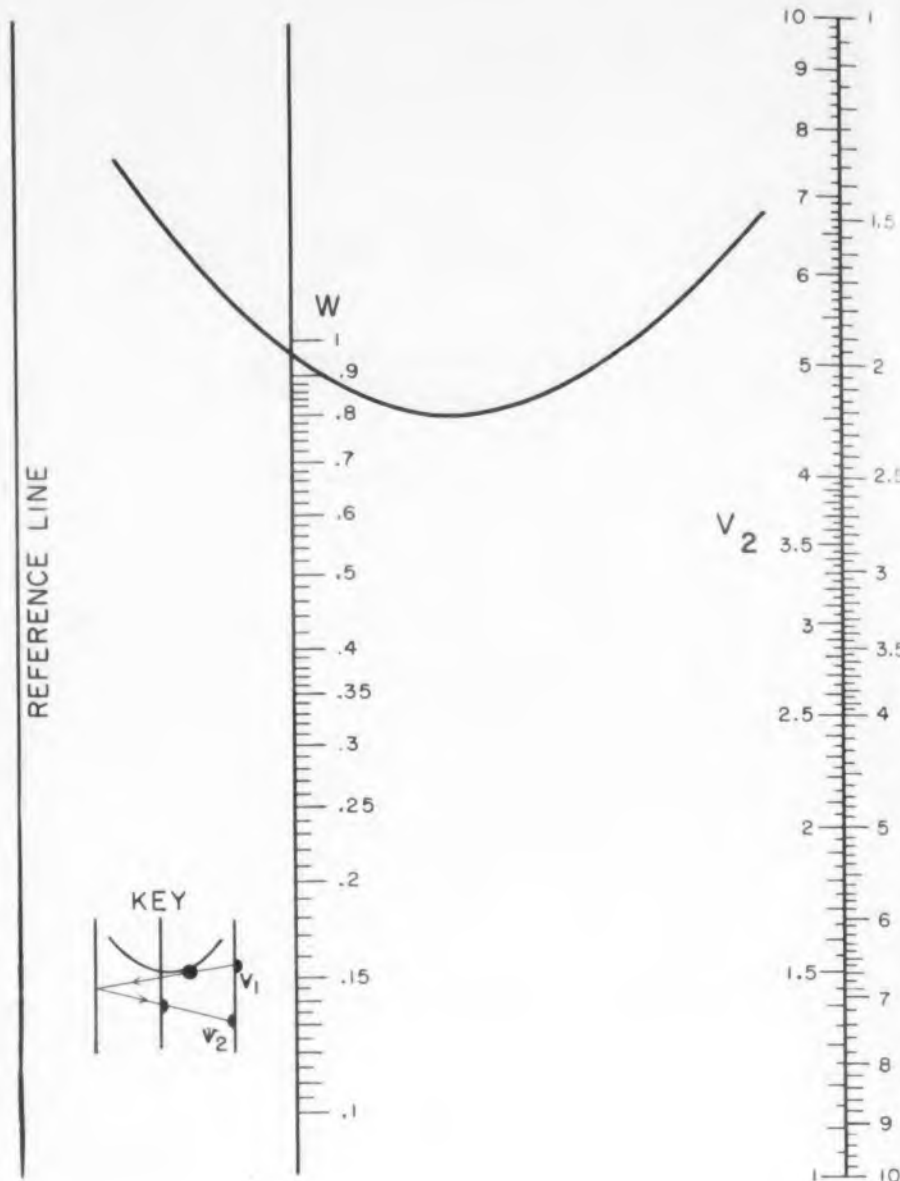


Fig. 7. To solve for v . Calculate $M/[e^2(6n-1)]$. With this point on scale w , find the number on the v_1 scale which, when the key is followed, gives the same number on the v_2 scale. This number is v .

Design Procedure

1. Assume values of $v = 2$ and $Q = 0.8$.
2. Find $P = Q/\rho_w S_w$ (20) and from manufacturer's data. Find corresponding value of B .
3. From the nomogram of Fig. 1 and from $V/N = c e^2$ (1a) find c . Assume a suitable high temperature and from Q find D . (Fig. 2) From D find T . ($D = T I/S_w$) (3). Find M from

$$M = \sqrt{\frac{V}{c k T}} = e f v^{1/2} \quad (2)$$

4. Find e for minimum weight with eq (9) solved by use of Fig. 5. Write values of e^2 , e^4 , and e^6 and check solution.

$$8.7 \rho_c S_c e^6 + 2 \rho_c S_c (v + 1) v^{-1/2} M e^4 - 4 \rho_w S_w M^2 e^2 - 6 \rho_w S_w M^3 v^{-1/2} = 0 \quad (9)$$

5. Find $v' = 1 + \frac{Q M^2}{P \rho_c S_c e^4} \quad (22)$

Use this as new value for v in minimum weight equation. Repeat until $v' = v$.

6. Find weight of core $= 2.9 \rho_c S_c e^3 + 2 \rho_c S_c (v + 1) v^{-1/2} M e$ (6). Find core loss (P times core

weight). Find volume of windings = $4 M^2 e^{-1} + 2 M^3 v^{-1/2} e^{-3}$ (7). Find wire weight ($\rho_w S_w$ times volume). Find wire loss (Q times volume). Core loss should be $2n$ times wire loss.

7. Find surface area = $2f^2(2 + 3v) + 6ef(2 + v) + 11.8 e^2$ (13); $f = M/e v^{1/2}$ (2). If no special methods of cooling are to be used, estimate the temperature rise from (14).

8. If temperature rise is too low, use a higher value of Q and repeat from Step 1, provided that this does not require a peak flux density which is too close to saturation.

9. If temperature rise is correct, proceed to Step 17.

10. If temperature rise is too low, and if closeness to saturation flux density prevents Q from being raised in accordance with (20), assume $v = 2$ and $Q = 1$ to start the calculation, or proceed from the results obtained in the previous calculation.

11. Use the maximum permissible values of B and P which do not involve saturation.

12. Same as Step 3.

13. Find v' from Fig. 7. Find Q (21). Check values of v' and Q from (22). Use these values for v and Q and repeat from Step 12. Repeat or anticipate likely change in M/e^2 to hasten reaching of stability, where $v' = v$.

14. Same as Step 6.

15. Same as Step 7.

16. Estimate temperature of wire from the surface temperature and apply this if necessary as a correction to Step 12. If temperature is unreasonably high or low, repeat from Step 10, using a lower or higher value of Q and the value of v yielded by the last calculation.

17. Evaluate $MLT = 4(e + f)$, and from wire tables confirm total wire loss and the fact that the window will accommodate all the turns.

18. From wire tables, check on the value used for T .

19. Construct a diagram of the window, dimensioning the insulation thicknesses, wire diameters, unused portions of final layers of windings, etc., to confirm assumed values of S_w and k .

In the majority of applications involving 400 cps and higher frequencies, the conditions described in Step 10 will apply and the design procedure can usually commence at that point.

References

- Electronic Transformers and Circuits*, Reuben Lee, John Wiley & Sons, Inc.
Radio Engineering, F. E. Terman, McGraw Hill Book Co., Inc.
Reference Handbook for Radio Engineers, International Telephone & Telegraph Corp.
 Arnold Engineering Co., *Bulletin SC-107*.
 Sprague Engineering, *Bulletin No. 400A*.

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The same hot-molded insulating jacket as larger Allen-Bradley resistors

yet it's only 1/4 inch long!

TYPE CB

1/4 WATT
at 70°C



Also hermetically sealed

Type CS—1/4-Watt Resistor

Allen-Bradley 1/4-watt resistors are available enclosed in a ceramic tube with high temperature end seals, making them impervious to humidity and moisture. Derated linearly from +70°C rating to 0 at +150°C. Available in 2% and 5% tolerances, and in resistance values from 47 ohms to 22 megohms.

These 1/4-watt composition resistors—ONLY ONE QUARTER OF AN INCH LONG—have the same hot-molded insulating jacket... the same reliability... the same physical uniformity... that have made the larger Allen-Bradley resistors the quality standard of the electronics industry for so many years!

Although exceptionally small, Allen-Bradley Type CB resistors are rated for continuous operation at 70°C ambient temperatures. The hot-molded insulating jacket of these resistors makes impregnation unnecessary... yet it provides the most reliable protection against extended periods of high humidity, as encountered in actual service. Available in all EIA resistance values from 47 ohms to 22 megohms. Tolerances: 5%, 10%, and 20%.

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

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QUALITY

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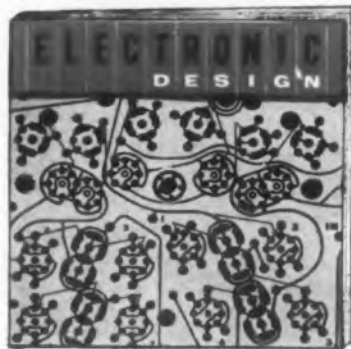
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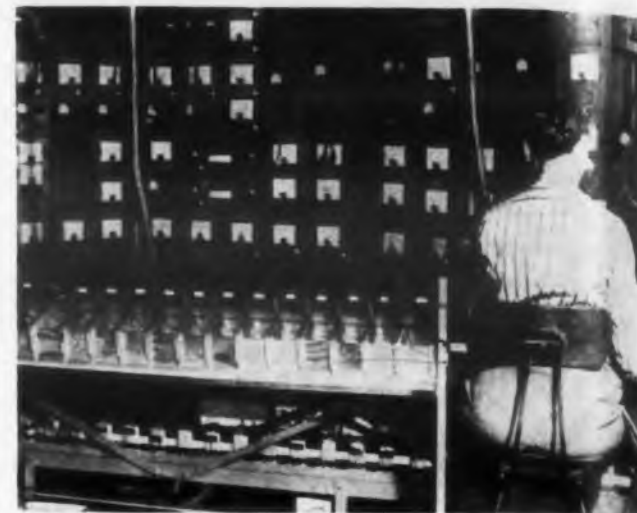
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PRODUCTION PRODUCTS

Faster Tube Checker

Tests 1200 tubes an hour



More than 20 tubes can be checked each minute for 20 characteristics per tube with a new tube tester, recently installed by Tung-Sol Electric Inc. The machine uses 60 meter-relays furnished by Chesterland, Ohio's Assembly Products, Inc., and can test tubes four times faster than hitherto possible.

The meter relays monitor plate, screen, filament, and gas currents; leakage and cut-off currents; emission, voltage gain, and mutual conductance, as well as short circuits.

The tube tester can test almost any of a thousand vacuum tube type. In addition to testing, the meter-relays monitor all voltages and can automatically shut down the conveyor if improper test conditions develop.

In about a third of a second, each meter-relay can measure an electrical property and display the magnitude on a dial; reject a faulty tube; and reset itself so it is ready to test another tube.

When a tube is faulty, a moving pointer on the meter-relay meets either a high or a low fixed pointer. Contacts on the pointer touch and lock electro-magnetically, closing a circuit. This actuates a load relay, closing the contacts of a heavy duty power relay. The power relay actuates a counter that keeps track of the number of tubes rejected for a particular characteristics. The power relay also breaks the circuit to a reject solenoid, whose plunger is released, pushing the defective tube from its socket at the right time so it falls through a chute with other tubes rejected for the same test.

Though the meter-relays are slower than electronic devices, they are more reliable, easy to work with, and rarely need calibration.

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

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ELECTRONIC DESIGN • May 28, 1958

NEW MATERIALS

Ceramic Magnetic Wire

Insulation withstands up to 1000 F

Two types of high-temperature magnet wire have been announced. One of these has a bonded refractory insulation which is rated for continuous use at 700 F, and for intermittent use up to 800 F. The other wire has a ceramic insulation which is rated for continuous use at 1000 F. Both of these insulations are normally supplied on copper wire but other metals or alloys which have better temperature characteristics are available.

Secon Metals Corp., Dept. ED, 7 Intervale St., White Plains, N.Y.

CIRCLE 48 ON READER-SERVICE CARD

Damping Fluid

Low viscosity silicone

Available in 5, 10, and 20 centistoke grades, type 81743 silicone fluid has a lower viscosity-temperature coefficient and lower pour point than most methyl silicone fluids. Suggested uses for this compressible fluid are as a damping medium in vibration dampers, shock absorbers, dash pot relays and timing relays; and as a hydraulic fluid in servomechanisms, accelerometers, instruments and other control devices.

In common with other silicone fluids, type 81743 is highly resistant to shear breakdown and possesses unusual chemical resistance. Typical values for the three grades include a specific gravity of 0.92, 0.94, 0.96; weight per gallon of 7.7, 7.8, 8 lbs; refractive index of 1.3965, 1.3998, 1.4016; minimum boiling point (1.5 mm Hg) 275, 390, 480 F; flash point, 310, 415, 525 F; and pour point -100, -100, -76 F.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N.Y.

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Tinning Process

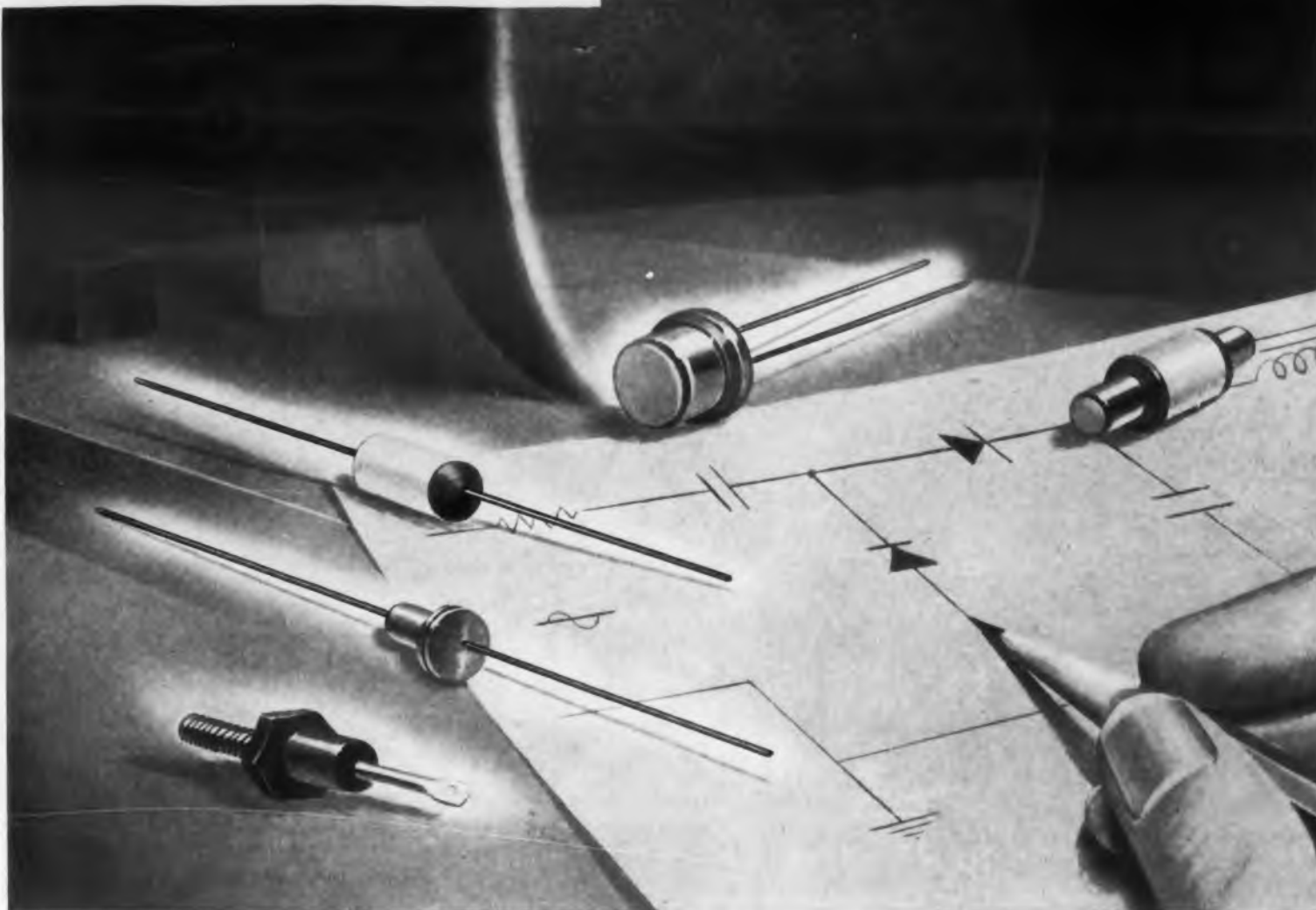
Instantly coats printed circuits

Called Instant Tin, this solution is designed for the tinning of brass and copper articles at room temperature. The process provides protection and acts as a soldering aid for non-ferrous electrical components, printed circuits, solder lugs and others.

Desert Laboratory, Dept. ED, 17-312 N. Indian Ave., N. Palm Springs, Calif.

CIRCLE 50 ON READER-SERVICE CARD

NEWS ABOUT SILICON DEVICES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies... savings in space and weight... important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Sil-

con components can operate in ambient temperatures from -65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps. and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are

available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use... with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont... pioneer producer of semiconductor-grade silicon.



NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

CIRCLE 51 ON READER-SERVICE CARD

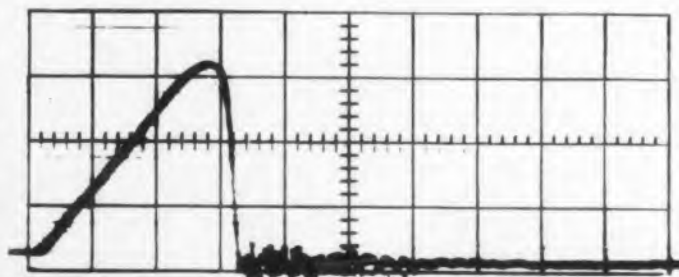
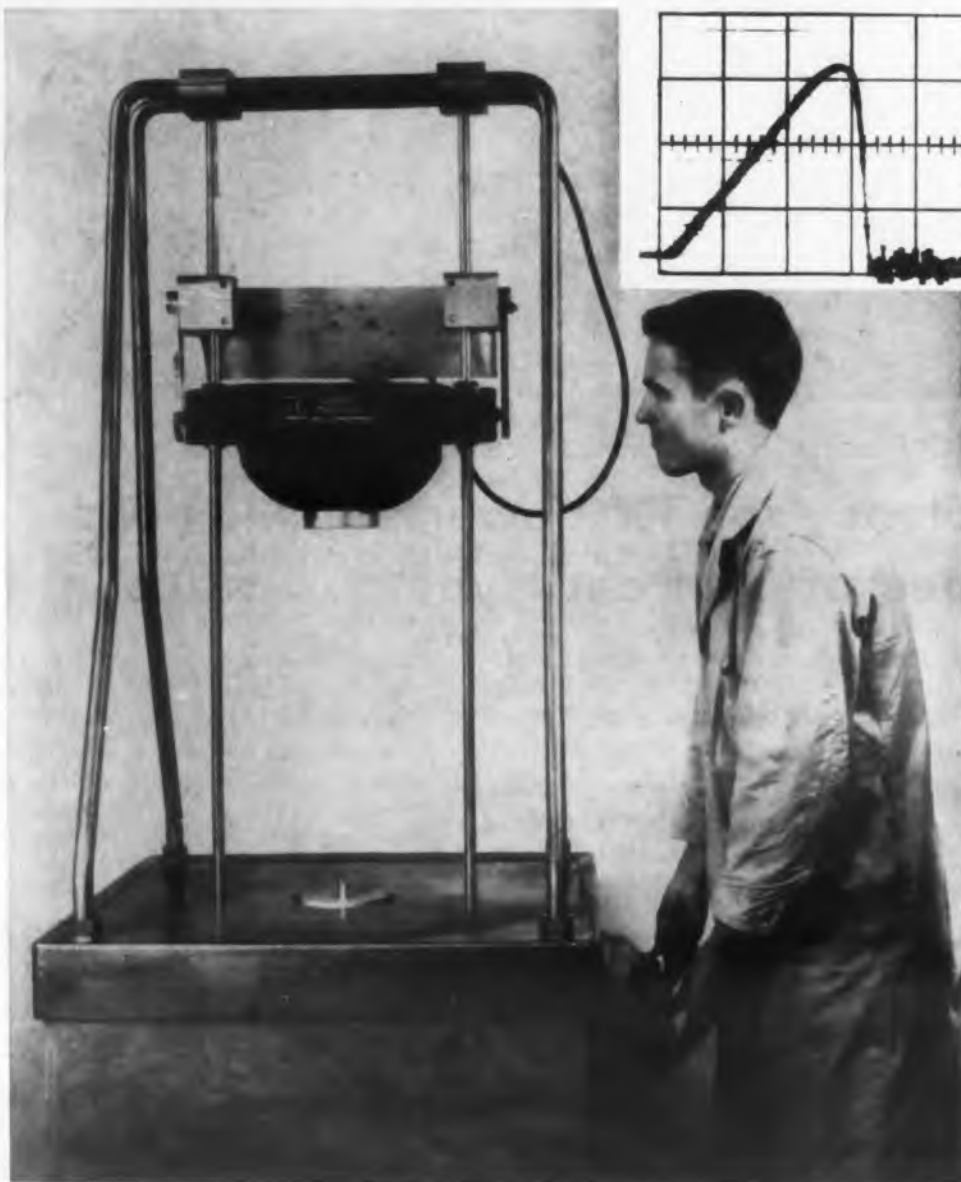
PIGMENTS DEPARTMENT

DU PONT HYPERPURE SILICON

BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

NEW PRODUCTS

To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the largest number of items, products which are best suited to a brief description have been noted at the end of the section.



SHOCK TESTER

Accurate shock patterns are reproduced on this machine through the use of differently shaped lead pellets placed on the impact anvil. Among other shock patterns, the shock tester provides a specified terminal-peak sawtooth pulse shape—similar to the one shown—rising to 100 g in 6 msec and then dropping abruptly to zero. The machine accommodates specimen weights to 40 lb, a cross-sectional area to 12-1/2 in. sq.

Avco Manufacturing Corp., Lycoming Div., Dept. ED, 550 Main St., Stratford, Conn.

CIRCLE 54 ON
READER-SERVICE CARD



OSCILLOSCOPE CAMERA

Ten traces can be photographed by the Oscillotron camera on a single frame, or a one-to-one presentation can be given, whichever is desired. The camera has a large polaroid back that takes up to 80 finished pictures in a single loading. The versatility of the unit is provided by a feather-touch multiple exposure positioning bar. A 35 mm or 70 mm electrically pulsed camera is also available for attachment to the same periscope system used with the Oscillotron camera.

Beattie-Coleman, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

CIRCLE 55 ON READER-SERVICE CARD

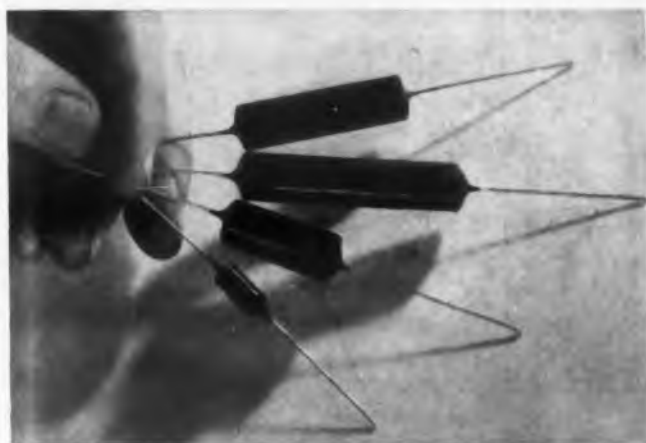


GAUSSMETER

Magnetic flux densities up to 50,000 gauss, in static or ac fields, are measured to an accuracy of ± 3 per cent by model 1295 gaussmeter. The transistorized instrument utilizes the Hall effect to make these measurements. Two standard magnets of 1000 and 5000 gauss, calibrated to ± 1 per cent, are included.

Radio Frequency Labs., Inc., Dept. ED, Powerville Rd., Boonton, N.J.

CIRCLE 56 ON READER-SERVICE CARD



WIREWOUND RESISTORS

Temperature ratings over 250 C are featured in the Blu-Ohm series of wirewound resistors. Seven different sizes cover a power range from 2.5 w through 15 w. A typical 3 w unit, type B-2, will maintain its 3 w rating at 80 C, derated to 1 w at 275 C. Larger units, from 5 through 15 w, will derate at full load to 0 at 275 C. The series is constructed of ceramic materials together with alloy wires designed to withstand high temperatures.

Bradford Components, Inc., Dept. ED, Box 107, 65 South Avenue, Salamanca, N.Y.

CIRCLE 57 ON READER-SERVICE CARD

ALL-ELECTRONIC DIGITAL VOLTMETER...ONLY \$960

MEASURE
MILLIVOLT TO
KILOVOLT WITH
0.1% ACCURACY

no moving parts
digital in-line readout
70 millisecond conversion time
adjustable display time
direct voltage conversion



Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. Direct voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable

only in the delicate, complex and expensive instruments. Extremely stable operation - continuous calibration against an internal reference.

The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KIN TEL's years of design and manufacturing experience . . . experience gained in the manufacture of more than 10,000 precision electronic instruments.

BRIEF SPECIFICATIONS (model 801)

Ranges . . . 0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000 to 1000 volts (manual ranging and polarity)
Accuracy 0.1% of full scale
Readout 4 digits plus decimal point
Input Impedance 20,000 ohms per volt*

Conversion Rate 10 per second
Conversion Time approximately 70 milliseconds
Display Time Adjustable from approximately .1 second to infinity (plus push-button read once control)
Dimensions 11" high x 7 1/2" wide x 20" deep
Power Requirements 105 to 125 volts, 60 cycle AC, 180 watts

*The Model 802 provides 10 megohms input impedance. Price \$1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

5725 Kearny Villa Road, San Diego 11, California, Phone BRowning 7-6700

Representatives in all major cities. Write today for demonstration or literature.

CIRCLE 58 ON READER-SERVICE CARD

KINTEL

A Division of Cohu Electronics Inc.

Amperex® proves
there's room for
extra engineering
even in standard
replacement tubes!

The hard core of the Amperex line has always been a group of electrically unique "proprietary" types, available from no other manufacturer. However, the Amperex name has come to mean concrete engineering benefits even in standard communications and industrial tubes, above and beyond plug-in interchangeability. Thanks to a manufacturing philosophy of untiring perfectionism — combined with the most recent techniques of production, quality control and applications research — the Amperex replacement tubes shown here offer tighter tolerances, greater uniformity, extra ruggedness in critical applications, plus remarkable freedom from common defects and failures: in short, an extra dimension of quality.



for example

here's what happens
when Amperex combines
ultramodern production
techniques
with uncompromising
manufacturing integrity
to make
a standard replacement
tube better...

Amperex
C3J/5632 THYRATRON
with these **Amperex** extras:

- ① hard glass envelope
- ② rigid anode connection
- ③ rugged grid cylinder
- ④ anti grid-emission slot
- ⑤ heat shield prevents excessive grid temperatures
- ⑥ reinforced cathode with special emitting material
- ⑦ ceramic insulators
- ⑧ heavy leads allow high peak-currents
- ⑨ highly effective getter
- ⑩ rugged powder-glass base
- ⑪ 8 supports give mechanical strength

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Duffy Avenue, Hicksville, L. I., N. Y. In
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Toronto 17.

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replacement tubes with
extra engineering:



Amperex 6146
HIGH-SENSITIVITY
BEAM POWER TUBE



Amperex 4X500A
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Amperex C3JA/5864
THYATRON

(Same as C3J/5632 above,
but with increased reverse
peak voltage rating)

ask your distributor about
Amperex replacement
tubes with **extra engineering**
for industrial and communications applications

NEW PRODUCTS

Gear Train Analyzer Measures gear play



This gear train analyzer accurately evaluates lost motion in precision gear trains. The instrument consists basically of controls and a two-phase torque actuator. Total lost motion is measured by applying constant torque to the input pinion of the locked gear train and reading clockwise and counter-clockwise actuator shaft displacement.

Daco Instrument Co., Dept. ED,
Tillary & Prince Sts., Brooklyn, N.Y.

CIRCLE 59 ON READER-SERVICE CARD

Sampling Switches

2400 samples per min



General specifications for the series 1300 sampling switches include up to four accurately synchronized poles, and as many as 24 non-shorting channels. Type 1300-a samples at the rate of 24,000 samples per minute per channel. The unit weighs 1 lb. and measures 2 x 2 x 3 in. Sizes in other models vary with the requirements of the switch.

General Devices, Inc., Dept. ED,
Princeton, N.J.

CIRCLE 60 ON READER-SERVICE CARD

◀ CIRCLE 61 ON READER-SERVICE CARD

Microwave Attenuator

Cover 0.8 to 6 kmc bandwidths



These microwave attenuators measure 5 in. diam and cover bands of 0.8 to 2.5 kmc and 2.0 to 6.0 kmc. There are three units to each bandwidth. The minimum insertion loss is 0.2 db and full insertion loss is at least 30 db over the full band. High resettability and accurate calibration are also featured.

Antenna and Radome Research Associates, Dept. ED, 1 Bond St., Westbury, N.Y.

CIRCLE 62 ON READER-SERVICE CARD

True Airspeed Computer

Accuracy of ± 2 knots



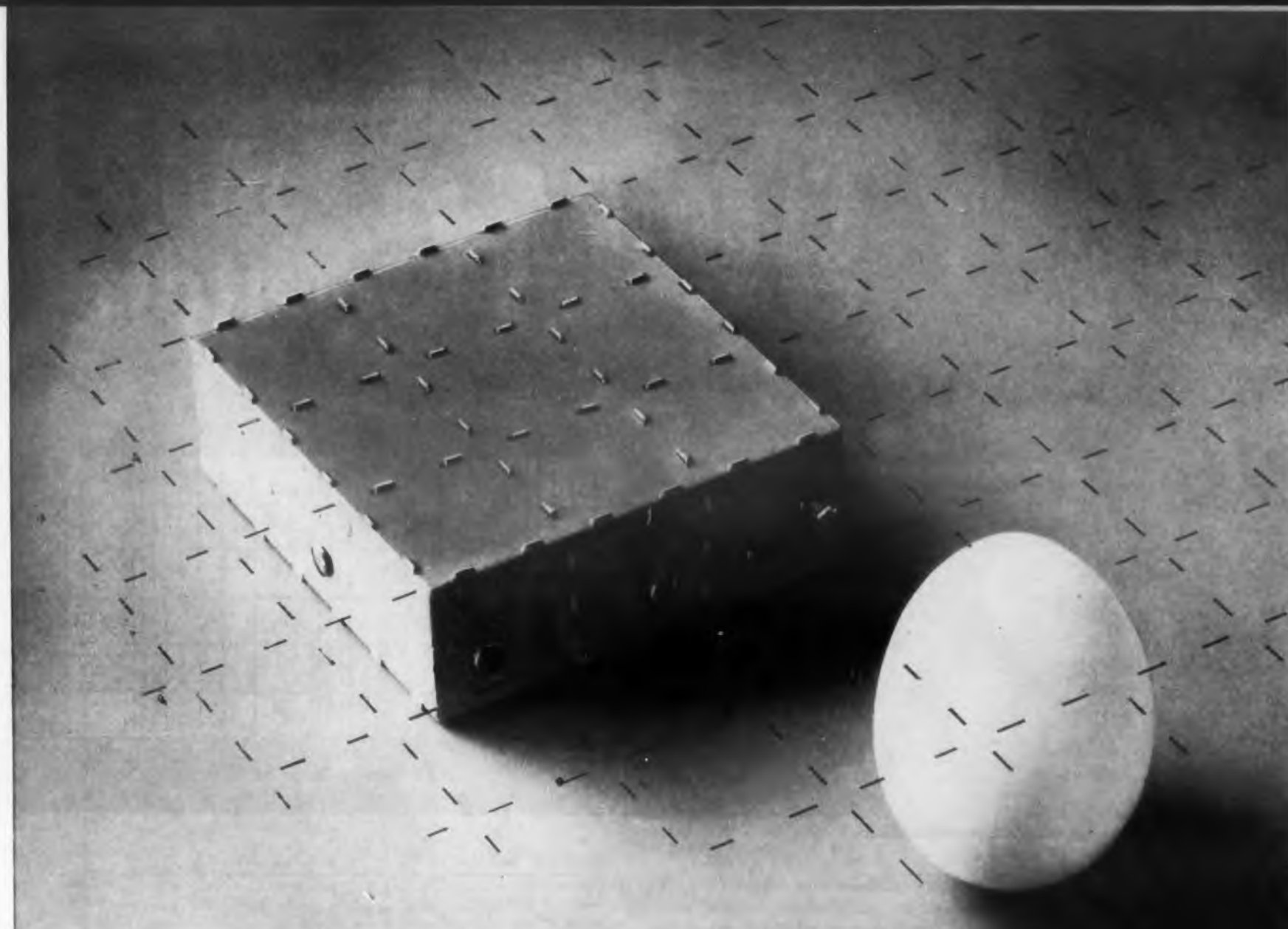
SMI Type AXC 529 true airspeed computer has an accuracy of ± 2 knots in a range of 100 to 250 knots. The accuracies are possible through the utilization of a highly accurate and sensitive force balance Mach number transducer which generates a shaft position functionally proportional to Mach number.

The unit is designed to provide the necessary true airspeed input to airborne navigational systems.

Servomechanisms, Inc., Dept. ED, 12500 Aviation Blvd., Hawthorne, Calif.

CIRCLE 63 ON READER-SERVICE CARD

CIRCLE 64 ON READER-SERVICE CARD ➤



**Better shape factor
over wider frequency range**

Daven's new EGG CRATE LC filters...

Center frequency: covers the range from 0.4 MC to 60.0 MC depending upon specific requirements. Center frequency stability: ± 1.0 KC per MC from -55°C to $+105^{\circ}\text{C}$. Shape factor: BW_{60}/BW_6 to 2.1. Shape factors can be modified for optimum time delay.

In addition to these outstanding specifications, Daven's new LC filters offer a unique type of construction which makes them the most rugged filters ever built. Small cells are welded

together to form the partitioned shield compartment...making this the first filter with truly continuous mechanical and electrical bond...providing a high degree of inter-circuit shielding.

Daven's new LC filters are ideal for shaping the pass band of AM/FM or FM/FM data link receivers, double or single side band receivers and generators, direction finding receivers, communication and telemetering receivers, and spectrum analyzers. So versatile, in fact, that applications are almost limitless. Write today for complete, newly-published technical data

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TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

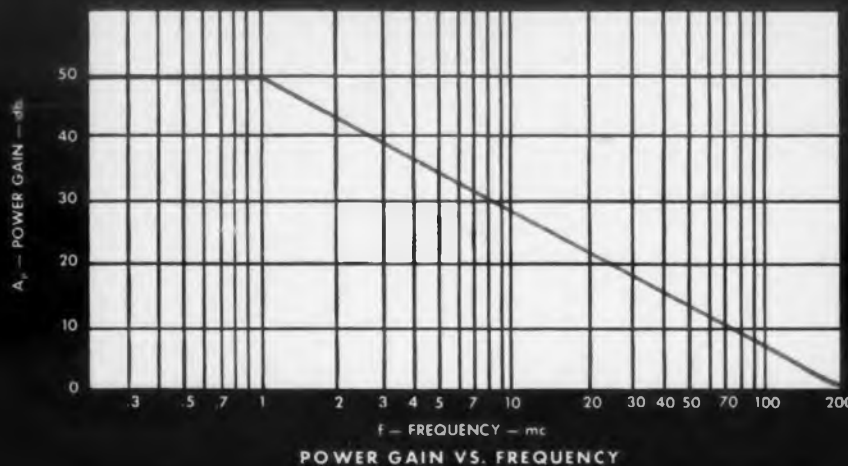


NEW 90 MC alpha cutoff

P-N-P germanium

T/I diffused base transistors

In a JETEC TO-5 Package!



Now for your television IF's, VHF oscillators and amplifiers plus high speed computer applications... new round welded 2N623 diffused-base germanium transistors give you 200 mc typical maximum frequency of oscillation, 90 mc alpha cutoff, plus a 25 μ sec typical total non-saturated switching time.

Check the specifications and application notes below — see how the TI 2N623 can help you with your next high gain/high frequency or ultra high speed switching application.

Write today to your nearest T/I sales office for Bulletin DL-S 904

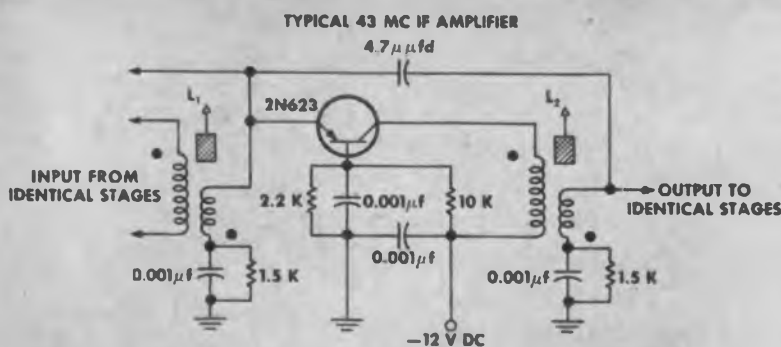
maximum ratings at 25°C

collector to base	—30V
collector to emitter	—15V
emitter to base	—1V
total dissipation	40mW

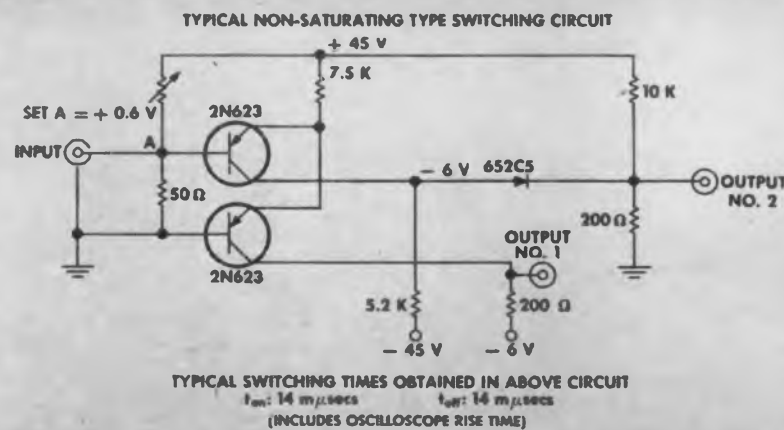
typical design characteristics at 25°C

(conditions)			
collector reverse current	$I_c = 0$	$V_{cb} = -20V$	2 μ A
emitter reverse current	$I_e = 0$	$V_{eb} = -0.5V$	0.5 μ A
forward current transfer ratio	$I_c = -2mA$	$V_{cb} = -6V$	35
current transfer ratio cutoff frequency	$I_c = -2mA$	$V_{cb} = -6V$	90 mc
max. frequency of oscillation	$I_c = -2mA$	$V_{cb} = -6V$	200 mc
frequency where h_{fe} is unity	$I_c = -2mA$	$V_{cb} = -6V$	60 mc

APPLICATION NOTES



TYPICAL VALUES — AVAILABLE POWER OUTPUT 20 mW (PEAK)
NOISE FIGURE 6 db • POWER GAIN 15 db • BAND WIDTH, ONE STAGE 11 mc
APPROX IMPEDANCE LOOKING INTO PRIMARY 56 Ω • LOAD ON SECONDARY 3000 Ω



TYPICAL SWITCHING TIMES OBTAINED IN ABOVE CIRCUIT
 t_{on} : 14 μ secs t_{off} : 14 μ secs
(INCLUDES OSCILLOSCOPE RISE TIME)

TEXAS INSTRUMENTS SALES OFFICES
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TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR - COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

NEW PRODUCTS

Power Converter Missile-telemetry types



Measuring 5-1/2 in. in diam and 4-3/4 in. long, these telemetry converters provide 270 v at 22 ma, 150 v at 10 ma, and 30 v at 15 ma, all with 75 mv or better ripple.

Inputs are respectively 16 v dc and 7 v dc for the PS1008 and PS1009 models. Weight is 2 lb 8 oz. Units are capable of operation at temperatures up to 85 C.

Power Sources, Inc., Dept. ED, Burlington, Mass.

CIRCLE 65 ON READER-SERVICE CARD

Decade Counter

Counts at rates of 150 kc



Model CT-101 transistorized decade counter is capable of counting at rates as high as 150 kc. The unit has an easy-to-read visual display featuring large 3/8 in. numerals. A 9-pin socket provides decimal or binary coded decimal electrical output for remote indication purposes. Power consumption is 120 mw, and only two supply voltages of -3 and -10 v are required.

Epsco Components, Dept. ED, 108 Cummington St., Boston, Mass.

CIRCLE 66 ON READER-SERVICE CARD

◀ CIRCLE 67 ON READER-SERVICE CARD

Commutation Switches

With printed circuit commutation plates



Each commutation switch, designated Mycalex PC, has 2-poles, 60 contact per pole, and operates on a duty cycle of either 54 ± 4 , or 87 to 95 ± 4 per cent, at speeds up to 1800 rpm, 30 signals per revolution, break before make. Depending on circuit conditions, noise level performance is less than 1 mv with a 5 v input signal. The switch can be completely enclosed, and measures $2\text{-}3/16 \times 2\text{-}3/16 \times 3\text{-}9/16$ in. weighing approximately 24 oz.

Mycalex Electronics Corp., Dept. ED, 125 Clifton Blvd., Clifton, N.J.

CIRCLE 69 ON READER-SERVICE CARD

Quartz Crystals

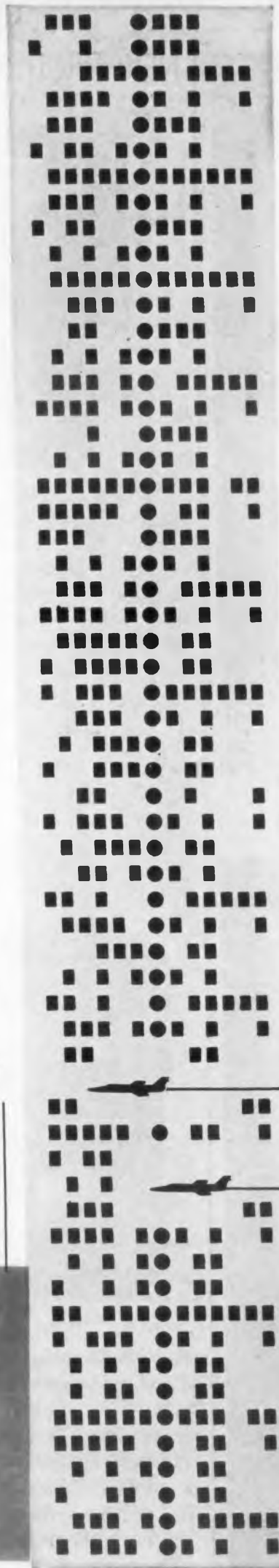
Frequency range 3 to 15 kc



These vibration-resistant quartz crystals have a frequency range of 3 to 15 kc. Crystals will operate through vibration frequencies of 5 to 2000 cycles at 10 g over temperature range of -55 to 105 C and maintain a frequency stability of ± 0.025 per cent under dynamic conditions stated. When smaller ambient temperature ranges are encountered frequency stability as close as ± 0.002 per cent can be achieved. Where greater frequency stability is required, temperature-controlling ovens are available.

Hill Electronic Engineering & Mfg. Co., Inc., Dept. ED, 400 E. Factory St., Mechanicsburg, Pa.

CIRCLE 70 ON READER-SERVICE CARD



maintain and control reliability

with new

PRE-PROGRAMMED INSTRUMENTATION

NEW ROBOTESTER — IMMEDIATE AID TO IMPROVE MAINTAINABILITY OF EQUIPMENT RELIABILITY

A bold imaginative concept has evolved from Lavoie Labs in the form of a Programmed Instrumentation Approach with Failure Prediction. Designed for the active control of maintainability and reliability of electronic equipment in aircraft, missile and weapon systems.

The universal-tape programmed performance checking Robotester is versatile and flexible and is the basis of this forward-thinking Lavoie program.

The Robotester itself expands checkout capabilities and slashes 80% of final test time. Operational testing and production line check out is accomplished through continuous, high-speed sampling and comparison . . . split-second recognition, isolation and identification of abnormal functions.

Nominal circuit values and specified tolerances are tape-punched in minutes to accommodate voltages (AC and DC) from 0.5 to 500 volts; Hi Pot to 500 volts; resistances from 1 ohm to 9.99 megohms; and tolerances of 1%, 5%, 10% and 20% of nominal. A total in excess of 60000 tests possible . . . the Robotester will check any two circuit points at rates up to 100 tests per minute.

Write today for complete technical information and specifications on the New Robotester.



Write on company letterhead for "Lavoie Programmed Instrumentation" . . . please specify application.

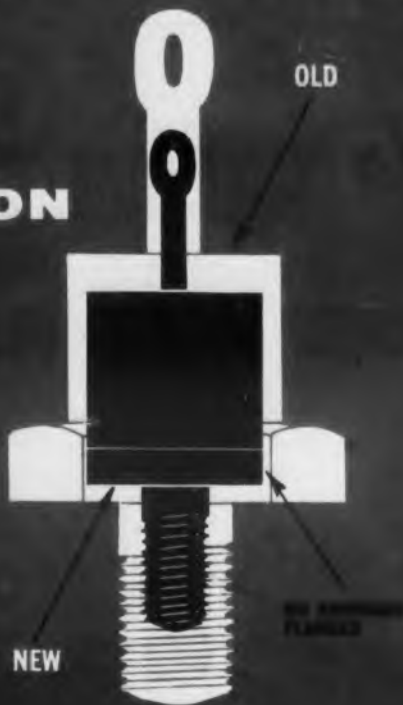


Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

OPTIMUM MINIATURIZATION



ACTUAL BODY SIZE
only .250" diameter x .250" long

u.s. semcor *medium power* Sub-miniature Diodes

1.5 amps at 150°C.

*TWICE the
performance ...
in HALF the space!*

U. S. SEMCOR's new rectifier-type silicon diodes permit optimum space utilization for sub-miniature packages. With higher power and far smaller size than similar diodes ... with total indifference to position ... these new silicon diodes provide complete flexibility in any mounting position. You'll find them a big advance toward still further miniaturization!

streamlined configuration
awkward hex or flange

may be installed for maximum
pattern density

in free air—up
to 12 watts with heat sink.

inverse voltage—up to
500 volts

forward conductance—
1 amp at 1.5 volts

construction:
stainless steel body and stud,
hermetically sealed glass end

Stud mount—with
4-40 stainless steel stud



Our Field Engineering Representatives welcome the opportunity to consult with you on your medium power DIODE requirements.

3536 West Osborn Road • Phoenix, Arizona
Applegate 8 5591

For address of office nearest you—or for complete technical data—WRITE TODAY to Sales Engineering Dept., U. S. Semiconductor Products, Inc., 3536 West Osborn Road, Phoenix, Arizona

CIRCLE 72 ON READER-SERVICE CARD

NEW PRODUCTS

Electronic Timer

Ranges from 25 msec to 50 sec



Model T1 electronic timer can be used for single or repeat cycle timing, interval or delayed action timing. It features 25 msec to 50 sec range, regulated power supply, plug-in relays, 5 a isolated load contacts. Included are stabilized tubes, line transient suppression components, Mylar timing condensers.

Ferrara Inc., Dept. ED, 8106 W. Nine Mile Rd., Oak Park 37, Mich.

CIRCLE 73 ON READER-SERVICE CARD



Magnetic Clutches

16 and 32 oz-in. clutching torques

Model D-103 (shown) is a size 11, 1.062 in. diam single-ended, magnetically activated clutch. Clutching torque is rated at 16 oz-in., with three watts of dc applied to the control coil. Voltage ratings range from 1.5 to 300 v dc, with 24 v as standard. Size 18 magnetic clutch brake, designated D-102, has a clutching torque of 32 oz-in. The voltage ratings are the same as D-103. The unit has a diameter of 1.75 in.

Dynamic Instrument Corp., Dept. ED, 59 New York Ave., Westbury, N.Y.

CIRCLE 74 ON READER-SERVICE CARD



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**SUPERIOR
ELECTRONICS**
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GUN MOUNTS?

Because this firm

- ★ Has pioneered many new manufacturing techniques
- ★ Is constantly improving the quality of its gun mounts
- ★ Offers uniform product performance and dependable service
- ★ Assures me of fair prices

- 1 -
New! 110°
deflection
gun

- 2 -
Electro-
static
focus gun

- 3 -
Electro-
magnetic
gun



World's oldest and largest
exclusive manufacturer of
quality electron gun mounts

- 4 -
Electro-
static
deflection
gun

- 5 -
Special
purpose
gun

- 6 -
New!
Short neck
90° gun



WRITE FOR DESCRIPTIVE MATERIAL

SUPERIOR

ELECTRONICS

CORPORATION

GRegory 2-2500

212 PIAGET AVE., CLIFTON, N. J.

CIRCLE 75 ON READER-SERVICE CARD

Endurance RATED COUNTERS



Stroke and Revolution Counters for the Toughest Jobs

- 200 Million Count Life
- Rugged, oversize shaft and bearings
- Shakeproof—only one screw in counter assembly.
- All steel housing with snap-on cover—chrome plated.
- Reliable — no skip or over-count.
- Tamperproof reset.

Thousands used in Automobile and Aircraft factories; in stamping, metal working, die casting and plastic molding plants; in foundries, printing plants and factories.

PIC-600 Electric Counters



Basemount
Knob reset

- 50 Million Count Life
- 7 watts power consumption—operable in plate circuit of electronic tubes.
- 1000 CPM rating—reliable to 1600 with suitable actuation.
- Quiet—no AC hum.
- Balanced armature—for reliability on airborne equipment.

Also endurance rated counters for all purposes. See your PIC Distributor or write for catalog.

Production Instruments

DIVISION OF GENERAL CONTROLS CO.

8078D McCormick Blvd., Skokie, Ill.

42 Branch Offices and Representatives
serving USA and Canada

CIRCLE 76 ON READER-SERVICE CARD

Transistor Tester

Gives direct I_{cbo} readings



Model 960 portable transistor and crystal diode tester can test for I_{cbo} gain, leakage, shorts, on low, medium and high-power transistors of both the pnp and npn types, as well as the new tetrode transistors. Operating specifications are: direct I_{cbo} readings, in terms of true collector current, on wide-angle 5-1/2 in., 100 ua meter; five I_{cbo} ranges; wide range of collector potentials from 0.5 v dc to 100 dc in 17 selected steps; direct reading gain ranges with five separate injection currents for low, medium and high power types; and leakage tests to check emitter to collector current at fixed collector bias.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale, Long Island, N.Y.

CIRCLE 77 ON READER-SERVICE CARD

Gyro Transducer

Senses motion about the roll, yaw and pitch axes



Consisting of three gyros mounted so as to sense motion about the roll, yaw and pitch axes of a vehicle, the free gyros provide an accurate reference in the form of an electrical signal which is proportional to displacement about the outer gimbal axis. The hermetically sealed unit weighs 19-1/4 lb, including caging mechanisms, inverter and radio-noise filters. Gyro motors may be operated directly from a 115 v, 400 cps source. If required, unit may be supplied with 27 v dc, and the 400 cps power generated internally. Altitude and humidity conditions have no effect and the unit will operate satisfactorily at temperatures from -65 to +160 F.

Clary Dynamics, Dept. ED, 408 Junipero St., San Gabriel, Calif.

CIRCLE 78 ON READER-SERVICE CARD

permanent
dependability in
small packages

for HIGH
VOLTAGES

from 600 to 50,000 volts



u. s. edcor *hermetically sealed*
"glass-kase" capacitors

A proven line of hermetically sealed in glass, HIGH VOLTAGE capacitors — custom made with a variety of plastic film dielectrics to meet your requirements precisely. U. S. Edcor's exacting quality control, functioning through newly developed techniques and equipment, assures you of exceptionally reliable plastic film capacitors. Where your operational requirements are critical, you will find U. S. Edcor's "glass-kase" Capacitors.

OUTSTANDING FOR USE IN



- Electronic Computers
- Differential Analyzers
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- Audio Coupling Devices
- Integrating Circuits
- Electrodeless Circuits
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U. S. Electronics Development Corporation
3540 West Osborn Road, Phoenix, Arizona

This field Engineering Department welcomes the opportunity to consult with you to standardize on special capacitor requirements. Please describe your requirements — or for complete technical data — WRITE TODAY to Sales Engineering Dept., U. S. Electronics Development Corp., 3540 West Osborn Road, Phoenix, Arizona.

CIRCLE 79 ON READER-SERVICE CARD

A Stand out

THE 1802 HYDROGEN THYRATRON, WITH UNPRECEDENTED PERFORMANCE AND RUGGEDNESS, CERAMIC-ENVELOPED AND FAR SMALLER

The new EG&G Hydrogen Thyatron, Model 1802, delivers 30 megawatts peak power in a smaller package than any comparable unit. It supersedes many older types, and surpasses the performance of the Type 5948/1754 on all counts, in less than 1/7th the size. The new 1802 is air-cooled by convection and will tolerate ambient temperatures up to 100° C. Yet its warm-up time is only 5 minutes. Other comparisons with the 5948/1754:

	1802	5948/1754
Input trigger power	250 v at 400 ohms max.	650 v at 250 ohms max.
Delay time	0.5 μ s rated (average is 0.25 μ s)	1 μ s
Jitter	.002 to .005 μ s	.02 μ s
Reservoir Range	$\pm 10\%$	$\pm 5\%$
Filament Power	90 watts	200 watts
Ambient Temp. Max.	100° C	75° C

The hydrogen thyatron was invented by K. J. Germeshausen, President of EG&G. Advanced research continues to keep this company in the forefront of hydrogen thyatron development. For specific data on the 1802, and for the most authoritative information on gas-discharge tube types and MILLI-MIKE* CRT's, TW oscilloscopes and systems, write to us on your company letterhead.

*Trademark

EDGERTON, GERMESHAUSEN & GRIER, INC.



160 Brookline Avenue, Boston, Mass. 1622 South "A" Street, Las Vegas, Nev.

CIRCLE 80 ON READER-SERVICE CARD

NEW PRODUCTS

Attenuator

Measures rf power ratios



This instrument is intended for measuring rf power ratios in systems employing modulated rf power sources and square-law rf detectors. In such systems the audio voltage output from the detector is proportional to the rf power input, and it is therefore necessary to substitute audio attenuation corresponding to the change in rf attenuation. This audio attenuator reads, in decibels, this change in rf attenuation. The audio frequency attenuator has a characteristic impedance of 2000 ohms and is adjustable over a range of 104 db audio attenuation corresponding to 52 db rf attenuation.

Weinschel Engineering, Dept. ED, Kensington, Md.

CIRCLE 81 ON READER-SERVICE CARD

Power Supplies

For transistor use



The first of this series of power supplies is designed for both laboratory and production line use, and features three models with variable dc output. Model VM-120 has an output variable from 0-15 v dc, a maximum current of 2 and an internal impedance of 1.3 ohm. Model VM-300 has an output variable from 0.30 v dc, a maximum current of 1, and an internal impedance of 5 ohm. Model VM-500 has an output from 0-50 v dc, a maximum current of 1 and an internal impedance of 8 ohm.

The second series has an output variable from 0-28 v dc, a maximum current of 1 a, an internal impedance of 1.1 ohm; and a ripple factor of 0.065 per cent.

Ferrotran Electronics Co., Dept. ED, 693 Broadway, New York 12, N.Y.

CIRCLE 82 ON READER-SERVICE CARD

NEW! ELECTRONIC TEST EQUIPMENT

PHASE SHIFTER

Models PS60 & PS400

For measurement and comparison of phase angles or as a secondary phase standard



SPECIFICATIONS

RANGE.....	0-360° (continuously variable)
ACCURACY.....	± 1 degree (Higher accuracies available)
FREQUENCY.....	60 CPS for PS 60 400 CPS for PS 400 (other frequencies available)

FREQUENCY STANDARD

A SELF-CONTAINED FORK STABILIZED FREQUENCY SOURCE

- Accurate
- Stable
- Low Distortion
- Variable output voltage
- Compact



Model 1400

SPECIFICATIONS

ACCURACY.....	Available to .005%
DISTORTION.....	Less Than 1%
FREQUENCY.....	400 CPS or 1000 CPS (Other Freq. Avail.)
Dimension.....	6x9x6 inches
Power Supply.....	115 volts, 60 CPS

OTHER MODELS AVAILABLE

MODEL 600 LOW FREQUENCY STANDARD DESCRIPTION: Utilizes scaling circuits to provide tuning fork accuracies at frequencies below the range of precision tuning forks.

AUTOMATIC HI-POT TESTER

Model A

FAST, ACCURATE, DIELECTRIC TESTING FOR MULTI-CONDUCTOR DEVICES



DESCRIPTION: The function of this instrument is to apply in programmed sequence a known voltage between the various conductors under test for a specific period of time and to indicate breakdowns when and where they occur.

SPECIFICATIONS

TEST VOLTAGE.....	0-2000 Volts RMS
TEST TIME.....	2-120 seconds
NUMBER OF TEST TERMINALS.....	11

NULL DETECTOR

Model 60B



A sensitive battery operated null detector ideal for shering bridges or other applications where complete isolation from power lines is desirable.

- Long Battery Life
- High Harmonic Rejection
- Shielded against external fields

SENSITIVITY: † microvolt for 1% deflection



Write for Catalogs
Reps in Principal Cities

INDUSTRIAL TEST EQUIPMENT CO.
55 E 111th ST · NEW YORK 3 · GR 3-4684

CIRCLE 83 ON READER-SERVICE CARD

Telemetry Noise Cutout

Permits recovery following noise bursts



Model MNC-1 noise cutout unit provides for the rapid recovery of telemetered signals following noise bursts which often cause data to be temporarily lost due to interference. During periods of signal drop-out, this unit stores control-loop voltage levels to provide wave form restoration with a minimum loss of data due to recovery time factors. Signal restoration accuracy after one-half minute of drop-out is within two per cent of full scale.

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

CIRCLE 84 ON READER-SERVICE CARD

Power Pack

For electrostatic devices



Designed primarily for electrostatic devices, this encapsulated high voltage dc power pack will deliver voltages up to 12,000 v at currents ranging up to 0.5 ma. It is current limited to 5 ma under short circuit conditions and measures only 2-1/4 x 2-1/2 x 6-1/4 in.

Skysweeper, Inc., Dept. ED, McHenry, Ill.

CIRCLE 85 ON READER-SERVICE CARD

CIRCLE 86 ON READER-SERVICE CARD

A COMPLETELY NEW Concept IN

BOBBINLESS RESISTORS

New Subminiature Precision Wirewound Bobbinless Resistors feature exceptional stability, reliability and performance

General Transistor has developed a new concept for precision bobbinless resistors incorporating these exclusive features . . . the bobbinless construction eliminates wire stress and strain . . . a special viscous medium is used providing extreme shock and vibration resistance . . . welded case for positive hermetic sealing . . . the temperature coefficient of resistance of the finished resistor is the same as the wire and is not affected by the container. This insures repeatability and minimum hysteresis of resistance characteristics with temperature cycling.

These positive hermetically sealed units are designed for printed circuit boards and subminiature assemblies for airborne and missile applications.

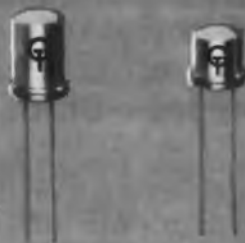
The quality of materials and production superiority of these resistors is the same that has made General Transistor the Fastest Growing Name in Transistors.

Write today for complete technical information.

SPECIFICATIONS

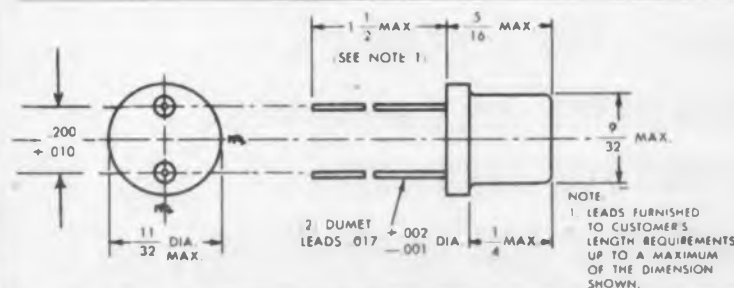
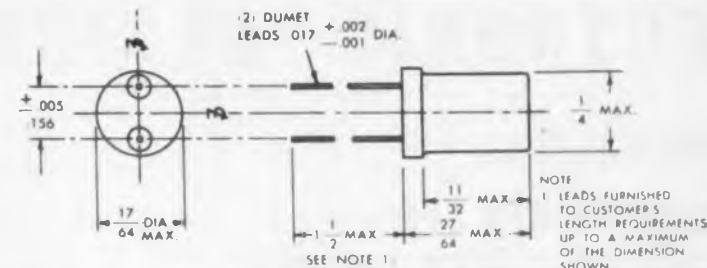
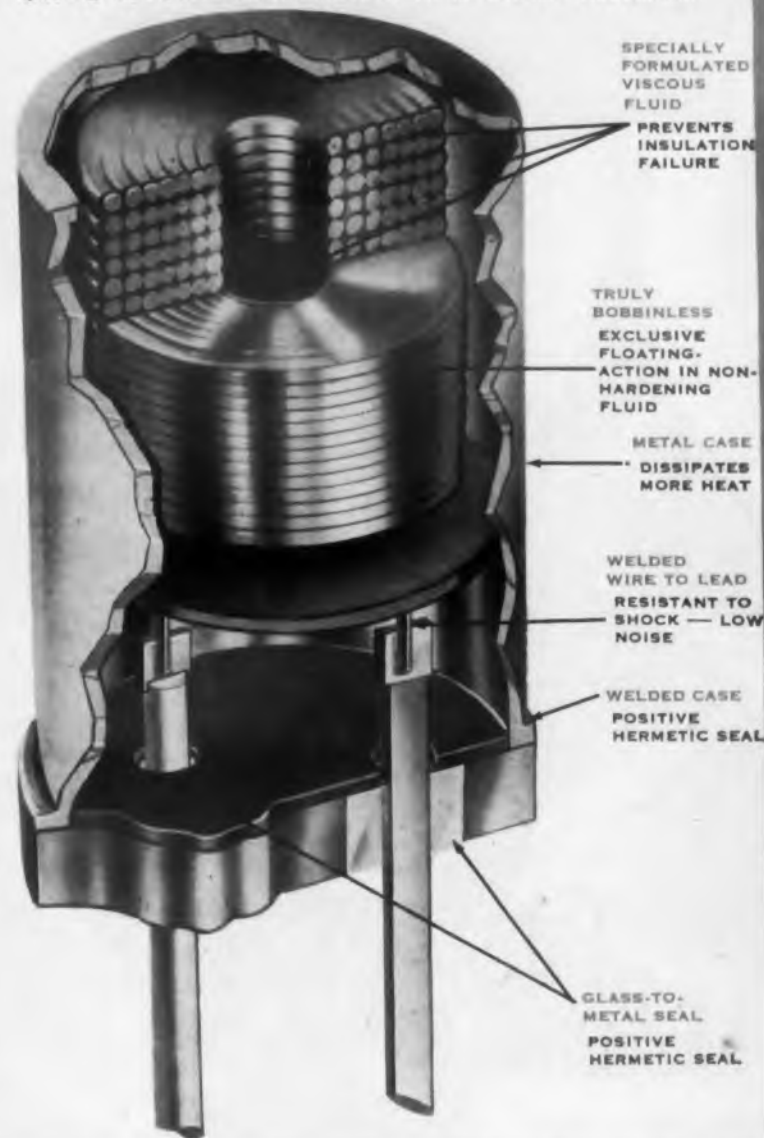
	Style R-2	Style R-5
Resistance Range	0.1Ω to 750KΩ	0.1Ω to 750KΩ
Resistance Tolerance	±0.05% min. at 25°C	±0.05% min. at 25°C
Power Rating	1/4 watt continuous in free air (increased dissipation possible with heat sink)	1/2 watt continuous in free air (increased dissipation possible with heat sink)
Temperature Range	-65°C to +125°C	-65°C to +125°C
Maximum Operating Voltage	250V, DC	500V, DC
Temperature Coefficient of Resistance	±20 parts per million/°C	±20 parts per million/°C
Dielectric Strength	500V rms, winding to case	1000V rms, winding to case

Construction — Terminations: — Welded



ACTUAL SIZE

another QUALITY PRODUCT FROM GENERAL TRANSISTOR



GENERAL TRANSISTOR

C O R P O R A T I O N
91-27 138TH PLACE JAMAICA 35, NEW YORK

IN CANADA: DESSER E-E LTD., 441 ST. FRANCIS XAVIER, MONTREAL 1, QUEBEC
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TRANSISTORS



TRANSISTOR ISSUE

PUBLISHED JULY 9th—CLOSES JUNE 9th

CBS-Hytron Photo

ELECTRONIC DESIGN FEATURE REPORT

- TRANSISTORS
- COMPONENTS FOR TRANSISTORIZED CIRCUITS
- TRANSISTOR ASSEMBLIES
- TRANSISTOR TEST EQUIPMENT
- DESIGN FOR TRANSISTORS
- MATERIALS FOR TRANSISTORS

The 6th annual Transistor Data Issue of *Electronic Design* will be published July 9th—complete with TRANSISTOR DATA CHART, the first and only complete transistor data source of its kind in the industry. The chart is bound in each copy of the magazine—can be removed for permanent reference. Extra editorial, extra readership, extra *reader action!* Schedule this issue of greatest value NOW . . . forms close June 9th.

JULY 23rd—DIODES

Also in July: an *Electronic Design* feature report on *Semiconductor Diodes*. Special editorial, characteristics charts, performance data, will make this issue in extra demand by design engineers throughout the industry. Forms close June 23rd.

NEW PRODUCTS

Transistor Enclosure Hermetically sealed at 1000 C



This all-glass transistor enclosure is made possible by the development of a close-control electric sealing process. The base and envelope are hermetically sealed at 1000 C while temperature near the semiconductor, less than 1/4 in. away, is kept below 150 C. Sealing is done in approximately 10 sec. Both base and envelope of the 200 mil lead circle-enclosure are made of strong, thin-walled, precision glass tubing.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 88 ON READER-SERVICE CARD

Dual-Beam Scope DC to 100 kc frequency response



Type 502 dual-beam oscilloscope has two high-gain vertical amplifiers with calibrated sensitivities in 16 steps from 200 $\mu\text{v}/\text{cm}$ to 20 v/cm .

Frequency response is dc to 100 kc at maximum sensitivity, dc to 500 kc at sensitivities lower than 50 mv/cm . Both channels have differential input with high rejection, and a constant input impedance of 1 meg, 47 μf .

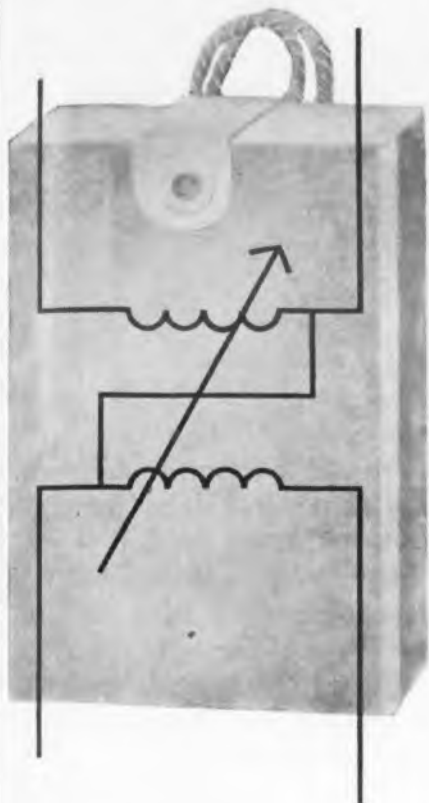
Tektronix, Inc., Dept. ED, Portland 7, Ore.

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC
DESIGN

a HAYDEN publication • 830 Third Avenue, New York 22, N.Y., Telephone PLaza 1-5530

NO BRUSH PROBLEM



You get . . . Greater Reliability From G-E Inductrol* Voltage Regulators

There are no brushes to worry about on the G-E Inductrol regulator. Because it is a brushless induction device, this highly reliable voltage regulator is far easier and more economical to operate. There are many more advantages, such as high overload capabilities and accurate, drift-free control (just set it and forget it), that you'll want to know about.

For more information, write Section 425-11, General Electric Company, Schenectady, N. Y.

*Registered trademark of General Electric Company for Induction Voltage Regulators

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 91 ON READER-SERVICE CARD

DC Potentiometer

Permits readings to three places



This dc potentiometer includes standard cell, working battery, null balance galvanometer, volt box, shunts and adjustable power supply for calibration of dc instruments in any ranges from 0.1 μ a to 9.99 a and 0.1 mv to 999 v. Three decade switches provide readings to three places. Precision wire wound resistors are manganin with tolerance of 0.5 per cent.

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

CIRCLE 92 ON READER-SERVICE CARD

Parabolic Antennas

Range between 200 and 5000 mc



These 28 foot parabolic antennas with dual-polarized feed horns cover the range between 200 and 5000 mc. The reflector consists of a center section of four identical pie segments, and an outer section of six ring segments. Type 21 mount is for mounting on the face of a 10-foot tower, but is adaptable to other sizes. It provides for azimuth and elevation positioning through ± 5 deg. Type 22 mount is for mounting on the corner of a tower, and may be used on triangular towers with leg spacings of 10 feet or less, providing azimuth and elevation position through ± 4 deg. The antenna weighs 1800 lb net, including face mount.

Technical Appliance Corp., Dept. ED, 1 Taco St., Sherburne, N.Y.

CIRCLE 93 ON READER-SERVICE CARD

FERRANTI

HIGH SPEED TAPE READER

...handles punched tape data
at electronic speeds



The Ferranti High Speed Tape Reader accelerates to full speed within 5 milliseconds and stops within 3 milliseconds. It has achieved a sound reputation for simplicity and reliability in regular operation.

Proven Reliability in hundreds of data processing and data transmission installations from coast to coast.

Photoelectric Sensing uses "pin hole camera" optical system for increased signal/noise ratio with any type of fully punched tape; no lenses or mirrors. Output signals greater than 20 volt.

Rugged Differential Type Friction Drive eliminates sprocket hole wear and requires very little maintenance.

Stop-on-a-Character feed mechanism allows operation in any mode from free run to stop on every character at any speed up to 200 characters/sec. Feed speed controlled by equipment receiving data. Tape positioned by sprocket hole associated with character being read, eliminating errors due to variations in character pitch. Higher speed models available for 400 characters per second, stopping on or before next character.

Simple Tape Loading with no threading. Character being read is visible to operator. Lap or butt splices accepted.

No Minimum Tape Length. Compatible motorized spooling units available for lengths up to 1,000 feet.

Desk or Console Mounting for comfortable operation.

Size 9" x 11½" x 11¼", Weight 37 lbs.

Consult Ferranti Electric for any paper tape reading problem.

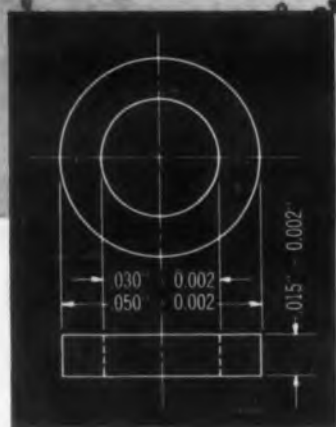
FERRANTI ELECTRIC, INC.

30 Rockefeller Plaza New York 20, N. Y.



CIRCLE 94 ON READER SERVICE CARD

NEW! From the Laboratories of General Ceramics



50 MIL O.D. Memory Cores for Transistorized High Speed Memories

These new 50 mil O.D. cores are now available in General Ceramics S-4, the material that has proven so successful in such vitally important systems as the SAGE computer. Switching time is less than one microsecond with 550 ma full drive. At recommended operating conditions, the "ONE" output voltage is greater than 60 millivolts; the "ZERO" output voltage is less than 6 millivolts. Cores are provided in two quality levels, to .015 AQL and to 6.5 AQL. Dimensions are .050" O.D., .030" I.D.

and .015" in height, all with tolerances of $\pm .002$ ". General Ceramics has designed and built special equipment for core testing to insure that each unit meets established electrical properties. 50 mil O.D. cores are supplied in production quantities in two quality levels. Parts are shipped according to MIL Specification 105A to 0.015 AQL or 6.50 AQL. For complete information on this core write General Ceramics Corporation, Keasbey, New Jersey, for Bulletin 326; address Dept. ED.

GENERAL CERAMICS

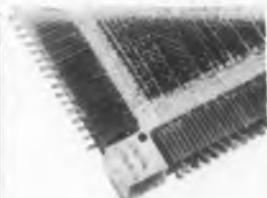
Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES



PRECISION
STEATITES



MAGNETIC
MEMORY PLANES



"ADVAC" HIGH
TEMPERATURE SEALS



SOLDERSEAL
TERMINALS

CIRCLE 95 ON READER-SERVICE CARD

NEW PRODUCTS

Time Delay Relays 10 a contact rating



Design and performance details of the transistorized time delay relays include: timing delay periods from 0.01 to 60 sec; timing accuracy of ± 10 per cent of nominal delay period; contact arrangements and ratings of 1-pole, double throw, 10 a resistive or 3-pole, double throw, 10 a resistive; ambient temperature from -55 to 125 C; vibration resistance of 10 to 80 cps., 0.12 g peak double amplitude, 80 to 2000 cps at 20 g; shock resistance of 50 g for 11 msec; input voltage of nominal 28 v dc. A typical model measures 1-1/4 x 1-11/16 x 2-1/4 in. and weighs 5-1/2 oz.

Tempo Instrument Inc., Dept. ED, 240 Old Country Rd., Hicksville, N.Y.

CIRCLE 96 ON READER-SERVICE CARD

Data/Log

Capable of 150 printing operations a minute

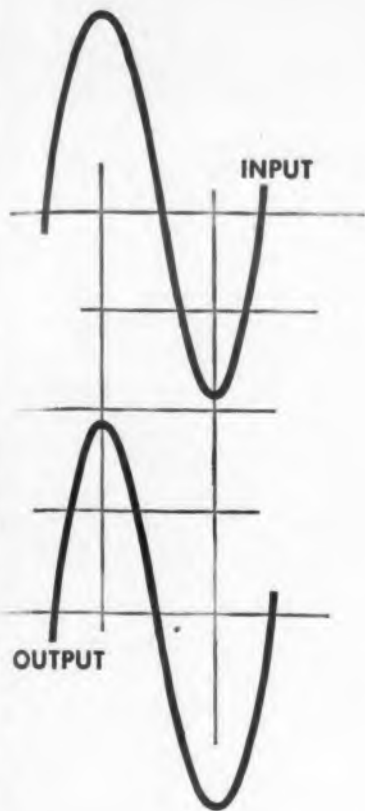


The Data/Log series MC 203 units are adapted to large scale data logging systems. As many as 14 digits can be entered on one printing cycle in any arrangement from 1 up to 14, or in any grouping within 14 digits. These machines are capable of a maximum of 150 printing operations a minute. Hence it is possible to obtain a speed of over 30 characters per second. With the 18 in. carriage, up to 136 characters and spaces may be printed on a single line.

Monroe Calculating Machine Co., Inc., Electronics Components Div., Dept. ED, 60 Main St., San Francisco, Calif.

CIRCLE 97 ON READER-SERVICE CARD

NO WAVEFORM PROBLEMS



You can . . .
Simplify
Design Circuitry
With G-E Inductrol*
Voltage Regulators

The G-E Inductrol voltage regulator does not introduce harmful waveform distortion in your circuits.

Because it's an induction device, this voltage regulator offers you the advantages of brush-free operation . . . no voltage drift and tubeless control. Result: the ultimate in reliable voltage control.

For more information write Section 425-16, General Electric Company, Schenectady, New York.

*Registered trademark of General Electric Company for Induction Voltage Regulators

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 98 ON READER-SERVICE CARD



Antennas

For communication and telemetering in the 2-200 mc region

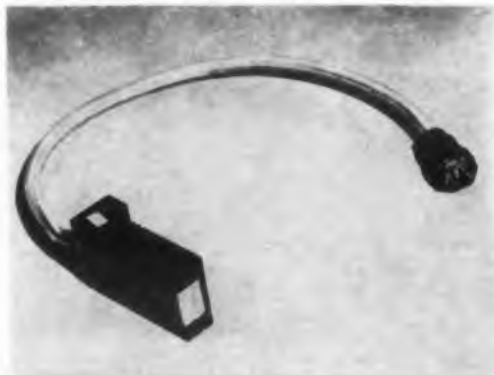
This 8 foot diameter horn-fed paraboloid antenna weighs only 82 lb and provides a 4 deg pencil beam for high gain requirements. Another type is a compact blade antenna which has been designed for missiles and supersonic aircraft. It is less than 1 in. high, has very low drag, and provides an omni-directional pattern. A conical scanner is available for installation in 6, 8, or 10 foot diameter paraboloids. Optimum reception of telemetering signals even at long range is obtained by automatic tracking with the narrow beam provided. Horizontal, vertical and circular polarization are available.

Canoga Corp., Dept. ED, 5955 Sepulveda Blvd., Van Nuys, Calif.

CIRCLE 99 ON READER-SERVICE CARD

Transducer

Accurate to 1 sec of arc



T833 transducer which is a differential transformer type pickoff consists of an E-core stator and one or more separate companion rotors. The transducer is accurate to 1 sec of arc and is used in position pickoff in servo rate or optical systems. The dimensions of the transducer in potted core are 1-1/8 x 5/8 x 1/2 in. while in potted housing the dimensions are 2 x 1-1/4 x 3/4 in. The rotor face is 0.250 in. diameter round or 0.250 in. square. Excitation: 5 to 100 ma/300 cps to 2 kc. Sensitivity of 0.1 ma per .001 in. per ma excitation at 400 cps.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 100 ON READER-SERVICE CARD

ACEPOT®

SUB-MINIATURE, PRECISION, WIRE-WOUND

LINEAR POTENTIOMETERS



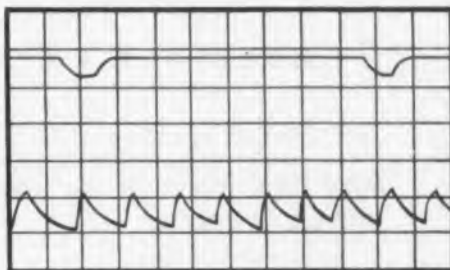
Small pot size — Big pot performance

Only 1/2" in diameter, the ACEPOT excels in a combination of all around top performance characteristics comparable to larger units. For example, these precision units feature $\pm 2\%$ resistance tolerance and $\pm 0.3\%$ independent linearity. Every potentiometer is completely sealed against sand, dust and foreign matter to avoid abrasive action between moving parts. All materials and metals are treated for maximum resistance to salt spray, corrosion, humidity and conform to shock and vibration tests. ACEPOTS are designed and assembled MIL-A-8625A, QQ-M-1512, JAN-T-152, MIL-E-5272A, MIL-R-19A, NAS-710 and MIL-R-19518 (ships).



ACEPOT LINEARITY TEST

Plot of voltage ratio error versus rotation illustrates linearity to better than $\pm 0.3\%$.



ACEPOT RESOLUTION TEST

Section of oscillograph trace of electrical resolution shows voltage change for each turn of wire.

ACE offers a wide variety of linear and nonlinear precision, wire-wound potentiometers in standard, special and AIA sizes. Custom designs to meet special requirements can be made available on short lead time. Call, write or teletype Dept. G, ACE ELECTRONICS ASSOCIATES, INC., 99 Dover Street, Somerville, Mass., SOMerset 6-5130, TWX SMVL 181.

ACEPOT®
ACETRIM®
ACESET®
ACEOHM®

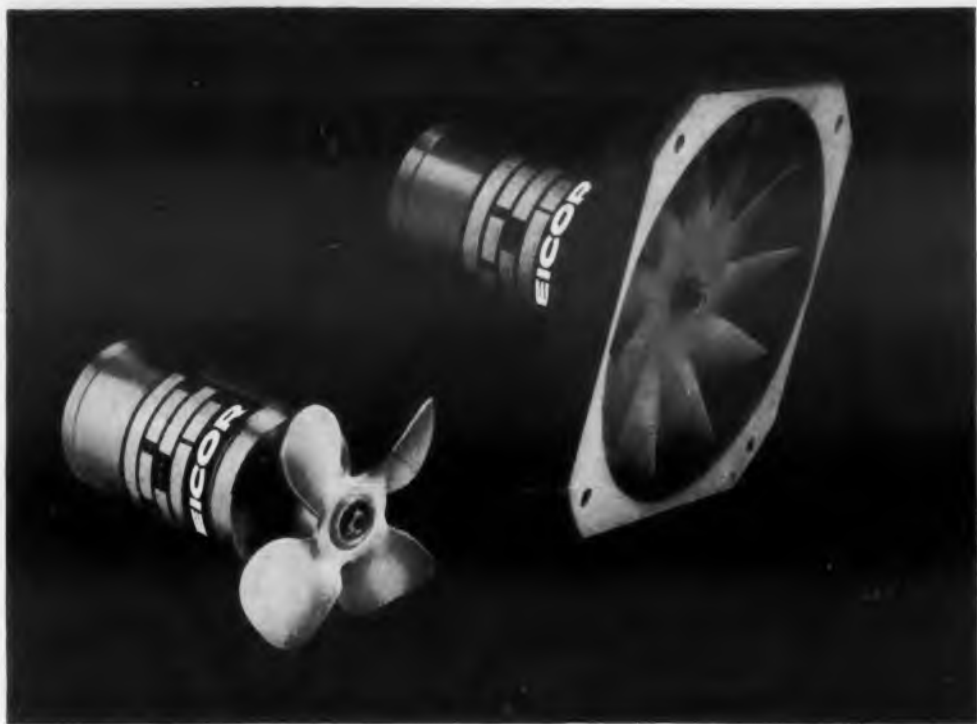
ACE

 ELECTRONICS ASSOCIATES, INC.

CIRCLE 101 ON READER-SERVICE CARD



PM BLOWERS



NEW

MINIATURE, 60 VDC BLOWER UNITS

RELIABLE • EFFICIENT • RUGGED

Eicor Permanent Magnet 60 Volt blower motors provide unusual power and performance in a small unit of only 1.186 diameter and 1.890 length.

- Class B insulating system.
- Suitable for operation from a rectified 115V, 60 cps or 400 cps source.
- Input voltage may be designed for any voltage up to 60V.
- Long brush life.
- Toroidal magnet for low external field and high mechanical strength.
- Cartridge brushholders for easy field maintenance.
- All-metal frame construction.
- Designed to withstand severe environmental conditions.



EICOR

4233 WEST NORTH AVE., CHICAGO 39

Another F. L. Jacobs Division

CIRCLE 102 ON READER-SERVICE CARD

NEW PRODUCTS

Telemetry Unit

For use with solid state commutators



The DKO-11 keyer subcarrier oscillator makes it possible to combine pw data channels with existing channels in fm/fm and fm/pm airborne telemetry systems. The DKO-11 is especially designed to operate from negative pedestal triggering pulses typical of those generated by solid state high level commutators. It is suited for use in airborne pw/fm/fm telemetry systems. When used in conjunction with a suitable pw commutator, the DKO-11 permits the multiplexing and pw encoding of a large number of data channels on a single 70 kc subcarrier oscillator frequency. This subcarrier can then be mixed with other subcarriers and applied to an rf carrier for radio transmission.

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

CIRCLE 103 ON READER-SERVICE CARD

Terminals

Features 4 way crimp



These terminals used on both stranded and solid wire, are available in three sizes: 22 thru 16, 16 thru 14 and 12 thru 10. These one-piece terminals are all copper and feature small overall size for applicability in restricted spaces, wide bell-mouths for easy wire insertion, serrated barrels for joint efficiency, and open-end construction for easy visual inspection. The terminals may be installed with the C-241 hand pressure tool or with the D-241 dies which are adaptable for mounting in most common presses.

Buchanan Electrical Products Corp., Dept. ED, 234 Rt. 22, Hillside, N.J.

CIRCLE 104 ON READER-SERVICE CARD

HIGH Sensitivity RELAYS

for Military Equipment
and
Commercial Applications



- Switching Capacities up to 5a., 30 v., d.c.
- Sensitivity down to 9 mw.
- Coil Resistances to 20,000 Ohms.
- Environmental specifications will meet latest revision of MIL R-5757 and MIL R-25018.
- Standard contact arrangement up to 4 Form A and 2 Form C.

For commercial and industrial applications
ask about the new Series SC
high sensitivity relay

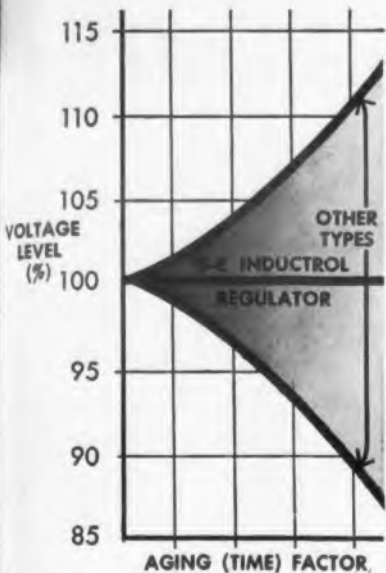
WRITE FOR RELAY DATA BULLETIN

B

BASO, INC.

Dept. RN-1, Milwaukee 1, Wisconsin
CIRCLE 105 ON READER-SERVICE CARD

NO DRIFT PROBLEM



You get . . . Assured Accuracy From G-E Inductrol* Voltage Regulators

With the G-E Inductrol regulator control, voltage is automatically held to within $\pm 1\%$ bandwidth. Unique compensating controls on the G-E Inductrol regulator make it unnecessary to continually reset voltage level. You merely set it at the desired voltage level, and forget it. This highly reliable and accurate automatic control is also compensated for temperature, and is inherently insensitive to frequency or power factor changes.

For more information write Section 425-12, General Electric Co., Schenectady, N. Y.

*Registered trademark of General Electric Company for Induction Voltage Regulators

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 106 ON READER-SERVICE CARD

Oscilloscope DC to 15 mc



Type 533 is a dc-to-15 mc oscilloscope with the company's plug-in feature. All type 53/54 plug-in units can be used with this instrument for signal-handling versatility. Risettime of the main vertical amplifier is $0.022 \mu\text{sec}$. The Type 533 has 22 calibrated direct-reading sweep rates from $0.1 \mu\text{sec/cm}$ to 5 sec/cm , with sweep magnifications of 2, 5, 10, 20, 50, and 100 times. Full sweep range is $0.02 \mu\text{sec/cm}$ to 15 sec/cm .

Sweep lockout-reset feature provides for one-shot recording, 10-kv accelerating potential assures bright trace for single sweeps. Writing rate is $250 \text{ cm}/\mu\text{sec}$. Viewing area is 6 by 10 cm. Amplitude calibrator has 18 fixed steps from 0.2 mv to 100 v peak to peak. Square-wave frequency is about 1 kc. Other features include automatic blanking for switching transients when dual-trace unit is used in its chopped mode, and warning lights for uncalibrated sweep rate and magnifier settings.

Tektronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

CIRCLE 107 ON READER-SERVICE CARD

RF Amplifier Extended range to 245 mc



The REL-09-HF is a further development of the REL-09 rf power amplifier extending the amplification range from 235 to 245 mc. The unit employs a type 6360 miniature dual-beam power-amplifier tube with a CCS rating of 15 w. With 1.4 w input drive, it will deliver an 8 w minimum output to a 52 ohm grid plate.

Rheem Electronics Div., Dept. ED, 7777 Industry Ave., Rivera, Calif.

CIRCLE 108 ON READER-SERVICE CARD



FXC

presents a

comprehensive line of

threaded ferrite slugs

for permeability tuning

Ferrites are the finest material for tuning slugs wherever a high-Q, high-permeability core is required and space is at a premium. These Ferroxcube tuning slugs have been specifically developed for the permeability tuning of inductors, filters and transformers in the 1 kc to 4 Mc frequency range. They come in a large variety of sizes and threads, and have been found particularly useful for final inductance adjustments on filters with ferrite pot cores. The screw-driver slot in the slugs runs all the way through the core for simpler coil assembly and easy adjustability at either end. All Ferroxcube threaded slugs are furnished complete with self-threading coil forms of phenolic-impregnated tubing.

For complete data, as well as information on the availability of specific types and sizes, write to:

FERROXCUBE CORPORATION OF AMERICA
55C East Bridge Street, Saugerties, New York



Manufacturers of ferrite cores for recording heads, magnetic memories, TV flyback transformers, pulse transformers, filters, inductors, high frequency shields and power transformers

CIRCLE 109 ON READER-SERVICE CARD

NEW PRODUCTS

4PDT Relay

Sensitivity of 1 mw per contact



Type 104 4pdt relay features a sensitivity of 1 mw per contact. The unit can be used for very close differential applications where dropout is required as close as 85 per cent of pickup. The relay is designed for dc operation but is also made for ac, using selenium rectifiers contained within the enclosure. Standard coil resistance is up to 30,000 ohms with special windings to 100,000 ohms.

Contact capacity is 1 amp inductive or 3 amp resistive at 115 v ac or 29 v dc. Contacts are available in silver, palladium, silver cadmium oxide, or gold alloy. The relay has thorough wipe action on the contacts.

General Automatic Corp., Dept. ED, 12 Carlton Ave., Mountain View, N.J.

CIRCLE 110 ON READER-SERVICE CARD

Temperature Control

Explosion-proof dual switch

Type D98A is a sensitive, remote bulb temperature control designed for use in hazardous locations where explosive vapors and gases are present. Two separate switches permit switch action above or below the set point, control of two independent circuits, and great flexibility of switching arrangement. The standard head compensation provided is effective from -65 to +160 F.

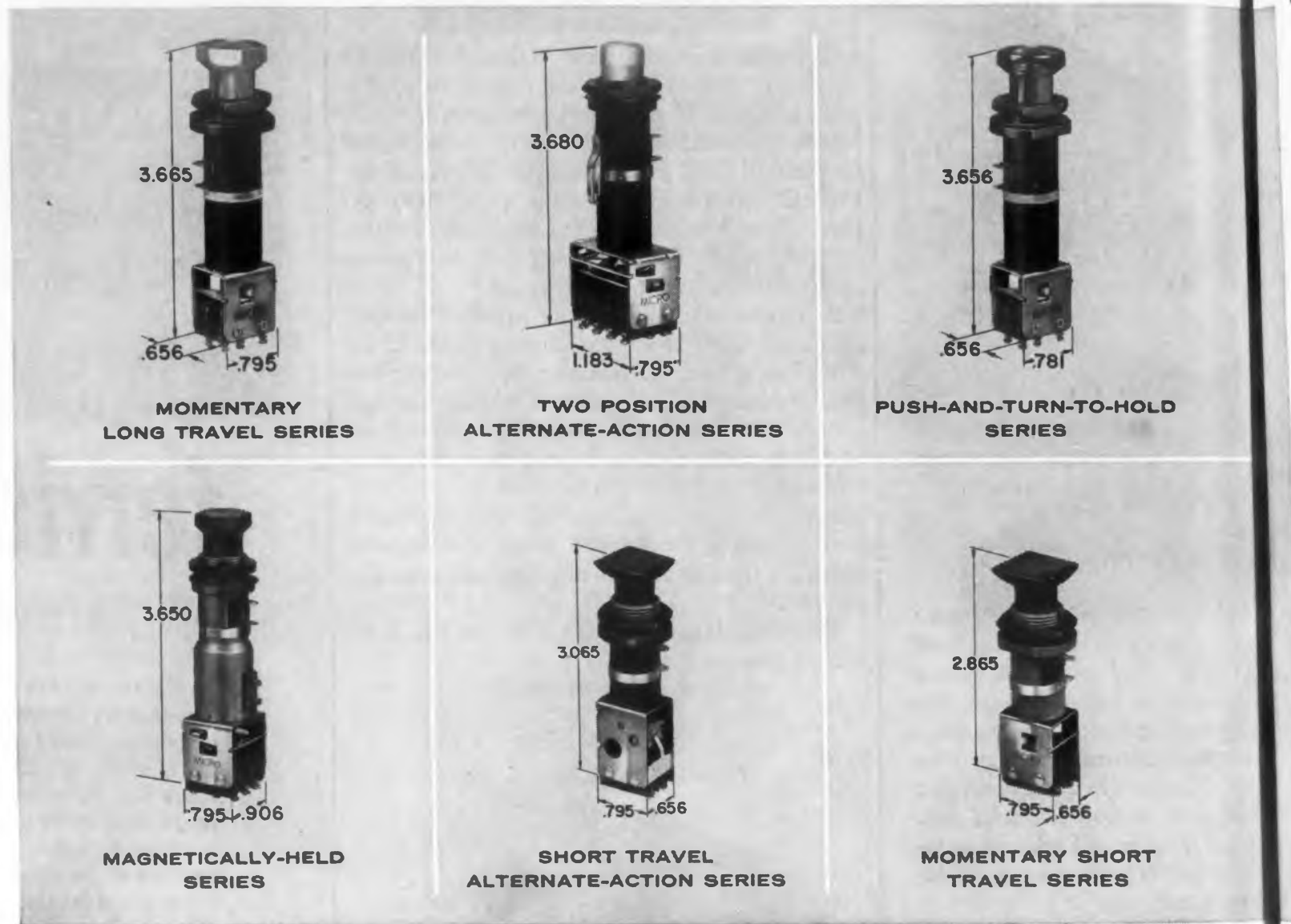
United Electric Controls Co., Dept. ED, 79 School St., Watertown, Mass.

CIRCLE 111 ON READER-SERVICE CARD



MICRO SWITCH Precision

"50 PB" Series Lighted Provide More Versatility



BUTTONS

Buttons for "50 PB" Series switches are available from MICRO SWITCH in four sizes and shapes, as illustrated, and in a selection of colors, as listed.



1/4-inch Round. Available in red, yellow, blue, green and white.



1/4-inch Hex. Available in red, yellow, and green.



1/4-inch Round. Available in red, yellow, blue, green, white and clear.



1/4-inch Square. Available in red, yellow, blue, green and white.

Switches have uses unlimited



Pushbutton Switches

... More Flexibility

... Require Less Panel Area

These switches combine indicating light and switch in one unit, have separate lamp and switch terminals for maximum freedom in circuitry, and are available in more than 200 variations to meet your requirements.

The six switches shown are representative of only one of the several families of lighted pushbutton switches. All are panel mounting designs, and are easily mounted on one-inch centers. Indicating light and switch are combined in one unit to further conserve panel space and simplify design. Separate terminals for the light and the switch assure

widest circuit adaptability. Basic switching element is the well-known MICRO SWITCH sub-miniature switch. Each is a single-pole double-throw unit. Number of SPDT circuits is given in the description of each series. These switches have qualified under many of the Military environmental specifications.

Request Data Sheet No. 133 which covers all details.

MOMENTARY LONG TRAVEL SERIES

Provides excellent positive "feel" action with long travel—more than 1/4 inch including lost motion—to guard against false actuation. The longer travel and positive "feel" action fit the accepted human engineering concept of pushbutton switch operation. Available in 2-, 3-, or 4-pole construction.

TWO POSITION ALTERNATE-ACTION SERIES

Combines visual mechanical indication and visual electrical indication in one unit. Has simple action with long operating life. Gives excellent positive "feel" in operation. Available in 2-, 3-, or 4-pole construction.

PUSH-AND-TURN-TO-HOLD SERIES

A combination momentary and optionally maintained-contact action switch. Locks and releases with the turn of a fingertip. Available in 2-, 3-, or 4-pole construction.

MAGNETICALLY-HELD SERIES

Combines a switch, a light, and a magnetic coil in one unit. Coil is available in 6, 28, or 48 vdc. Coil, lamp and switch terminals are electrically isolated. Energizing of coil does not operate switch, but does hold switch in ON position after manual operation. De-energizing of coil returns switch to normal. Available in 2-, 3-, or 4-pole construction.

SHORT TRAVEL ALTERNATE-ACTION SERIES

Push to turn "on," push to turn "off." In this series, the back-of-panel space is 2 1/4 inches. Available in 2-pole construction only.

MOMENTARY SHORT TRAVEL SERIES

A short-length switch with back-of-panel length less than 2 inches. Available in 2-, 3-, or 4-pole construction.

MICRO SWITCH... FREEPORT, ILLINOIS

*In Canada: Leaside, Toronto 17, Ontario
A division of Honeywell*

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.



Honeywell

MICRO SWITCH PRECISION SWITCHES

CIRCLE 112 ON READER-SERVICE CARD

Control Panel Units

For transistorized circuitry



Included in this line of control panel components are: the Echo-lite, a push button with an NE-2 neon bulb enclosed; the Memo-lite, a subminiature thyatron indicator for transistor circuitry; and the Transistor-lite, a transistor controlled neon lamp circuit. Each is housed in an anodized aluminum tube of 1/2-in. diameter, 2-in. long. The gold plated terminal connections take A-MP series 53 taper pins. The lenses are molded from clear plastic, but are available in colors as well. The terminal header is nylon, and mylar insulation is used internally. Provisions are made internally for as many as four 1/2 w composition resistors.

Transistor Electronics Co., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 113 ON READER-SERVICE CARD

Digital Totalizer

Visual and electrical readout



Model 7106 Digitote accepts pulses at a rate of 60 per second and totalizes any input quantity for remote indication, control, or telemetry. Three and five digit visual and electrical readouts provide high accuracy and large capacity (up to 99999) totalizing. Number wheels are lighted for photographic and visual clarity.

Digitran Co., Dept. ED, 45 W. Union St., Pasadena, Calif.

CIRCLE 114 ON READER-SERVICE CARD



in tune with the tines*

Our friend Sherman's tuning fork technique has received extensive notoriety at many of the posh type missile test centres throughout the land. Obstinate audile that he is, his attempt at aligning specific frequencies to assure accurate reception and transmission has led many a countdown into the wee hours. A pity, too, when one considers how perfectly our new Model 82 Signal Generator Series may be utilized as a pole beacon for missile checkout equipment. One power supply - six plug in r-f oscillators and you're in business all over the place.

The basic power chassis comprises both high and low voltage power supplies, a variable-amplitude (1 kc) sine-wave oscillator and a square wave shaper. Individual, interchangeable, r-f oscillator assemblies contain the remainder of the generator components: low frequency unit 20-80 mc, medium frequency units 300-500 mc, and four hi-freaks 500-1000 mc, 800-1100 mc, 1100-1600 mc and 2700-3000 mc. The people who use it say such versatility makes it truly unique among all other signal generators.

The Model 82 Series is *very* flexible plug-in equipment, taking up but a bit of the van racking space previously required for attuning telemetry and guidance channels, tracking and acquisition radar and voice links too. If you warm toward the 82 for missile checkout or even general laboratory measurements, be of inquiring mind - write for literature please.

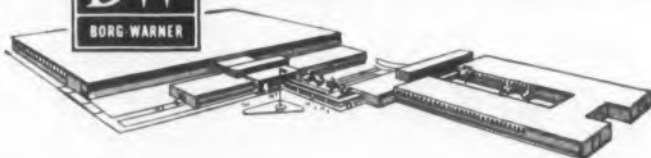


*Think about it



BJ ELECTRONICS

BORG-WARNER CORPORATION
Reliability you can count upon



3300 NEWPORT BOULEVARD, P. O. BOX 1679, SANTA ANA, CALIFORNIA
EXPORT SALES: BORG-WARNER INTERNATIONAL CORP., CHICAGO, ILLINOIS
CIRCLE 115 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducer

Repeatability of 1 per cent



Model 451212 pressure transducer, a potentiometer output device, has a 2000 wire (0.05 per cent) resolution and accuracy within 1.0 per cent of reading. The instrument is available in pressure ranges from 0-10 through 0-50 psi absolute, differential, or gage.

G. M. Giannini & Co., Inc., Dept. ED, 918 E. Green St., Pasadena, Calif.

CIRCLE 116 ON READER-SERVICE CARD



Tape Strobe

Checks tape speeds of all tape records

Under 60 cps light sources, reference marks on the wheel disc appear to stand still if the tape is moving past the capstan at correct speeds: 7-1/2, 15, and 30 ips. Only a 60 cps light source is necessary.

Scott Instrument Labs., Dept. ED, 17 E. 48 St., New York 17, N.Y.

CIRCLE 117 ON READER-SERVICE CARD

Magnetic Shield

Eliminates ion fields



This small cylindrical netic co-netic magnetic



GUDEBROD
LACING
TAPES ARE
USED IN
COMMUNICATION,
UTILITIES
& MILITARY
AS WELL AS
RESEARCH
PROJECTS.
CAN WE
HELP YOU?

Gudebrod flat braided lacing tapes hold harness securely—no bite-through or slip, yet are easy on the hands. Some resist high temperature, some are color-coded . . . and they come wax-coated or wax-free . . . rubber-coated . . . or with special coating. Gudebrod makes many tapes for many purposes, including defense work. Send us your lacing problems or your specifications . . . we can supply the answer to both.

GUDELACE • GUDE-NYLACE
GUDELACE H • TEFLACE

GUDEBROD BROS. SILK CO., INC.

ELECTRONICS DIVISION

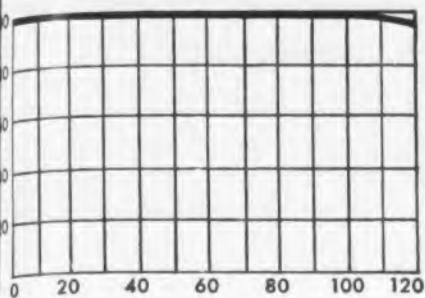
225 W. 34th St., New York 1, N. Y.

EXECUTIVE OFFICES

12 South 12th St., Philadelphia 7, Pa.

CIRCLE 118 ON READER-SERVICE CARD

STILL
OPERATING



% RATED LIFE

If you want reliable transformers

...don't overlook this old solution

Right now, you demand more from transformers than ever before. You must have high reliability, even at extreme altitudes, and you need smaller lighter units.

Used, and *proved*, for decades, oil-encased transformers should not be forgotten in a search for new methods.

Everyone knows the advantages: effective convection of heat, excellent insulating properties, complete insurance against hidden leaks. Oil-encased types (with a nitrogen bubble) are good, light, high-altitude transformers. Gas-free oil-filled types (with a bellows to allow for heat expansion) withstand very high voltage stresses. Except in the smallest sizes, they save space, too.

You can place several high voltage units close together in a single oil-filled case, and save case weight. Those connections moved inside the case no longer need large insulators. Even the units themselves can be smaller. This all adds up—particularly in high altitude service—to interesting savings in space and weight.

We make all sorts of transformers and special assemblies for the communication industry: encapsulated, cast in epoxy or foam, and just potted in pitch. But oil transformers still have an important place.

Whatever type you need, we'll be glad to hear from you. Our facilities in design, production, and quality control are at your service. Our experience, too.

CALEDONIA

ELECTRONICS AND TRANSFORMER CORPORATION

Dept. ED-5, Caledonia, N. Y.

In Canada: Hackbusch Electronics, Ltd.
23 Primrose Ave., Toronto 4, Ontario
CIRCLE 119 ON READER-SERVICE CARD

shield fits over the gun portion of a crt and eliminates most of the indication caused by ion fields entering at the face of the tube. Construction is 1 layer of netic and 1 layer co-netic clad together. The shield provides permanently effective shielding because it is non-shock sensitive, non-retentive and does not require periodic annealing.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 No. Elston Ave., Chicago 22, Ill.

CIRCLE 120 ON READER-SERVICE CARD

Digital Actuator Motor

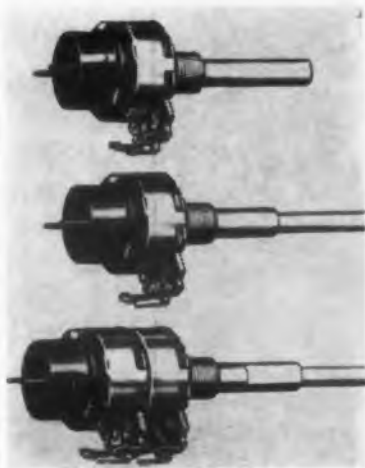
Provides digital to analog conversion



Model 7105 Digistepper, a digital actuator motor, is capable of bidirectional digital stepping rates up to 60 steps per second. The large step travel of 180 deg increases available torque in exchange for angular travel by the addition of standard servo gear heads. Typical motor with 180:1 gear head produces 80 in.-oz. of torque for a 1 deg step.

The Digitran Co., Dept. ED, 45 West Union St., Pasadena, Calif.

CIRCLE 121 ON READER-SERVICE CARD



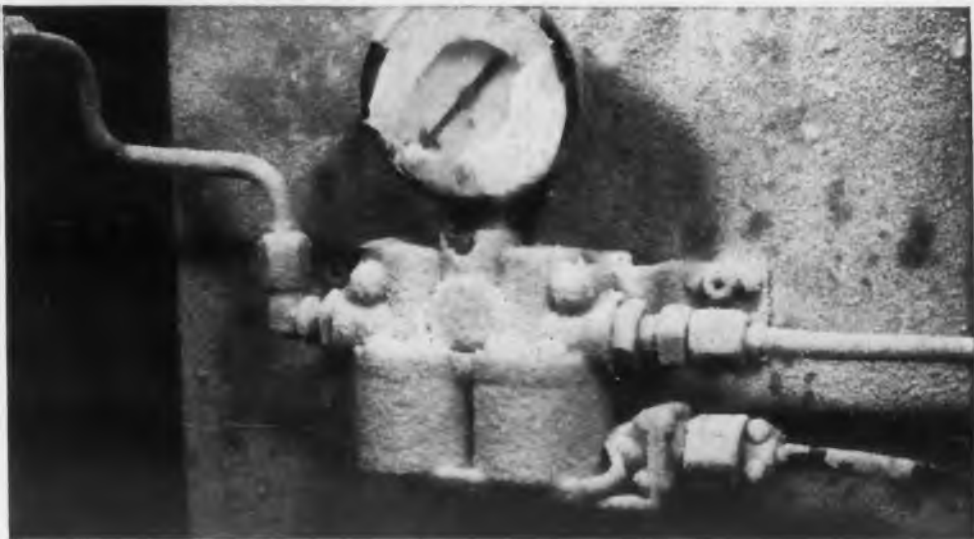
Potentiometers

Independent control and switch action

These variable resistors also operate as push-on, push-off line switches. Pushing the shaft once closes the switch. Pushing the shaft again, opens the switch. Thus the equipment may be turned on and off without disturbing the setting of volume, tone, contrast, or other function.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, Stackpole St., St. Marys, Pa.

CIRCLE 122 ON READER-SERVICE CARD



FREEZE-UP of solenoid-controlled valve in airborne system at -65°F can choke off vital air supply. Manufacturer faces tight contract delivery schedule.



SPECIAL HEATING unit custom-designed and delivered by G.E. in 5 days enables stock valve to function properly, saves customer time, money.

AIR VALVE OPERATING AT -65°F SHOWS HOW . . .

General Electric Specialty Heating Maintains Component Temperature

When components must be kept at operating temperature, G-E specialty heating equipment does the job! Thermal conditioning applications ranging from hydraulic and electronic components to tiny test instruments have all been solved by experienced G-E heating engineers.

LET US ANALYZE YOUR HEATING PROBLEM. Whether it's fast delivery on a prototype or quantity production, General Electric can provide specialty heating products engineered to your specific component needs.

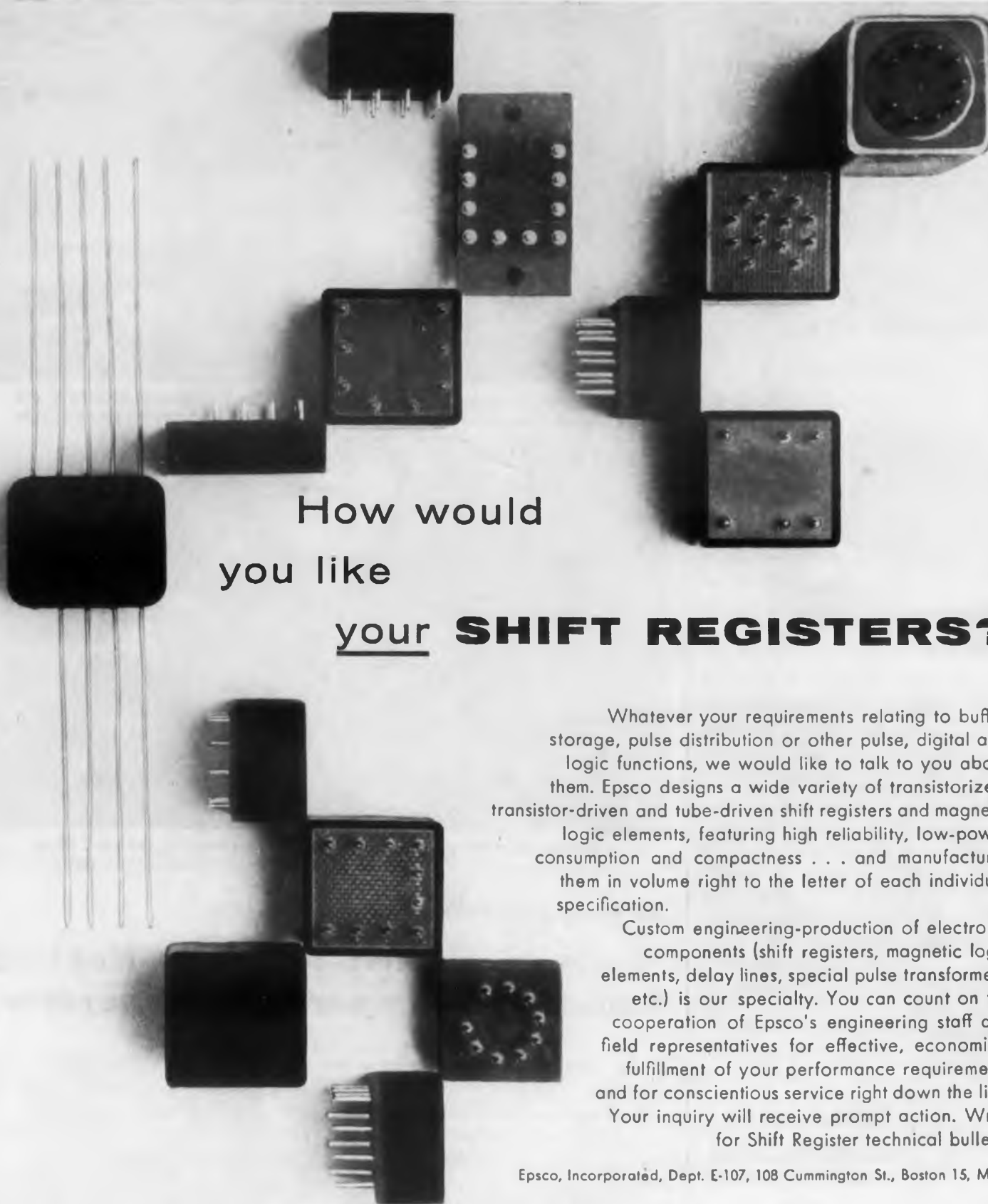
FOR MORE INFORMATION contact your local General Electric Apparatus Sales Office or send coupon.

General Electric Company	
Section W220-12, Schenectady 5, N. Y.	
Please send bulletin GEA-6285A, G-E Specialty Heating Equipment	
..... for immediate project	
..... for reference only	
Name	
Position	
Company	
City	State

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 123 ON READER-SERVICE CARD



How would
you like
your **SHIFT REGISTERS?**

Whatever your requirements relating to buffer storage, pulse distribution or other pulse, digital and logic functions, we would like to talk to you about them. Epsco designs a wide variety of transistorized, transistor-driven and tube-driven shift registers and magnetic logic elements, featuring high reliability, low-power consumption and compactness . . . and manufactures them in volume right to the letter of each individual specification.

Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, etc.) is our specialty. You can count on the cooperation of Epsco's engineering staff and field representatives for effective, economical fulfillment of your performance requirements and for conscientious service right down the line. Your inquiry will receive prompt action. Write for Shift Register technical bulletin.

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SALIENT FEATURES OF EPSCO SHIFT REGISTERS

- Standard packaging—9-pin miniature base, dip-solder terminals for printed circuits, and solder-lug panel with mounting ears; standard epoxy and hermetically sealed cases, or custom packaging to your specifications.
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- Surpass applicable MIL specification.
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- Wide operating tolerances: dependable field performance.

CIRCLE 124 ON READER-SERVICE CARD

NEW LITERATURE

Semiconductor Applications

"The Use of Silicon Junction Diodes to Protect Sensitive Current Devices" is the first of a new 12-page bulletin series on semiconductor applications. The 4-page text shows how silicon diode nonlinear characteristics, both in the forward and reverse operating regions, improve the protection of ac and dc meters. Typical circuits are illustrated along with the test results obtained from these circuits. The applications presented include dc microammeter, dc and ac voltmeter, ac milliammeter, and microwatt and low current relay protection. Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

Rectifier Handbook

A silicone rectifier handbook explains the technicalities of these devices, how they are made, where they are used, and how they can be used in many applications. This booklet is available at a price of \$1.00. For further information write direct to Audio Devices Inc., Rectifier Div., Dept. ED, 620 E. Dyer Rd., Santa Ana, Calif.

HF Transistor

High-frequency transistors are described in this 12-page brochure. The maximum ratings, cut-off and small signal characteristics, and charts showing the common emitter output static characteristics for 4 npn and 5 pnp transistors are included in Brochure G-150. General Transistor Corp., 91-27 138th Pl., Jamaica 35, N.Y.

Bobbin Cores

With pictures, Bulletin TB-103 describes a line of bobbin cores for digital data processing systems. The 4-page folder includes data on available magnetic materials—Orthonik and 4-T molybdenum permalloy. It also covers the sizes, and protective covering of the bobbin. G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N.J.

Permanent Magnets

Publication of a 20-page bulletin on permanent magnets is announced. Entitled "Permanent Magnet Design" or Bulletin 158, it covers such subjects as permanent magnet applications, fundamental properties, design problems, magnet testing, magnetic attraction, mechanical considerations, and stabilization and magnetization of finished magnets. The booklet is illustrated with pictures and curves. Thomas & Skinner Inc., 1151 E. 23rd St., Indianapolis 7, Ind.

Variable-Variable Capacitors 129

Two papers about a voltage-variable capacitor are offered free: "Report on Potential Applications of the PSI Varicap" and "Varicap Research and Development." The papers are reprints of interdepartmental correspondence multilithed to 12-page and 8-page formats. Pacific Semiconductor, Inc., 10451 W. Jefferson Blvd., Culver City, Calif.

Punched Card Reader 130

In Product Data Sheet 5705, a punched card reader for automatic control of blending, batching, and proportioning operations is described. Illustrated with photographs and a cutaway installation drawing, the 2-page sheet shows how formula changeovers are made. It also tells how the PCR control is used with IBM or other punched cards. Richardson Scale Co., Clifton, N.J.

Solenoids and Switches 131

Four-page Bulletin 1157LS presents a line of solenoids, selector switches, hermetically sealed selectors, and stepping motors. It has a dimension and torque chart for all stock solenoid models, a cutaway drawing of the stepping motor, dimensional data on selector switches, and a brief review of sealed selectors. G. H. Leland, Inc., 123 Webster St., Dayton 3, Ohio.

Electronic and Magnetic Alloys 132

The engineering properties and fabrication characteristics of a complete range of special alloys for electronic, magnetic, and electrical applications are detailed in a 64-page booklet. The information covers physical constants, mechanical properties, working instructions, heat treatment, and corrosion resistance in all categories. The illustrated booklet also has a useful glossary of terms. The Carpenter Steel Co., 3116 W. Bern St., Reading, Pa.

Terminal Catalog Directory 133

The "Selectalog" is a 20-page annotated directory of catalogs on solderless terminals and application tooling. A reference index for those concerned with electric circuitry, the 4-color booklet is also a digest of solderless termination techniques. From it engineers can select the catalog with the information they want. The catalogs at lists cover all company terminal and connector types, splices, Autostrip terminals, as well as capacitors, pulse forming networks, power supplies, patchcord programming systems, and application tooling. Amp Inc., Harrisburg 30, Pa.

DELCO HIGH POWER TRANSISTORS are made from



In the center of the quartz housing, a germanium crystal is being grown. A "perfect crystal lattice," it will be cut into wafers 3/10ths of an inch square and less than 1/100th of an inch thick to become the heart of Delco High Power transistors.

DELCO RADIO

Division of General Motors, Kokomo, Indiana



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because it alone combines these 5 advantages:

Lower saturation resistance—Germanium gives Delco High Power transistors a typical saturation resistance of only 3/100ths of an ohm. No other present material offers this characteristic, which permits efficient high-power switching and amplification from a 12- or 24-volt power supply.

Higher current gain—Gain with germanium is not only higher but is more linear with current.

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Greater economy—More power per dollar.

Examine Delco High Power germanium transistors and see how practical it is to go ahead with your plans now. For high current applications there is no better material than germanium, or Delco Radio would be using it. All Delco High Power transistors are produced in volume; all are normalized to retain their fine performance and uniformity regardless of age. Write for engineering data and/or application assistance.

CIRCLE 134 ON READER-SERVICE CARD

20 Insulated Clips on a $\frac{15}{16}$ " Diameter Centralab Switch



NEW sub-miniature Series 100 laminated Phenolic Switches



ACTUAL SIZE

This high quality, economical sub-miniature rotary switch provides up to 20 insulated heavy duty clips on each section. These contact combinations are available plus any intermediate arrangement to meet your requirements:

- | | |
|----------------|---------------|
| 1 Pole-12 Pos. | 3 Pole-4 Pos. |
| 2 Pole-6 Pos. | 4 Pole-3 Pos. |

Laminated type PBE (MIL-P-3115) phenolic construction makes these Series 100 switches suitable for high reliability commercial use, as well as many military applications.

- **RATING:** Make and break, resistance load, 0.5 amp, 6 VDC, 100 ma, 110 VAC. Current carrying capacity 5 amp.
- **VIBRATION:** Meets MIL-S-3786
- **INSULATION:** Meets MIL-S-3786
- **CONTACT RESISTANCE:** Meets MIL-S-3786
- **SECTIONS:** $\frac{1}{8}$ " thick, back-to-back insulated clips; up to 4 sections on a 2" deep switch; 1 pole-12 position (continuous rotation) through 4 pole-3 position.
- **SECTIONS:** $\frac{1}{8}$ " thick, no back-to-back insulated clips; up to 6 sections on a 2" deep switch; 1 pole-11 positions (continuous rotation).
- **MOUNTING:** Bushing $\frac{3}{8}$ " 32 NEF 2A Thd. $\frac{1}{4}$ " dia., shaft length optional. Bushing $\frac{1}{4}$ " 32 NEF 2A Thd. $\frac{1}{8}$ " dia., shaft length (2" max.).

For detailed specifications write for Centralab Engineering Bulletin EP-529.

Centralab

P-5827

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VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

CIRCLE 135 ON READER-SERVICE CARD

NEW LITERATURE

Bellow Diaphragms 136

A 5-page brochure describing a precision built welded diaphragm type bellows has just been prepared. It gives facilities available, industries served and material used. Metal Bellow Corp., 31 Mica Lane, Wellesley Hills, Mass.

Testing Facilities 137

This brochure illustrates and describes facilities, equipments, and instrumentations used for testing components for missile, rocket, and aircraft applications. The laboratories are available to general industry for component reliability tests. Networks Electronic Corp., 14806 Oxnard St., Van Nuys, Calif.

Terminals 138

Subscriptions to "Terminalogy," a bi-monthly news bulletin devoted to Teflon terminals and connectors, are offered free. The first issue, January-February, contains information on the latest press-fit types, installation procedures, applications, and tests. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N.Y.

Servomotor 139

Details of an adjustable, size 11, velocity-damped servomotor are covered in Data Sheet 912. The sheet includes cutaway drawing, electrical and mechanical specifications, dimensional and schematic drawings, and torque-speed curve of the 115-v, 400 cycle servomotor. Beckman/Helipot Corp., Newport Beach, Calif.

Electrolytic Capacitors 140

Bulletin TQ-10 covers subminiature tantalum solid electrolyte capacitors that are metal cased and hermetically sealed. The 1-page sheet gives specifications, capacitance ranges, and dimensions. Mintronics Corp., 328 Grand St., New York 2, N.Y.

Fasteners 141

A complete line of "quarter-turn" fasteners is illustrated and described in this 24-page catalog. Information on each fastener includes dimensional data, comprehensive installation instructions, and where-to-use information. Illinois Tool Works, Fastex Div., 195 Algonquin Rd., Des Plaines, Ill.

new FORK OSCILLATOR— Stability 1 part in 10,000,000



Improvements in the amplifier circuitry have minimized frequency excursions caused by variables such as temperature, plate supply voltage, tube aging, etc.

Fork employs compact oven developed for this unit.

Fork **FK5-A** Standard frequencies

(1600, 1800 or 2000 cps). **\$350.00.**

Also furnished without oven. Write for detailed specifications.

TIMES FACSIMILE CORPORATION

540 West 58th Street, New York 19, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 28, 1958

Toggle Switches 143

Pull-to-unlock, sealed toggle switches are cataloged and described in Data Sheet 142. The 4-page brochure has photographs and dimensional drawings of 1-, 2-, and 4-pole types. It also has drawings showing 11 locking designs, and charts of electrical data. Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

RF Filters 144

Hermetically sealed rf filters that will withstand extreme temperatures without loss of impregnant or degradation of performance are the subject of a 4-page brochure. The pamphlet contains general characteristics and frequency vs. attenuation curves. The Magnavox Co., Ft. Wayne, Ind.

Contacts 145

This revised and expanded 16-page general catalog describes properties and uses of a line of electrical contacts. The publication is designed to aid in selection and application of these electrical contacts throughout the broad original

equipment field. One feature of the catalog is an outline showing the company's best contacts for various applications. The company's contact assembly service is also described. Gibson Electric Co., Delmont, Pa.

Microwave Test Units 146

Detailed coverage is given to microwave test equipment in 32-page Catalog No. 58. Pictures, descriptions, and specifications cover coaxial attenuators, insertion loss test sets, modulated rf sources, bolometer preamplifiers, terminations, and other units. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Automation Controls 147

A catalog lists automatic controls most commonly used to design automatic systems. Called "Automation Controls," the booklet includes counting devices, switches, electric valves, actuators, relays, limit controls, time switches, and accessory equipment which can serve as building blocks. General Controls Co., 801 Allen Ave., Glendale 1, Calif.



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*military cases,
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Choose from more than 1400 standard sizes and save tooling cost. All can be trimmed and modified to your specification by secondary operations...brackets and fasteners installed, holes and louvers punched, welding, painting, etc. Choose from rectangular, round, square boxes and covers. Custom deep drawn parts at nominal cost using exclusive ZERO-method tooling—send your print or contact your local ZERO representative for a quotation.



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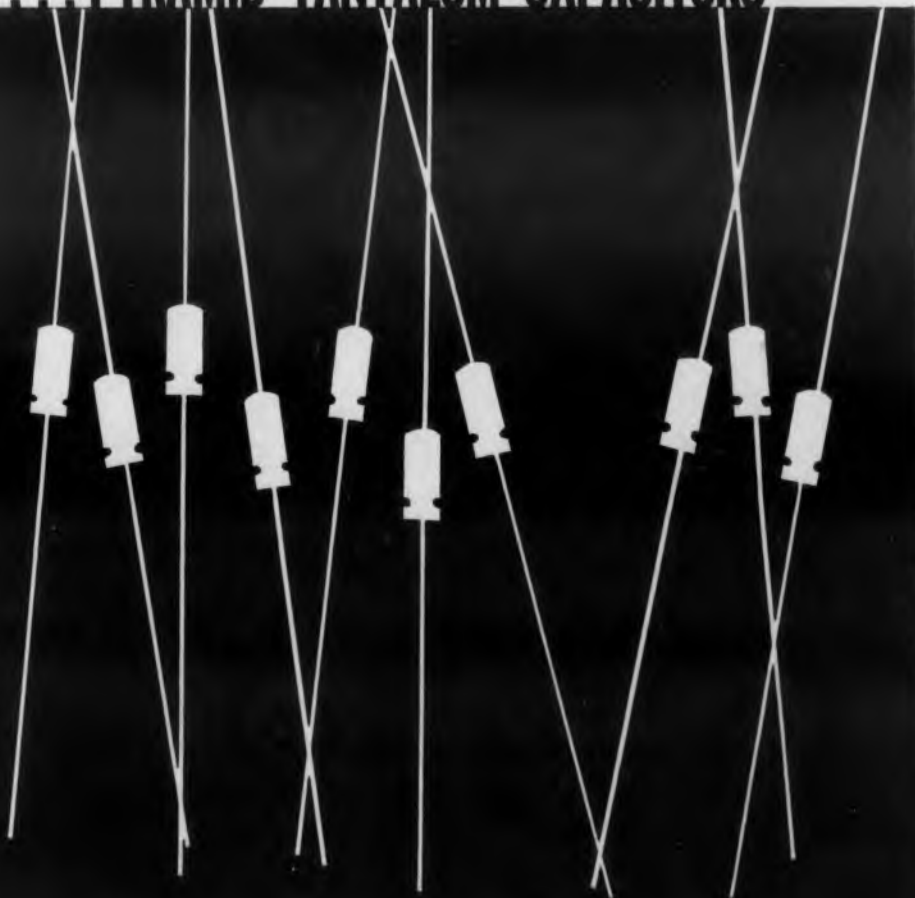
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CIRCLE 148 ON READER-SERVICE CARD

UP TO 1000 MFD-VOLTS IN LESS THAN 2/100 OF A CUBIC INCH

... PYRAMID TANTALUM CAPACITORS



Pyramid Tantalum slug capacitors are miniaturized to provide maximum space economy.

New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance — made to meet MIL-C-3965 Specifications.

Commercially available immediately, these new Pyramid Tantalum capacitor units have an operating range between -55°C to 100°C for most units without any de-rating at the higher temperature.

To obtain complete engineering data and prices for Pyramid Tantalum slug capacitors, write to: Pyramid Research and Development Dept., Pyramid Electric Company, 1445 Hudson Boulevard, North Bergen, New Jersey.

CAPACITORS — RECTIFIERS
FOR ORIGINAL EQUIPMENT —
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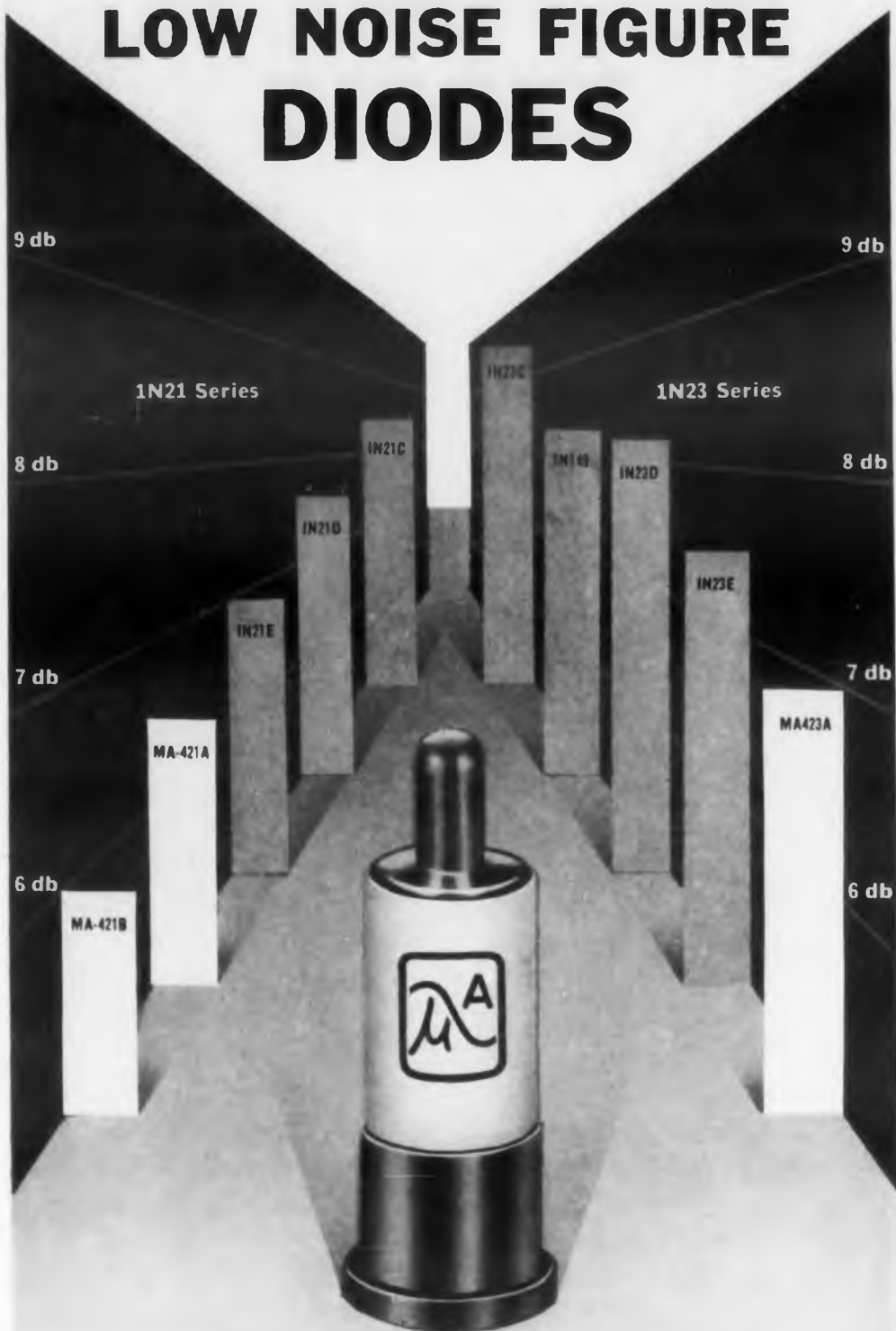
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NORTH BERGEN, N. J.

CIRCLE 105 ON READER-SERVICE CARD

NEW LOW NOISE FIGURE DIODES



Microwave Associates' new MA421A, 421B and 423A provide the lowest noise figures in the field to date.

Available in production quantities right now, these rugged, high-reliability diodes mark a new advance in the field.

Electrically these new diodes are similar to Microwave Associates' well known E series, but provide a significant advance in noise figure as shown in the above illustration.

Physically, they are fully interchangeable with the older 1N21 and 1N23 types which they can replace in existing systems to advantage.



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Our new Handbook-Catalog is a valuable aid in application and measurement techniques. Ask for Brochure 58S



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CIRCLE 149 ON READER-SERVICE CARD

Zener Diode Uses—

1 In Series With Capacitor

WHEN circuits require subminiature parts, an electrolytic capacitor with a low voltage rating can be used in series with a zener diode. This is illustrated in a dc restorer application.

The dc restorer illustrated was required for a 15 cps square wave signal. The resulting varying dc voltage was required to be insensitive within a temperature range of 0 to 100 deg C. The circuit was required to utilize subminiature components.

The output of an ac amplifier stage with a 150 to 300 v plate supply may well have 100 to 200 v dc level at the plate. The conventional dc restorer will require a series capacitor with a voltage rating equal or larger than the dc level at the plate. To hold the flat top of the square wave within 2 per cent, a capacitor of at least 3.33 μf is required in accordance with the equation $T/RC = P/100$ where P is the desired percentage, R , C and T as indicated on the diagram.

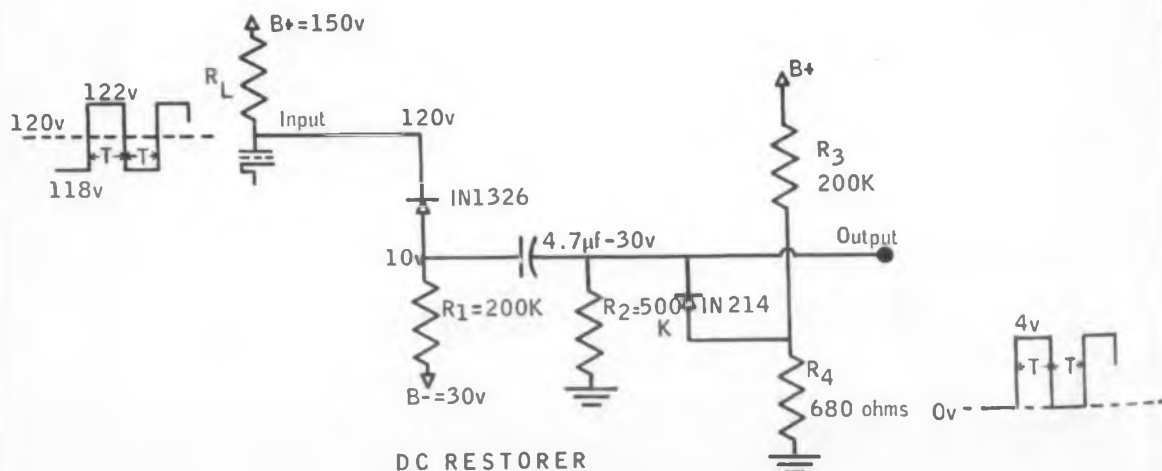
In the illustrated example, a 4.7 μf , 150 v capacitor would be required. Even an electrolytic capacitor would be of considerable size, besides an appreciable

amount of leakage current would flow through the capacitor.

A zener diode in series with the capacitor overcomes both disadvantages. The diode D_1 drops the dc plate level to the vicinity of ground level. A small voltage rating for the capacitor is sufficient and a subminiature capacitor can be used.

Temperature changes will influence the zener breakdown voltage of D_1 but this is of no consequence since the charge of the capacitor will adjust to compensate for that change. For similar reasons $B+$ changes are not sensed at the output. R_1 provides for current flow through D_1 and its value should be chosen in accordance with allowable dissipation of D_1 . Without the divider network of R_3 and R_4 the restorer will restore to -0.5 v rather than to ground because of the forward breakdown characteristic of D_2 . At the expense of increasing the forward resistance of D_2 by R_4 the biasing network R_3 and R_4 provide precise restoration to ground potential.

Manfred Hilsenrath, Assoc. Engineer, Lockheed Aircraft Corp., Palo Alto, Calif.



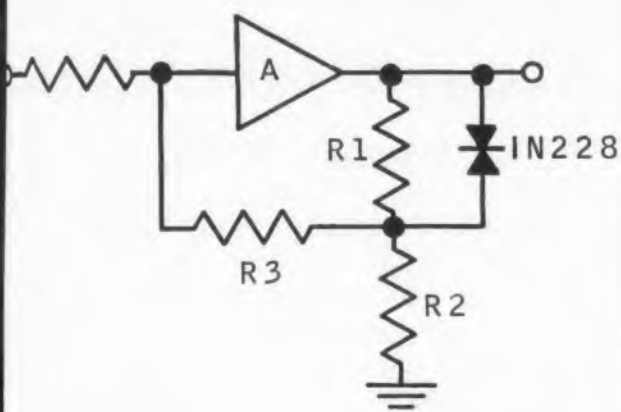
Get \$10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

As Output Limiter

A zener diode at the output of an amplifier can replace input limiting devices which alter frequency response. This solution worked well in protecting a magnetic deflection amplifier from overloading. The output of the operational amplifier which preceded the magnetic deflection amplifier was limited.

The maximum operating output of the operational amplifier was to be ± 30 v; the maximum allowable without damaging the deflection amplifier was ± 35 v. Amplifier saturation occurred at ± 70 v, so a limiter was required which would operate in the range of 35 to 70 v, without affecting the amplifier characteristics.

A feedback divider (R1 and R2) of 1:1 was inserted, and the feedback resistor (R3) was reduced by a factor of two to retain the same



feedback factor as originally. R1 was bypassed by a 15 v (1N228) double anode zener diode.

These characteristics determine R1 and R2: a. R1 limits the current through the diode to prevent burnout, hence it depends on the wattage rating of the diode; b. the combination of R1 and R2 must be of high enough value not to load the amplifier; c. R1 must be sufficiently low not to be affected by the leakage resistance of the diode. The leakage current of the diode prevents its use directly in the high impedance feedback loop in ordinary feedback systems.

Once the output signal exceeds thirty volts, the diode conducts heavily, effectively removing R1 from the circuit. The gain of the amplifier is cut in half, and the amplifier saturation level serves a limit for the new gain factor, and the output never exceeds ± 35 v.

Hal C. Martin, Intermediate Engineer, Litton Industries, Beverly Hills, Calif.

RELIABILITY HIGHEST EVER

DOWN-TIME reduced to MINUTES

CUBIC'S NEW DIGITAL SYSTEMS with built-in rely/ance*

Cubic's Digital Systems reflect the extreme reliability and ease of maintenance present in Cubic's Electronic Tracking Equipment, currently in use by the United States Air Force in the IRBM and ICBM programs. They have

been designed to accommodate the widest possible range of customer applications. A demonstration of these systems and individual units will prove that they are the most reliable, practical and versatile available.



EASE OF MAINTENANCE CUTS DOWN-TIME

SPECIAL FEATURES INSURE RELIABILITY

Careful attention has been given to even the smallest components. For example, wire-wound resistors are wound on bobbins of encapsulating material in which the coefficient of thermal expansion closely matches that of the resistance wire. Thus resistor stability is assured.

Another reliability feature is *controlled drive*. Transistors drive the stepping switches, and these, in operating, turn off the transistor drive circuit. Since the switches control their own drive, circuit adjustments are neither frequent nor critical.

Cubic Digital Systems provide easy and rapid access to replaceable parts and adjustments, an indispensable requirement in any system.

When rack-mounted, simply releasing the front panel locking knob allows the unit to slide out. No other operation is required.

The switch assemblies, mounted on horizontal bars, swing up and out, giving easy access to wire-wound resistors and/or switch assemblies.

***rely/ance**

is Cubic's engineering philosophy which regards reliability and ease of maintenance as inseparable features of a truly functional system.



For a free illustrated brochure, write

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Photo of "Atlas" missile, courtesy General Dynamics Corporation

1000° F. FLEXIBLE WIRE

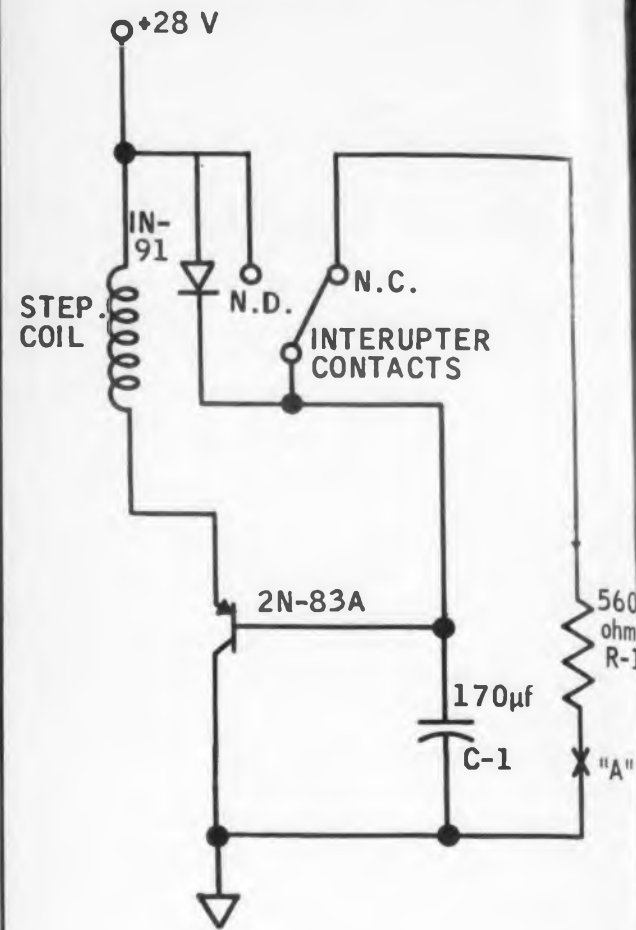
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HERE TODAY— Not a dream of the future, but a ready-to-use reality. "Ceramatemp" 1000°, ceramic insulated magnet wire is now being produced in limited quantities to meet a vital need long expressed by the missile, aircraft and nuclear energy industries. Years in development, "Ceramatemp" wire marks another significant advance by Hitemp Wires, Inc. in its search for insulations which not only match, but exceed today's severe environmental requirements. Write Hitemp Wires, Inc., 1200 Shames Drive, Westbury, N. Y. today, for further information on "Ceramatemp" and how it may solve your particular problem.

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IDEAS FOR DESIGN



Transistor Driven Slow Speed Stepping Switch

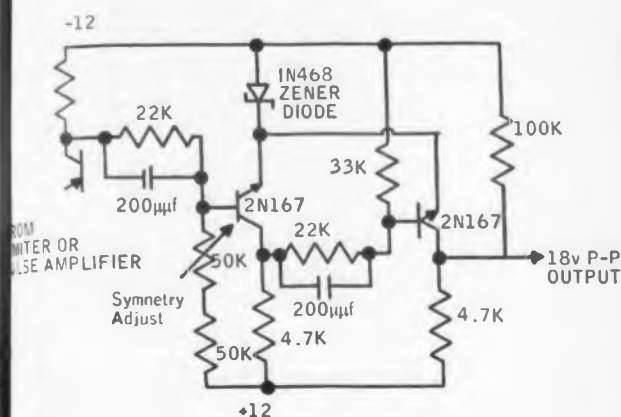
Problems of radio noise and slow speed which occasionally arise in stepping switch circuits are eliminated in a circuit using a p-n-p power transistor to drive the switch. Radio noise is reduced from approximately 75 $\mu\text{v}/\text{meter}/\text{kc}$ in a conventional circuit to 0.15 $\mu\text{v}/\text{meter}/\text{kc}$ as measured at 50 mc in a screenroom. The high speed of selfdriven switches may be preserved if desirable, but can be reduced to any reasonable rate down to about 1 step per second without component values getting excessively large.

In the circuit shown, C-1 discharges through R-1 until its potential is within about a volt of ground. At this point, the transistor goes into conduction and pulls in the stepping switch coil, holding it closed. The interrupter contacts recharge C-1 to +28 v, cutting off the transistor and releasing the armature of the switch, which then steps forward. Holding the switch closed is an undesirable delay since the switch cycles only on the release. The 1N91 diode prevents arcing when the capacitors are charged. A small resistor can also be inserted in the N. O. contact to avoid the charging surge.

With the circuit constants shown, the switch cycles at about 2 steps per second. C-1 can be changed, or R-1 can be reduced to adjust the

constant. R-1 cannot be increased since the current would then result in a bias high enough to prevent the transistor from conducting. The lead may be broken at "A" to control the circuit.

George S. F. Orsten, Engineer, The Martin Company, Denver, Colo.



A Fast Square Amplifier

A squaring amplifier capable of constant output amplitude, fast rise and fall time, and minimum distortion of symmetry, can be designed with two high frequency transistors utilizing a modified Schmitt trigger configuration.

There are four design considerations to keep in mind:

1. pnp transistors can be used equally effectively;
2. zener diode may be replaced with an appropriate emitter resistor and bypassing capacitor. This will require the two transistors to have similar saturation voltages;
3. keep collector current low and transistor cut-off frequency high, rise and the fall time can be as low as 0.2 µsec;
4. excessive loading is to be avoided since it generally detunes waveform and output amplitude. Output impedance is essentially 7/100 k.

Max Lang, Electronic Engineer, Consolidated Electrodynamics Co., Pasadena, Calif.

No More Lost Wires

Too often, when wiring electronic equipment, small pieces of cut wire fall into the chassis and are lost or hard to find.

A couple of small pieces of 1/16 in. neoprene, glued to the open side of diagonal pliers, can solve the problem. They will grip the wire as pliers close.

Clarence J. Brown, SCP-11, Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

New Silicon Rod

for Transistor Research

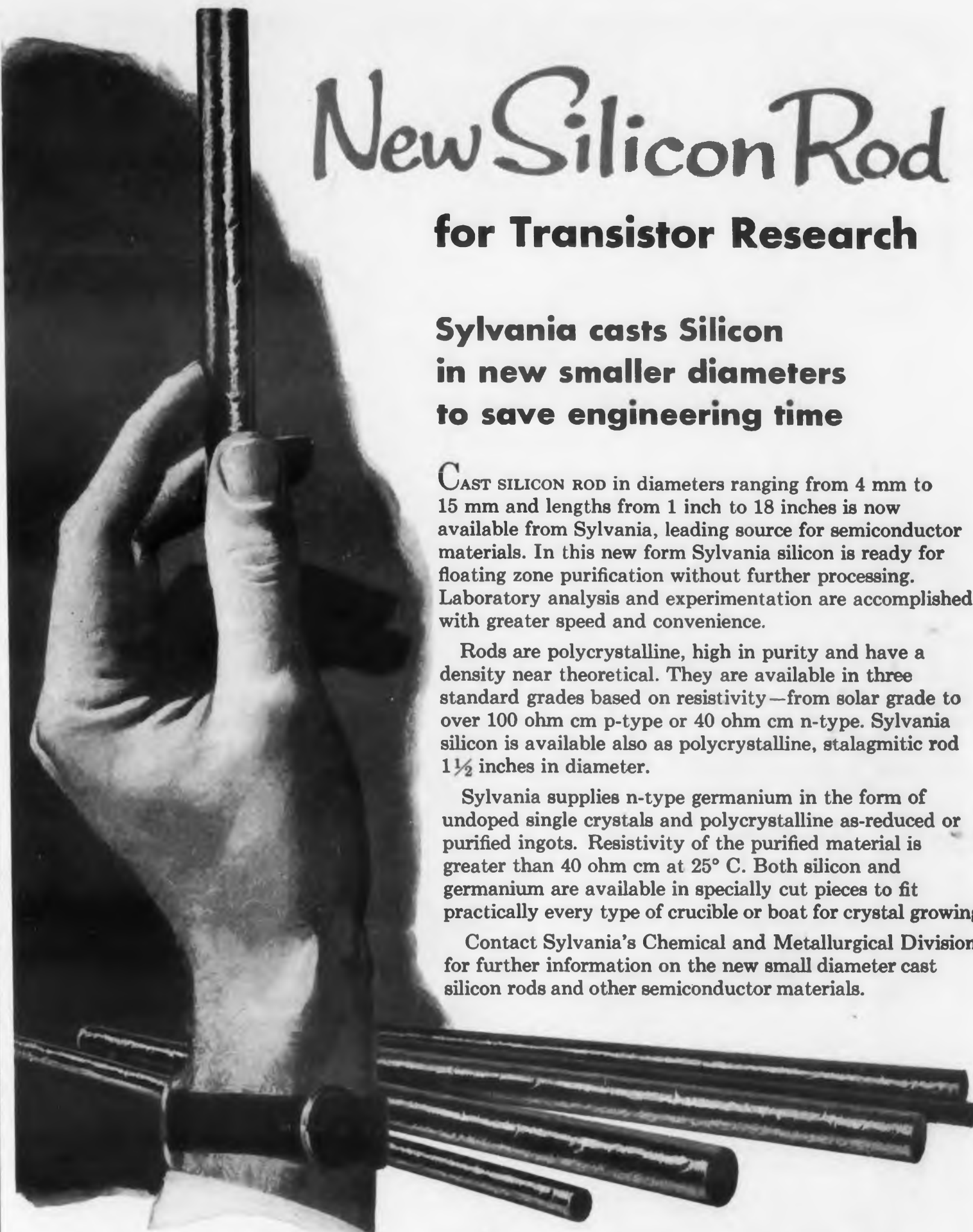
Sylvania casts Silicon in new smaller diameters to save engineering time

CAST SILICON ROD in diameters ranging from 4 mm to 15 mm and lengths from 1 inch to 18 inches is now available from Sylvania, leading source for semiconductor materials. In this new form Sylvania silicon is ready for floating zone purification without further processing. Laboratory analysis and experimentation are accomplished with greater speed and convenience.

Rods are polycrystalline, high in purity and have a density near theoretical. They are available in three standard grades based on resistivity—from solar grade to over 100 ohm cm p-type or 40 ohm cm n-type. Sylvania silicon is available also as polycrystalline, stalagmitic rod 1½ inches in diameter.

Sylvania supplies n-type germanium in the form of undoped single crystals and polycrystalline as-reduced or purified ingots. Resistivity of the purified material is greater than 40 ohm cm at 25° C. Both silicon and germanium are available in specially cut pieces to fit practically every type of crucible or boat for crystal growing.

Contact Sylvania's Chemical and Metallurgical Division for further information on the new small diameter cast silicon rods and other semiconductor materials.



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SYLVANIA ELECTRIC PRODUCTS INC.
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NEW STRAIGHT BLADE PUSH BUTTON SWITCH
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CIRCLE 154 ON READER-SERVICE CARD

REPORT BRIEFS

Alkaline Storage Batteries

This volume reports part of a continuing project aimed at better understanding, and possible utilization in naval applications, of the alkaline type of storage battery. Positive plate characteristics of the nickel oxides were studied in several different types of cells. It was found that a current efficiency of 95 to 100 per cent could be attained if oxygen evolution was avoided during charge. Under such conditions, however, the capacity of the positive plate nickel oxide was reduced one-third. A summary of earlier and present work on the electrode showed that the $\text{NiNi}(\text{OH})_2$ and $\text{Ni}_3\text{O}_2(\text{OH})_4$ -beta NiOOH couples are well defined, while two other possible nickel oxide couples are not. (Two other NRL studies were released earlier through OTS and are still available under the general title *Alkaline Storage Batteries: The Self-Discharge of the Positively Charged Nickel Oxide Electrode*. The volumes are PB 121430 Part 1—*The Role of Water in the Process*, Oct. 1956, 7 pp, \$0.50; and PB 121483 Part 2—*Potential as a Function of Time on Open Circuit and as a Function of the Active Oxygen on the Nickel Oxide Plates*, Oct. 1956, 17 pp, \$0.50.)

Alkaline Storage Batteries: An Investigation of Nickel Oxide Positive Plate Characteristics, A. L. Pitman and G. W. Work, Naval Research Lab., Dec., 1957, 23 pp, \$0.75. Order PB 131329 from OTS, U.S. Department of Commerce, Washington 25, D.C.

Copper-Mandrel Potentiometers In A-C Operational Amplifiers

A simple method is described for phase error compensation for multiturn copper-mandrel potentiometers used as variable feedback resistance elements for gain setting of operational amplifiers in a-c analog computers. The potential of the copper mandrel is held close to one-third the potential of the potentiometer slider with respect to the beginning of the resistance winding. A figure of merit is established. The report discusses the stability of the operational amplifier with phase error compensation. Practical circuit configurations employing phase error compensation are presented. A study also is made of the envelope behavior of the compensated operational amplifier by means of modulation equivalent transfer matrices. *Performance of Copper-Mandrel Potentiometers In A-C Operational Amplifiers*, H. H. Hosenthien, Army Ballistic Missile Agency, Sept., 1956, 35 pp, \$1.00. Order PB 131289 from OTS, U.S. Department of Commerce, Washington 25, D.C.

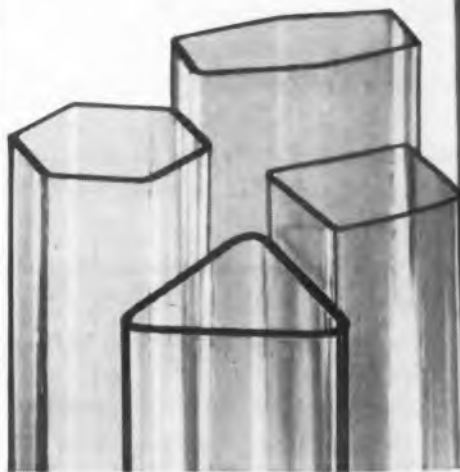
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Environmental Requirements

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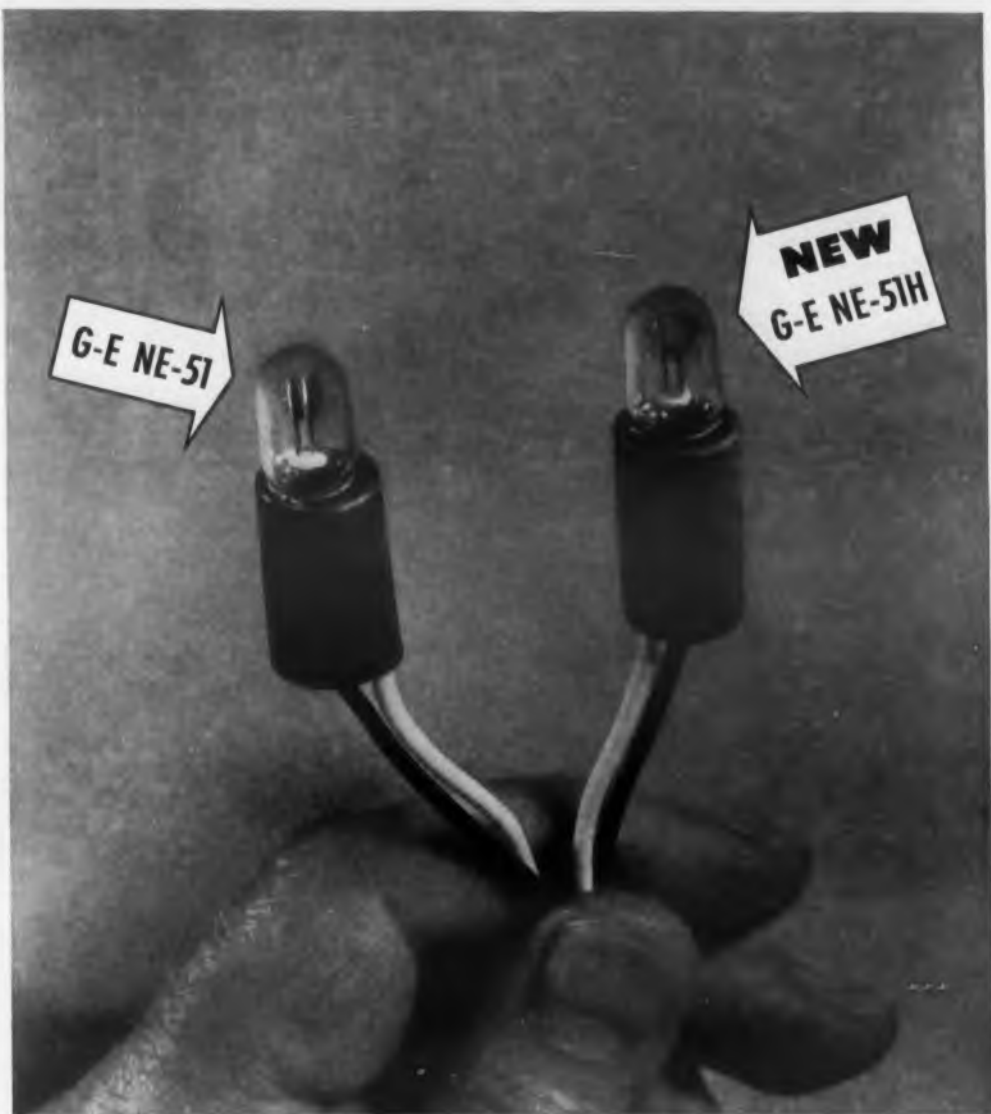


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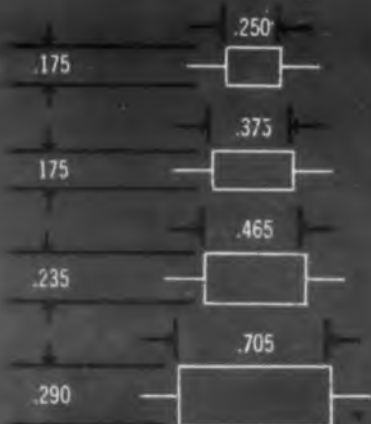


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	STA-439	7	10	12
	STA-443	4	15	18
	STA-447	3	20	24
MEDIUM SIZE	STA-452	2.4	30	36
	STA-477	3	35	42
	STA-237	25	10	12
	STA-242	11	15	18
LARGE SIZE	STA-267	8	20	24
	STA-273	6	30	36
	STA-277	5	35	42
	STA-257	20	10	12
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PATENTS

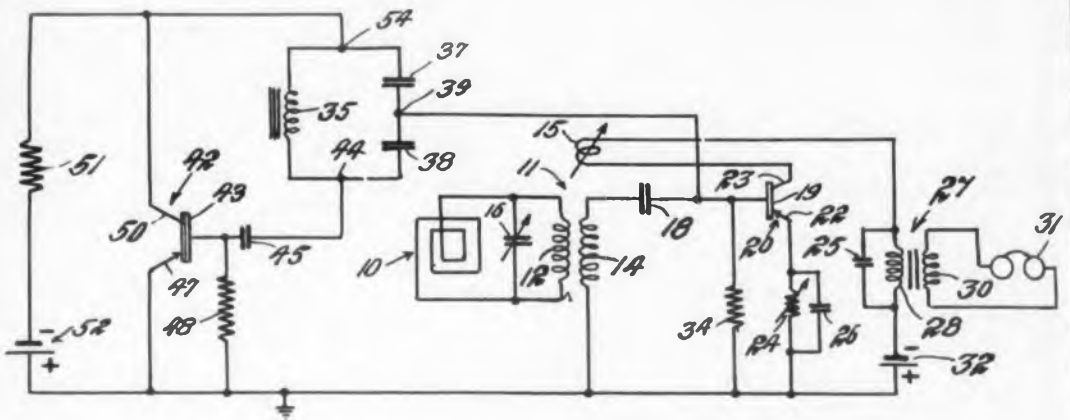
Miniature Super-Regenerative Radio Receiver Using Transistors

Patent No. 2,821,625. Harry L. Price.

A special super-regenerative circuit described in this patent permits the production of miniature transistorized receivers.

Transistor 20 is connected as a tuned regenerative detector. Tickler winding 15 adjusts the feedback and resistor 24 introduces volume control. The Colpitts quench oscillator includes pnp transistor

42 and the tank circuit of inductance and condensers 37 and 38. At junction point 39, a tap point of relatively low impedance, the quench signal is conductively coupled to the low impedance base electrode input circuit of transistor 20. As a result there is a minimum loading on the quench oscillator by the regenerative detector and vice versa. Good selectivity is obtained with transformer 11 operated in a high "Q" circuit



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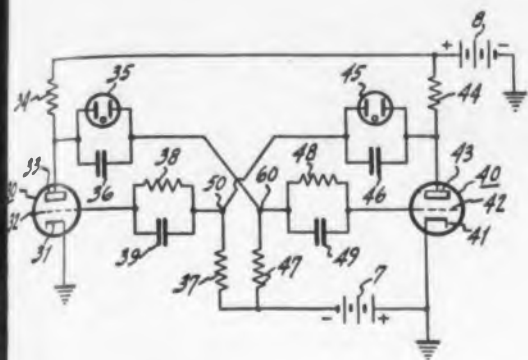


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Bistable Multivibrator

Patent No. 2,803,747. W. E. Woods. (Assigned to United States of America)

The multivibrator illustrated permits wider tolerances in component parts and hence becomes less expensive to manufacture. This circuit substitutes a gaseous discharge tube 35 and 45 for the shunting resistor in each of the connections from the anode of one tube to the control grid of the other. In addition a parallel combination of a resistor and condenser are included in each connection. The gaseous discharge tube provides constant voltage drop across its terminals and across its parallel condenser for all values of current. The grid current of each tube is limited by resistors 38 and

48. Capacitors in parallel with the gaseous discharge tubes result in a quick response of the circuit. Because of the gaseous discharge tubes the voltages at the junction points 50 and 60 change with the respective anode voltage, volt for volt. As a result resistor tolerances are much less critical and much less dependent upon each other.

Magnetic Pulse Generator

Patent No. 2,817,773. Henry F. McKenney. (Assigned to Sperry Rand Corporation)

The rectangular pulse generator comprises a source of alternating voltage having a pair of branch circuits across its terminals. Each of the circuits has a reactor winding disposed on one of the cores of a pair of saturable cores. The flux is controlled to consecutively saturate the cores. A transformer has a pair of input windings each of which is disposed in one of the circuits and poled to induce opposing fluxes in the transformer. The output is taken from an output winding of the transformer.



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BOOKS

Logical Design of Digital Computers

Montgomery Phister, Jr., John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. 408 pp, \$10.50.

Using synchronous circuit components almost entirely, this book describes and interprets the methods and techniques used in the digital computer field, and applies them to a wide variety of problems in logical design. The book provides the reader with the information, tools, and procedures needed to carry out the complete design of a general or special-purpose computer.

Featured in this volume are the detailed discussions of: (1) the Veitch Diagram method of simplification of Boolean equations; (2) the "difference-equation" approach to memory elements; (3) the Huffman-Moore model of digital sys-

tems; (4) the complete solutions to flip-flop input equations; and (5) a mathematical introduction to Boolean Algebra.

Permanent Magnet Handbook

Crucible Steel Co. of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa., 360 pp, \$10.00.

A complete, authoritative reference of the nature, characteristics, and economic uses of permanent magnet materials is provided by this handbook. It includes sections on Permanent Magnet Design, Permanent Magnet Measurements, Theory of Ferromagnetism, Magnetization and Demagnetization, and Electromagnetic Theory. Sections on important permanent magnet materials commercially available or not are included.

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Solid State Physical Electronics

Aldert van der Ziel, Prentice-Hall, Englewood Cliffs, N.J., 604 pp, \$13.00.

Here is a comprehensive account of the application of solid state physics to modern solid-state devices used in, or developed for, the electronics industry. The author attempts to convey a clear understanding of the operation of cathodes, vacuum tubes, transistors, and other solid state devices in terms of the physical phenomena which make them possible. Circuit applications are elaborated only to the degree required for a better understanding of the operation and the usefulness of the devices.

The author has organized his book in four main sections. In the first five chapters he presents a lucid account of atomic physics, statistics, structure of the solid state, and the theory of semiconductors. Chapters 6 through 11 cover thermionic and field emission, cathodes, vacuum tube problems, secondary emission, and photo-emission. The third section, devoted to semiconductor devices, discusses metal semiconductor contacts, p-n junctions, transistors, semiconductor photo-devices, and luminescence and light amplification.

In his concluding section, the author takes up dielectrics, piezoelectrics, and ferroelectrics (with applications in each case), as well as ferro- and ferri-magnetic devices of various kinds.

Management for Engineers

Roger C. Heimer, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 453 pp, \$6.75.

The book takes a practical basic look at the impact of costs, standards, materials, methods, taxes, insurance, power, equipment, labor, and ethics upon engineering considerations. It describes the fundamentals of business cost considerations and shows how both cash and credit are made to work in behalf of the overall business purpose.

The author analyzes the income contributions of engineers and the costs which are controllable by them in his discussion of a mythical business firm. A chapter "Money Flow in the Business Enterprise" explains basic record keeping for corporation financial transactions. Another chapter is on "Depreciation" and one acquaints the reader with "The Legal Forms of Business Organization."

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MI-104 ★	-75° to 250°C	11.0 ± .5	.019"	.185" ± .004	110 ± 5 ohms
MI-125 ●	-40° to 80°C	11.5 ± .5	.019"	.185" ± .004	105 ± 5 ohms
MI-126 ★	-75° to 250°C	6.0 ± .3	.007"	.330" ± .010	190 ± 10 ohms
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What The Russians Are Writing

Y. George Adashko

MICROWAVES

Large-Amplitude Electromagnetic Waves in Ferrite with Alternating Magnetization by Ya. A. Monesov. REE 8/57, pp 951-959, 5 figs.

Examination of the propagation of a uhf electromagnetic wave in a ferrite medium, magnetized by an alternating magnetic field. The problem is solved by assuming the magnetizing and microwave fields are commensurate. If the frequency of the electromagnetic oscillations exceeds a certain critical value and the frequency of the magnetization field is less, the parameters of the medium for the electromagnetic oscillations vary with the magnetizing oscillations, but with a certain phase shift. This change in parameters is linearly related to the amplitude of the magnetizing field and is independent of the amplitude of the microwave field. Theoretical results are confirmed experimentally for 3-cm.

Quadratic Relationships for Media with Tensor Parameters by A. G. Gurovich. REE 8/57, pp 960-968, 3 figs.

General quadratic relationships (such as the Lorentz or the Poynting-Umov equations), which are very significant in electrodynamics, are obtained for complex amplitudes in the case of media with tensor parameters. These equations, together with the use of perturbation theory, lead to formulas for hollow systems (regular and irregular waveguides and resonators) containing media with tensor parameters.

Variational Method of Design of Waveguides with Periodic Irregularities, Part II by Sh. Ye. Tsimring. REE 8/57, pp 969-988, 6 figs.

The variational method, developed in the first part of this article (Radiotekhnika i Elektronika, January 1957, Page 3) (ED 9/1/57) is extended to periodic waveguide (resonant cavity) permits the par-

tial-region method. The author formulates and proves a theorem to determine a pair of dispersion curves (and corresponding natural frequencies), located on both sides of the true dispersion curve. This is important in the estimate of the accuracy of the results.

As an example, the procedure developed was used to obtain the dispersion equation for a decelerating system with rectangular corrugations of finite thickness. Various dispersion curves are calculated for several values of dimensions of this system. Reference is made to work by Chu and Hansen, Journal of Applied Physics, 1949, Volume 20, Page 280 and to J. R. Pierce's "Traveling Wave Tubes."

Calculation of the Critical Wave Lengths of the Lower Modes for Asymmetrical Pi, T, and Several Other Waveguide Shapes by A. Ya. Yashkin. REE 8/57, pp 989-1000, 7 figs.

The author derives equations relating the critical wave lengths with the cross sectional dimensions of asymmetrical pi and T waveguides, of waveguides having L and E cross sections, and of waveguides having two symmetrically located grooves. The calculated data are used to plot curves which illustrate the characteristics of these waveguides. Certain calculation data are compared with available experimental data.

Determination of Eigenvalues and Eigenfunctions of Gyrotropic Systems by Successive Approximations by V. V. Nikol'skiy. REE 8/57, pp 1074-1077, 3 figs.

Supplement to work performed by the author and published in the April 1956 (Page 447) and February 1957 (Page 157) issues of Radiotekhnika i Elektronika. See ED 11/15/56 and 9/15/57. In these articles the author derived an exact formula for the gyrotropic perturbation of a resonator waveguide. In this article he shows approximate solutions to these equations.

Nonlinear Theory of Traveling Wave Tube, Part II. Numerical Results by L. A. Vaynshteyn. REE 8/57, pp 1027-1047, 25 figs.

The first part of this article was published in the July issue of Radiotekhnika i Elektronika, Page 883. (See ED 3/19/58.) In this part the equations of the nonlinear theory of the traveling wave tube, operating as an amplifier for monochromatic signals, are numerically evaluated. The propagation and buildup of the electromagnetic field along the tube are studied, as well as the motion and bunching of the electrons. Dependence of the maximum power of the electromagnetic field on various factors and the connection between the input and output powers are investigated. Certain new nonlinear effects are obtained. Reference is made to work by Nordsieck (proceedings IRE, 1953, Vol. 41, Page 630) Tien, Walker and Wolontis (ibid. 1955, Vol. 43, Page 260), and to Pierce's "Traveling Wave Tubes."

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AT	Automation and Telemechanics (<i>Avtomatika i Telemekhanika</i>)
CJ	Communications Journal (<i>Vestnik Svyazi</i>)
EC	Electrical Communications (<i>Elektrosvyaz'</i>)
IET	Instruments and Experimental Techniques (<i>Pribori i Teknika Eksperimenta</i>)
R	Radio
RE	Radio Engineering (<i>Radiotekhnika</i>)
REE	Radio Engineering and Electronics (<i>Radiotekhnika i Elektronika</i>)

TRANSLATIONS AVAILABLE

ELECTRONIC DESIGN is gratified to learn of the growing availability of full translations of important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th St., New York 11, N.Y. translates *Automation and Telemechanics* regularly.

Pergamon Press of 122 E. 55th St., New York 22, N.Y. is preparing translations of *Radio Engineering, Radio Engineering and Electronics, and Electrical Communications*.

Readers interested in specific Russian journals can obtain more information by writing directly to one of these publishers.

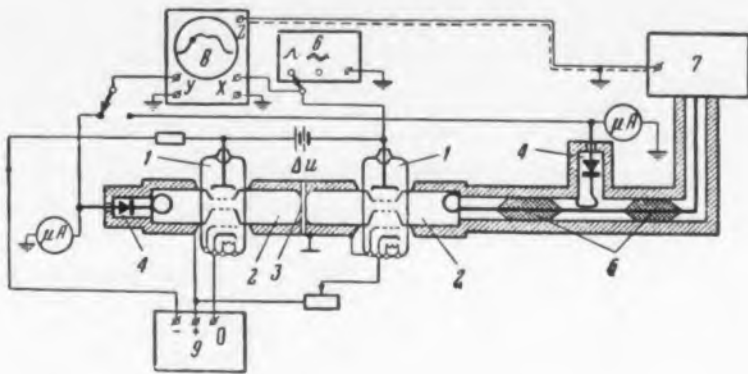


Fig. 1. Setup for investigating simultaneous operation of two reflex klystrons: 1—klystron; 2—cavity; 3—coupling element; 4—detector; 5—attenuator; 6—modulator; 7—wavemeter; 8—oscillograph; 9—power supply.

Mutual Synchronization of Reflex Klystrons Without Discontinuities in Amplitude and Frequency by R. B. Braginskiy, S. D. Grozdover, A. S. Gorshkov, and I. T. Trofimenko. REE 8/57, pp 1048-1052, 5 figs.

The purpose of this experimental investigation was to obtain a wide band of electronic frequency retuning. The authors have established the region of the values of fundamental parameters, in which klystrons operate in synchronism without discontinuities in amplitude and frequency of the generated oscillations. The resultant range over which electronic frequency detuning is possible is three times greater than obtained with a single klystron. Although the simultaneous operation of klystrons was already considered previously by Abdel Dayen (Synchronization of Reflex Oscillators, Zurich, 1953), the mutual synchronization studied there was under identical transit angles, and the purpose of that investigation was an increase in the general output power in the center of the oscillation region. The problem of extending the range of electronic retuning of the generated frequency was not touched upon there at all. Fig. 1 shows the experimental setup.

Contribution to the Design of Waveguides with Gradually Changing Cross Sections by A. L. Gutman. RE 9/57, pp 20-28, pp 20-28.

Expressions are derived for the elementary waves in a waveguide with gradually changing transverse cross sections. These expressions are used to obtain formulas for converting impedances

and admittances in such a waveguide. The external parameters of the four-terminal equivalent of a gradually varying section are formulated.

An integral equation for the longitudinal profile of a waveguide junction with minimum distortion, namely a waveguide section with gradual change in transverse cross section is also obtained.

COMPONENTS

New Type of Broadband Transformers by Yu. M. Lebedev-Krasin. RE 9/57, pp 38-46, 9 figs.

Description of new broadband transformers operating effectively from 10^3 to 10^8 cps. They are used in apparatus designed for simultaneous transmission of signals with a wide frequency spectrum, as well as for tuned amplifiers with a tuned frequency that is smoothly adjustable over a wide range. In the latter case the special transformer developed for this purpose is used simultaneously for inductive variation of the resonant frequency of the tuned circuit with electronic control. Refers to "Very Wide Band Radio Frequency Transformers" by Maurice and Minns (Wireless Engineer, June 1947) and "A Wide Band High Frequency Transformer Using a Ferrite Core" by T. R. O'Meare (Proceedings of the National Electronic Conference, October, 1954).

High Sensitivity Vacuum Relay by K.P.Yegorov, V.G.Krasin'lov and L.V.Reyman. EC 9/57, pp 58-64, 9 figs.

Description of a relay design for operation at 0.01-0.05 microamperes, with a



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RUSSIAN TRANSLATIONS

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INFORMATION THEORY

Contribution to the Estimate of the Noise Rejection of Radio Reception Methods Based on Averaging the Functions of the Signal and Noise by N. L. Teplov. RE 9/57, pp 3-11, 8 figs.

Generalized statistical analysis and relative comparison of radio reception methods based on averaging the functions of a signal and a random noise (method of multiple repetition, integral reception method, method of storage, and method of discrete averaging). The deductions and equations derived can be directly used for calculating the noise rejection of actual radio receiving apparatus. Refers to "Mathematical Analysis of Random Noise" by S. O. Rice, Bell System Technical Journal, July 1944 and January 1945.

RECEPTION

Mechanism of Occurrence of Phase Distortion in Partial Suppression of One Sideband Frequency by A. B. Polonskiy. RE 9/57, pp 29-37, 11 figs.

Phase distortion in partial suppression of one sideband occurs, fundamentally, as a result of carrier phase shift, occurring in the single sideband receiver. This leads to a phase shift in all the modulating frequencies transmitted by the single sideband, by the same phase angle through which the carrier is shifted.

The transient characteristics of the single sideband receiver with phase distortion are calculated.

CIRCUITS

Analysis of Detection of Amplitude-Modulated Oscillations by Means of Low-Frequency Equivalent Method by L. S. Gutkin. REE 8/57, pp 1012-1026, 17 figs.

In the detection of am signals the loading produced by the detector on the circuit that feeds it should, in general, be taken into account not only by determining the input resistance of the detector for the carrier frequency, but also by determining the input impedance of the same detector for deviations of the envelopes of the detected signal. The difference in many cases of practical importance can be so great, that the bandwidth of the tank circuit for the sideband frequencies may differ by a factor of several times from the bandwidth of this tank circuit determined by taking only the impedance into account.

A general method is given for the analysis of the detection of am signals, based on the account of the difference between the input impedance and resistance and replacing the supply tuned circuit (or system of tuned circuits) by its low-frequency equivalent.

Lock-in of a Self Excited Oscillator by Means of an Amplitude Modulated External Signal by P. Martynenko and R. V. Khokhlov. REE 8/57, pp 1001-1011, 6 figs.

The article shows that if a detuned oscillator is synchronized by an amplitude modulated voltage, and if detuning does not exceed the lock-in band, phase modulation appears in the output signal, and the envelope waveform is distorted.

If the detuning exceeds the lock-in band, and the modulation frequency is less or slightly greater than the lock-in band, the beats are synchronized at the modulation frequency.

Frequency Dividers Employing Transistors by M. Z. Tseytlin. EC 9/57, pp 33-41, 11 figs.

Description of regenerative transistorized frequency dividers using junction and point-contact transistors. This circuit contains a frequency multiplier in the feedback loop and is similar to the vacuum-tube equivalent circuit. The application of the circuit is described and an experimental proof of the theoretical premises is given. The circuit gives reliable frequency division at a coefficient from three to ten and above. The divider operates reliably with supply voltages ranging from five to 40 volts. The tolerance in the circuit parameters increases from 2-2.5 per cent at $n = 0$ (n is the frequency division coefficient) to 4-10 per cent at $n = 3$.

Another circuit described is a regenerative frequency divider employing a ferrite peaking transformer, in accordance with the circuit proposed by V. M. Rozov (Elektrosvyaz', June 1956), (See ED 1/15/57), which can raise the frequency division coefficient to 14-16. A divider with a peaking transformer is cheaper and consumes less power than a circuit using two transistors. See Figs. 2, 3 and 4.

Coupling of Tank Circuits of Superheterodyne Receivers and Nonlinear Distortion Connected with Misalignment by I. M. Simontov and L. Ye. Yashchuk. EC 9/57, pp 30-32, 2 figs, 1 table.

The present method of aligning superheterodyne tuned circuits with trimmer capacitors produces a correct alignment only at two or three frequencies, depending on the number of additional elements in the heterodyne circuit. At the remaining circuits there is a certain detuning. This article tells how to determine how close the alignment is in mass-produced radio broadcast apparatus and to what extent the misalignment increases the nonlinear distortion in the receiver.



Fig. 2. Block diagram of frequency divider.

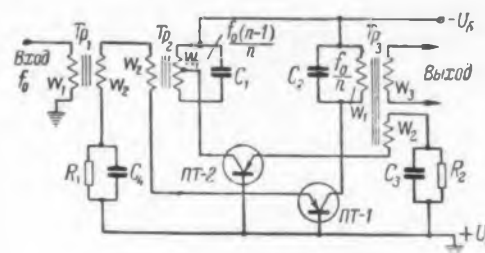


Fig. 3. Actual frequency divider circuit.

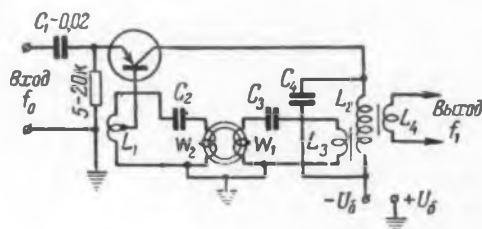
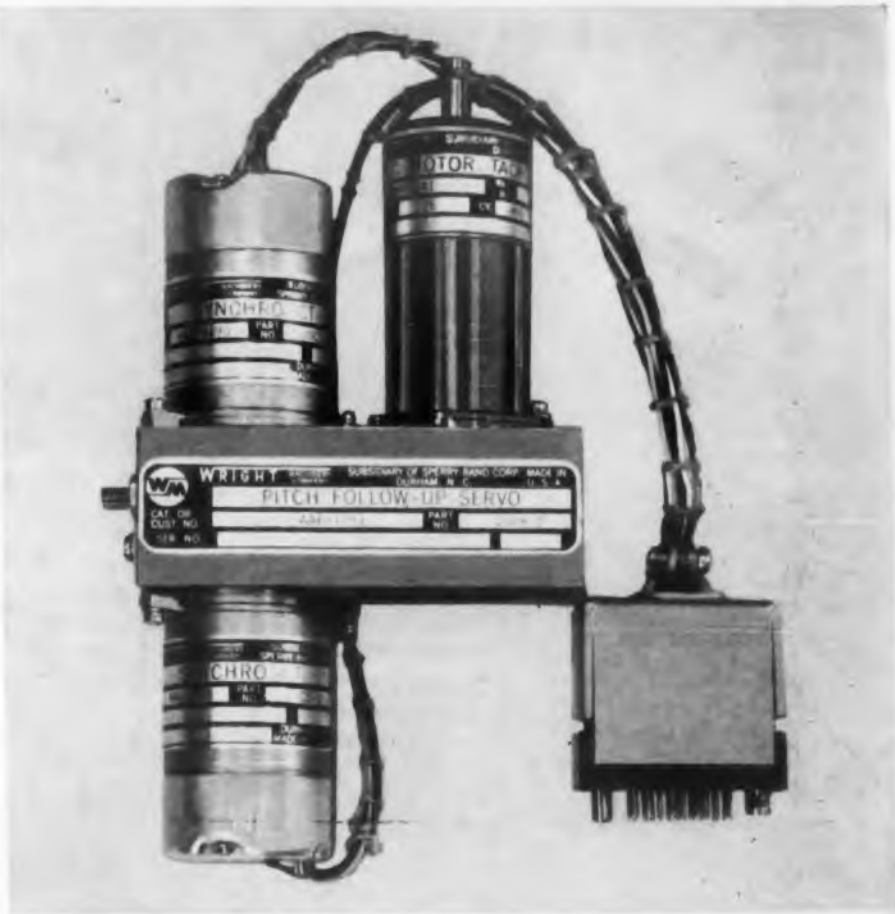


Fig. 4. Another version of the frequency divider.

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RUSSIAN TRANSLATIONS

WORLD'S FAIR

World's Fair by M. Likhachev and A. Shokin, 1/58, pp 28-30, 5 figs.

Describes what the Russians planned to exhibit at the World's Fair in Brussels. A television studio installed at the Soviet pavilion is to produce local tv programs and demonstrate the on new model sets. They intend to broadcast in Belgium and surrounding countries.

They will telecast exhibits, commercial meetings, appearance of Soviet artists, scientists, and other guests. Telecasts of Soviet theatrical groups, both from the pavilion and from theaters in Brussels are to be broadcast from mobile equipment.

Various tv cameras incorporate new transmitting tubes. A new truck-mounted three-camera mobile station with receiving equipment to insure reliable transmission of images with 600 line definition, and a frequency characteristic, uniform to within 2 or 3 db. A reporting setup is intended for on-the-spot transmission. It includes a portable transmitting camera with gun-like construction and a stationary receiving stand. With transmission regulated with change of illumination, high sharpness is insured, even at low illumination levels.

The Russians will also display underwater apparatus, with a special camera in a bathysphere. Many circuit novelties make it smaller, lighter, and reduce the power consumption. This equipment provides maximum image linearity and permits instantaneous change in viewing angle.

The exhibit will have many industrial tv installations as well as more than twenty types of tv receivers. These will have crt's measuring from 14 inches to 21. Some will include radio and phonographs. The article illustrates many of the new models.

In addition to tv apparatus, they will show some of their best radio receivers and sound systems, many of them pilot models of equipment they expect to sell in the USSR next year.

REE NOVEMBER 1957

This issue has no technical articles. It is entirely devoted to a survey of the history of electronics in the USSR since the November 1917 revolution.

Articles cover the history of Soviet developments in surface propagation; and meter, decimeter, and centimeter wave propagation in the ionosphere and troposphere. Also covered are antenna theory, interference immunity, nonlinear oscillations and the development of thermionics.

RUSSIAN BOOK REVIEW

Intermediate Frequency Amplifiers

M. L. Volin, 3rd edition, Soviet Radio Publishing Press, Moscow, 1956, 232 pages.

This was written for electronic engineers who design intermediate frequency amplifiers. It contains very practical information. This reviewer discussed the book with two Russian electronic engineers at the 1957 Wescon show; they said it was highly regarded by Soviet engineers. A German translation has also been published.

The first part of the book develops basic i-f amplifier theory. It develops methods of calculating selectivity, shape factor, gain, LC ratios, and maximum gain stability. Results of the analyses are tabulated.

The material illustrates the design of complete i-f amplifier sections to meet specific requirements. These include a 465 kc, 8 kc bandwidth amplifier; a 30 mc amplifier with an 8 mc bandwidth; and a 60 mc unit with 20 mc bandwidth.

The author then presents a detailed treatment of i-f amplifier transient response. He treats methods for computing rise time, overshoot, and decay time for pulse modulation signals as encountered in television, radar and data transmission systems. Here again, design examples illustrate the text.

One of the more difficult aspects of practical i-f amplifier design is the prevention of feedback loops that cause regeneration and distortion of the frequency response. The last two chapters depict the most common feedback problems and their correction. It covers shielding, decoupling, measurement technique, and physical placement of parts. For many engineers, this will be the most valuable part of the book, since published material dealing with i-f amplifier feedback problems is very rare.

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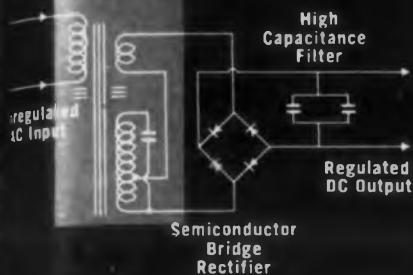
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Reviewed by Richard E. Daniel, Sr., Electronic Engineer, Hoffman Laboratories Div., Hoffman Electronics Corp., Los Angeles, California.

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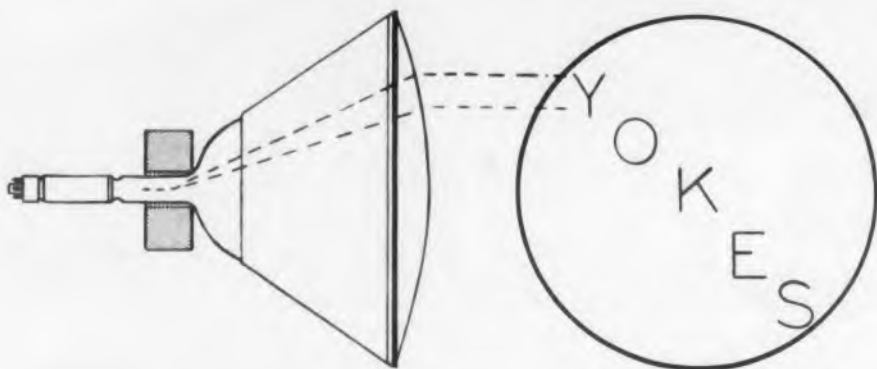
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Noise Voltage Measurement in Low Impedance Elements

WHEN noise voltages generated in resistors are measured, a wide-band amplifier generally precedes the frequency selective voltmeter. The order of magnitude of the equivalent noise resistances of such preamplifiers increases with decreasing frequency in the audio frequency range. The order of magnitude of this equivalent resistance with typical first stage tubes is about 1 K at 5 kc. Consequently the noise voltage generated by resistors of the order of 10 ohms cannot be measured with such an arrangement.

In many practical applications such measurements must be made; i.e. the measurement of noise voltage generated by germanium or silicon diodes conducting in the forward direction. A suitably designed transformer, connected as in Fig. 1, can be used to step up the noise voltage of the test element so that the

equivalent noise voltage at terminal pair *a-a* can be made to exceed the noise generated by the first stage of the wide-band amplifier.

The equivalent noise resistance, R_e , of a device whose complex impedance is Z is defined from the basic resistor noise equation

$$\overline{V_N^2} = 4 k T \int_{f_1}^{f_2} R_e Z df$$

through the formula

$$\overline{V_N^2} = 4 k T R \Delta f$$

where T is temperature in $^{\circ}K$.

The transformer introduces the extra noise due to the losses in the transformer. The equivalent circuit of the arrangement is shown in Fig. 2. All quantities are referred to the secondary, and the "noise generator" associated with each

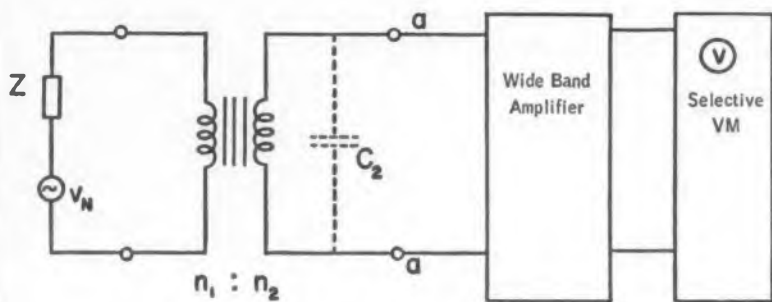
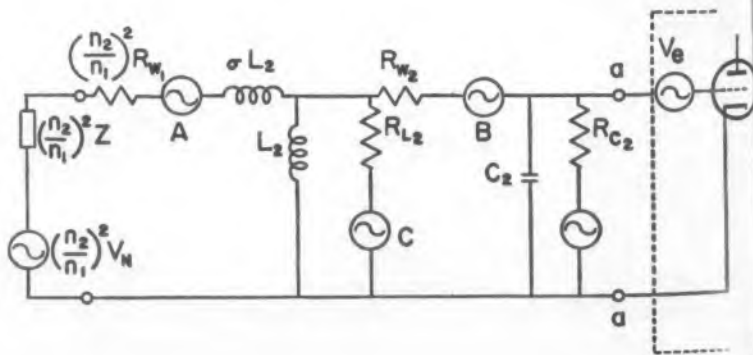


Fig. 1. Use of input transformer to step up noise voltage from the test element Z .

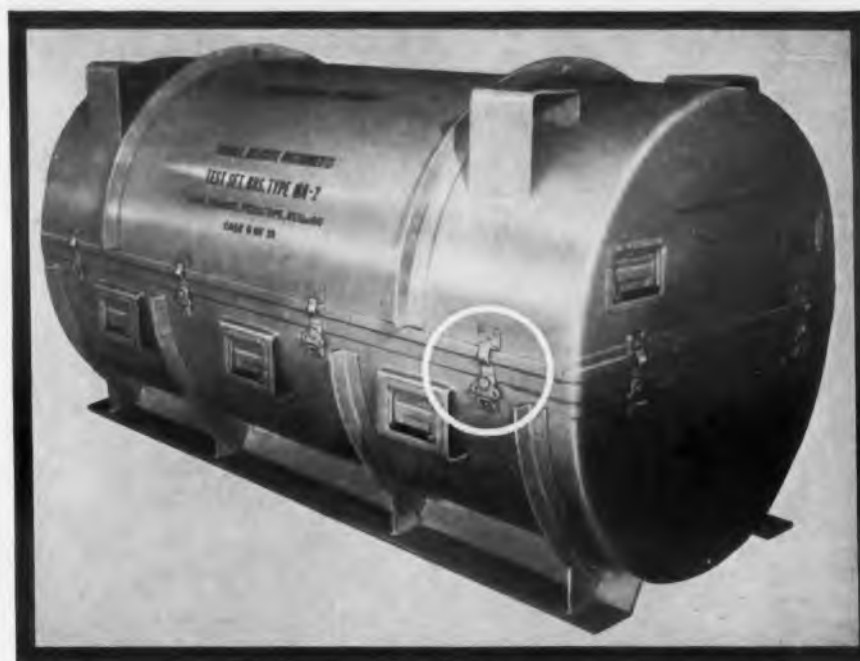
Fig. 2. Equivalent circuit for Fig. 1. Generators A, B, and C represent noise voltages due to transformer resistance. Generator V_e represents noise generated by first amplifier stage.



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istance is shown in the diagram. It is desirable to have a large input impedance at the primary terminals of the transformer compared to the resistance of the test element since this element can vary within wide limits. Assuming the element under test is principally resistive, the transformer is designed for a particular frequency f_0 . It can be shown, however, that a particular transformer can serve over a frequency range of about two decades.

The inductance L_2 , given by $(n_2/n_1)^2 L_1$, is chosen to resonate with C_2 . The capacitance C_2 includes the winding capacitance of the secondary, and the input capacitance of the amplifier. The order of magnitude of C_2 is 10^{-10} fd. The turns ratio of the transformer is chosen from the inequality

$(n_1/n_2)^2 Z \geq 5 [R_e + (n_2/n_1)^2 R_{w1} + R_{w2}]$ where R_e is the noise resistance of the amplifier, and R_{w1} , R_{w2} are the winding resistances of the primary and secondary, respectively. If the winding resistances are negligible compared to R_e then the turns ratio is chosen to correspond to the minimum expected value of the test impedance by

$$(n_1/n_2)^2 = 5 R_e / Z_{min}$$

In addition, if the maximum value of the test element is Z_{max} , it can be shown that

$$Z_{max} / Z_{min} = R_{p2} / 50 R_e$$

Where R_{p2} , the resonant resistance of the link circuit is given by

$$R_{p2} = Q / \omega_0 C_2$$

The transformer can be realized using a ferrite core. A Mu metal magnetic shield for the transformer and the input circuit is used to eliminate stray noises. Using a wide bandwidth, it is possible to measure the noise voltage of a 10 ohm resistor with an accuracy of 10 per cent.

With this arrangement it was found possible to measure the noise voltage generated by crystal diodes in the high current region. It was found that while for low currents the diode acts as a resistor with half the value of the incremental resistance, for large currents the noise resistance ceases to decrease (with increasing currents) and actually increases in the ma range.

Abstracted from an article by W. Nonnacher, Nachrichtentechnische Zeitschrift, Vol. 10, No. 11, Nov. 1957, pp 569-563.

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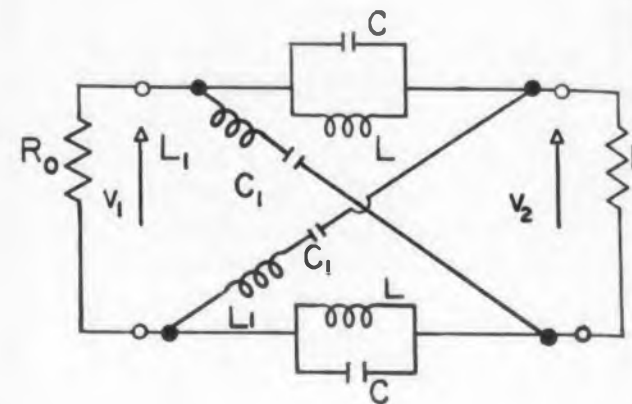
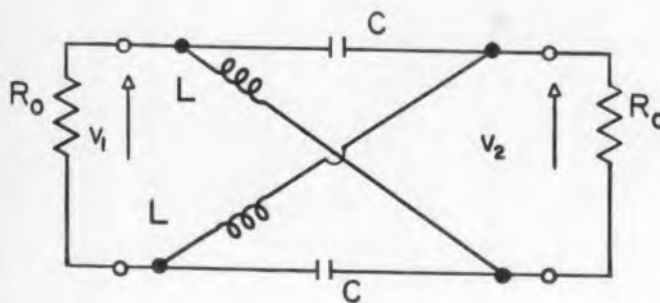
GERMAN ABSTRACTS

All-Pass Filter Time and Frequency Response

THE lattice-type, all-pass filters shown in the accompanying table are used as phase equalizers. Various reference equations are provided for each. Such networks are popular for the linearization of the envelope delay time in single side-band transmission, as in TV. The original

paper includes universal curves for the characteristic functions given in the accompanying table.

Abstracted from an article by H. Dobesch, *Hochfrequenz und Elektrotechnik*, Vol. 66, No. 3, Nov. 1957, pp 67-70.



Parameters

$$R_0 = \sqrt{L/C} \quad \omega_0 = 1/\sqrt{LC}$$

$$R_0 = \sqrt{L_1/C} = \sqrt{L/C_1}; C = 1/2R_0a;$$

$$L = 2R_0a/(a^2 + b^2); L_1 = R_0/2a$$

$$a = 1/2R_0C; b^2 = 1/(LC) - a^2$$

Complex Transfer Function

$$\frac{V_2}{V_1} = \frac{j(\omega/\omega_0) - 1}{j(\omega/\omega_0) + 1}$$

$$\frac{V_2}{V_1} = \frac{(j\omega - a - jb)(j\omega - a + jb)}{(j\omega + a + jb)(j\omega + a - jb)}$$

Phase Shift of the Transfer Function

$$\phi = \text{Tan}^{-1} \frac{Z \omega/\omega_0}{(\omega/\omega_0)^2 - 1}$$

$$\phi = \text{Tan}^{-1} \frac{2\alpha \mu (\mu^2 - 1)}{(1 - \mu^2)^2 - \alpha^2 \mu^2}$$

$$\alpha = \frac{Z a}{\sqrt{a^2 + b^2}}; \mu = \frac{\omega}{\sqrt{a^2 + b^2}}$$

Envelope Delay: $\tau = d\phi/d\omega$

$$\tau = -\frac{1}{\omega_0} \cdot \frac{2}{(\omega/\omega_0)^2 + 1}$$

$$\frac{d\phi}{d\mu} = -\frac{2\alpha(\mu^2 + 1)}{(1 - \mu^2)^2 + \alpha^2 \mu^2}$$

Step Response

$$v_2(t) = (2e^{-\omega_0 t} - 1)$$

$$v_2(\tau) = 1 - \frac{4\alpha}{4 - \alpha^2} e^{-\frac{\omega_0 \tau}{2}} \sin \sqrt{1 - \frac{\alpha^2}{4}} \tau,$$

$$(\tau = \sqrt{a^2 + b^2} t).$$

Approximation for Logarithmic Functions

TRANSCENDENTAL equations involving the natural logarithm can often be explicitly solved by approximating the logarithmic function with a function of the form Ax^c . Using this form, power series approximations may often be avoided.

It can be shown that in an interval x_1 to x_2 , as illustrated, the function $\ln x$ may be approximated within a relative error value, Δ , by the form

$$\ln x \approx Ax^c = \frac{\ln x_m}{1 + \Delta} \left(\frac{x}{x_m} \right)^{1 + \Delta} \approx \ln x_m \frac{(x)^{1/\ln x_m}}{e}$$

where the last approximation holds for very small values of Δ . The limits of the approximation, x_1 and x_2 are chosen so that the error is just equal to Δ at these extremes. It is shown that x_m is the geometric mean of x_1 and x_2 ($x_1 x_2 = x_m^2$). The ratio x_2/x_1 is related to x_m and Δ through

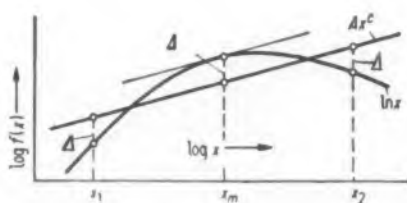
$$\frac{x_2}{x_1} = x_m \frac{1 + \Delta}{1 - \Delta} \approx x_m \frac{4\sqrt{\Delta}}{1 - \Delta}$$

It can be shown that the approximation improves, i.e., includes a larger interval of the variable, as the value of the variable increases. For this reason a scale change is often indicated. If

$$\ln x = \frac{1}{m} \ln x^m = \frac{A}{m} (x^m)^c$$

written then the choice of m as 10 or 100 results in the desired improvement.

Abstracted from an article by W. Rehwald and O. Zinke Archiv der Elektrischen Uebertragung Vol. 11, No. 10, October 1957, pp 397-402.



The function and curve which approximates the function.

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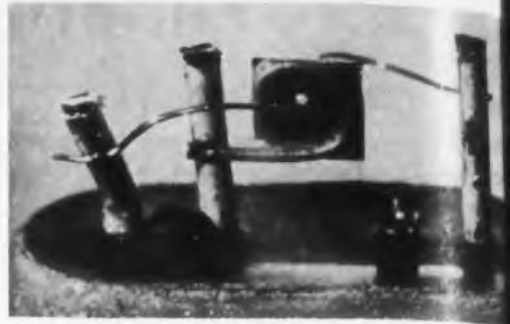


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ABSTRACT



The Intrinsic-Barrier Transistor

THE INTRINSIC-BARRIER transistor offers the following advantages over the familiar pnp or npn transistor structures:

- Feedback capacitance from collector to base is reduced;
- Maximum voltage sustainable between collector and base is greatly increased permitting operation at higher power levels;
- Transit time is reduced, hence, a smaller base current is necessary to control emitter-to-base current to much higher frequencies;
- Smaller input power is required for any given value of control current since base resistance is reduced.

Significant improvement in the design of familiar pnp and npn transistors can, of course, be obtained by reducing the thickness and the resistivity of the base region, and by reducing the area of the transistor in an effort to reduce und

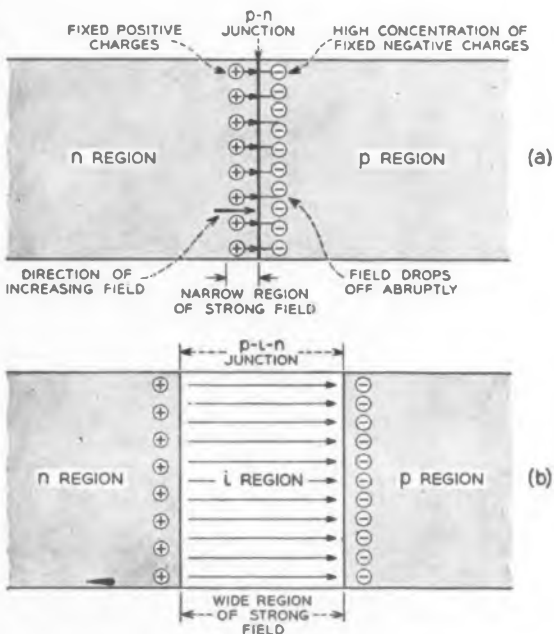


Fig. 1.(a) conventional pn junction has narrow strong-field region; (b) n-i-p junction has constant field through wide intrinsic layer.

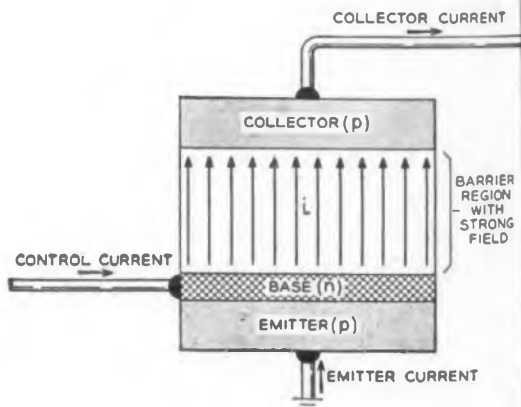


Fig. 2. The pnp transistor in a common emitter circuit; relatively thick i-layer has been introduced between base and collector.

able feedback capacitance. There are, however, very definite limits to such design modifications. Since thinner base regions and lower base resistivities decrease the width of the strong-field region between collector and base there is an associated larger feedback capacitance and, hence, smaller permissible maximum voltage. A relatively wide strong-field region is necessary to permit application of high and useful voltages between collector and base. An examination of the factors affecting width of the strong field region leads to the concept of the intrinsic-barrier transistor.

P-N and P-I-N Junctions Compared

Consider the distribution of charges in an ordinary pn junction, as illustrated in Fig. 1(a). A very narrow region of strong field is developed. This region acts as a parallel plate capacitor and, therefore, capacitance is high. The maximum voltage which this field can sustain is small.

If now the n and p regions are separated by a wide region material, as in Fig. 1(b), which is either n nor p type and which contains substantially no fixed-charge centers, this layer will act as a strong-field region. The base layer may now be made much thinner and at the same time its resistivity may be reduced. Moreover, the transit time is lowered without raising base resistance.

The intrinsic barrier is incorporated into the transistor structure illustrated in Fig. 2.

465 Mc Transistors Built

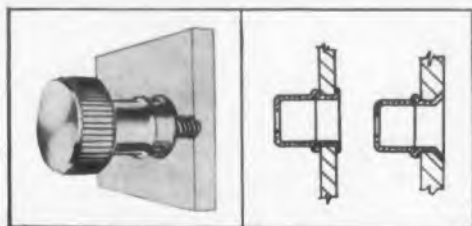
An oscillator circuit in which intrinsic-barrier transistors have been operated at a frequency of 465 mc has been built. The circuit employed is a common-base circuit in which a tuned circuit is placed between the collector and base electrodes, a feedback capacitor between collector and emitter, and a tuned circuit between emitter and base. In circuits of this type, very substantial powers have been obtained at frequencies as high as 400 mc.

It should be emphasized that despite the reduced capacitance possible in intrinsic-barrier transistor structures, the high-frequency transistor remains a very small-area device. For example, all of the electronic action in the 465 mc oscillator takes place in a region which is only 0.010 in. in diam and 0.001 in. thick. A structure so exceedingly small is, of course, difficult to construct. Nonetheless, this tiny structure promises to help solve the problem of application of the transistors to broadband systems and to tuned high frequency systems like mobile radio.

Abstracted from the article, *The Intrinsic-Barrier Transistor—How It Works* by J. M. Early, Bell Laboratories Record, March, 1958.

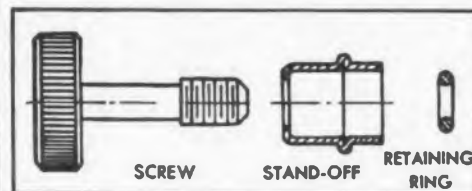
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SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic. Overall length of screw: 1 3/16" Depth of screw head: 1/4"

Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
3/4"	1/4-20
1/2"	1/4-20, 12-24
3/8"	10-24, 10-32

Length of thread: 3/8"

Screw head is supplied plain, as shown, or slotted for screw driver.

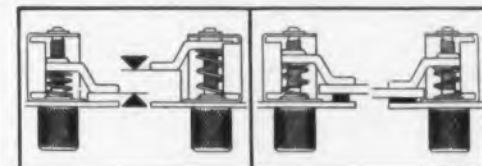
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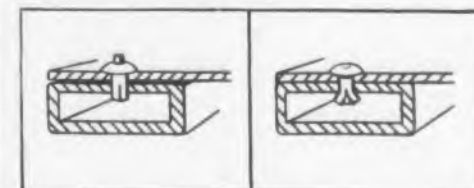
SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

Head Styles: Protruding ribbed or knurled knob; flush screw driver slotted for large size only.

	LARGE	INTERMEDIATE	MIDGET
Knob diameter	7/8"	3/4"	1 1/2"
Total width	2 1/2"	1 3/4"	1 1/8"
Total height	1 3/8"	3/8"	2 3/4"
Back of panel depth	1 3/8"	1 1/4"	3/8"
Knob length	1 1/4"	1 3/8"	3/2"

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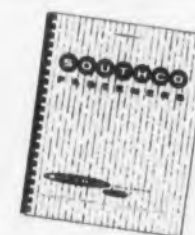
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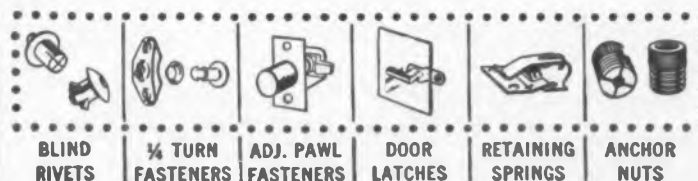
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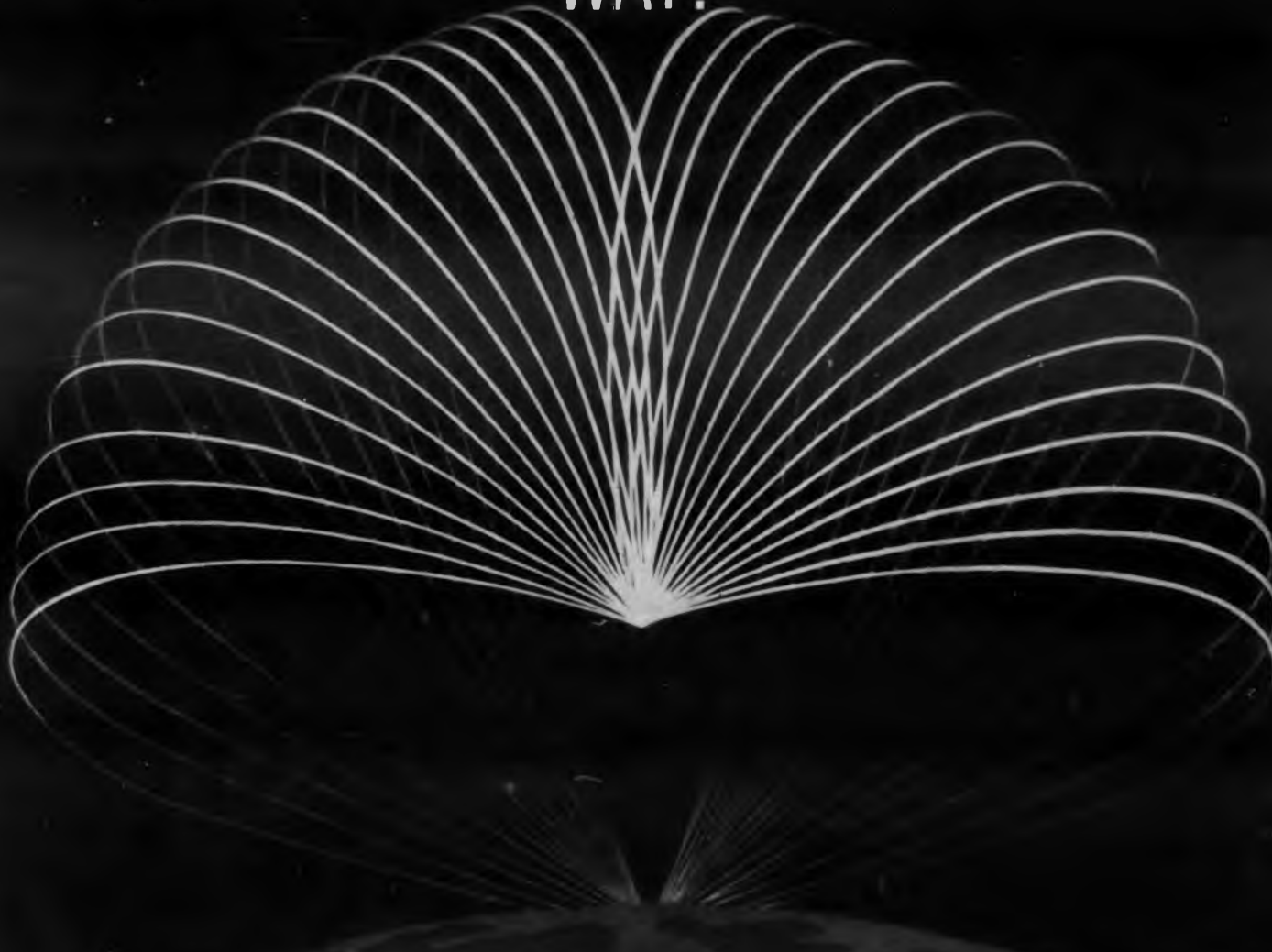
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The curious Trojans, neglecting to look this gift hearse in the mouth, dragged it inside the city — their last mistake of the war. That night the scientists managed to escape and open the gates of the sleeping city for the Greek Army. No one could have been more surprised at this unexpected victory than Odysseus — but he managed to squelch the real story and claim all the credit for himself. Which goes to show that people haven't changed much in 3500 years. But tubes have.*

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		C 265	55		C 240	65		
	550	L 200	60		L 190	70		
		C 300	50	C 280	60			
H-84	700	L 255	170	6.3V-5A 6.3V-1A 5V-3A	L 240	210	6.3V-6A 6.3V-1.5A 5V-4A	KA
		C 400	110		C 360	150		
	750	L 275	160		L 260	200		
		C 420	105	C 380	140			
H-86	720	L 240	260	6.3V-6A 6.3V-2A 5V-3A	L 220	310	6.3V-7.5A 6.3V-2A 5V-4A	MB
		C 425	170		C 410	210		
	790	L 270	250		L 250	300		
		C 450	160	C 440	200			
H-92	900	L 330	230	6.3V-6A 6.3V-2A 5V-4A	L 320	290	6.3V-8A 6.3V-2A 5V-4A	MB
		L 385	220		L 370	270		
	1050							

*After appropriate H series choke. L ratings are choke input filter, C ratings are condenser input.



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H-71	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	11	200	10	230	8.5	250	8.5	300	90	700	2500	KB
H-77	10	300	9	350	8	380	8.5	435	60	2000	5500	MB
H-79	7	800	6.5	900	6	1000	5.5	1250	20	3000	9000	9x7x8

*Based on maximum ripple voltage across choke in choke input filter circuit, in terms of DC output voltage.

TYPICAL FILAMENT TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles... suited to 400 cycles.

Type No.	Sec. Volts	Amps. (MIL)	Amps. (Ind)	Test Volts RMS	MIL Case
H-121	2.5	10	12	10000	JB
H-126	5	20	25	10000	LA
H-127	5	20	30	21000	NA
H-131	6.3CT	2	2.5	2500	FB
H-134	6.3CT	10	12	2500	HA
H-136	14, 12, 11CT	10	14	2500	LA



United "H" series filament transformers have multi-tapped primaries, good regulation, and are rated for industrial as well as military service.

TYPICAL PLATE TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

United "H" series plate transformers incorporate dual high voltage ratings and tapped primaries to provide versatile units for a wide range of military and industrial electronic applications. Large units have terminals opposite mounting for typical transmitter use.



Type No.	Sec. V. C.T.	Approx.* DC Volts	MA DC	Choke No.	MA DC	Choke No.	Case
H-111	1050	415	440	H-77	550	H-77	NA
	1200	480	400	H-77	800	H-77	
H-112	1500	615	290	H-77	350	H-77	NA
	1900	790	250	H-76	300	H-76	
H-114	2500	1050	450	H-79	500	H-78	6 3/4 x 6 1/2 x 8
	3000	1265	400	H-78	450	H-78	
H-116	5000	2125	450	H-79	560	H-78	8 1/2 x 9 3/4 x 10 1/4
	6000	2550	400	H-78	500	H-78	

*After filter choke. All ratings are for choke input filter

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"
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Another RCA First...



A 40-Ampere Thyratron

RCA-7086... Xenon
Thyratron Forced-Air-
Cooled, Negative-
Control Triode Type
(shown $\frac{1}{2}$ actual size)

*Anode current averaged over any period of 15 seconds maximum

Again, RCA leads the way in industrial tube development—with a husky thyatron designed for applications in which high peak currents are required or in which high average or rms currents are demanded. Here are just a few of the big jobs the RCA-7086 can do:

- It can deliver a maximum peak anode current of 400 amperes in intermittent service or 160 amperes in continuous service.
- In a typical X-ray tube control circuit, two tubes can control a current of 280 amperes rms through the primary of the power transformer (supplying high voltage to the X-ray tube).
- In welding service utilizing a single-phase inverse-parallel circuit, two tubes can provide a maximum average ac output of 130 kva.
- In inverter equipment, two tubes can deliver up to 15 kva average power.
- In speed control of dc motors, two tubes will control 220-volt dc motors rated up to 20 horsepower.

The 7086 has a high commutation factor, a relatively short dionization time, and a negative-control characteristic that is essentially independent of ambient temperature over the wide range -55° to $+75^{\circ}\text{C}$ because of its xenon gas content.

RCA-7086 DATA

Filament volts	2.5
Filament Amperes	92
Air Flow (cfm)	60
Supply Frequency (cps)	25 to 60

	Continuous Service	Intermittent Service
Peak Anode Volts:		
Forward	650 max.	650 max.
Inverse	650 max.	650 max.
Anode Amperes:		
Peak	160 max.	400 max.
Average	40 max.*	7 max.**

*Averaged over any period of 15 sec. max.
**Averaged over any period of 36 sec. max.

Your RCA Field Representative will be glad to discuss application of this new thyatron with designers of power-control equipment. For a technical bulletin on the RCA-7086, write RCA Commercial Engineering, Section E-18-Q-2, Harrison, New Jersey.



RADIO CORPORATION OF AMERICA

Electron Tube Division

Harrison, N. J.

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DESIGN