

ELECTRONIC DESIGN

MARCH 2, 1960

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RADIATION AND HEAT-RESISTANT RECTIFIER... p 38

GIVE YOUR PRODUCTS MORE RELIABILITY AND BETTER PERFORMANCE WITH

-FREED QUALITY

MINIATURE PULSE TRANSFORMERS



- Meets all requirements of MIL-T-27A
- Small size and weight
- Ideal for computer applications

CATALOG #	APPLICATION	TURNS RATIO
EPT-1		1:1
EPT-2	Impedance	2:1
EPT-3	Matching	3:1
EPT-4		4:1
EPT-5	and	4:1
EPT-6		5:1
EPT-7	Interstage	7:1
EPT-8	Coupling	5:1
EPT-9		3:1
EPT-11		1:1
EPT-12		1:1
EPT-13	Blanking	2:1
EPT-14	Oscillator	1:1
EPT-15		1:1
EPT-16	Memory core &	5.5:1PP
EPT-17	Current driver	3.3:3.1PP
EPT-18	Current driver	4:1
EPT-19	Current Transformer	11:1
EPT-20	Pulse Inversion	4:1

*Supplied both molded and lead

Ruggedized, MIL STANDARD POWER & FILAMENT TRANSFORMERS

Primary 105/115/125 V 50-60~

Cat. No.	Appl.	MIL Std.	MIL Type
MGP 1	Plate & Fil.	90026	TF4RX03HA001
MGP 2	Plate & Fil.	90027	TF4RX03JB002
MGP 3	Plate & Fil.	90028	TF4RX03KB006
MGP 4	Plate & Fil.	90029	TF4RX03LB003
MGP 5	Plate & Fil.	90030	TF4RX03MB004
MGP 6	Plate	90031	TF4RX02KB001
MGP 7	Plate	90032	TF4RX02LB002
MGP 8	Plate	90036	TF4RX02NB003
MGP 9	Plate	90037	TF4RX02PB004
MGP 10	Plate	90038	TF4RX02SB005
MGP 11	Plate	90039	TF4RX02TB006
MGP 12	Plate	90040	TF4RX02UB007
MGP 13	Plate	90041	TF4RX02VB008
MGP 14	Plate	90042	TF4RX02WB009
MGP 15	Plate	90043	TF4RX02XB010
MGP 16	Plate	90044	TF4RX02YB011
MGP 17	Plate	90045	TF4RX02ZB012
MGP 18	Plate	90046	TF4RX02AB013
MGP 19	Plate	90047	TF4RX02BB014
MGP 20	Plate	90048	TF4RX02CB015
MGP 21	Plate	90049	TF4RX02DB016
MGP 22	Plate	90050	TF4RX02EB017
MGP 23	Plate	90051	TF4RX02FB018
MGP 24	Plate	90052	TF4RX02GB019
MGP 25	Plate	90053	TF4RX02HB020
MGP 26	Plate	90054	TF4RX02IB021
MGP 27	Plate	90055	TF4RX02JB022
MGP 28	Plate	90056	TF4RX02KB023
MGP 29	Plate	90057	TF4RX02LB024
MGP 30	Plate	90058	TF4RX02MB025
MGP 31	Plate	90059	TF4RX02NB026
MGP 32	Plate	90060	TF4RX02PB027
MGP 33	Plate	90061	TF4RX02SB028
MGP 34	Plate	90062	TF4RX02TB029
MGP 35	Plate	90063	TF4RX02UB030
MGP 36	Plate	90064	TF4RX02VB031
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MGP 39	Plate	90067	TF4RX02YB034
MGP 40	Plate	90068	TF4RX02ZB035
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MGP 42	Plate	90070	TF4RX02BB037
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MGP 250	Plate	90278	TF4RX02CB245
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MGP 252	Plate	90280	TF4RX02EB247
MGP			

Highlights of This Issue

Don't fail to follow through on the following series that continue in this issue: Part 2 of a three-part series dealing with radar modulator circuits; Paul Wrablica's articles describing the industrial designer's novel approach to human factor engineering in industry.

Super accurate cryogenic gyros may result from two projects underway at General Electric Co. and Jet Propulsion Laboratory. Some people feel that mechanical gyros for inertial guidance have been pushed to the absolute limit. That's why at least two companies are now developing cryo gyros to meet the stringent requirements of space. See what advantages—as well as problems—are involved in the design of these radical gyros.

The load-line approach to transistor amplifier design offers many advantages over conventional methods, according to Alan Phillips of Sperry Gyroscope Co. He feels that this method provides a rapid way to find low-frequency gain and input impedance. Read this article in which he shows how easy it is to use the load line in amplifier analysis.

Applications of tunnel diodes in conventional circuits are presented on page 10. The four circuits shown represent some typical uses for Esaki diodes not in the near future—but now. Read these interesting uses that General Electric application engineers have suggested for these solid-state devices.

Speaking of solid-state devices, the recent Solid State Conference held in Philadelphia attracted experts from all over the world. *ELECTRONIC DESIGN*'s News Staff was, as usual, right there to cover the proceedings, and interview the people you want to hear from. The entire story will be presented in detail in the next issue, but see the preliminary notes on the conference in this issue.

CIRCLE 2 ON READER-SERVICE CARD ➤

At Victor's Electric-Car Division...

where
precision
is a
must



RED/LINE

timing relays "Pay Off"!



The design engineers at Victor's Electric-Car Division sought a way of making their Dyna-Powered Maintenance Truck accelerate automatically and smoothly through the three forward speeds. The answer: Two G-V Red/Line Thermal Relays, each providing a two-second delay between steps. This assures smooth, even acceleration every time. A third Red/Line Relay shuts off the dynamic brake after a fixed time interval, conserving battery power. **So, at Victor, G-V Red/Line Timing Relays are "paying off".**

More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will "pay off" in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

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Livingston, New Jersey



HOW TO PRODUCE

33 UNIFORM MINIATURE

WELDS OF

4 DIFFERENT METALS



Collins Radio Achieves Production Goals with Weldmatic Welding

A new, exceptionally reliable mechanical filter—key component in the Collins version of the highly strategic Single Sideband Radio—is now in production using an all-welded construction provided by Weldmatic equipment. This advanced filter makes possible improved selectivity characteristics and better utilization of the radio spectrum. Unvarying uniformity of the weld nugget and absolutely no displacement of the positioned parts are required specifications. Electrical characteristics are extremely critical . . . each of 33 connections must be identical in production quantities! After extensive evaluation, Collins selected Weldmatic's 1032 Miniature Welding Head and Model 1026 Power Supply . . . the combination that has enabled Collins to meet its production goals. They're a real team for precision welding: the miniature head with perfect vertical electrode motion and accurate repeatable pressure—the power supply with ultra-short current flow (0.001 second) over a continuously variable heat range. Why not consider Weldmatic for your metal-joining problems? WRITE for our free 20-page brochure describing techniques, applications, and Weldmatic's sample welding service.



Weldmatic pressure gage reads firing force...calibrated from 0 to 50 lbs., insures exact weld pressures from job to job. (Right) Welded filter cartridge and completed miniaturized Collins filter.

WELDMATIC

950 ROYAL OAKS DRIVE • MONROVIA, CALIF.  DIVISION OF UNITEK CORPORATION
CIRCLE 3 ON READER-SERVICE CARD

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Stand temperatures of 500 C, are 10 times more resistant to radiation than silicon	

In The Next Issue

- More than 200 IRE products and where to find them at the IRE show will appear as part of a huge 335-page special issue.
- Using the resonance equation, anyone can find the bandwidth, impedance, voltage, phase, and Q of resonant circuits. In an important article, Dr. Phil Amlinger will show how to solve the resonance equation much faster using graphical methods.
- Close temperature control in miniature ovens challenges the ingenuity of many designers. A down-to-earth article shows how to meet the challenge without "hit or miss."

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Engineering notes from the **SMI REPORTER**

BY STANLEY M. INGERSOLL, Capabilities Engineer



Report No. 4

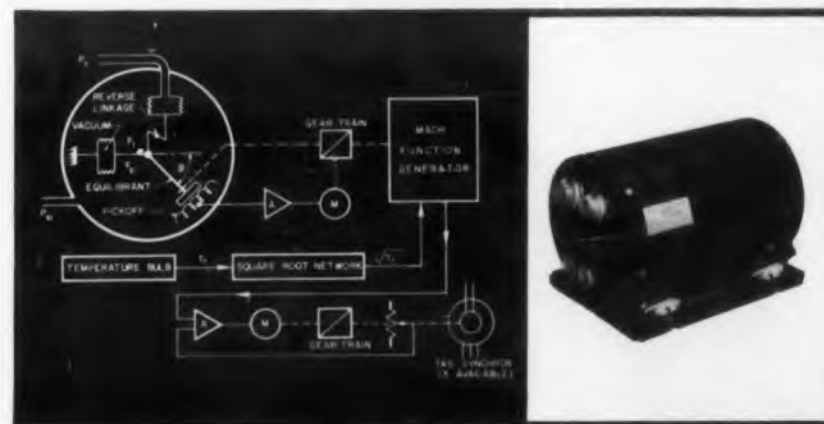
AXC 620 Miniature True Airspeed Computer (Minitas)

Exceptional accuracy and small size are key features of SMI's new Miniature True Airspeed Computer. Any one of three true air speed operating ranges and accuracies can be supplied to meet the requirements of high-performance aircraft, patrol planes, helicopters, artillery-directing aircraft, and missiles. The MINITAS consists of an extremely sensitive and accurate force balance Mach transducer, a passive resistance network, and a follow-up servo. The transducer is made up of a pressure ratio sensor — which is the heart of the system — a servo, and an electrical function generator. All servo amplifiers use silicon transistors for uniform reliability in severe environments. The MINITAS is capable of operation in a 125°C. environment and requires only 20 watts of 115 vac, 400 cps power. Without shockmounts, the computer measures 5" dia. x 8 1/4" and weighs 6.5 lbs. The MINITAS conforms to MIL-E-5400 and MIL-E-5272.

Typical Performance Specifications

TYPE NO.	TRUE AIRSPEED RANGE (KNOTS)	ALTITUDE (FT.)	ACCURACY (KNOTS)
AXC 620	70 - 450	0 - 20,000	± 4%
	70 - 125	0 - 20,000	± 1%
	125 - 450	12,000 - 20,000	± 2%
AXC 620-1	100 - 200	0 - 10,000	± ¾%
AXC 620-2	300 - 1500	0 - 80,000	± 12%

NOTE: These are standard accuracies. Increased accuracies are available over restricted ranges upon request, and special ranges and output forms are also available. AXC 620 and AXC 620-1 are capable of operation up to 40,000 ft. with reduced accuracies.



FUNCTIONAL SCHEMATIC—AXC 620 Miniature True Airspeed Computer

For more information and complete operating specifications, write or wire SMI today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.



SERVOMECHANISMS INC.

Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

Designers Tackle Tough Problem:

Cryogenic Gyros With Super Accuracy

FOR MISSILES traveling ultra-precise trajectories into unexplored space; for atomic submarines cruising murky seas for months without resurfacing, and for many other present and foreseeable applications, the precision gyroscope of today is fast becoming obsolete. Needed are revolutionary instruments—gyros so refined that drift rate is all but eliminated. A long stride toward this goal is envisioned in two design projects under way at General Electric Co. and Jet Propulsion Laboratory. The projects: cryogenic gyroscopes.

The drive to build the first practical cryogenic gyro may produce instruments with less than one-hundredth the drift rate of conventional types. Both GE and JPL are designing gyros that would operate at cryogenic temperatures and in the superconductive state. Frictional and electrical losses would be cut to insignificant amounts.

Success is being pursued in the face of the knowledge that the company that did the original design research on cryogenic gyros, Arthur D. Little, Inc., abandoned the project when the

magnitude of the problems became apparent.

GE is developing a rate gyro for the Army Ballistic Missile Agency that may achieve a random drift rate as low as 0.0001 deg hr.

JPL is designing a free gyro for the National Aeronautics and Space Agency that would not use servos. Both the GE and the JPL designs represent additional support for the so-called "West Coast" approach to gyro design, which favors two-degree-of-freedom devices over those able to move in only one plane.

Two Advantages in Cryogenics

In the cryogenic gyros under development, the gyro bearing would be supported by a magnetic force field. This field would be induced by superconductive coils acting on a superconductive bearing surface. To achieve superconductivity, both components would be cooled to temperatures near absolute zero.

Two features of this type of design are:

1. Extremely low frictional losses, because the bearing spins in a vacuum and is supported by

a magnetic force field; and

2. Elimination of gyro power supply once the bearing is spinning properly. With no resistance in either the superconductive bearing coils or surface, an electrical current, once started, continues as long as superconductivity is maintained, thereby maintaining the magnetic field.

Applying Superconductivity to Gyros

The most important characteristic of superconductors for gyro applications is their ability to exclude magnetic fields from their interiors. This is the Meissner effect, which can produce a diamagnetic body that is repelled by, rather than attracted to, regions of relatively high magnetic field density.

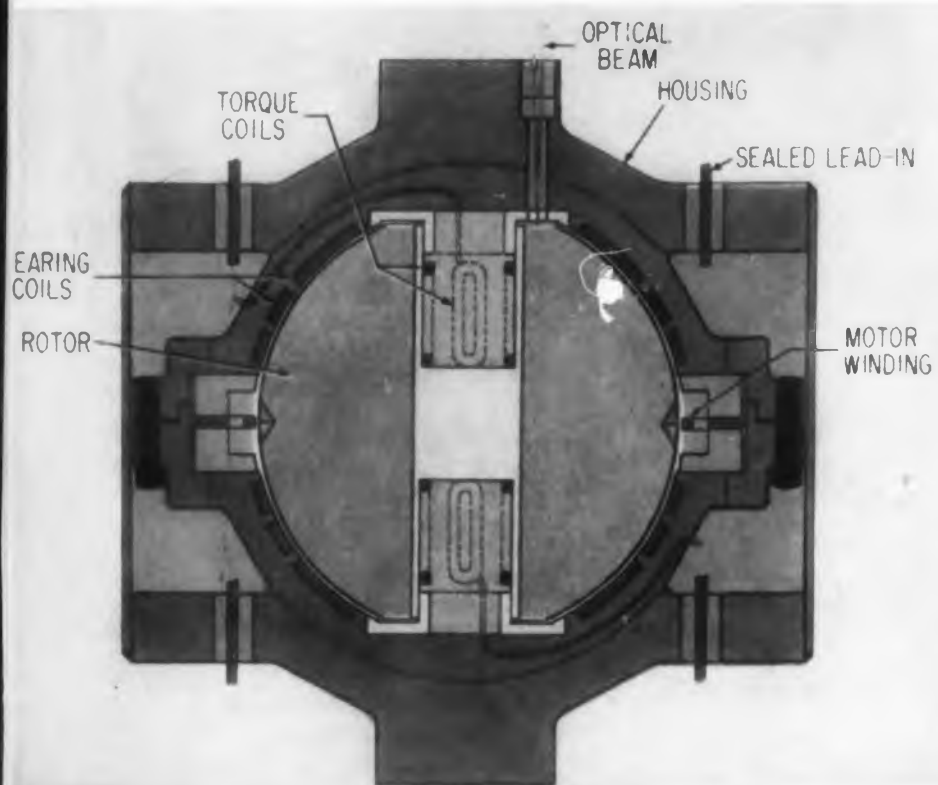
The magnetic field excluded from the interior of a superconductor forms in lines of magnetic flux on the conductor's surface. Because the lines form parallel to the surface, the force they exert is perpendicular to the surface. In a sphere, such as a gyro bearing, the forces can be made to act through the center of the mass, which results in translational but not torquing forces. The JPL gyro will exploit this absence of torque; the GE gyro will not.

GE Gyro to Use Niobium

GE plans to use niobium as the basic superconductive material of its gyro. This hard-to-machine metal becomes superconductive at the highest temperature—18 K—of all materials considered by the company. But it exhibits a relatively poor Meissner effect and one that can be destroyed completely by welding and soldering.

The gyro bearing would be about 1.5-in. in diameter and would rotate at about 20,000 rpm. GE reports that the smoothness of the bearing surface is not critical, because the rotating speed can be adjusted to compensate for irregularities. (JPL considers bearing smoothness one of the most difficult problems to be overcome.)

Because niobium is hard to work, GE designers are using in their experiments a hollow titanium ball covered by a thin sphere of spun niobium. Clearance between the stator of the gyro and the bearing would be 0.3 mm.



Cryogenic gyro system of General Electric would keep a superconductive bearing spinning in a supporting magnetic field. The bearing coils encircling the sphere and generating the field would also be superconductive. They would generate a field that would induce a counter-field on the surface of the bearing. The repelling force of fields acting on each other would support the bearing with almost no friction loss after the bearing was started by the motor winding. The torque coils would keep spin on one axis to compensate for unevennesses. The gyro would work in a tight vacuum at liquid-helium temperature. All electrical leads into the system would be transformer-coupled to keep out heat.

Sharper Definition... Improved Gray Scale... with RAYTHEON "KILOLINE" RECORDING STORAGE TUBES

A Raytheon-designed tetrode gun insures higher resolution — 1,000 TV lines at 50% modulation — and improved control over beam cut-off in Raytheon's new CK7571/QK685 and CK7575/QK787 recording storage tubes. A new multiple collimating lens improves background uniformity and results in a signal-to-shading ratio of ten.

These advanced design features, plus low noise and stable operating characteristics, make Raytheon recording storage tubes ideal for frequency and scan conversion. Among the applications where these tubes play an important role are:

- Scan conversion for bright display and target trails.
- Slow-down video for transmission of still pictures over telephone lines.
- Stop motion to permit analysis of production machinery or to stop action in a sporting event.
- Signal-to-noise improvement of radar or other still pictures by integration.
- Conversion of television pictures from one transmission standard to another.
- Indication of moving targets by electrical comparison of pictures taken at different times.

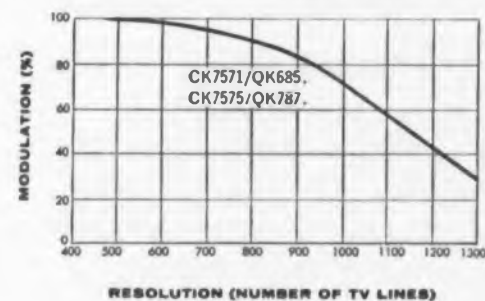
For scan conversion applications, both r.f. read-out and video cancellation techniques have proved equally effective with Raytheon single- and dual-gun storage tubes.

Raytheon's single-gun CK7571/QK685 and dual-gun CK7575/QK787 recording storage tubes are available from stock in sample quantities. Detailed technical data bulletins are yours for the asking — write direct to Dept. 2527.

TYPICAL OPERATING CHARACTERISTICS CK7571/QK685 and CK7575/QK787

Anode Voltage.....	4,000 Vdc
Magnetic Focus Resolution.....	1,000 Lines (nominal)
Electrostatic Resolution.....	700 Lines (nominal)
Output capacitances:	
CK7571/QK685.....	12 μ f (nominal)
CK7575/QK787.....	27 μ f (nominal)
Maximum Deflection Angle.....	30 Degrees

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CIRCLE 5 ON READER-SERVICE CARD



Hollow sphere of spun niobium would cover a titanium ball and form a rotor bearing of GE's cryogenic gyro. Bearing would spin with 0.3-mm clearance.

The stator contains a conventional motor winding to start the bearing spinning and to accelerate it to speed, and bearing coils of niobium to induce the supportive magnetic field. In the bearing are torque coils to keep the spin on one axis and to compensate for unevenness of surface or of homogeneity.

Readout would be optical, using either the known position of the torquers or a special mark on the sphere.

To maintain the low temperatures to make niobium superconductive, GE is using liquid helium at 4 K. The company has developed an insulator, P-Zero, that it calls "better than a Dewar flash" for conserving the cooling agent.

The gyro will operate in a vacuum of about 10^{-6} or 10^{-7} mm of mercury. The company has already achieved this vacuum.

JPL Gyro Is Gimbal-less

In contrast to the GE gyro, which can be considered a step in the advance of the rate-gyro art through the harnessing of superconductivity, JPL's gyro is planned as a long leap forward. It would be a free, or gimbal-less, gyro that would make use of the absence of torque and would have no torquers or servos.

For the bearing, JPL is planning to use a sapphire sphere about 0.5-in. diameter, coated with a vacuum-deposited layer of pure lead. Lead shows a better Meissner effect than niobium, but it requires a lower temperature to become super-

NEWS

conductive and a higher field strength to return to its normal state.

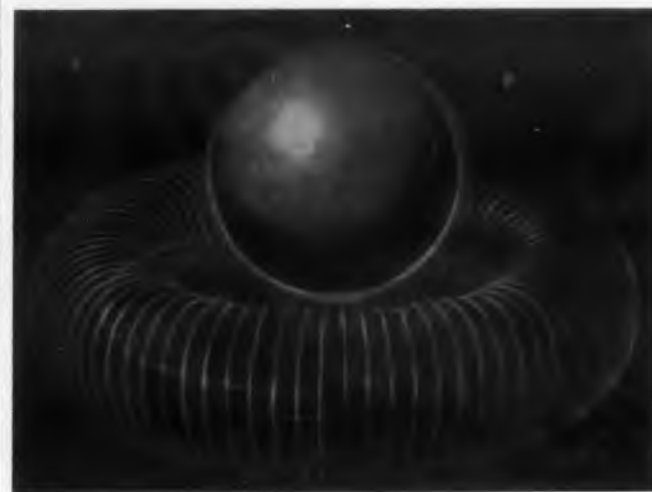
JPL, like GE, will use an ac-induced field to accelerate the rotor to speed. But the JPL gyro will not be cooled and made superconductive until it is at speed. When the rotor is spinning properly, the ac supportive field will be switched to dc.

The rotor of the JPL gyro would be supported while at non-cryogenic temperature by ac levitation. It would then be spun by the rotating magnetic field of an induction motor. While it spun to speed, it would be supported by high-frequency eddy currents. At speed, the bearing would be cooled and made superconductive, and dc would replace ac to induce the supporting field.

Progress Thus Far

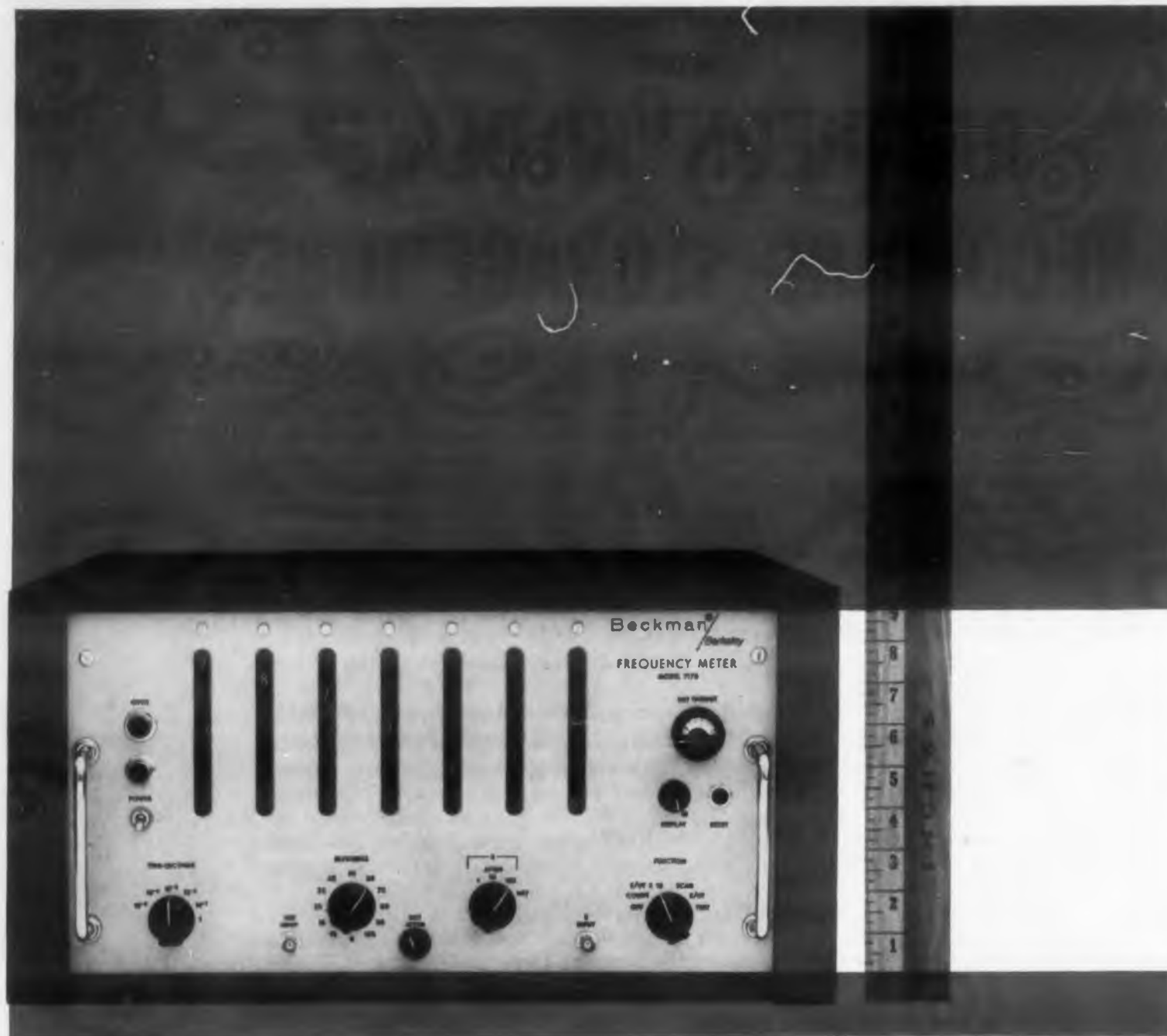
GE is scheduled to show an engineering model of its gyro to the Army missile agency by the end of this year. A cylindrical superconductive rotor has been spun at 21,000 rpm in a 10^{-6} -mm vacuum at cryogenic temperatures; and the problems of thermal and electrical shielding have been solved. But the company is hoping to find a better material than niobium, and it has yet to put together a working model of its gyro.

How Magnetic Field Supports Cryogenic Gyro Bearing



Magnetic field generated by a superconductive coil induces a counter-magnetic field in a superconductive sphere. The counter-field forms on the surface of the sphere, where its lines lie parallel to the surface, as shown by the faint aurora at the surface edge of the sphere. The two fields repel each other, indicated by the flattening of the coil's field lines, and support the sphere. Lines of force will act through the center of a homogeneous, sufficiently spherical spinning body to give torqueless support with no important friction loss.

ELECTRONIC DESIGN • March 2, 1960



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CIRCLE 6 ON READER-SERVICE CARD



Lead-coated ping-pong ball under test at Jet Propulsion Laboratory has been supported, while superconductive, in a magnetic field as part of a cryogenic gyro project.

JPL has computed the fields, forces and coil geometry of its design on a computer and has actually lifted a lead-coated ping-pong ball at 4.2K. The laboratory expects that its design will be adequate to support a 0.5-in., lead-coated sapphire sphere against 2 g in all directions. As at GE, readout would be optical.

Great Problems Remain

Both GE and JPL have enormous problems to overcome. JPL's calculations indicate that "sphericity of the bearing must be on the order of 100 times better than anything devised by man," says Dr. J. T. Harding, head of the laboratory's cryogenic gyro project. This requirement represents a sphericity tolerance of about one atom in diameter. Such sphericity is believed necessary to reduce torques in a free superconducting gyro bearing to below the value that would impair accuracy.

Although bearing-surface unevennesses not parallel to the axis of spin tend to even out, those parallel to the spin axis do not. This means great surface smoothness is necessary.

Keeping the gyro bearing suspended in high-g environments is another major problem. As the g's increase, the magnetic force field supporting the bearing must be strengthened. But as the field gets stronger, the temperature has to be dropped to prevent superconductivity from being destroyed. JPL is now researching requirements for a 0.5-in. diam bearing in a 4-g environment. The eventual goal is a bearing the size of an "orange or grapefruit," says Dr. Harding.

GE is leaning heavily on trial-and-error design, which is being complicated by the difficulties of working with niobium. At this time the company cannot predict the configuration of the engineering model that it is preparing for the Army. ■ ■



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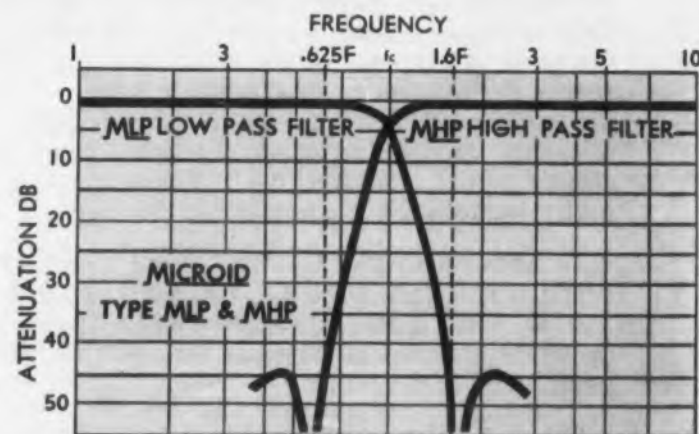
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CIRCLE 7 ON READER-SERVICE CARD

FIRST Navy Militarized SSB Transmitter Generates Cleaner Signal Using HERMES CRYSTAL FILTERS



Hermes Crystal Filter Model 2MUB, Carrier Frequency 2 Mc. Shown approx. 1/2 size.

Single-Sideband Transmitter, Model AN/WRT-2 developed by Westinghouse Electric Corporation for the U. S. Navy uses Hermes Crystal Filters, Model 2MUB and 2MLB.

Recently installed on the atomic submarine SKIPJACK (SSN585), the Westinghouse Electric AN/WRT-2 SSB Transmitter is now standard Navy equipment.

Single sideband signals are generated in the AN/WRT-2 by the selective filter method employing Hermes 2MUB and 2MLB Crystal Filters. These 2.0 Mc Crystal Filters not only offer all the basic advantages of the filter SSB generation method, but reduce the number of heterodyning stages required to translate the modulated signal to the required output frequency. The attendant decrease in unwanted signal generation results in a cleaner signal. The AN/WRT-2 is also a more reliable transmitter because fewer components are used.

In addition to the 2.0 Mc Crystal Filters, Hermes has also supplied SSB units at 87 Kc, 100 Kc, 137 Kc, 1.4 Mc, 1.75 Mc, 3.2 Mc, 6 Mc, 8 Mc, 10 Mc and 16 Mc. These Crystal Filters are presently installed in airborne HF, mobile VHF and point to point UHF SSB systems.

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CIRCLE 8 ON READER-SERVICE CARD

NEWS

Thin-Film Modulator Revealed At Winter PGMIL Convention

MODULATORS formed of a thin film of single-domain permalloy were described at the 1960 Winter Convention of the IRE Professional Group on Military Electronics.

R. L. Samuels and A. A. Reed of Iowa State University told the meeting in Los Angeles that experimental, completely balanced circuits incorporating thin-film modulators to modulate a 4-mc carrier provided carrier feedthrough of 2.5 mv peak for no modulation.

Among other developments described at the convention were:

- Design of transistorized telemetry equipment for the Mercury and Centaur satellite programs.

- The Signal Corps dual-channel infrared reconnaissance system.

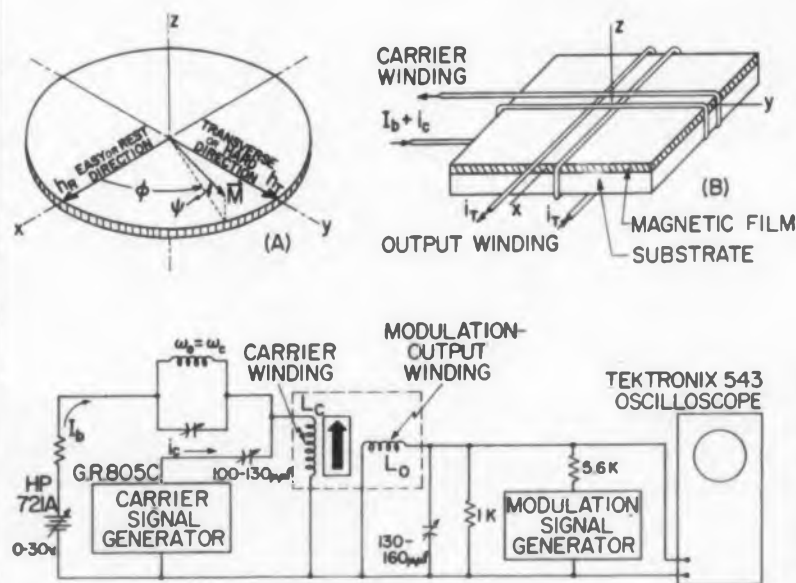
Thin-Film Modulators Handle Vlf to Uhf

The thin-film modulators described by the Iowa State researchers are built by winding two mutually perpendicular wires around the film, which is less than 1 micron thick. The carrier winding axis is parallel to the film magnetization rest direction; the output winding at right angles to it. A modulation winding can

be parallel to the output, or the output winding itself can be used for modulation, the researchers said.

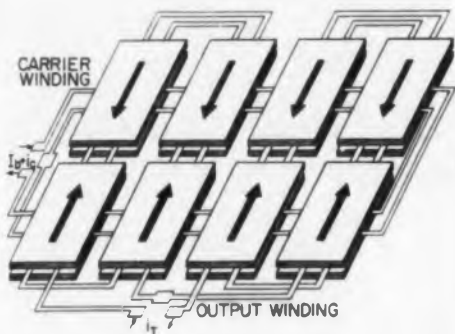
A modulation signal rotates the magnetization to provide coupling between the carrier and the output windings proportional to signal amplitude, giving suppressed-carrier amplitude modulation. Carrier frequencies from vlf through the lower uhf region are possible, as are dc through video modulation frequencies.

Mr. Reed gave the results of an experimental, completely passive balanced modulator circuit designed at the university. Sinusoidal frequencies from 20 cps to 20 kc and square-wave frequencies up to 100 kc were used to modulate a 4-mc carrier. Carrier feedthrough of 2.5-mv peak for no modulation was measured. Mr. Samuels and Mr. Reed did not have equipment to measure feedthrough with modulation, but they believe it could be kept very low. With the use of sandwich construction and potting techniques, a balanced modulator could be made almost completely immune to the effects of a wide range of mechanical and thermal environments, Mr. Reed reported. He added that the modulator would be very small as well. This work



Balanced thin-film modulator is made by winding two mutually perpendicular wires around a base coated with single-domain permalloy film less than 1 micron thick. Vectors in upper drawing show how fields are applied.

Developmental circuit with a thin-film modulator used sinusoidal frequencies from 20 cps to 20 kc and square-wave frequencies up to 100 kc to modulate a 4-mc carrier.



A thin-film inductor of sandwich construction could be constructed as shown. After potting, it would tolerate vibration and temperature over wide ranges.

was partially supported by the National Science Foundation.

Transistorized Telemetry

State-of-the-art achievements in transistorized telemetry design were described by J. H. Smith of Texas Instruments' apparatus division. Specifically discussed in his paper, "Recent Advances in Transistorized Telemetry," were a highly flexible and reliable eight-bit pcm system with low-level capabilities, high- and low-level solid-state multiplexers, transistorized transmitters, and subcarrier oscillators designed to the rigid needs of the Mercury, Centaur and Vega missile programs.

Mr. Smith described some of the design problems of getting higher bit rates for pcm telemetry, including the transistor types involved, and of obtaining increased power output from transmitters at high frequencies. He discussed, also, recent work on Varactor multipliers and offset and drift problems with low-level commutation.

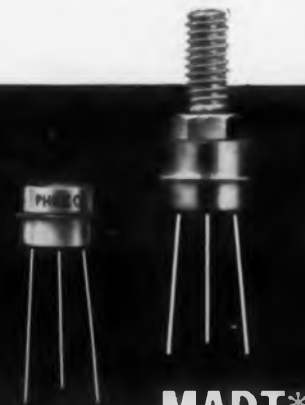
IR Recon System Has Two Channels

An unusual dual-channel ir reconnaissance system, AN/AAS-5, was described in a classified technical session by W. B. Birtley and D. D. Chaffee Jr. of HRB-Singer, Inc., State College, Pa. This airborne system, developed for the Signal Corps, uses two detectors simultaneously, with interchangeable detector preamplifier assemblies. Several sensors are also used. ■ ■

CIRCLE 9 ON READER-SERVICE CARD >

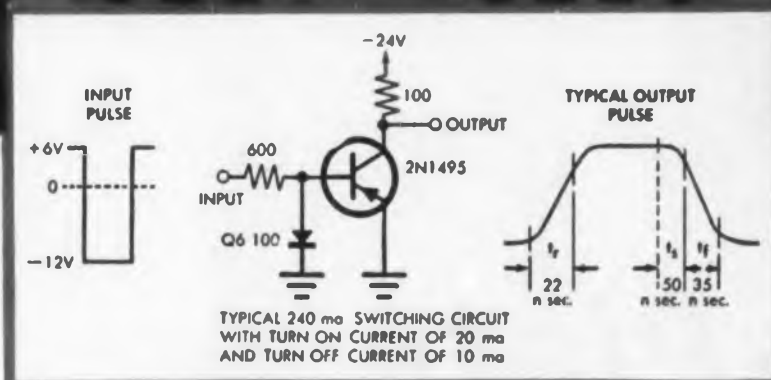
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These Diffused-base Transistors are capable of utilizing the full speed of new magnetic film memory planes



TYPICAL CHARACTERISTICS							
TYPE	CASE	P _T @25°amb. (Max)	V _{CE(SAT)} (Max)	V _{CE(SAT)}		h _{FE}	f _T
				I _C = -200ma I _B = -10ma	V _{CE} = -1v I _C = -200ma		
2N1495	TO-9	250mw	-30v	0.35v	0.60v	60	320mc
2N1496	TO-31	*0.5w	-30v	0.35v	0.60v	60	320mc
2N1204	TO-9	250mw	-20v	0.35v	0.60v	60	320mc
2N1494	TO-31	*0.5w	-20v	0.35v	0.60v	60	320mc

*At 25°C case temp.

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CIRCLE 10 ON READER-SERVICE CARD

NEWS

Tunnel Diode's Future Use Stirs Speculation at Solid-State Parley

The tunnel diode has the experts temporarily stumped.

Semiconductor specialists at the 1960 Solid-State Conference in Philadelphia, besieged for details on circuit-design limitations and applications of the new solid-state device, had a stock reply: "We don't really know." A panel at one session compared the uncertainty today over the future use of the diode to that accompanying the introduction of the transistor in 1949.

Research physicists, one panelist noted, are still studying how to build and reproduce the tunnel diode, and application engineers are only scratching the surface of possible circuit configurations.

Other observations made at the conference included:

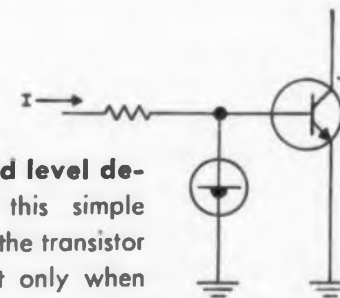
Transistor and tube users, familiar with devices having separate input and output takeoffs, are trying to uncover new techniques needed for a bilateral, two-terminal device. They are not alone in their effort. Computer designers are applying three-phase supply principles to overcome this difficulty, and others are experimenting with hybrid-T connections.

At present communication engineers are convinced that the tunnel diode is the answer to high-speed computers, and computer designers are equally certain that the device is a natural for high-gain, low-noise amplifiers. Granted sufficient time for laboratory and developmental work, both groups may be right.

A full report on the conference, attended by more than 3,100 engineers, will appear in the March 16, 1960 issue of *ELECTRONIC DESIGN*.

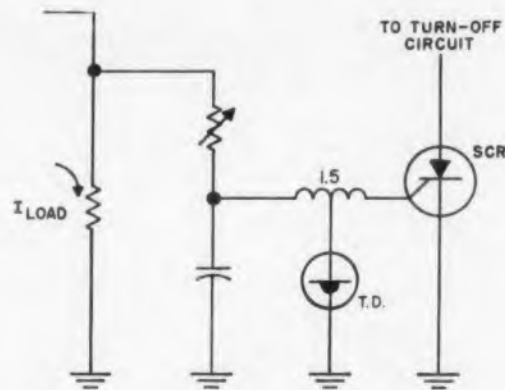
Basic Tunnel-Diode Circuits Designed for Immediate Use

Four basic tunnel-diode circuits for detecting, switching, clipping and delay have been designed by applications engineers of General Electric. The company released the circuits concurrently with

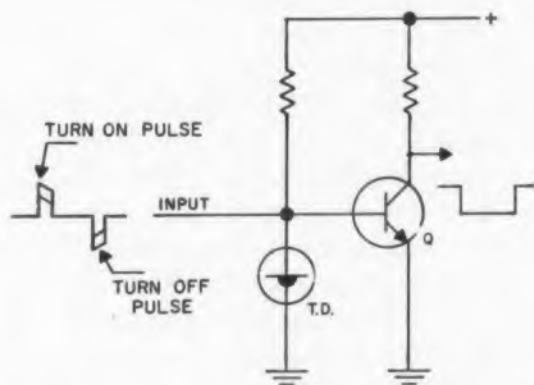


Clipper and level detector. In this simple application the transistor will conduct only when the input current exceeds the tunnel-diode peak current.

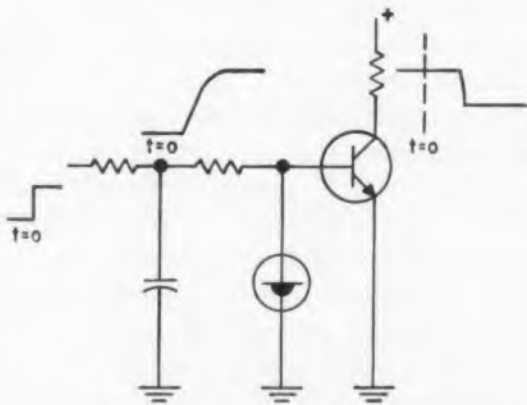
the announcement of reductions in the prices of its germanium tunnel diodes, which are in limited production. The diodes, previously sold to designers at \$60 and \$75 each, now cost \$10 and \$12.50 each.



Overcurrent detector. When load current exceeds a specified level, tunnel diode *TD* produces a pulse, which is stepped up by an auto-transformer to fire silicon-controlled rectifier *SCR*. This action is superior to that of similar circuits using Zener diodes, because the tunnel diode requires only 60 mv to fire, compared with 3 to 5 v for Zeners.



Bistable circuit. As tunnel diode *TD* is flipped by input pulses, transistor *Q* is turned on and off. The action is similar to that produced by pnpn structures but with improved control and stability of turn-on-and-off characteristics.



Time-delay circuit. Transistor one-shot multivibrators, differentiators and flip-flops used to obtain time delays in computers are replaced by this simple arrangement. Alternate stages with complementary transistors can be used to obtain multiple time lags.

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	Min.	Typ.
h_{FE}	20	95
f_{max}	40	60

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NEWS

Electronics Keys AIEE Conference

Microcircuitry byplay, design needs and suggestions for inductors, broadcast equipment and data systems among high points of Winter Meeting.

LIVELY REPARTEE among top specialists in molecular circuitry was a high point of an electronics-oriented Winter General Meeting of the AIEE in New York. Of nearly 500 technical papers, some 240 dealt with electronics, in contrast with the concentration on power generation, rotating machinery, and allied topics at previous national AIEE meetings.

Among reports of specific interest to electronics delegates, in addition to the microcircuitry discussion, were ones on:

- Design of miniaturized inductors, using counter-biased permanent magnets rather than air gaps.
- Adaptability of principles of the human nervous system to equipment design.
- The need for newly designed TV equipment for a nationwide educational system.
- The use of data logging and automatic-control equipment for broadcasting stations.
- Development of a new silicon pnpn diode switch with 10-m μ sec turn-on and off times.
- The use of digital differential analyzers as opposed to GP computers in control applications.

Microcircuit Production Problems Cited

The microcircuitry discussion indicated that engineers now face the practical problems of getting such devices into production.

Several companies have already developed devices using microcircuit techniques (*ED*, Dec. 23, 1959, p 3). But production is generally limited to the laboratory.

An exception was reported by Dr. Richard Lee, department manager for

solid circuits of Texas Instruments, Inc., who said TI was prepared to quote on 500 units a day now in production.

Major production problems, panelists agreed, are in the areas of materials and process control. The consensus was that the role of the electronics circuit designer was becoming less important, with the physicist and chemist assuming more importance. Reproducibility is a problem that some felt would not be solved for several years.

During the discussion after the papers, Harry Owens of Texas Instruments chided some of the people working in microcircuitry for shrouding their activities. He implied that the concept of a block that could not be characterized as a circuit composed of resistors and capacitors was ridiculous.

In discussing reliability, some panelists, noting that transistors were expected virtually to "last forever," suggested that new orders of reliability would be achieved by solid circuitry. Others disagreed, citing the problems of unknown surface factors, interconnections between surfaces, and the complexity of solid circuits in contrast with a single component such as a transistor.

Because of the need for understanding surface phenomena, research is being directed to this area, it was observed. Mr. Owens said progress was also needed in the related area of interconnection between surfaces. Better understanding of surface phenomena should contribute to the solution of this secondary problem, he added.

I. A. Lesk of General Electric argued that interconnections could be made very reliable. In response to a question by Nick DeWolf of Transitron, however, he implied that because of the number of com-

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The LN-3000 digital process control computer was described at an AIEE session. The unit was developed jointly by Leeds & Northrup Co. and Philco Corp. The computer controls all sections of the system, except for alarm detection circuitry, so that the input scanner selection sequence can be changed in response to process variables.

ponents in a solid circuit, reliability would be a long time coming. Mr. Owens disagreed, saying that if the number of components were kept below ten, the circuits could be made very reliable.

H. W. Henkels of Westinghouse countered both these views with an example of a silicon transistor whose yield rate did not change despite great increases in complexity during production.

Speakers then turned to the testing problem, suggesting that testing would probably be performed during process with new test procedures.

Because of the specific application of the finished "lumps"—as these solid circuits are sometimes called—they will probably need fewer final tests than a conventional component. A transistor, for example, might require tests of 16 parameters.

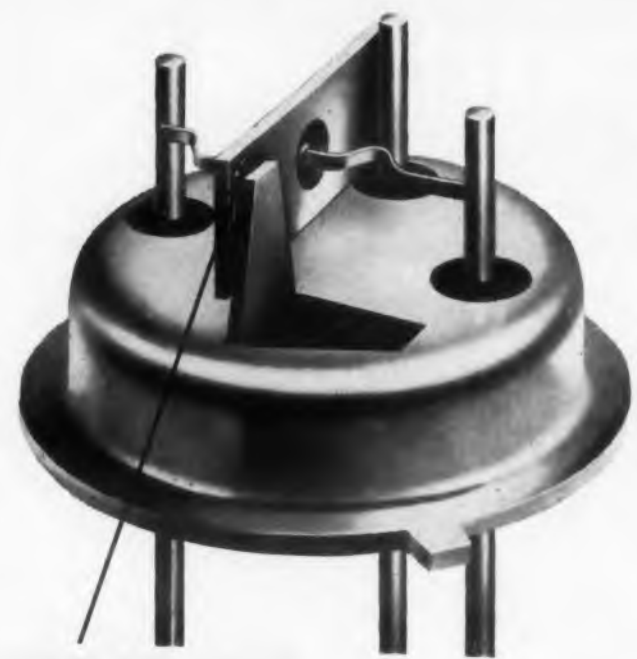
Magnet-Gapped Inductors Described

Miniaturized inductors using counter-biased barium ferrite permanent magnets rather than air gaps can now be designed instead of developed by hit-or-miss methods, according to J. T. Ludwig of Minneapolis-Honeywell's aeronautical division. His paper gave mathematical procedures for constructing design charts directly from the characteristics of the magnetic material.

Digital data blocks, each filling one of six main data-handling functions, were recommended as

5 GUARANTEES

for Tung-Sol 2N1313 Computer Transistor mean new freedom for designers



THERMAL BOND

And there's still another. For a nominal additional charge any specific electrical design characteristic will be 100% guaranteed not to exceed its distribution limits. These guarantees add up to a marked upgrade in circuit design accuracy . . . high reliability in operation . . . and consistent repeat performance. In specifying the Tung-Sol 2N1313 high speed switching transistor, you're selecting a transistor which features an ideal balance of the most wanted characteristics as revealed by a survey of computer designers. You're also choosing a transistor which offers improved performance at lower cost over most

- ▶ GUARANTEED DESIGN CENTER VALUES OF ALL MAJOR PARAMETERS
- ▶ GUARANTEED MIN-MAX LIMITS FOR ALL MAJOR PARAMETERS
- ▶ GUARANTEED DISTRIBUTION OF ELECTRICAL DESIGN CHARACTERISTICS
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- ▶ GUARANTEED UNIFORMITY OF EVERY LOT

of today's popular computer types.

The 2N1313 is designed to meet vigorous military environmental standards. It features "Thermal Bond" construction, exclusive with Tung-Sol. The transistor junction tab is securely joined to the base of the transistor. The bonding material provides high heat dissipation while maintaining complete base-to-case electrical isolation.

Tung-Sol Electric Inc., Newark 4, N. J. SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Philadelphia, Pa.; Seattle, Wash.; Toronto, Canada.

Absolute Maximum Ratings (@ 25°C)

BV_{CB0}.....-30 Volts
 BV_{EB0}.....-20 Volts
 BV_{CEX} (V_{BE} = 0.1V).....-20 Volts
 BV_{CEO}.....-15 Volts
 I_C (continuous).....400mA
 I_B (continuous).....50mA
 T_j.....-65°C to +100°C
 P_C.....180mW

Typical Characteristics (@ 25°C)

Parameter	Conditions	Min.	Design Center	Max.	Units
I _{CB0}	V _{CB} = -0.5V	—	1.5	2.5	μA
I _{CB0}	V _{CB} = -15V	—	2	3.5	μA
h _{FE}	I _B = 1mA, V _{CE} = -0.25V	40	70	125	
h _{FE}	V _{CE} = -0.35V, I _C = 400mA	20	30	50	
f _{αb}	V _{cb} = -6V, I _c = 1mA	6	12	—	Mc
C _{0B}	V _{CB} = -6V, I _E = 1mA, f = 1Mc	9	14	20	μμf
(t _r + t _d) (rise plus delay time)	I _{B1} (turn on current to base) = 1mA I _{B2} (turn off current) = 1mA I _C = 10mA R _L = 1K	—	0.45	0.70	μsec
t _s (storage)		—	0.30	0.60	μsec
t _f (fall)		—	0.25	0.40	μsec

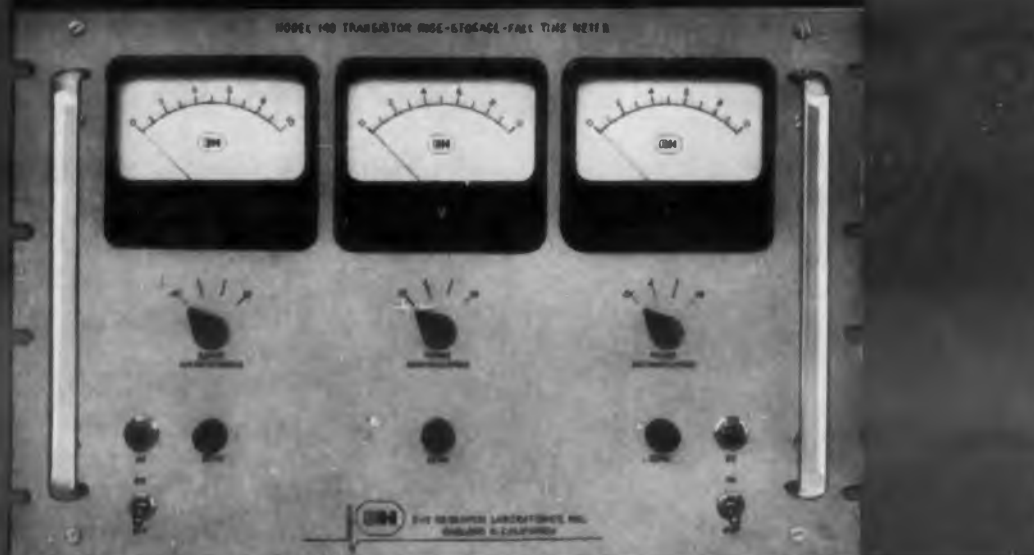


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New from E-H!



E-H Model 140 F.O.D. Oscilloscope, Pulse, Tester



DIRECT READOUT FEATURE eliminates need for using expensive oscilloscopes and fast pulsers. All three time parameters are displayed on panel and given as voltages, require no difficult interpretation. Even operators with little technical ability find it easy to read measurements. Another advantage: Responses are very fast, require less than 100 milliseconds readout time for high speed punched card recording.

A new transistor RISE, STORAGE AND FALL TIME METER for fast, millimicrosecond-accurate measurements you read directly

Here is a great new advance in metering—an instrument which makes possible quick, simple measurements to millimicrosecond accuracy. Three independent channels of time measurement are provided. Each has individual adjustable voltage discriminators, permitting measurements of any three times of interest over the delay, rise storage or fall of the switching transient characteristic. E-H Model 140 is designed primarily for fast measurement of rise, storage and fall time parameters of transistors in saturated mode operation. It is also useful for transient response measurement of diodes, cables, pulse transformers, delay lines, amplifiers and similar high speed devices. Like all E-H instruments, the 140 is conservatively designed for trouble-free performance. Top quality components are used throughout.

For more information on the 140, write or wire E-H today.

SPECIFICATIONS:

TIME DIFFERENCE CHANNELS (Three)
RANGES: 10 millimicroseconds full scale to 10 microseconds full scale—four ranges
READOUT: 1 volt full scale at BNC connector and panel meter for each channel
READOUT TIME: Less than 100 milliseconds
ACCURACY: $\pm 7\%$ ± 5 millimicroseconds
POWER SUPPLY (for transistor collector)
VOLTAGE: 3 to 20 volts, continuously variable
CURRENT: up to 1 ampere available
MERCURY PULSER (Base drive)
RISE AND FALL TIME: less than 2 millimicroseconds
REPETITION RATE: 60 cps
AMPLITUDE: 3 to 20 volts, continuously variable
PREAMPLIFIERS
 Separate preamplifiers are available for testing either PNP transistors, NPN transistors, or Diodes; the preamplifiers may be remotely located at the test fixture
 Model 141-PNP (for PNP transistors)
 Model 141-NPN (for NPN transistors)
 Model 141-DI (for Diodes)
 The Model 140 comes equipped with any one preamplifier—additional preamplifiers are priced at \$600.00 each

NEWS

the proper direction for digital equipment design by Helmut Schwab, Consolidated Electrodynamics Corp. The six submodule types in Mr. Schwab's "combi-system" are: position selection, value comparison, data-flow switching, memory, systems control and character translation. Combinations of these units can be used to form the data-handling system required for a specific application.

A panel on the adaptability of principles of the human nervous system to equipment design pointed out that sensory data were handled in parallel rather than serially. The brain computes the most probable values for the sensory data and cross-compares these with the actual received values. This cross-comparison at various levels achieves a high degree of reliability and permits rejection of inaccurate sensory data.

Educational TV Needs Noted

Newly designed TV equipment, providing maximum possible transmission power and minimum receiver noise, will probably be necessary for a nation-wide airborne educational system, according to Martin T. Decker of the National Bureau of Standards. Current uhf TV equipment will probably not be adequate for these requirements, he said. The National Bureau of Standards is studying the problem under the sponsorship of the Ford Foundation Fund for the Advancement of Education. Mr. Decker reported that further theoretical work would be carried out to estimate the number of aircraft and portion of the frequency spectrum required for efficient coverage of the United States.

Automatic data-logging systems are now being used by broadcasting stations to monitor transmitting equipment, and the National Association of Broadcasters is attempting to have logging charts accepted as the official log of a station, according to Gustave Ehrenberg of Minneapolis-Honeywell. He said that current measuring and telemetering systems were being built with provision for later addition of automatic control systems at the transmitting site.

New Pnpn Diode Developed

A triple-diffused silicon pnpn diode with turn-on and off times of about 10 μ sec was reported by A. N. Baker, J. M. Goldey, and I. M. Mackintosh of Bell Telephone Laboratories. The diode, which is said to be capable of switching several watts of power, is triple-diffused, starting with an n-type layer. The wafer is etched to form a mesa-like construction, producing a unit with a capacity of about 5 μ f.

High speed is attributed to the thin layers and



E-H RESEARCH LABORATORIES, INC.

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CIRCLE 15 ON READER-SERVICE CARD

reduction in the lifetime of the charge carriers. The latter is accomplished either by irradiation with high-energy electrons or by diffusing in small amounts of gold.

At a session devoted to a comparison of digital differential analyzers, DDA, and general purpose computers, GPC, in control applications, the "feud" between engineers in the two groups turned out to be no feud at all.

The consensus at the session was strongly—"each has its place." Despite attempts by the session chairman to evoke definitive support for one or the other type of computer, each speaker held closely to the idea that in some situations the GPC is best, and in others the DDA, or incremental computer as it is called, is preferable.

In general, where large, rather unpredictable changes take place in a process, a general purpose machine is called for, while processes involving slower, continuous changes are well suited to control by the DDA. It appears, speakers commented, that in actual applications general purpose machines are taking the lead.

Slow slewing is probably the chief limitation of the incremental computer, speakers said. Slewing time is the time required for the computer to provide an initial solution to a new problem.

The DDA starts with an initial set of values for process variables, and then works toward a solution using incremental changes. If the complete process set-up changes radically, the DDA might require 300 sec to reach a new solution. The general purpose computer, on the other hand, starts each new problem afresh with a new set of values so that large changes are as easy to handle as small ones.

With slow changing problems the DDA shows an advantage because it might produce 200 solutions per sec while the conventional computer gives only 10 to 20 solutions per sec. This is a distinct advantage in real-time problems, speakers pointed out.

Some of the other factors in favor of the GPC include: ease of reprogramming; ability to do general information processing; and relatively predictable behavior in dynamic situations.

Other factors favoring the DDA include: use of fewer components—for some uses it may be one-fourth the size and weight of a GPC with consequent cost savings; better reliability with respect to failures because of fewer parts; and accuracy equal to conventional machines.

According to a paper by S. M. Shackell, deceased, and J. G. Tryon, University of Alaska, the DDA makes more efficient use of circuitry, which allows the use of fewer parts but makes troubleshooting more difficult. It is also difficult to design the DDA because it is not easy to predict its behavior in highly dynamic situations, Mr. Tryon commented. ■ ■



FORD VIBRATION INSTRUMENTATION: The Ford Motor Company entered the experimental gas turbine engine field in 1952. The Ford Turbo Machines Department is now engaged in research and development of a turbine engine and a working model has been tested in a tilt-cab truck. An obsolete engine, the Ford 702, has developed 160 horsepower at shaft speeds up to 36,000 rpm. ■ A new supercharged 300 horsepower turbine engine was recently announced by Ford Engineers. Known as the "704," the engine weighs 650 pounds installed, compared to 2,700 pounds for a truck diesel engine of comparable horse-

ENDEVCO TRANSDUCERS SOLVE VIBRATION ANALYSIS PROBLEM

power. The engine has two stages of compression, each operating at a 4:1 pressure ratio. Two burners are used for driving the dual compressors, the low speed wheel turning at 46,500 rpm and the high speed wheel at 91,500 rpm.

THE PROBLEM: The Ford Test program requires a wide variety of instruments to measure, control and record performance data of component parts. Measurement of vibration, for example, is a critical factor in this program. Vibrations that may cause metal fatigue, oil film breakdown, overheating, etc., are discovered during tests on individual engine "stands."

THE SOLUTION: Ford engineers use a total of six Endeveco Series 2200 Accelerometers providing frequency responses up to 6,500 cycles per second. The accelerometers are connected to bearing test rigs, for example (see photo). The accelerometers relay measurements of acceleration movements in turbine shafts from three coordinates (radial vertical, radial horizontal and axial). Temperatures of the metal housings to which the standard Endeveco transducers are attached average up to +150°F. Temperatures at which the water-cooled, heat-resistant models are used range up to +1000°F or more. The large self-generated output of the Endeveco accelerometers eliminates the need for additional stabilization of a power supply.

THE RESULTS: The Endeveco transducers are attached with a single-pole threaded bolt. The signal is fed through an Endeveco amplifier to an oscilloscope or panoramic analyzer. The analyzer concentrates on a small section of the total signal and may present from 4 to 10 harmonic vibrations of different frequencies being fed from the unit at one time. This analyzer separates the frequency bands into individual bands, which it then sweeps from 20 to 40,000 cycles every second, measuring the frequency and amplitude in millivolts. ■ Ford Technicians convert these vibration records by mathematically integrating acceleration with respect to time to obtain the displacement or housing vibration. Thus, they locate the sources of objectionable resonance and take steps to eliminate or reduce vibration in the overall design. ■ Endeveco accelerometers have also served as pickups for determining spring rate and damping characteristics of rubber bonded bearings. • **ENDEVCO CORPORATION** • 161 EAST CALIFORNIA BOULEVARD PASADENA, CALIFORNIA • PHONE SYCAMORE 5-0271



Close-up shows two Endeveco Accelerometers on bearing test rig in Ford Instrumentation Section, Dearborn, Michigan. Cable passes to Endeveco Amplifier (not shown on right).

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Electronic Products **NEWS**

by **CARBORUNDUM**
Registered Trade Mark



GLOBAR® Silicon Carbide Varistors create unique percussive effects in electronic organ

In the well known Thomas electronic organ, GLOBAR silicon carbide varistors perform a function as balanced modulators to produce instrumental percussive effects.

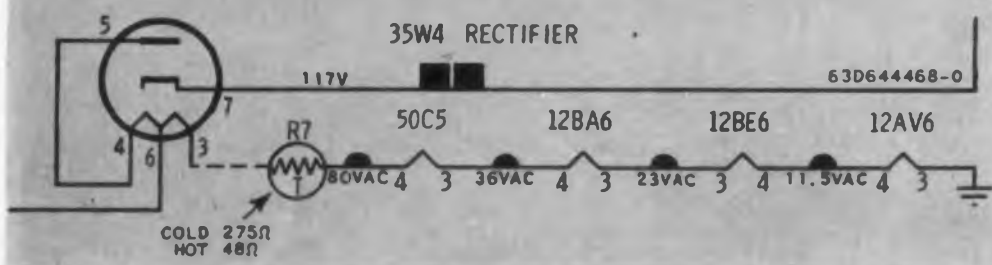
Clearly seen in the photo above, GLOBAR varistors are non-linear, voltage-sensitive resistors with the advantages of extreme ruggedness, small size and excellent performance characteristics. They are widely

employed for reducing arcing at relay contacts, suppression of RF interference, limiting voltage surges, back-voltage protection for diodes and transistors, and stabilization of rectifier circuits.

For types, ratings and other catalog data, write Globar Plant, Refractories Div., Dept. EDV-30, The Carborundum Co., Niagara Falls, New York.

CIRCLE 804 ON READER-SERVICE CARD

Motorola protects radio tube filaments with GLOBAR® Thermistors



Motorola, Inc., protects the tube filaments of its table and clock radios, except for the low cost leader models, in a simple, inexpensive way. A GLOBAR silicon carbide thermistor is used in series with the tube filament string. Its negative temperature coefficient is utilized to limit the initial voltage surge during warm-up. Motorola expects tube life

to be prolonged up to ten times.

GLOBAR thermistors find many other applications where surge protection, time-delay operation, or temperature sensing and control are required. There is a wide range of sizes and ratings. Write: Globar Plant, Refractories Div., Dept. EDT-30, The Carborundum Co., Niagara Falls, N. Y.

CIRCLE 806 ON READER-SERVICE CARD

Vacuum-Tight High Voltage Connector poses ceramic-to-metal sealing problem



The connector shown above is designed to meet severe space limitations which necessitate maximum voltage protection with a minimum of ceramic insulation.

The 1552 alumina insulator has a metallized coating for corona protection. The housing is heavy stainless steel.

Making the insulator to the required close dimensional tolerances, accurately centering the electrode in the housing, and then providing a vacuum-tight seal, were some of the problems Carborundum had to solve. To add to the difficulties, the center electrode had to be a special high conductivity material to provide sufficient current capacity.

Ingenious methods had to be worked out to seal this high expansion material to the ceramic. The complete assembly is hydrostatically tested for vacuum tightness, and withstands an electrical test of 30,000 volts. For help on your sealing problems, write Latrobe Plant, Refractories Div., Dept. EDS-30, Carborundum Co., Latrobe, Pa.

CIRCLE 805 ON READER-SERVICE CARD

LATEST INFORMATION ON KOVAR® ALLOY



Kovar is the standard matched-expansion alloy for critical glass-to-metal sealing problems. A comprehensive bulletin gives technical data and information on available forms, shapes and sizes. Write Latrobe Plant, Refractories Div., Dept. EDK-30, Carborundum Co., Latrobe, Pa.

CIRCLE 807 ON READER-SERVICE CARD

NEWS BRIEFS . . .

. . . **ELECTRIC POWER CONSUMPTION** in the nation will rise to 1.5 trillion kw-hr by 1970, Don G. Mitchell, President of General Telephone and Electronics Corp., has predicted. In 1959, about 700 billion kw-hr were consumed.

. . . **THE TITAN ICBM** has successfully completed its first guided test flight. It was the first time that the second-stage engine had been fired.

. . . **AN EXCHANGE AGREEMENT** between the Raytheon Co., Waltham, Mass. and the Compagnie Générale de TSF, Paris, France, has been signed. The companies will exchange information about microwave tubes.

. . . **THREE-DIMENSIONAL TELEVISION** has been developed by E.M.I. Electronics, Ltd., Middlesex, England, for use in plants where dangerous materials must be manipulated remotely. Images from two cameras are superimposed on polarized glass to form a single image. The viewer must use polarized spectacles.

. . . **RADAR SIGNALS** have been bounced off the sun's corona by Stanford University scientists. The signals were received 16 and a half minutes after their transmission. Stanford Provost Fredrick E. Terman said this was "by far the greatest distance man has ever sent anything and been able to get part of it back."

. . . **A NEW INERTIAL GUIDANCE SYSTEM** has been developed for long-range missiles, satellites and space vehicles by the Avionics Division of Bell Aircraft Corp., Buffalo, N. Y. Bell engineers describe the classified system, developed by Dr. Helmut Schlitt, as "the most successful and reliable of any new instrumentation concepts so far tested."

. . . **A DIGITAL VELOCITY METER** utilizing a miniature accelerometer of extremely stable mechanical configuration has been developed by engineers of the Bell Aircraft Corp., Buffalo, N. Y. The device is designed to operate over a wide range of accelerations, temperatures and vibratory forces.

. . . **WESCON** (Western Electronic Show and Convention) has mailed exhibit-space applications for the 1960 show to more than 4000 electronics companies. A priority system, based on a company's previous exhibits in WESCON and promptness in replying to the mailing, will be used in allocating space.

ELECTRONIC DESIGN • March 2, 1960



For ceramic parts and metallized assemblies, Kovar alloy, ceramic resistors, varistors and thermistors . . . count on **CARBORUNDUM**®

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... A SATELLITE WITH BRITISH EQUIPMENT may be put into orbit by a United States 4-stage Scout rocket by the end of 1961, Prof. H. S. W. Massey, Chairman of the British National Committee in Space Research, reports. He said other satellites may be orbited at yearly intervals. They will be designed to last at least six months at altitudes between 200 and 600 mi.

... MISSILE-GUIDANCE AND TRACKING RADAR manufactured by the Sperry Gyroscope Co., Great Neck, New York, will be installed in the Navy's first nuclear-powered cruiser, the USS Long Beach.

... TRANSLATING LANGUAGES BY MACHINE is an area in which the United States appears to be lagging the Soviet Union according to Dr. Kenneth E. Harper of the University of California at Los Angeles. He said the Russians had 450 machine-translating experts, compared with 120 in the United States.

CHANGES IN PRICES AND AVAILABILITY

... UNIVERSAL BRIDGE, Type B-221 has been reduced 10 per cent in price by Wayne Kerr Corp. The transformer ratio-arm bridge has been reduced from \$990 to \$880, fob Philadelphia.

... LOW-CURRENT SILICON RECTIFIERS have been reduced 28 to 61 per cent in price by General Electric Co. The new prices affect nine types of military silicon rectifiers.

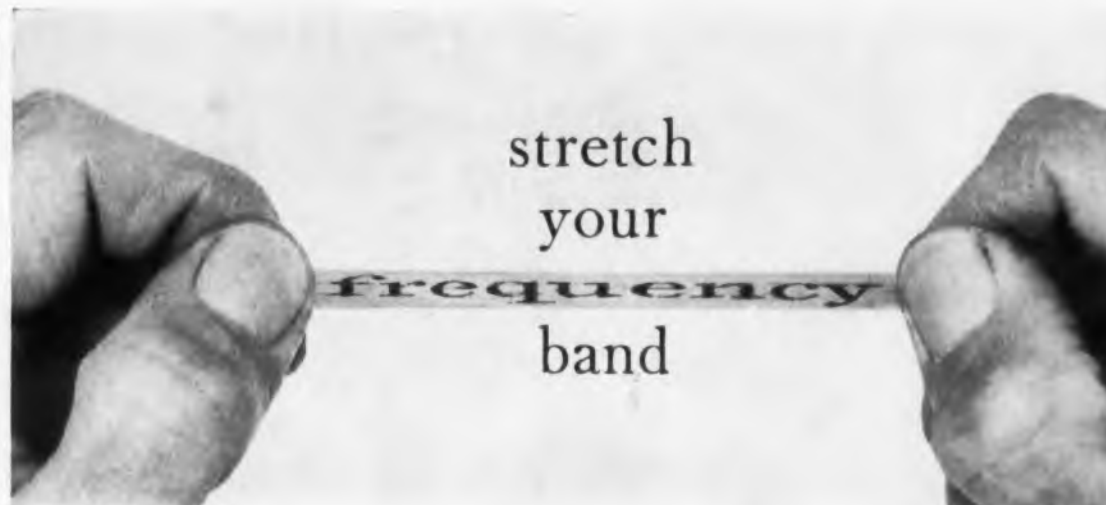
... TEFLON TUBING, including standard and thin-wall spaghetti tubing, flexible and millimeter tubing has been reduced in price by Pennsylvania Fluorocarbon Co.

... MICRO-MIN glass-encapsulated microwave diodes have been reduced in price from 10 to 30 per cent by Sylvania Electric Products, Inc.

... SINGLE-SUPPLIER silicon transistors have been reduced 25 per cent in price by Fairchild Semiconductor Corp. Types 2N696 and 2N697 npn units have been reduced from \$28.50 each in lots of less than 100, to \$22.70. The 2N1131 pnp, formerly \$37.50 is now \$28.80.

... SILASTIC LS fluorosilicone rubber has been reduced 25 per cent in price by Dow Corning Corp. The price has dropped from \$22 per lb to \$18 per lb.

Is your company making changes in prices or availability of its products? Send the details to ELECTRONIC DESIGN, 830 Third Ave., New York 22, N.Y.



with new Hughes "20-20" Circulators!

With 20% bandwidth and over 20 db isolation, the new Hughes "Y" and "T" Circulators are ideally suited for microwave reception and transmission applications. They also give you small size and weight...without sacrifice in performance. C- and X-Band models are available today!

For information on the new "20-20" Circulators, or other advanced microwave components, please write Microwave Products Department, Advanced Program Development, Hughes Aircraft Company, Culver City 7, California. Or, phone Upton 0-7111, Ext. 6919.

	Model C-201A	Model X-230A (Illustrated)
Frequency:	4.9-6.2 Kmc	8.0-9.8 Kmc
Isolation:	20 db	20 db
Insertion Loss:	0.3 db	0.3 db
Input VSWR	1.10	1.20
Power Capacity	10 Kw peak 100W avg (Min.)	3 Kw peak 50W avg (Min.)

ALSO AVAILABLE: Miniaturized S- and L- Band Coaxial Circulators. New, extremely small (1" x 2" x 8") circulators with bandwidths to 10%, over 20 db isolation, and 0.5 db insertion loss are now available.

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MICROWAVE PRODUCTS



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LITTLE INSTRUMENTS BY DeJUR PERFORM BIG PRECISION FUNCTIONS

Potentiometers

Small but Accurate—unique design and production techniques assure exceptional functional accuracy.



SERIES C-050

1/2". Sealed, sub-miniature type with one-piece metal case and bearing. Completely enclosed. Solid terminals, integrally cored with molded covers. Rotation: 320° electrical, 325° mechanical, 360° continuous.



SERIES C-078

7/8". Weight only 1/2 ounce. Independent linearity: $\pm 1\%$ of total resistance is standard. Linear or non-linear windings on flat card. Fully enclosed. Tolerance: $\pm 5\%$ standard, $\pm 1\%$ on order.



SERIES C-178

1 7/8". Sine-cosine units with peak-to-peak accuracies to 0.25%. Independent brush contacts on common shaft, 90° apart. Ganged types available. Also 2" and 3" diameters.

Panel Instruments

Ruggedized . . . round or square—miniature high precision units meet reduced size and weight requirements of aircraft and electronic applications



SERIES 100

1". Accuracy $\pm 3\%$ at full scale. Non-magnetic calibration. Scale length, 0.738". Background markings black or white, lance pointer, sealed solder lug terminals, aluminum housing. Watertight to meet MIL-M-3823 specs.



SERIES SC-031

1/2". Rugged, micro-miniature sealed unit. Includes external pivot D'Arsonval movement and high flux density Alnico magnet. Optional mounting, face plate and hex nut.



SERIES 131

1 1/2". Ruggedized to withstand shock, vibration or thermal extremes. Meets MIL-M-10304 specs. Positive watertight seal of meter and terminal studs.

Write for detailed literature on complete lines.

You're
always
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WASHINGTON REPORT



Ephraim Kahn

. . . R&D PRIORITIES have been juggled by the Air Force. As a result, some projects formerly in Importance Category 1 have slipped back to Categories 2, 3, or 4. The new first priority class calls for R&D spending "as necessary" to insure that "an operational or technical capability" will be attained by a specified date. Items in this class comprise vital operational systems (both present and planned) and their supporting projects. Second priority goes to systems considered an "essential element" of military strength, to operational support items needed to "eliminate major deficiencies," and to projects needed to avert a "critical degradation of a future operational capability." Budgetary limitations will govern the extent to which funds are applied to R&D in this category. Less urgent items are relegated to Categories 3 and 4, where stringent funds limits will apply.

. . . PARTIAL FINANCING of defense contracts by private firms has been scored by the General Accounting Office. Commenting on three Air Force contracts, it notes that the policy of forcing contractors to finance 20% of costs incurred before delivery had sharply increased the government's final cost of production. Reason is that the private firm had to pay about 5% for money when the government was getting funds for 3%. Both the contractor and the Accounting Office agreed that this financing requirement—intended to furnish an incentive to reduce costs—probably was not effective.

. . . COMPULSORY QUESTIONNAIRE on R&D spending has been proposed by the Census Bureau. The National Science Foundation is sending a 3-page questionnaire to about 8,000 firms. Firms that do not answer this inquiry would be sent a brief, two question, query by Census. It would be compulsory to answer and return it. Questions to be asked are (1) cost of R&D in the physical and life sciences during 1959, and (2) the portion financed by the government.

. . . SUBCONTRACTOR PRICES are being checked carefully by the Defense Department. The General Accounting Office has complained

ELECTRONIC DESIGN • March 2, 1960

to Congress that some "unreasonably high prices" have been accepted by prime contractors when offered by suppliers. It cited profits ranging from 24% to 41% made by some subcontractors and attributed them to price acceptance by the prime contractor "without requiring the suppliers to furnish information on costs incurred in producing similar items under earlier purchase orders or explanation for any increases in estimated costs over prior cost experience." Laxity in price negotiation, according to the agency, is "attributable in part at least to the fact that in most cases the prices negotiated with the suppliers are passed on to the government and consequently the contractor has little financial self-interest in close subcontract pricing."

... **MASS PRODUCTION** of tiny, precise, and reliable electronic parts for the Nike-Zeus anti-missile system is feasible, according to the Army's Chief of Research and Development, Lt. Gen. Arthur G. Trudeau. Pilot lines to make items now hand-made were set up in two companies (and probably paid for with funds allocated to industrial readiness). Gen. Trudeau says that "these operations indicate that the miniature devices can be produced on a mass basis with a high degree of equipment reliability."

... **ELECTRONICS INDUSTRY** study is planned by the Commerce Department, provided Congress grants sufficient funds. Data to be compiled include the industry's basic structure, products made, end uses, value and volume, employment, capital invested and similar items. Also to be looked at are the kinds of raw materials and components required, their sources, the problems of sources, and the degree of dependence on imported raw materials. Also to be studied would be growth trends and characteristics, competitive effects of new things that substitute for existing products, industry capacity and its utilization, factors that influence new investment, and the effects of government policies and programs of industry. Expansion prospects, both short- and long-term and technological developments as they affect expansion would also be looked at, as would the impact on the industry of imports, exports, and U.S. investment overseas.

... **MISSILE INSTALLATIONS** account for about half of the military construction money asked for fiscal 1961. Installations for both long- and shorter-range missiles would be covered by the approximately \$650 million to be spent. Also included are substantial (but classified) sums to pay for electronic facilities that are a part of the Pacific Missile Range, DEW Line, Pine Tree Line, SAGE, expansion of Loran, and improvements to radar used in connection with Nike Hercules.

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EDITORIAL

These Are Times . . .

These are times that try engineers' thinking.

Success was once a "planned" affair (after an initial lucky break). An enterprising engineer might stumble on an idea that appeared good. He might scrape up a few dollars, get started, and if luck was with him, the idea caught on and he was in business.

Then, to ensure long-range success for his idea, he tried several well-known techniques: He improved his product; he cut costs; he expanded his sales effort; he trained his personnel; he watched the market and his competition . . . and so on.

Consider the present situation. Tube manufacturers have been improving tubes for years—and along comes the transistor. Transistor manufacturers have been improving transistors—and along comes the tunnel diode. Component designers have been improving capacitors, resistors, coils, and the like for years—and now the solid-circuit era seems to be at hand.

Whole technical areas are being "leapfrogged" like an army leapfrogging islands to its objective on the mainland.

There is every possibility that while we worry about making a component more reliable, the component may soon become unnecessary. Knowing this, we must continue to try to make the component more reliable until new devices are available.

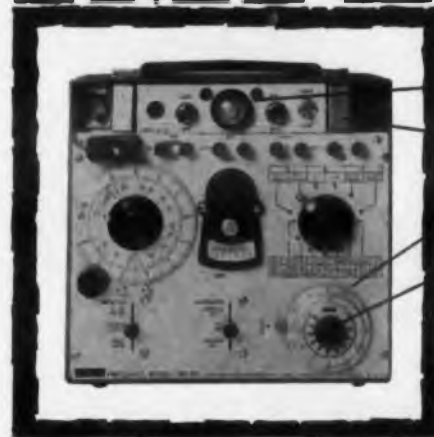
In many ways it is a frightening time to live in—but a stimulating one too. The engineer who is afraid to think imaginatively while keeping his feet on the ground is going to be left behind.

Today's technical world calls for bold, original thinking, for an intense awareness of what is being done in many technical disciplines, and for a deeper understanding of basic principles underlying the electronic art.

Truly these are times that try engineers' thinking.

Edward S. Graydon

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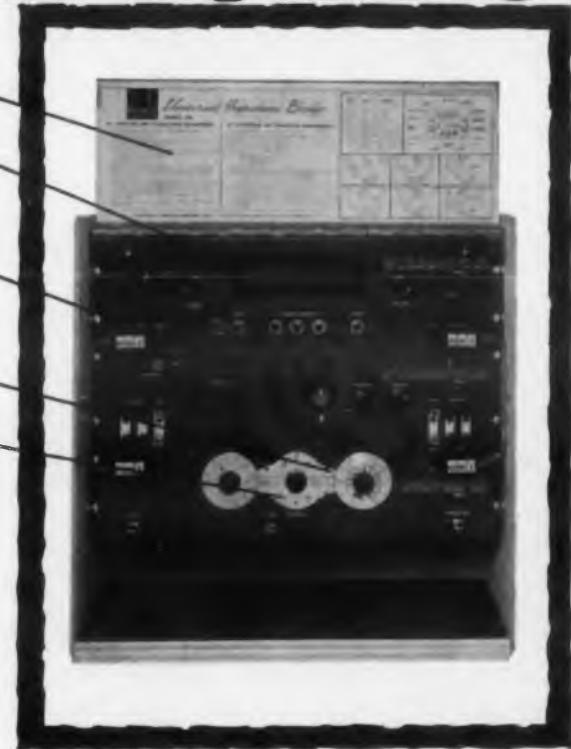
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CIRCLE 22 ON READER-SERVICE CARD

Alan Phillips feels that the load line approach to transistor amplifier design offers many advantages over conventional methods which assume that the actual current gain is equal to the short-circuit current gain. In this article he shows how easy it is to use the load line in amplifier analysis.



Load Lines Simplify Transistor Amplifier Analysis

Alan H. Phillips
Sperry Gyroscope Co.
Great Neck, N. Y.

WITHOUT RESORTING to conventional approximations, the load-line method of transistor-amplifier design provides a rapid way to find low-frequency gain and input impedance. When used with manufacturers' "typical" curves, the method provides accuracy adequate for most applications.

The advantages of the load-line method over others are:

- It helps the designer visualize what is going on in the circuit.
- It directly provides a current-gain term B (not to be confused with short-circuit current gain β) which simplifies the expressions for gain and input impedance. These expressions use no approximations.
- It locates the dc operating point of a transistor

amplifier more accurately than do the customary equations using a dc beta.

Input Impedance

Fig. 1 shows the basic circuit of a transistor amplifier. To find the input impedance R_{in} of the amplifier stage, it is necessary to find the current gain which can be designated B .

Assume that the load line is as shown in Fig. 2 and the quiescent operating point is point 1. If the input current swings $25 \mu\text{a}$ peak-to-peak, the operating point swings from 4 to 5. The output current changes 2.4 ma peak-to-peak. Hence:

$$b = 2400/25 = 96$$

The transistor input impedance r_{in} is the slope of the base-input characteristic curve of Fig. 3

at the operating point. Then,

$$i_c = B i_1$$

$$i_e = i_c + i_1 = (B + 1) i_1$$

$$i_1 = \frac{v_1 - i_1 r_{in} - i_e R_e}{R_b}$$

$$i_1 = \frac{v_1 - i_1 r_{in} + (B + 1) R_e}{R_b}$$

$$i_1 = \frac{v_1 - i_1 [r_{in} + (B + 1) R_e]}{R_b}$$

$$R_{in} = v_1 / i_1 = R_b + r_{in} + (B + 1) R_e$$

As far as the base circuit is concerned the emitter resistance R_e looks as if it has been multiplied by $(B + 1)$.

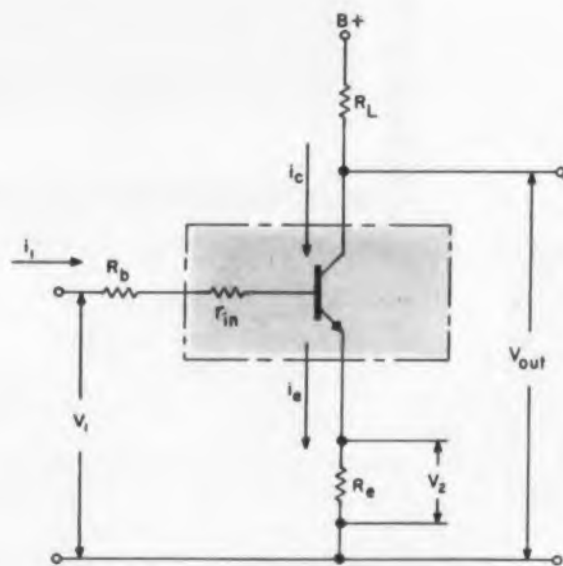


Fig. 1. A basic, single-stage transistor amplifier.

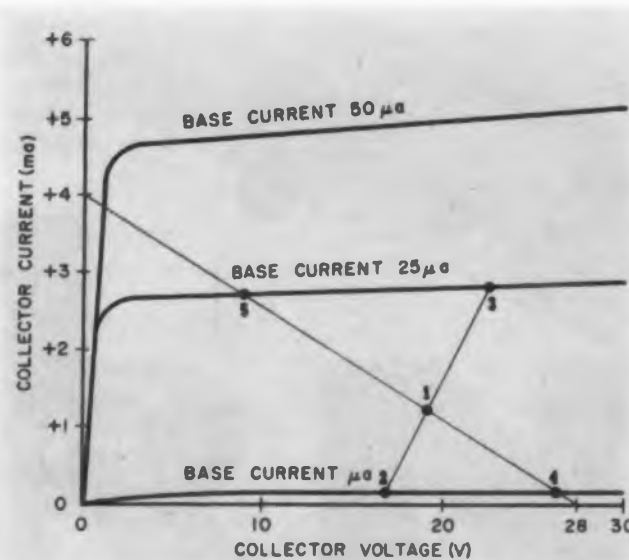


Fig. 2. Collector characteristics for a 2N167.

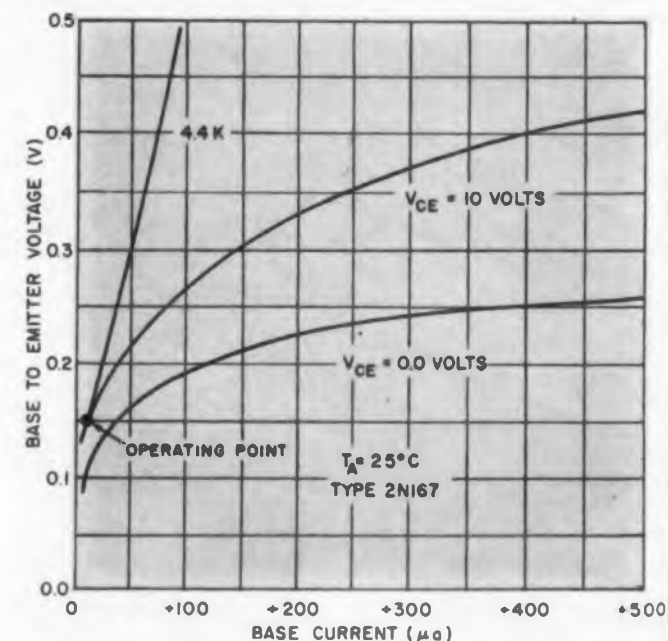


Fig. 3. Base-input characteristics for a 2N167.

Amplifier Gain

We know that

$$v_{out} = i_c R_L = B i_b R_L$$

But

$$i_b = \frac{v_1}{R_{in}}$$

Hence

$$v_{out} = \frac{B R_L v_1}{R_{in}}$$

$$\text{Gain} = \frac{v_{out}}{v_1} = \frac{B R_L}{R_b + r_{in} + (B + 1) R_e}$$

The Emitter Follower

The input-impedance expression for the emitter follower is the same as for a conventional amplifier.

$$R_{in} = R_b + r_{in} + (B + 1) (R_e)$$

The output voltage appears across R_e and is called v_2 in Fig. 1.

As before:

$$i_b = \frac{v_1}{R_b + r_{in} + (B + 1) R_e}$$

$$v_2 = \frac{(B + 1) R_e v_1}{R_b + r_{in} + (B + 1) R_e}$$

$$\text{Gain} = \frac{v_2}{v_1} = \frac{(B + 1) R_e}{R_b + r_{in} + (B + 1) R_e}$$

The output impedance is derived as follows:

It was shown previously that R_e appeared to be multiplied by $(B + 1)$ when transferred into the base circuit. In like manner R_b appears to be divided by $(B + 1)$ when transferred into the emitter. Hence:

$$r_{out} = \frac{R_b + r_{in}}{B + 1}$$

Since r_{out} is in parallel with R_e , the output impedance as seen by the next stage is

$$\frac{r_{out} (R_e)}{r_{out} + (R_e)}$$

Cascaded Amplifiers

In the case of cascaded amplifiers, R_i is the input impedance of the following stage in parallel with the collector load resistance. The gain of an n -stage amplifier is obtained by solving for the gain and input impedance of each stage in turn, starting from the last stage.

Effect of Increased I_{co}

At high temperatures I_{co} increases. The effect of increased I_{co} may be found by carrying out the

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Type	Max. W Diss. ^o	Max. V _{CEO}	Min. BV _{CEO}	h _{FE}		V _{AS}		Max. Thermal Res. °C/W
				(I _C =2A, V _{CE} =-2V) Min.	(I _C =2A, V _{CE} =-2V) Max.	(I _C =2A, V _{CE} =-2V) Min.	(I _C =2A, V _{CE} =-2V) Max.	
2N1433	35	-80	-50	20	50	—	3.3	2
2N1434	35	-80	-50	45	115	—	1.8	2
2N1435	35	-80	-50	30	75	1.0	2.5	2

All types have: Max. collector current, 3.5 amps; junction temperature, -65 to +95°C; max. saturation voltage, 0.6 volts (I_C=2A, I_B=200 mA). Minimum alpha cutoff frequency is 200 KC (I_C=100 mA, V_{CE}=-4 volts).
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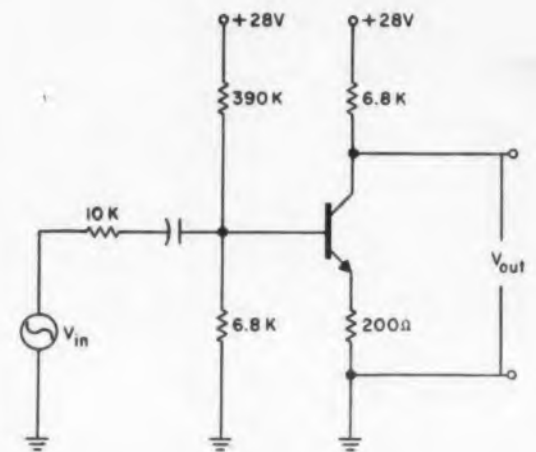


Fig. 4. A typical transistor-amplifier stage.

analysis using a new set of characteristic curves which are the same as the old ones except that the base current corresponding to a given curve is changed. For example, if I_{co} is increased by $30 \mu\text{a}$ with temperature, then in Fig. 2, the $50 \mu\text{a}$ curve now corresponds to $20 \mu\text{a}$ base current.

Variations

To clarify the effects of varying β , halve each of the base current numbers in Fig. 2 and repeat the analysis.

Sample Computation

To illustrate the load-line method, the circuit of Fig. 4 will be analyzed. The dc equivalent circuit reduces to Fig. 5 the Thévenin's theorem. The ac Thévenin equivalent circuit is given in Fig. 6. The line 2-3 in Fig. 2 represents the collector voltage for various assumed base currents. Its intersection with the load line at point I is the quiescent operating point. Its equation is

$$V_3 = V_{cc} - (V_1 - I_b R_b' - V_{be}) \left(1 + \frac{R_L}{R_c} \right) + I_b R_L$$

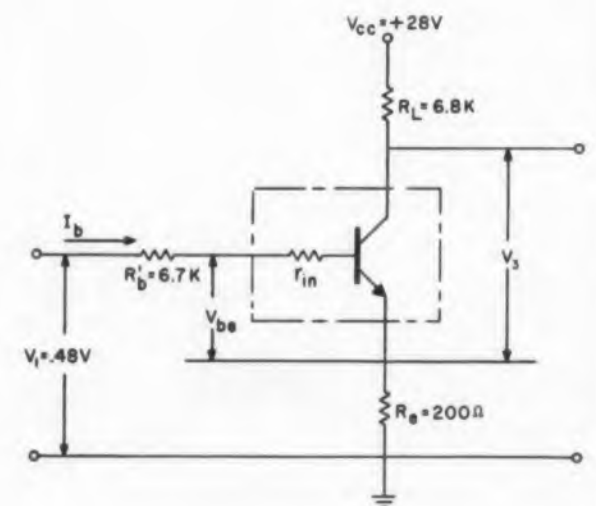


Fig. 5. Dc Thevenin equivalent for the circuit of Fig. 4.

Fig. 5 defines the symbols in this equation. V_{be} is the dc drop between base and emitter. Fig. 3 is actually a plot of V_{be} vs collector current for a type 2N167 transistor.

$$\text{Gain} = \frac{B R_L}{R_b + r_{in} + (B + 1) R_e}$$

From Fig. 6:

$$R_b = 4.0 \text{ K}$$

$$R_e = 200 \text{ ohms}$$

$$R_L = 6.8 \text{ K}$$

From Fig. 3:

$$r_{in} = \frac{d V_{be}}{d I_b} = 4.4 \text{ K}$$

As before:

$$B = 96$$

$$\text{Gain} = \frac{(96)(6.8)}{4.0 + 4.9 + 97(0.2)} = 23.5$$

Since $v_1 = 0.4 v_{in}$

$$\frac{v_{out}}{v_{in}} = 9.4$$

Load-Line Construction

The equation for load line with the entire load in the collector circuit is

$$E_c = E_{cc} - I_c R_L$$

where E_{cc} is the collector supply voltage.

When part of the load is in the emitter circuit this becomes:

$$E_c = E_{cc} - I_c(R_L + R_e) - I_b R_e$$

This can readily be plotted on the transistor characteristic curves. However, the change in load line is usually small. ■ ■

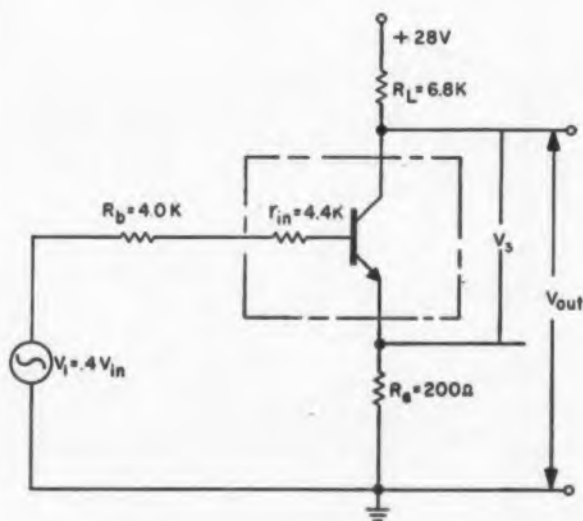


Fig. 6. Ac Thevenin equivalent for the circuit of Fig. 4.

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CIRCLE 26 ON READER-SERVICE CARD

How To Design Symmetrical

"T" "Pi" Attenuators Rapidly

Glyn Bostick

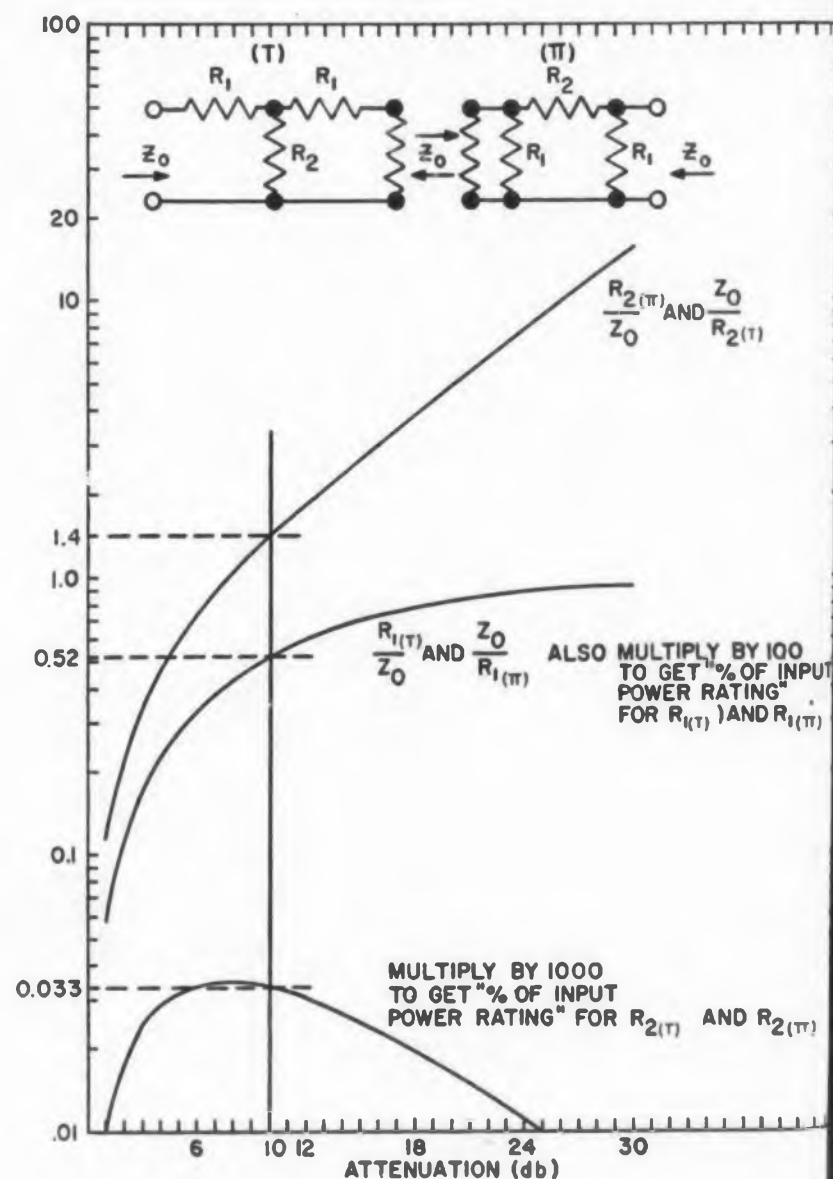
Chief Engineer
Radar Design Corp.
Syracuse, N. Y.

OHMIC VALUES and power ratings of resistors used in symmetrical "T" and "Pi" type attenuators can be quickly determined by using the accompanying nomogram that combines the design procedures for the two types.

Attenuator parameters that are most commonly specified are:

- Characteristic impedance
- Input power
- Attenuation value

The characteristic impedance of this symmetrical network is defined as that value of impedance



Ohmic values and power ratings of resistors used in "T" and "Pi" Attenuators can be determined quickly with this nomogram.

which, when connected as the output impedance, reproduces itself at the input of the network.

Example

Assume the values for the above parameters are 100 ohms (characteristic impedance), 10 w (input power) and 10 db (attenuation value). Given these values, find the ohmic value and power rating for both the "T" and "Pi" type attenuators.

In this example the 10-db rating is used for both types for convenience of illustration only. To keep errors at a minimum, due to frequency sensitivity of resistors, use the following rule:

Below 6 db, use the "Pi" type

Above 6 db, use the "T" type

Step 1. Draw a vertical line from 10 db and intersect all three curves.

Step 2. Intersection of the vertical line with the lower curve occurs at an ordinate of 0.033. Thus R_2 , for either type, must handle 0.033×1000 per cent = 33 per cent of the input power, or 3.3 w.

Step 3. Intersection of the vertical line with the middle curve occurs at an ordinate of 0.52. Thus R_1 , for either type, must handle 0.52×100 per cent = 52 per cent of the input power, or 5.2 w.

Also:

$$R_{1(T)}/Z_0 = R_{1(T)}/100 = 0.52$$

$$R_{1(T)} = 52 \text{ ohms}$$

$$Z_0/R_{1(\pi)} = 100/R_{1(\pi)} = 0.52$$

$$R_{1(\pi)} = 100/0.52 = 192.5 \text{ ohms}$$

Step 4. Intersection of the vertical line with the upper curve occurs at an ordinate of 1.4. Thus:

$$R_{2(\pi)}/Z_0 = R_{2(\pi)}/100 = 1.4$$

$$R_{2(\pi)} = 140 \text{ ohms}$$

$$Z_0/R_{2(T)} = 100/R_{2(T)} = 1.4$$

$$R_{2(T)} = 100/1.4 = 71.5 \text{ ohms}$$

Impedance Check. If the above computations are correct, then, with an output impedance of 100 ohms and Z_0 connected, the input impedance should also be 100 ohms. For the "T" type, the input impedance equals:

$$\frac{R_2(R_1 + Z_0)}{R_2 + R_1 + Z_0} + R_1 = \frac{71.5(52 + 100)}{71.5 + 52 + 100} + 52 = 100.8 \text{ ohms}$$

For the "Pi" type, the input impedance equals:

$$\frac{\left(\frac{Z_0 R_1}{Z_0 + R_1} + R_2\right) R_1}{\frac{Z_0 R_1}{Z_0 + R_1} + R_1 + R_2} = \frac{\left(\frac{100 \times 192.5}{100 + 192.5} + 140\right) 192.5}{\frac{100 \times 192.5}{100 + 192.5} + 192.5 + 140} = 99.3 \text{ ohms}$$

Therefore, the nomogram errors are less than 1 per cent. ■ ■



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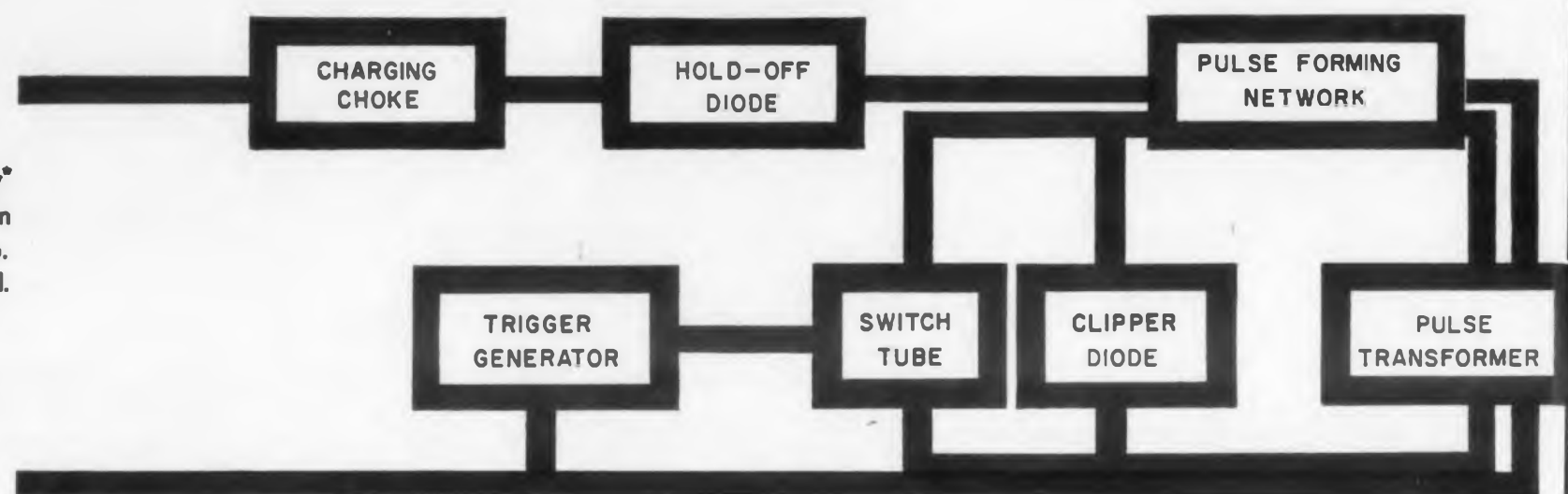
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CIRCLE 27 ON READER-SERVICE CARD

How to Design a Line-Type Modulator

Part II—Charging Circuit



Igor Limansky*

Electronic Research and Development Section
The Martin Co.
Baltimore, Md.

Practical steps involved in designing the charging circuit of a line-type modulator are presented for the circuit engineer. The typical design problem, begun in Part I (*ED*, Feb. 17, 1959, p 42) is carried forward from the discharge circuit parameters to the charging circuit.

BY DETERMINING the discharging-circuit components in Part I, we now have gained enough information to compute the values of the charging-circuit components. This, in turn, will permit us to specify the characteristics of the power supply needed for this modulator.

Quantities and Relationships Used

Three important parameters are used in the charging-circuit design. They are the pulse repetition rate prf , the pulse width t_p , of the output pulse (both given), and the pulse forming network (PFN) impedance Z_N , determined in Part I. The relation between the PFN parameters C_N (total PFN capacity, Z_N and the pulse width t_p , is:

$$t_p = 2C_N Z_N \quad (1)$$

*Now with Air Arm Div., Westinghouse Corp., Baltimore, Md.

The formula for the charging circuit, Fig. 1, is:

$$prf = \frac{1}{\pi \sqrt{L_o C_N}}$$

Using Frequency-Reactance Charts

Note that C_N is common to both expressions, and that the expressions themselves can be represented by modified reactance-frequency charts. This allows the complete representation of the charging-PFN circuits to be arranged as shown in Fig. 2. The portion of this chart representing the PFN (lower right) is after C. A. Epp.¹ The portion of the chart representing the charging circuit (upper left) is the normal reactance-frequency chart, except for the frequency scale, which has been modified to follow

$$prf = 2f_o, \quad (3)$$

where f_o is the resonant frequency of the $L_o C_N$

charging circuit.

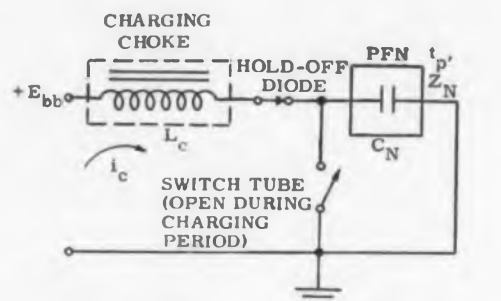
Starting from the PFN section (lower right), the chart is entered from the bottom for the pulse width t_p , and from the right side for the PFN impedance Z_N . The intersection of these two lines will give a value of total PFN capacitance C_N . The latter will be on a line parallel to the diagonal lines connecting the two sections of the chart, and need not be recorded.† The intersection of the total PFN capacitance line, with the vertical pulse-repetition frequency line, located in the charging-circuit section (upper left), will give the required value of charging-choke inductance L_o , necessary for resonant charging.

An Example—Continued

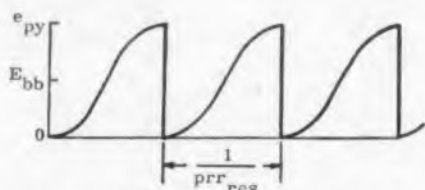
To illustrate the use of Fig. 2, the example

†If it is desired to construct a PFN, this value is needed. The total PFN inductance L_N , also necessary, may be taken from the chart given in Reference 1.

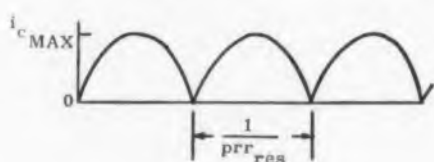
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a) CHARGING CIRCUIT--FUNCTIONAL DIAGRAM



b) VOLTAGE WAVEFORM ACROSS C_N



c) CHARGING CURRENT WAVEFORM

Fig. 1. Basic functional diagram and waveforms of the charging circuit.

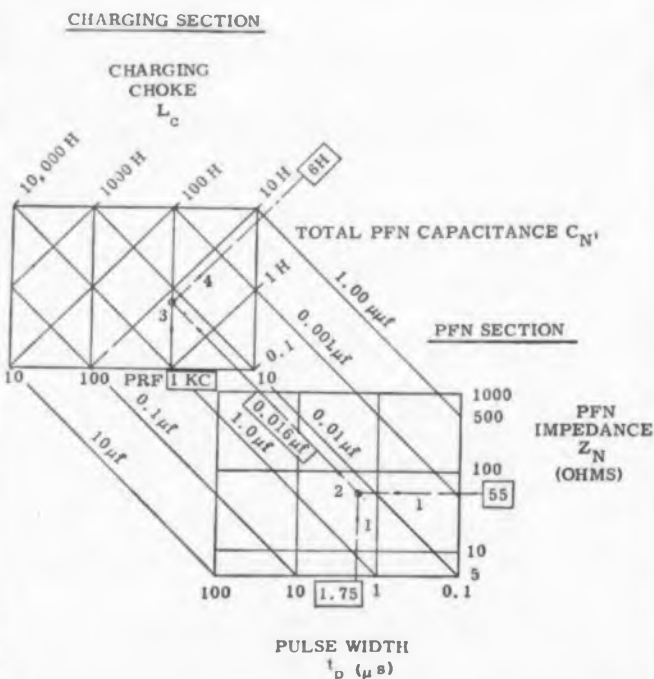


Fig. 2. Use these modified reactance-frequency charts to determine the value of charging choke reactance.

begun in Part I will be continued in Fig. 3. In that example, the given value of t_p was 1.75 μ sec while the given prr was 1000 cps. It was also found (assuming a 10-per-cent mismatch between the magnetron-pulse transformer combination and PFN) that the value of Z_N necessary for proper operation of the hydrogen thyratron, was 55 ohms.

Entering Fig. 3 at 1.75 μ sec and 55 ohms, a value of 0.016 μ f is found for the total PFN capacitance C_N . Continuing along the diagonal line corresponding to this value of C_N , to the vertical line representing 1000 pps in the charging circuit section, the required value of charging-choke in-



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Model	Power W	Frequency MHz	Life Hours	Weight Oz.	Price \$
B-111	100-200	100-1000	500-1000	100	1000.00
B-112	100-200	100-1000	500-1000	100	1000.00
B-113	100-200	100-1000	500-1000	100	1000.00
B-114	100-200	100-1000	500-1000	100	1000.00
B-115	100-200	100-1000	500-1000	100	1000.00
B-116	100-200	100-1000	500-1000	100	1000.00
B-117	100-200	100-1000	500-1000	100	1000.00
B-118	100-200	100-1000	500-1000	100	1000.00
B-119	100-200	100-1000	500-1000	100	1000.00
B-120	100-200	100-1000	500-1000	100	1000.00

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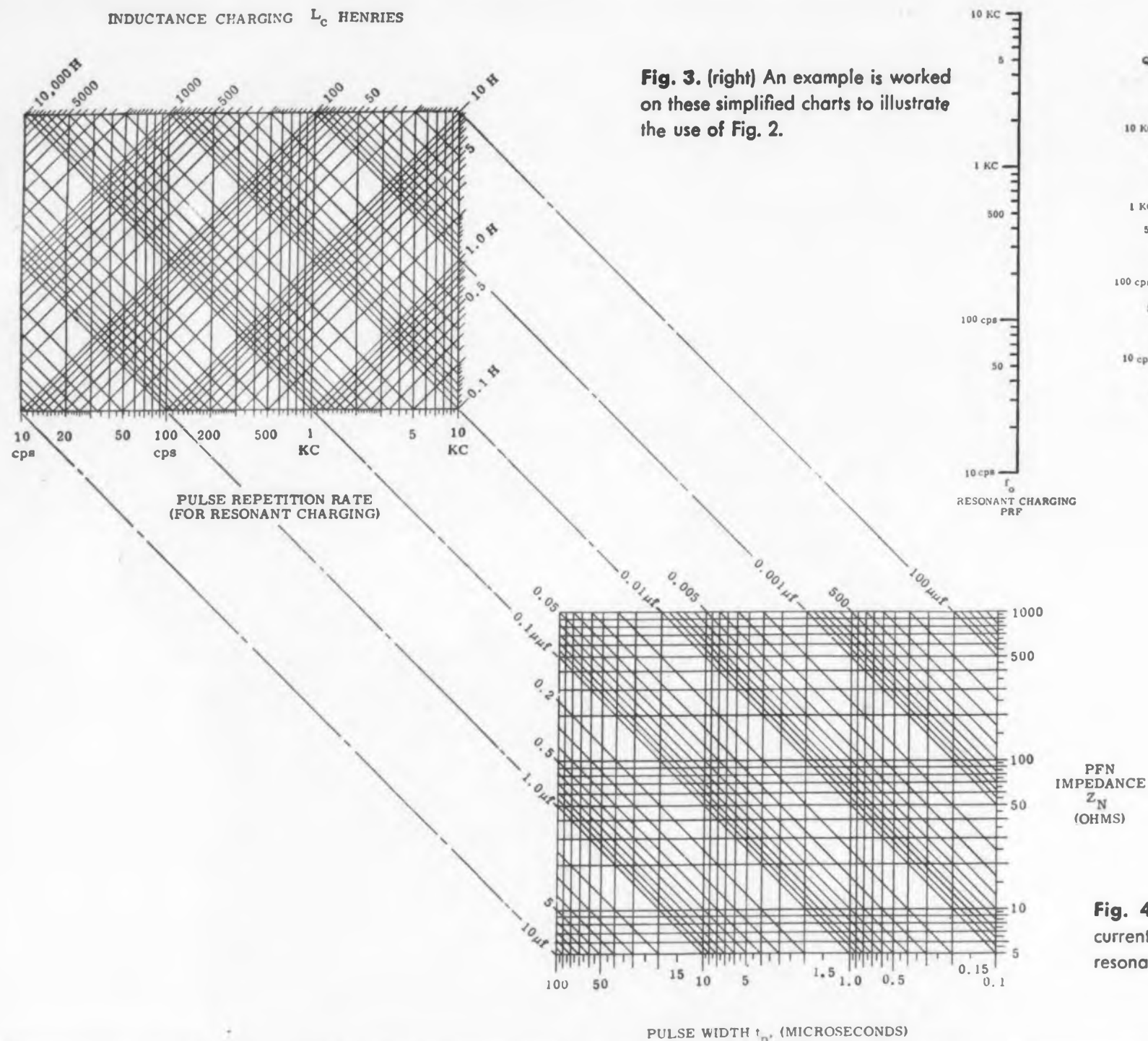


Fig. 3. (right) An example is worked on these simplified charts to illustrate the use of Fig. 2.

Fig. 4. Use this nomograph to determine the current drain on the power supply for non-resonant conditions.

ductance L_c , for resonant charging is found to be 6 h.

Resonant Charging

When resonant charging is being used, it is possible to specify the power supply parameters almost immediately. From the relation:^{**}

$$E_{bb} = 1/2 e_{pv}, \quad (4)$$

and the relations:

$$\frac{I_{cRMS}}{I_b} = 1.11, \text{ (resonant charging)} \quad (5)$$

$$\frac{i_{cMAX}}{I_b} = 1.57, \text{ (resonant charging)} \quad (6)$$

the power-supply voltage E_{bb} , power-supply rms current I_{cRMS} , and the power-supply peak current

i_{cMAX} , may be computed from the values of e_{pv} and I_b , found in Part I.

For example, it was found in Part I that our modulator had a peak forward voltage e_{pv} , of 2.8 kv, while the average current I_b , was 47 ma. If operated under conditions of resonant charging, the power supply ratings are:

$$E_{bb} = 1.4 \text{ kv,}$$

$$I_{cRMS} = 52 \text{ ma,}$$

$$i_{cMAX} = 74 \text{ ma.}$$

^{**}This relation is valid for charging chokes having Q 's larger than 10, and assumes that a clipper diode is used to remove any inverse voltage left across the network. It is not valid for linear charging ($prf > 2f_0$), but may be used for subresonant charging ($prf < 2f_0$), but may be diode is included in the charging path.

Designing For Variable Prr

If the modulator is to operate over a range of pulse-repetition frequencies, the charging circuit should be designed so that resonant charging conditions exist at the highest pulse-repetition frequency used. At the lower pulse-repetition frequencies, a hold-off diode should be employed to prevent the discharge of the PFN through the power supply.

Eq. 4 is still valid for finding the power-supply voltage E_{bb} . Fig. 4 will give the current demanded from the power supply for conditions other than resonant charging. Since the average current I_b , will naturally change with pulse-repetition rate, it must be recomputed, using Fig. 6 of Part I.

Our modulator is already designed for resonant charging at a prf of 1000 pps. Assuming that 1000 pps will be the highest frequency of operation and

230 pps the lowest frequency of operation, the duty cycle for this lowest frequency will be:

$$du = 1.75 \times 10^{-6} \times 230 = 0.000403.$$

The average current for a peak current i_b of 27 amp, will be (Fig. 2):

$$I_b = 11 \text{ ma};$$

(Fig. 4):

$$\frac{I_{crms}}{I_b} = 2.3; \quad I_{crms} = 25 \text{ ma};$$

$$\frac{i_{cmaz}}{I_b} = 6.8; \quad i_{cmaz} = 74 \text{ ma}$$

The preceding computation illustrates the wisdom of finding the values I_{crms} and i_{cmaz} , particularly for low duty cycle operation. The average current is usually employed to set the modulator power level, since the ordinary d'Arsonval movement measures the average current passing through it. At low duty cycles, however, the peak and rms currents are well in excess of the average current meter reading, and will cause overloading of the power supply if it has been designed for a given average current. The peak charging current i_{cmaz} , does not change in the resonant-subresonant charging range, if a hold-off diode is employed.

Specifying Diode and Choke

From the information derived so far, it is now possible to specify the type of hold-off diode to be used. From the circuit and waveform of Fig. 1, it may be seen that this diode must withstand an inverse voltage of E_{bb} , as well as passing a peak current of I_{cmaz} and an rms current of I_{crms} . As a possible candidate, the liquid-cooled 545 diode may be used as a hold-off diode in this modulator.

The manufacturers ratings for rectifier operation are:

Max. Inverse Voltage	5 kv,
Max. Peak Current	160 ma,
Max. Average Current	50 ma.

The calculated rms current is 92 ma for this tube. It is therefore applicable to this modulator design, whose operating conditions are well within the maximum ratings of the tube.

The charging-choke specifications may also be taken from the data derived. The currents will be the same as for the hold-off diode. The voltage excursion will be 0 to e_{pv} on the thyatron side, and the power supply terminal voltage will remain constant at E_{bb} .

The modulator design is now almost complete. Only the clipper diode and trigger source remain to be considered. These will be treated in the third and final article of this series. ■ ■

Reference

J. C. A. Epp, "Pulse Delay-Line Design Chart", *Electronics*, p. 150, June 1952.



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For further information, write to J. R. Woods, Dept. H, Mallory Controls Company, Frankfort, Indiana.

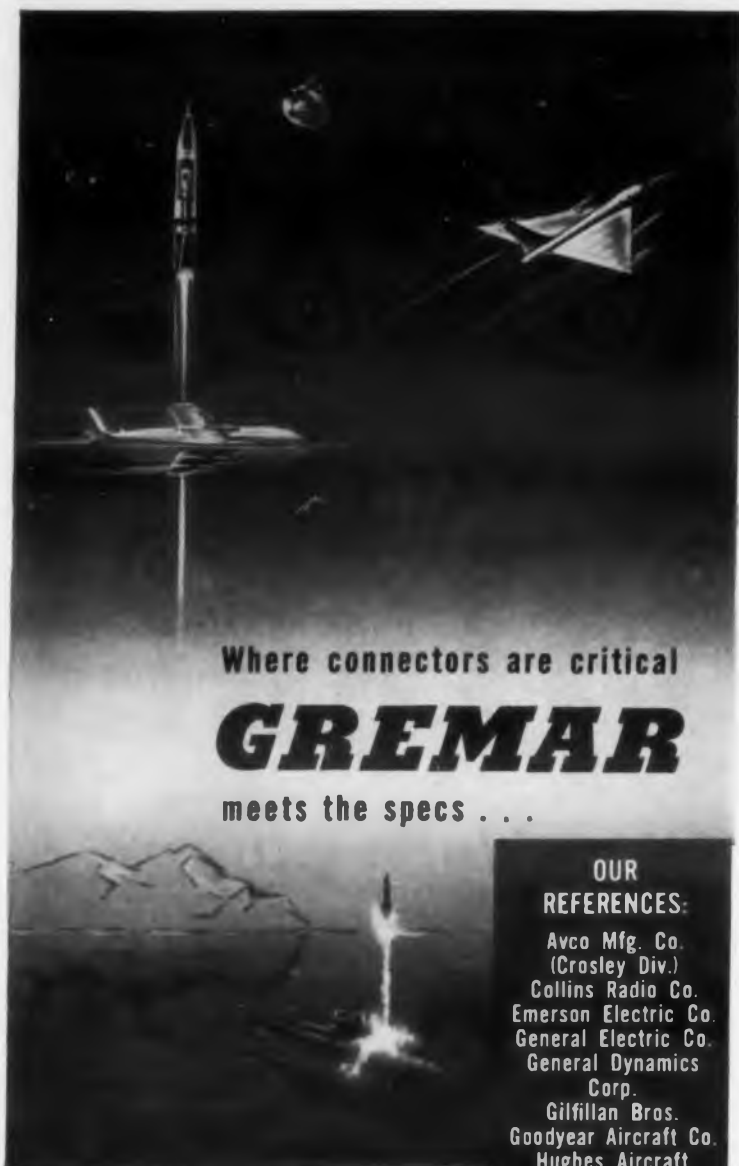
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CIRCLE 30 ON READER-SERVICE CARD

An Industrial Designer Discusses . . .



PANELS

Paul Wrablica

President

Paul Wrablica Associates

New York, N. Y.

By considering the human operator during equipment design, efficiency can be increased together with a reduction in operator fatigue and errors. Panels which are confusing and cluttered can be redesigned to achieve the above goals. (Knobs were discussed in the February 17th issue of ED, p 56.)

COMPLEX test equipment, hampered by a disorganized grouping of dials, jacks, and meters, can be responsible for excessive operator fatigue, poor technician efficiency and errors in measurements.

Frequency Meter Redesign

Typical of an industrial designer's assignment was the challenge to organize an existing panel for a frequency meter. The instrument, developed and produced by Lavoie Laboratories, Inc., Morganville, N.J., had been adjudged insufficiently confusion-proof in the hands of semitechnical operators.

In addition to creating a sense of visual organization to the panel, it was felt that the average semitechnical operator would sense more confidence in a unit that looked as though the various components were clearly related and placed with specific intention to perform a recognized function.

Original Panel Confusing

Although the meter in question, shown in Fig. 1, performed its function perfectly, it was a typical example of visually confused design. In effect, little attention had been given to the human being who became a "component" of the "instru-

ment-in-operation." Engineers had designed it for performance; this accomplished, the chassis was enclosed with sides and a front panel. As a result, the instrument was an unrelated group of windows, dials, gages, crank knobs, check points, inputs and outputs. Groups of components meant to be operated or in use simultaneously bore no visible relationship. Other information gathering areas were obstructed during operation.

Initial Considerations

The immediate problem facing the designer was to organize and create a panel with an immediate sense of visual organization, allowing the operator maximum orientation when facing the instrument and a direction and pattern from which to read and gather information correctly and efficiently.

To compound the situation, a basic requirement was that organization be carried out with minimum changes in the circuitry. All elements on the facing had, therefore, to remain in their original relative positions.

Initial problems included:

- Three radial dial windows, which provided simultaneous digital information, needed an obvious relationship.
- Gages supplying simultaneous or comparative data were spread apart whereas their optimum

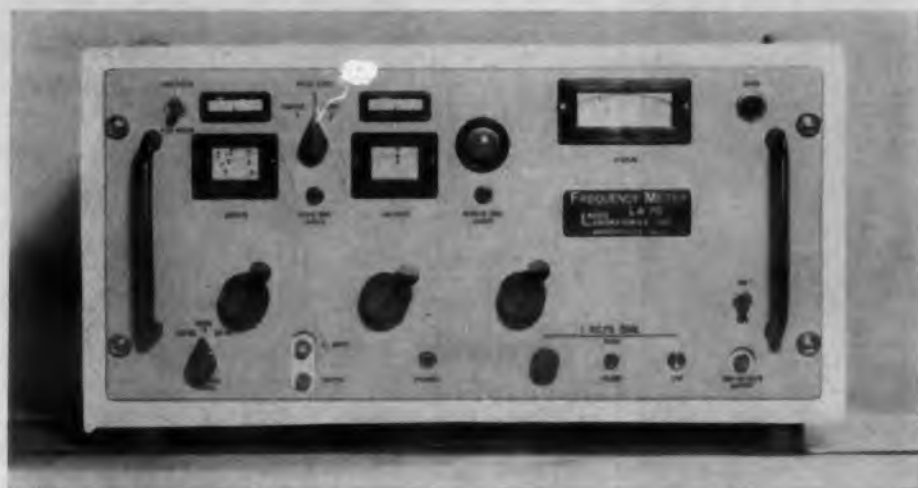


Fig. 1. Although far from unsightly, the panel consists of an unrelated group of dials, jacks and meters.



Fig. 2. A study revealed that pie-cut openings placed in a horizontal plane reduced time and errors.



Fig. 3. An alternate redesign proposal emphasizes vertical separation of functions by means of color areas.

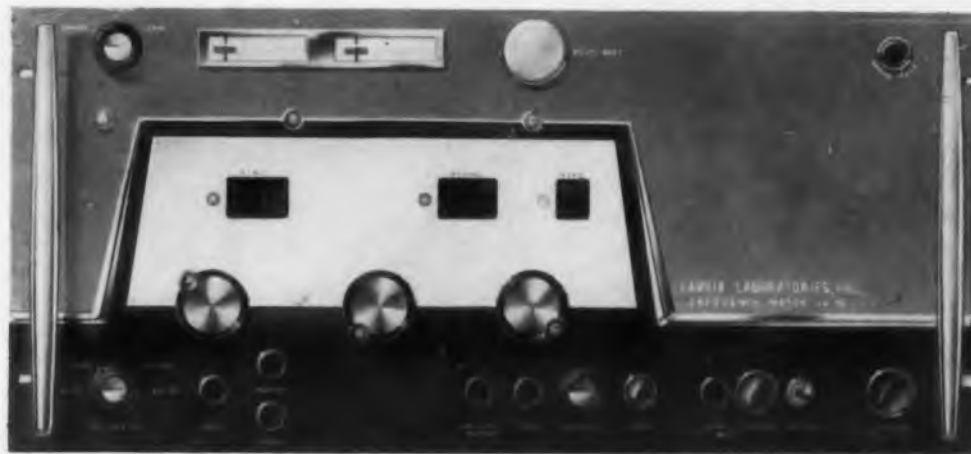


Fig. 4. Framing of the dial windows with a trapezoid molding strongly highlights key panel points.

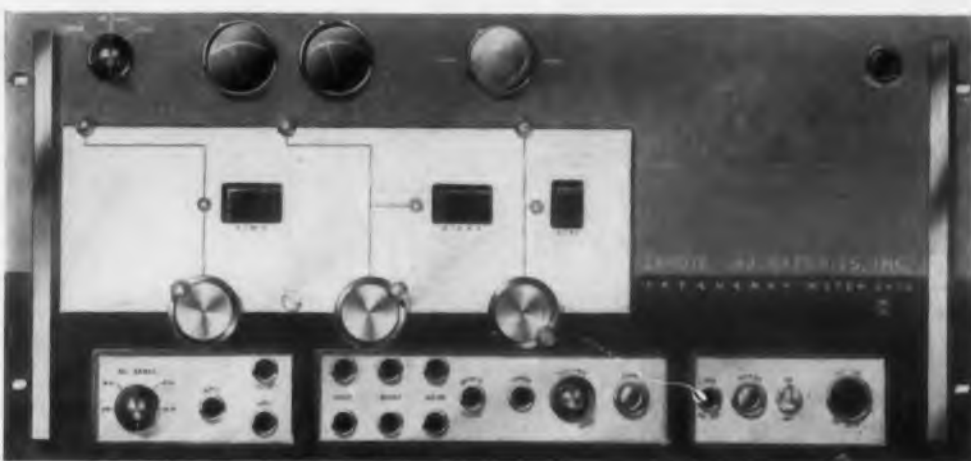


Fig. 5. The accepted design, similar to the approach of Fig. 4, uses a rectangular plate rather than a trapezoid to reduce production costs.



Fig. 6 (a). (left) A delicate touch and a tiny hand are required to vary the frequency due to poor dial drive placement.



Fig. 6 (b). (right) Control relocation simplifies operation and clarifies readings.

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VTA-24 Tong Welding Handpiece: Weld pressure continuously adjustable from 0.5-25 pounds. 3 different tip angles.



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VTW-1M Mobile Cabinet Spot Welder: 1-20 spots per second. 5.0 KVA. Usable with any VTP handpiece or welding head.

location should allow them to be sighted simultaneously.

- Crank knobs operated in conjunction with dials and check points bore poor relationships to each other and their functions.

- Dial check points were spotted so awkwardly that the operator was forced to block the windows during testing.

Design Steps

Organization began with an over-all look at the facing and a decision to relate entire areas in terms of their importance. Most important were the three large dials. In this application, where highest accuracy in reading was essential, design principles were applied with particular care. Since the operator was required to read initial, intermediate and final settings from left to right, windows were placed in a single horizontal line. Such placement also reduced time and errors. Though the mental process in operating the meter is relatively simple, the operator should easily read these facings while performing the series of manual operations required to obtain them.

Several Solutions Offered

Typical of such assignments, the industrial designer submitted more than one possible solution to the organizing of the meter facing. Such a procedure has many values. One solution rarely solves all the problems, some of which are based on the client's requirements and facilities. Alternate solutions to common problems allow the industrial designer to comprehend the entire score of solutions. Based on the client's appraisal of his product, the designer can recommend the best solution in keeping with these appraisals. In addition, such a method of alternative solutions has proven to be the least expensive, inasmuch as problems not clear in one design become markedly so in another.

In one suggested version, Fig. 2, clear pie-cut shapes were emphasized, focusing attention to the important areas. Strong horizontal emphasis was added to the instrument facing which could be manufactured as a one piece stamping. In addition to strong linear emphasis, the dimension added a rich appearance and a look of quality.

Gages were located vertically rather than horizontally since data was to be read simultaneously. Dial surfaces were designed with light calibrations and markings on dark backgrounds for focal contrast and ease of reading.

Another concept, Fig. 3, emphasized vertical separation of the components by means of color areas. Oval windows were employed, the frames of which complimented the shape of the round dials.

Note that in these two concepts, input jacks,

connectors, fuses, switches, and pilot lights were placed in a single line across the bottom. Common inputs and outputs were color-coded. Jacks providing similar functions could be seen at a glance. Additional jacks were added to provide greater capacity and located to permit neat and rapid hook-up. Knobs were restyled to introduce consistent and homogenous appearance; they were found judged easier to grip and less likely to be used in error.

A third concept, Fig. 4, was submitted as a suggestion for departure from the original version by the utilization of a flat overlay panel of aluminum on which all three windows are cutout and color-coded with crank and check knobs that control them. Here the proposed design theme is the framing of the windows with a trapezoid; additional emphasis is achieved by an applied molding. The horizontal meters were pulled together to minimize waste motion in comparative reading. The design makes use of tapered handles which tend to relate compatibly with the tapered theme around the windows. The handles also tend to visually combine the two-tone combination of colors selected.

Fig. 5 uses the same abstract approach for visual organization of the windows and controls. In this version, accepted as the final design, the use of a flat rectangular overlay plate minimizes cost and production problems. The straight vertical handles serve the same function of combining the two-tone effect and utilize existing hardware. The rectangular theme was carried out for grouping three areas with their appropriate jacks. The meters in this application are round due to an imposed subsequent requirement that they be ruggedized for military application. Meters are physically as close as possible for quick reading of data.

Colors, selected for their compatibility with other laboratory equipment, were a neutral warm grey of satin aluminum and off-black.

Audio Generator Redesign

Another example illustrating a dramatic "before and after" comparison is shown in Fig. 6. In Fig. 6a, the dial control is located in an awkward position for operator handling (especially a right-handed technician).

As shown in Fig. 6b, the redesigned version of the Kay Electric Co. "KC Audiolor" is vertical, with the face tilted back slightly, for greater ease in use and reading. The dial control has been labeled, to avoid confusion to newly-assigned operators, and is placed in a convenient spot. The jacks have been moved to the side of the unit for improved accessibility.

By making the panel in one piece, with silk screen areas, unsightly screw heads are eliminated while assembly time and cost are reduced. ■ ■



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$$E = \frac{mc}{2}$$

Ampex Reveals the IPS Corollary

WHAT a joy it is to sow a seed and see it flower. The ink was hardly dry on our revelation of the new physical law discovered in our laboratory, when the post brought us a singularly fat letter from a certain T. J. Ips. Mr. Ips, it seems, had read our paper and done some pondering of his own in regard to $E = mc/2^*$. He presented at some length a proposition which we have come to refer to as the Ips Corollary. We won't reproduce the entire letter here because of the exhaustiveness of Mr. Ips' thinking and the complexity of his mathematical proofs. His conclusion however is this. "There is a possibility that it might be probable to assume therefore, (what admirable caution—a true scientist) that if the rate of consumption of a material is cut in half, a given amount of material will last twice as long."

Now it is truly amazing that Mr. Ips was arriving at this conclusion independently, miles away, while we were doing experimental work along the same line with our new machine the FR-600 analog recorder—our practical application of $E = mc/2$. Our work proves in a practical way the Ips Corollary. Since our FR-600 machine records the same amount of data at half the usual speed, a given amount of tape lasts twice as long. (Engineering readers of our first paper will remember that bandwidth is 125 kc at 30 ips,** for example.)

The marketing people were very reluctant to allow us to publish these facts. They pointed out that by recording 125 kc data at 30 ips a 14-inch reel of tape would last a full 48 minutes. Enough for most complete missile tests including pre-launch time. This would eliminate the need for a stand-by machine or a second transport to take up where the first left off. Sales might be cut in half. But, altruism finally won out. We decided to go ahead and publish it even if our competitor's sales were cut in half.

We are sorry we cannot publish the answer to our last trial problem at this time. Our mathematician was taken ill after a strenuous bout with the mathematical proof of the Ips Corollary. As soon as he recovers we will have the answer for you. Meanwhile we invite our readers to try their hand at it. The marketing people respectfully submit that since the FR-600 does the work of two machines, half an FR-600 is better than none.

*For those who may have missed the first paper explaining $E = mc/2$, we have a limited supply of free copies on hand.

**A standard unit of measure for tape speed named in honor of T. J. Ips. (One-twelfth of a foot per second.)

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25-Kilowatt Magnetron Brings Millimetric Radar Down To Earth

USING A NEW magnetron that generates 25 kw of 8-mm power, radar designers can now take advantage of the high resolution and small size of millimetric waves for sea-level applications. A pulse length of only 0.02 μ sec, combined with a typical beam width of about 4.5 mil in an antenna of reasonable size, yields a square resolution of 4.5 yd at 1000 yd.

Designed by Philips Research Laboratories of N. V. Philips Gloeilampenfabrieken of Eindhoven, the Netherlands, the new magnetron type 7093 is being distributed by Ampex Electronics Corp. of 230 Duffy Ave., Hicksville, L. I., N. Y. The 4.2-lb tube is tightly designed to yield the optimum power-weight-pulse length compromise for short-range, light-

weight, high resolution systems.

Since magnet size varies exponentially with frequency, careful selection of total output power, in view of probable applications, was necessary. Because 8-mm waves are attenuated in normal atmosphere at almost 0.2 db per mile, a fairly high power level is necessary.

Rapid emission build-up, needed for the short pulses, is achieved by the use of a dispenser-type cathode. This is a sintered tungsten cathode impregnated with barium oxide emitting material. The design results in a rugged, yet "fertile" oxide.

The anode block, only 25/32 in. in diameter, contains 18 resonators in a sunburst pattern. Heat generated in the block is carried off by conventional air-cooling.



On map-like PPI presentation of airport, people walking show up plainly, dead time at close range almost disappears.



Tiny anode block, only 25/32 inch in diameter, employs sunburst cavity structure.

When operating with a 0.02- μ sec pulse length, duty cycle is 0.0001, peak anode voltage is 13.5-15 kv, and the peak power of 25 kw becomes 2.5 average. Rate of rise is 600 kv per μ sec. The extremely short pulse length enhances ranging performance in two ways.

The map-like presentation, illustrated in the photo of the PPI presentation, has a resolution of 13 ft or less. A jeep can be seen on the runway in the upper left hand portion of the PPI as a series of dots, one for each sweep. The speed of the vehicle can be calculated from the dot-spacing, knowing the prf of the Radar. In this case, after taking the corner at low speed, the jeep travelled up the runway at 55 mph. Even more impressive are the tracks of people walking on the apron near the center of the PPI.

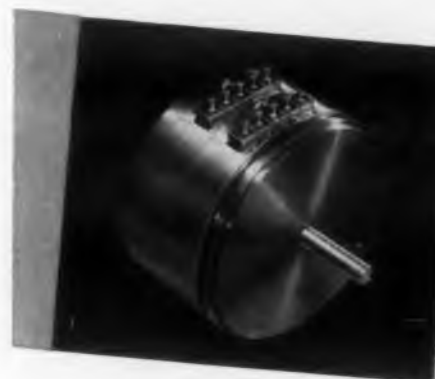
The second enhancement gained from the short pulse length is the ability to range on objects very close to the radar antenna. A dead-space of less than 15 yd has been achieved. Since 1 μ sec corresponds to a distance of 1 ft, the pulse length occupies about 20 ft during radiation, or 10-ft round-trip range.

To take advantage of the close-in ranging capability, special design must be employed in the accompanying circuitry. Among the more important is the use of two antennas rather than a duplexer. Thus far, no switch tube deionizes fast enough to permit reception soon enough after the transmitted pulse has ended.

For further information on the 25-kw magnetron, turn to the Reader-Service card and circle 101.

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POTENTIOMETER
series 57

Provides more performance in less space. Combines special rotor with Hi-Load winding element for maximum stability and reliability. Nickel-silver body only 1/2" in dia. Features new Clarostat positive mechanical internal lead connections. Ranges to 40K ohms. Linearity, $\pm 2\%$ standard; $\pm 1\%$ special.



for
versatility...
"42"
POTENTIOMETER
series 42

Precision potentiometers rated at 3 watts. Available in resistance ranges up to 100K ohms, from 1 ohm. Continuous or limited rotation. High-dielectric phenolic case. Units ganged by means of threaded tie rods. Switches available for actuation at any shaft position.



for super
accuracy in effect
and read-out...
MULTI-TURN
series 55

Potentiometers in 3- to 6-watt ratings. Diameters from .875 to 2". Improved design permits 20% more winding length for same outside diameter, resulting in greater overall resistance and higher resolution. Taps available.

● These items are available from your Industrial Distributor. Write us for technical data.

CLAROSTAT MFG. CO., INC.

DOVER, NEW HAMPSHIRE, U.S.A.

In Canada: CANADIAN MARCONI CO., Ltd., Toronto 17, Ont.

CIRCLE 34 ON READER-SERVICE CARD



Silicon-Carbide Rectifiers Operate in High-Heat and Radiation Environments

THE FIRST commercially-available silicon-carbide rectifiers, Types TCS10 and TCS5, are claimed to withstand temperatures of 500 C and are ten times more resistant to radiation damage than silicon units. During an equivalent bombardment of 2.3×10^{16} nvt ($e > 1$ kev), the forward voltage increased by less than 5 per cent, it was reported.

Made by Transitron Electronic Corp., 168 Albion St., Wakefield, Mass., the rectifiers will be exhibited at the IRE Show in March.

Transitron expects that the rectifier will be employed in many applications where silicon rectifiers are marginal. The present upper temperature limit of silicon units is about 200 C. The silicon-carbide rectifiers will be the first of a series providing "good performance" above 200 C, said Dr. David Bakalar, Transitron's president.

Typical reverse currents are less than 100 μ a at 50 v, at 400 C. At 500 C, the maximum average forward current (I_0) is 100 ma for both units. The maximum peak inverse voltage, at 500 C, is 100 v for the TCS10 and 50 v for the TCS5.

Rectifier Specifications

Type	Maximum Inverse Current I_b (μ a)	Maximum Forward Voltage Specified Current (v at ma)	Peak Inverse Voltage (v)
TCS10 at 500 C	500	6 @ 100	100
TCS10 at 25 C	10	12 @ 100	100
TCS5 at 500 C	500	4 @ 100	50
TCS5	10	8 @ 100	50



A few of Varian's large research team on wave tubes confer on new design features.

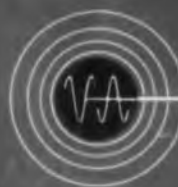
TOP TEAM IN WAVE TUBES

Varian has become the world's leader in the development and production of microwave tubes. With a greatly expanded wave tube team and larger manufacturing facilities, new tubes for advanced applications are being offered at an accelerated pace. From the small X-Band BWO's to the megawatt TWT, there is a Varian wave tube to meet your requirements.

Over 100 Varian Klystrons and Wave Tubes are pictured and described in our new catalog. Write for copy—address Tube Division.

VA-125A, B TWT	2.65 to 3.25 kMc 1 megawatt peak output
VA-161 BWO	8.2 to 12.4 kMc
VA-162 BWO	12.4 to 18.0 kMc
VA-128 TWT	2.6 to 3.4 kMc 10 kw peak output

SEE US AT THE I.R.E.—BOOTH NOS. 2714-16-18-20



VARIAN associates
PALO ALTO, CALIFORNIA
Representatives throught the world



VA-128 TWT



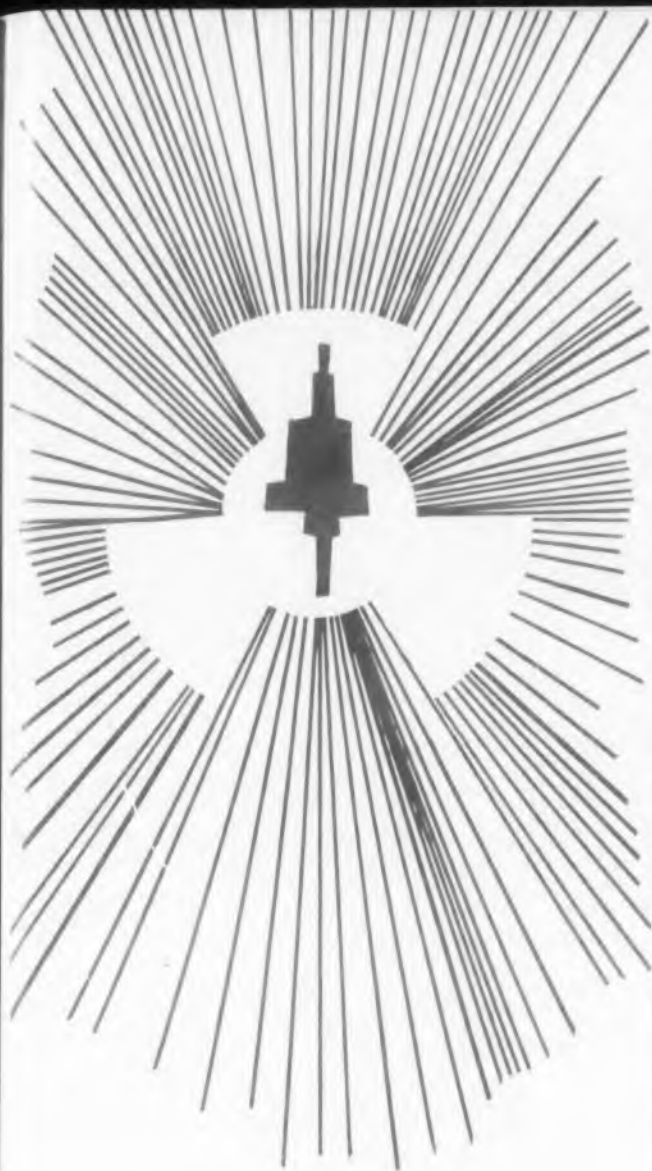
VA-125A,
B TWT



VA-161
BWO

KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MIMOTRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR & EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 35 ON READER-SERVICE CARD



Nuclear Applications

The rectifiers' radiation resistant properties make the units useful in such devices as neutron counters where radiation flux levels are excessive for silicon or germanium devices. Silicon-carbide rectifiers are also expected to find widespread use in instrumentation and electronic circuitry which must function in close proximity to nuclear explosions.

Both silicon-rectifiers are about one-half inch long and have a diameter of about one-third of an inch. They are placed in a ceramic-type casing.

Manufacturing Problem Solved

During the development of the silicon-carbide rectifiers, the firm's metallurgists were faced with the problem of growing junctions. Because silicon-carbide will not melt under normally-attainable pressures, it became necessary to design a furnace for vapor-phase crystal growing that would operate at 2500 C. The silicon-carbide is grown out of the vapor phase by depositing it on a seed at 2200 C. While the seed is growing, dope is added to the protective gas and a junction made.

Pilot line production is now underway and prototype orders are being taken for the rectifier.

For more information on these units, turn to the Reader-Service Card and circle number 100.

Engineers...

RCA and OFFENSE

WEST COAST

A Sunday punch in a velvet-covered gauntlet—this is the state of America's offensive muscle.

Missiles "at ready" in concrete silos buried deep in the earth. Swift submarines roaming the depths with missiles tucked away inside. Pentomic airborne divisions able to move anywhere on earth in a matter of hours. Far-reaching carrier groups controlling the seas. Space stations, atomic aircraft—the list is lengthy.

Some of this offensive might is now operational, some is being built, some exists only as germs of ideas in an engineer's mind. The engineer is the pivotal point around which revolves the development of well-rounded, imaginative offensive capabilities geared to today and tomorrow. This is the work of creative specialists.

Because of RCA's tremendous West Coast expansion program, we have need for electronic and mechanical project engineers, and development and design engineers to work on information handling and data processing systems, electronic countermeasures and missile launch control and check-out systems for the operational ATLAS missile. We also have openings for systems engineers to study future military needs and synthesize systems to meet these requirements. You'll work in the pleasant surroundings of our new, modern electronic center in the San Fernando Valley and you'll work on a number of high priority projects that mean added strength for our country's offense.

If you'd like to grow *with* RCA on the West Coast, we'd like very much to hear from you, in all confidence of course.

Call collect
or write:
Mr. O. S. Knox
EMpire 4-6485
8500 Balboa Blvd.
Dept. 360C
Van Nuys, California



RADIO CORPORATION OF AMERICA
WEST COAST MISSILE AND SURFACE RADAR DIVISION

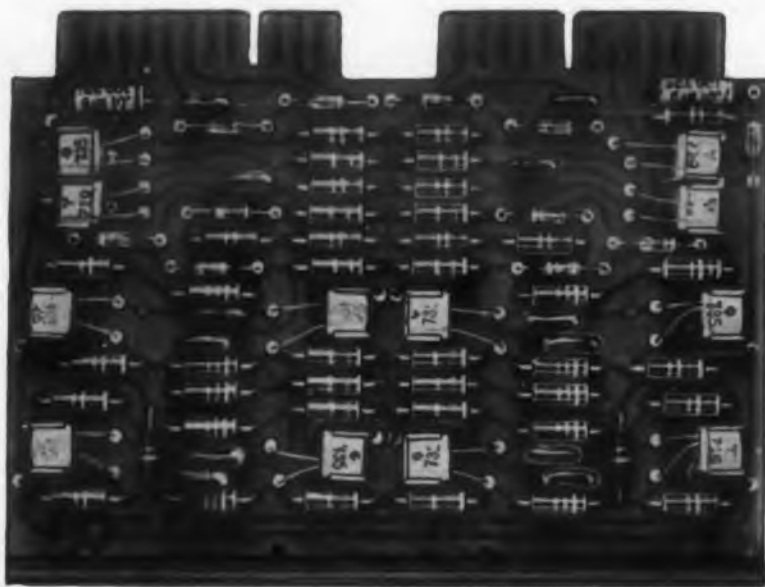
The name you know is the place to grow!



CIRCLE 915 ON CAREER INQUIRY FORM, p. 95

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.



Computer Circuit Synchronizes Random Input Signals

640

Model SY-101 Synchronizer is a double M-Pac designed either to synchronize random inputs to a clock, or to receive random parallel inputs and to deliver these serially to a counter. Each SY-101 package contains two identical synchronizer circuits. Up to six packages may be grouped to allow accumulation of signals from 12 asynchronous sources for delivery to a single counter. Maximum synchronizing rate for an individual circuit is 30 kc; for a group of n circuits, 30 kc/ n .

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Price & Availability: Price is \$77; available from stock.



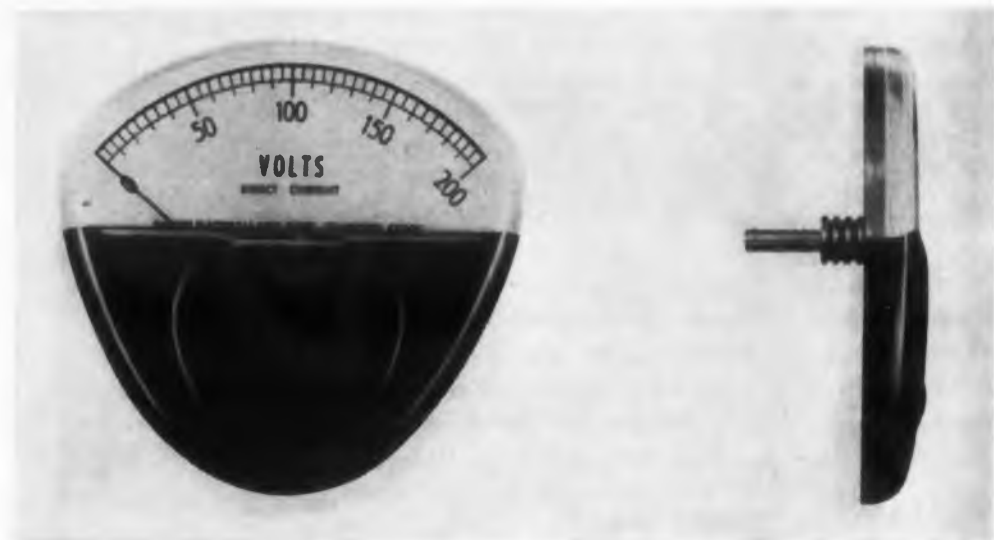
Modular Construction Gives Electronic Counter Flexibility

641

Designed to indicate any physical variable that can be converted to a proportional frequency, the model 720 electronic counter uses modular construction for flexibility. Frequency range is 0 to 120,000 pulses per sec or 1 to 120,000 cps. It is available with 3, 4, 5 or 6 decades. Other options include: four time-base modules, a remote readout indicator operable at distances to 100 ft, and a high sensitivity preamplifier providing 10 mv sensitivity. The unit weighs 21 lb and measures 19 x 5.25 x 10 in.

Erie-Pacific, Division of Erie Resistor Corp., Dept. ED, 12932 S. Weber Way, Hawthorne, Calif.

Price: Price for 4, 5, and 6-decade units is, respectively, \$525, \$595, \$665, fob Hawthorne, Calif.



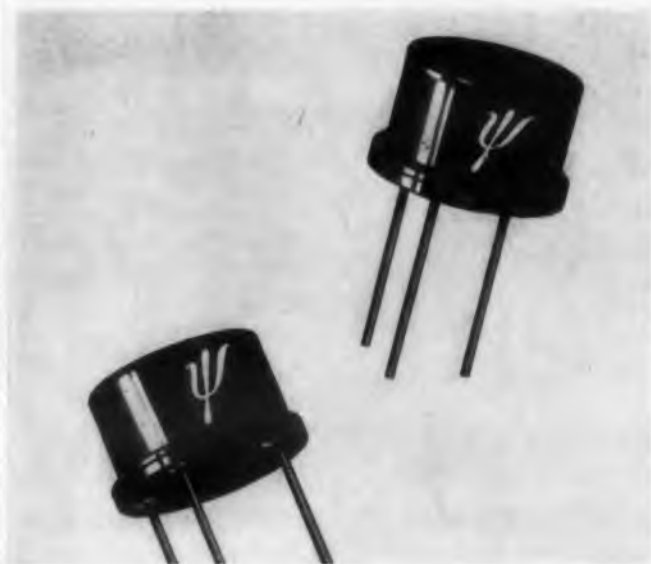
Thin Panel Meter Has Printed Circuit Movement

642

Series S35, 3.5-in. Parker panel-meter has four coils printed on a disc. This, a nylon pointer, and a thin ring magnet assembly make up the complete movement. The entire meter is contained in the scale housing and nothing projects from the rear except the terminals, which also serve as mounting screws. The four standard models available are: Group A, B, C, and D. They measure current from 1 ma to 1 amp, and voltage from 1 v to 500 v. Accuracy is better than 1.5% of full scale value at 70 F, and 0.5% accuracy is available on order.

Interlab Inc., Dept. ED, 437 Fifth Ave., New York 16, N. Y.

Price & Availability: Sample quantities shipped on short notice, but a lead time of 30 days is necessary for production orders. Prices range from \$14 to \$12.50, depending on model; discounts available.



VHF Silicon Mesa Transistors Deliver 1 W at 70 Mc

643

These vhf silicon mesa power transistors deliver 1 w of power output at 70 mc with a 28-v collector voltage. Type 2N1505, operating as an oscillator at 70 mc with a power output in excess of 1 w, has an efficiency of 45%. Type 2N1506 has a typical power gain of 12 db at 70 mc with a useful power output of 1 w. At 200 mc, it has a power output of 300 mw. Both units are characterized by a 3-w collector dissipation, 40-v collector-to-emitter rating, and low collector-capacitance.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

Price & Availability: The 2N1505 is priced at \$39.50 up to 99 pieces and \$29.60 up to 1000 pieces. The 2N1506 is \$49.50 and \$37, respectively. Delivery is now being made on both types.

Price and Availability

PRICE AND AVAILABILITY data is now being added, whenever possible, to the New Product descriptions that appear in ELECTRONIC DESIGN. This data will help you to:

- Evaluate the products more intelligently.
- Decide which products to buy now and which to wait for.
- Schedule your orders wisely.
- Get an insight into prices and savings for similar products.

Most manufacturers have been very cooperative in providing us with Price and Availability data. Since some of the data arrived after our deadlines, it was impossible to add it to all of the products. The data represents the latest information at the time of publication.



HB GROUP voltage regulated power supplies

0-325 VDC IN 3 1/2" PANEL

MODEL	DC OUTPUT VOLTS	DC OUTPUT CURRENT	RIPPLE	AC * OUTPUT
HB-2	0-325	200 ma.	0.003V	EACH SUPPLY HAS TWO UNREGULATED 6.5 VAC OUTPUTS AT 6 AMPS.
HB-4	0-325	400 ma.	0.003V	
HB-6	0-325	600 ma.	0.003V	

*Series connected: 13V CT — 6 Amps. Parallel connected: 6.5V — 12 Amps. (3% additional voltage provided to compensate for voltage drops in connecting cable)

ORDERING INFORMATION:

Units without meters use model numbers indicated in table. To include meters add M to the Model No.



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CIRCLE 37 ON READER-SERVICE CARD



SM TYPES



SL TYPES



S & R TYPES



MICRO-MINIATURE B SERIES



THE ONLY COMPLETE LINE OF BALANCED ROTARY RELAYS

CIRCLE 38 ON READER-SERVICE CARD

VIBRATION RESISTANT RELAYS

The heart of every Hi-G RELAY is the ROTARY BALANCED ARMATURE, effectively designed to provide superior resistance to smashing shock and severe vibration. Permanent magnet stabilization allows full contact pressure, eliminating chatter and eventual relay failure. Standard vibration immunity of 20G to 2000 CPS. Special units to 50G or more. For constant dependability under extreme operating conditions — see Hi-G.

Write for new catalog No. 259 for complete information and specifications

See Hi-G at the IRE Show Booth No. 2227



Hi-G

INC.

BRADLEY FIELD, WINDSOR LOCKS, CONN.

NEW PRODUCTS

PNPN Silicon Rectifiers

626

Rated at 1 amp from 50 to 400 v



Types 110 through 114 pnpn diffused silicon controlled rectifiers are rated at 1 amp from 50 to 400 v. Packaged in a JEDEC TO-5 case, the units are suited for printed circuitry, high-temperature switching, military airborne systems, and other uses. The average rectified forward current is 300 ma at 125 C case temperature. The maximum gate current required to turn on the device is 20 ma with maximum holding current of 25 ma and maximum leakage current at piv of 1 ma.

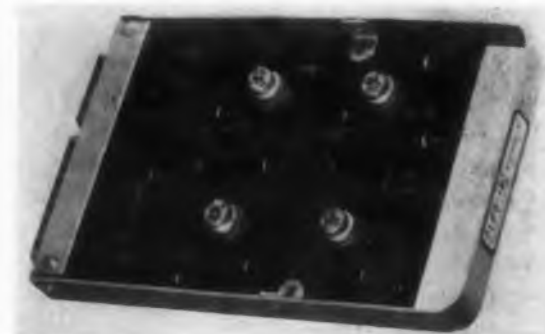
Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

Price & Availability: Price is between \$20 and \$65 ea for quantities of 1 to 99 and between \$12.50 and \$58.50 for quantities of 100 to 999. Units are available from stock.

Plug-in Circuit

627

Provides two flip-flops



Model S-84001-PD transistorized, plug-in circuit provides two identical RST flip-flops. It can be used in circuits with noise levels as high as 2.5 v. In addition to reset, set, and trigger (or binary) operation, provision is made for a manual reset. Pulse repetition rates to 150 kc with a 4-μsec resolution are standard. This circuit can be used with other plug-in circuits and mounting hardware to fabricate all types of medium speed digital or hybrid systems.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville, Tenn.

Availability: Delivered 3 weeks after order received.

ELECTRONIC DESIGN • March 2, 1960

Modulator Pulser

624

Contains four phase-shift oscillators



Model P-31 command modulator pulser contains four separate phase-shift oscillators covering the frequency range of 50 to 1000 cps. Any two oscillators are selected by front-panel push buttons. The unit contains a PRF generator with a range of 200 to 2000 groups per sec. The generator delivers a complex three-pulse output train; one pulse can be varied from 10 to 100 μ sec. One of the pulses is delay-modulated between 0 and ± 10 μ sec from the nominal value by the added frequency output of two selected phase-shift oscillators.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

Thermocouple Junctions

628

Come in 47 different models



A total of 47 different models, in each of three optional styles providing sensitivities from 2.5 to 1000 ma full scale, make up this line of vacuum thermocouple junctions. Both contact and insulated-heater types are included. The exact value of open-circuit voltage and junction resistance are individually calibrated to $\pm 0.5\%$ and marked on the unit case. For high precision uses, all units are available with an integral thermodynamically-controlled heater.

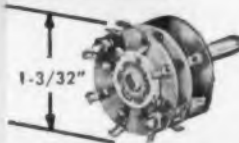
The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

Price & Availability: Delivered 15 days after order received. Prices range from \$35 to \$65, depending on type. Quantity discounts available.

EVERYTHING

IN Low-Power Switches

ROTARY



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

Series A



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

Series F



ADAPTABLE: 8, 10, 12, and 14 positions; many variations; economical.

Series J, K, N



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

Series H



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

Series QH



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

Series L



24-POSITION: 15° throw handles complex circuits.

Series MF



LOW COST: 2 to 5 positions; fits in limited space.

Series 50, 53



SIMPLE SWITCHING: Up to 5 positions combined with AC switch.

Series 52, 54



SIMPLE SWITCHING: Up to 4 positions; numerous variations.

Series 20



LEVER OPERATED: 2 to 5 positions; numerous variations using std. wafers.

Series 185



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



FOR PRINTED CIRCUITS: Special lug designs for direct insertions.

Endless Variety from Standing Tools



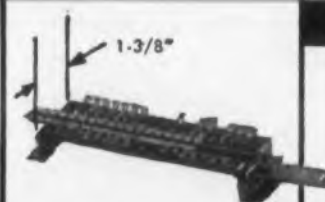
SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

SLIDE



2-POSITION: Shorting type with floating slider.

Series 70



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

Series 150

ROTARY SLIDE



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

Series 160

PUSHBUTTON



SINGLE BUTTON—1 to 4 poles; spring return and push-push.

Series 170, 175



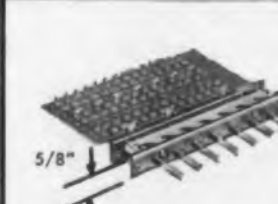
SIMPLER CIRCUITS: 3 to 12 buttons; very adaptable unit.

Series 80



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

Series 130



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

Series 131

Quick Solutions for Busy Designers

OAK MFG. CO.

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

Designing a low-power switch can sometimes turn into a real tussle. Before this happens, call in Oak specialists. From a vast store of past designs and experience they are able, many times, to offer a readymade solution... whether it be for a standard unit, something unusual, or a complete package of circuitry. The result is the exact switch you need, representing top engineering and optimum economy.

CIRCLE 39 ON READER-SERVICE CARD



...and now for a spot of welding!

Still at it? Trying to improve potentiometer reliability by building 'em yourself? Well, you're on the right track about one thing — welding's a sure way to eliminate a lot of operational headaches — like gassing contamination of contact metals at high temperature, from organic solder flux. No chance of "cold joints", either, to increase circuit resistance. No soldered connections to come loose under vibration and shock. Welding is the way to reliability!

But why set the wife's drapes afire to get a reliable, all-welded pot? Utilizing welding techniques, Ace produces reliable potentiometers operable at temperatures exceeding 150°C. and able to withstand 50 G's at 2000 cycles. All this, plus extremely low contact resistance and longer rated life. All taps, end connections, resistance elements, contact assemblies and terminal leads are specially prepared beforehand — then welded with pure nickel or palladium silver. So, for built-in reliability through sounder construction techniques, see your ACErep!

This 2" AIA Acepot® (shown 1/2-scale) incorporates all these exclusive welding construction features, for superior reliability.



ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOMerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim® Aceset® Aceohm® *Reg. Appl. for
CIRCLE 40 ON READER-SERVICE CARD

NEW PRODUCTS

Metallized-Paper Capacitors 619

Plastic-cased



Type P8292ZN metallized-paper capacitors have Polycap plastic cases construction and a high temperature solid impregnant. They offer excellent humidity resistance and improved insulation resistance characteristics. A wide range of sizes, voltages and capacitances are available.

Aerovox Corp., Dept. ED, New Bedford, Mass.

Portable Amplifier 635

For recording galvanometers

Model ASA-200 dual-channel amplifier system, designed to accept any two of the firm's preamplifiers, consists of two transistorized driver amplifiers housed in a portable cabinet. The system provides a power source for driving recording galvanometers. The input is ± 0.05 to $+200$ v for ± 10 mm deflection, the input impedance is 5 meg single ended and 10 meg differential, and the output is 600 ma max into a 20-ohm load. Drift is less than 2 mv equivalent input per hr at maximum gain.

Cohu Electronics, Inc., Massa Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

Core Mountings 622

Have one-piece construction



These core mountings accommodate 1600 different U and E core sizes. Having one-piece construction, they are made from steel or aluminum. Several adjustable lengths and 42 different strip widths are offered. More than one core can be mounted on a single strip.

Coremount, Dept. ED, 704 W. Slauson Ave., Los Angeles 44, Calif.



ALWAYS A
WINNING
HAND—WHEN
YOU SPECIFY

C-A-C

"POKER CHIPS"

Epoxy cast units resulting from C-A-C design engineering:

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Pulse transformers;

DC to DC converters

400 cycle power transformers.

Can be subminiaturized within performance limits. Terminal arrangements to meet requirements. Mil. Specs. Fast Delivery.

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LEE'S SUMMIT, MISSOURI

CIRCLE 41 ON READER-SERVICE CARD
ELECTRONIC DESIGN • March 2, 1960

Frequency Standards

625

Stability is 1 part in 100,000,000 per day



Available in frequencies of 1, 1.8, 2.5, 3, and 5 mc, the JKTO-PIP frequency standards offer a stability of 1 part in 100,000,000 per day under normal conditions. These compact, precision, plug-in signal sources use stable glass-sealed crystals, matched-design silicon-transistor oscillator circuitry, and proportional control oven performance. Other frequencies can be supplied on special order. Standard units have an output of 1 v into 500 ohms, operating from 24 to 28 v dc. Dimensions are 2 x 1.84 x 2.875 in. Weight is 10 oz.

The James Knights Co., Dept. ED, Sandwich, Ill.

Magnetic Force Welding Machine

634

For full area percussion welds

Model APPAMPF-1-100-12 magnetic force welding machine makes full area percussion welds. Specifically designed for welding silver alloy relay contacts in motor starters, it can be adapted to other operations requiring the joining of non-ferrous metals. The unit is composed of a 100-kva magnetic force projection and spot welding machine with a dc holding coil delayed forge, diaphragm safety head, and selective micro-switch firing features.

Acro Welder Manufacturing Co., Dept. ED, 1719 W. St. Paul Ave., Milwaukee 3, Wis.

Frequency Converter

636

Has magnetic-core components

This magnetic-core frequency converter is designed to convert three-phase power to either single-phase or three-phase power at a frequency which is seven times the supply frequency. Units are available in 2.5, 5, 10, and 20 kw sizes for converting 60 cps power to 420 cps.

Cambridge Products Corp., Dept. ED, 141 Main St., Cambridge 42, Mass.



You get an extra measure of design freedom with ... POWDERED PERMALLOY FILTEROID® CORES*

The high permeability and low core loss of powdered permalloy filteroid cores can remove design roadblocks for you. You can build extra frequency stability into filter networks with these cores. Their permeability *remains* stable with changes in time and flux levels. Distortion factors are held to a bare minimum. Temperature coefficient of inductance is tightly controlled.

There's extra design flexibility for you, too, in

the broad range of Filteroid cores available. They're made in three standard permeabilities—150, 125 and 60—in sizes up to 1.570" O.D., all carried in stock for immediate shipment.

Our engineers are ready right now to help you select the proper Filteroid core for your filter circuits. Write or call for a discussion of your needs, or send for Bulletin G-1.

*MADE UNDER A LICENSE AGREEMENT WITH WESTERN ELECTRIC COMPANY

MAGNETIC METALS

transformer laminations • motor laminations • tape-wound cores
powdered molybdenum permalloy cores • electromagnetic shields

MAGNETIC METALS COMPANY • Hayes Avenue at 21st Street, Camden 1, N. J.

CIRCLE 42 ON READER-SERVICE CARD

NEW PRODUCTS

Power Amplifier

630

Operates in telemetry band



Designed to amplify a 2-w signal to as high as 100 w, model PA-15 power amplifier operates in the 225 to 260 mc telemetry band. A self contained 400 cps blower is provided to give sufficient cooling air for conditions of maximum rf output. The unit withstands vibration of 10 g from 20 to 2000 cps, and shock and acceleration of 100 g each. Its operating temperature range is from -67 to $+176$ F.

United Electrodynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Analog-to-Digital Converter

620

Has servo type mounting



Type 18-1077 analog-to-digital converter with servo type mounting is for use in a military aircraft program, but variations of the unit are applicable in both military and industrial computer-controlled systems of automation, processing, programming and other servo devices. The maximum rated input speed is 400 rpm and life of the unit is 1,000,000 revolutions or 1000 hr of normal operation. Angular bit length is 18 deg, 100 revolutions of the input shaft are required to complete the code from 0 to 999 or from -0 to -000 , and accuracy is within $1/3$ of any bit in the entire range.

Memcor, Courter Products Div., Dept. ED, Boyne City, Mich.

new product designs get extra



● **FOR LONG LIFE**—The "Angler" Fathometer® is a portable, transistorized depth finder made by Raytheon Company for

fishing and boating enthusiasts. It aids in navigation and finding fishing holes by means of ultrasonic sound beams, pow-

ered by Mallory mercury batteries. Their longer life eliminates inconvenience of frequent battery changes.

ra sales appeal from

MALLORY MERCURY BATTERIES

Look to the amazing capabilities of Mallory mercury batteries for extra performance values, new sales appeal in your battery-powered electronic equipment . . . both in new designs and in product improvements. Pioneered and perfected by Mallory, mercury batteries give you features far superior to other commercial dry cells.

SMALLER SIZE—Mallory mercury batteries have a high energy-to-volume ratio, are miniaturized without performance loss.

HIGH STABILITY—Output remains so constant that they can be used as reference voltage standards. Constant voltage discharge is ideal for transistor circuitry.

EXTRA DEPENDABILITY—Mallory mercury batteries give at least four times longer service life than conventional types. Tests prove they can be stored as long as six years without appreciable loss of capacity. They operate over wide temperature ranges.

EXTRA CONVENIENCE—Longer life reduces frequency of battery changes.

The examples shown here are but a few of the many new electronic products now utilizing the outstanding characteristics of Mallory mercury batteries. Our application engineers will welcome the chance to discuss how you can apply these extra values to your products. We have a wide line of standard single and multiple voltage cells available . . . and we can develop customized power packs to your specifications. Write today for a consultation, and for our latest mercury battery engineering data.

MALLORY BATTERY COMPANY
Cleveland, Ohio
a division of

P. R. MALLORY & CO. Inc.
MALLORY

In Canada, Mallory Battery Company of Canada Limited, Toronto 4, Ontario

CIRCLE 43 ON READER-SERVICE CARD



IDEAL FOR TRANSISTOR CIRCUITS

A pocket-size radiation detection alarm for personal and area protection, FIDO[®] produces a warning sound clearly heard many feet away. Controls for Radiation, Inc. chose Mallory mercury batteries as the power pack because they ideally fit transistor circuit requirements for compactness and steady voltage output.

[®] Trademark—Fallout Intensity Detection Oscillator.



SMALL SIZE, STEADY VOLTAGE

This noise survey meter is used for measuring noise hazard in industrial hygiene studies, for noise reduction surveys and for architectural acoustic measurements. This small portable instrument is powered by a single Mallory mercury battery, chosen for its small size, steady voltage and long life.



FOR ACCURATE OUTPUT

This new small boat tachometer designed by McCulloch Corporation's Marine Products Division depends on Mallory mercury batteries as a voltage reference source. Open circuit output stays constant within 1% over periods up to 36 months.



NEW LOW-TEMPERATURE CELL

The RM-1450R mercury cell, using ribbon wound anode, gives considerably higher capacity at low temperatures. Ideal for emergency beacons, marker lights, rescue transceivers, it produces over 10 times as much output as earlier mercury cells at 32°F, and gives useful output even at -20°F. Capacity of packs is up to 45 watt-hours per pound. Write for new folder.

Radar Beacon

623

Measures 1-1/4 x 2-7/8 x 5-3/4 in.



Model SRT-3081 radar beacon measures 1-1/4 x 2-7/8 x 5-3/4 in. and weighs 1-1/4 lb. For the receiver and transmitter, the frequency range is 2750 to 2950 mc and stability is ± 2 mc. The following environmental conditions are met: temperature range, -54 to +125 C; vibration, 10 to 100 cps at 25 g; acceleration, 50 g; shock, 15 g; and altitude, 60,000 ft.

Telerad Manufacturing Corp., Dept. ED, 1440 Broadway, New York 18, N.Y.

Semiconductor Materials

632

Include gold, silver, and platinum

Gold, silver, platinum, and other precious metals are provided in the pure state or alloyed with other materials. Fine diameter wire, ribbon, sheets, rings, and preforms are offered for semiconductor use.

Western Gold and Platinum Co., Dept. ED, 525 Harbor Blvd., Belmont, Calif.

Tape Loop Magazine

621

Handles 120 ft of tape



This tape loop magazine contains easily threaded rollers for handling 1/4, 1/2, or 1-in. tape up to 120 ft in length. All standard tape speeds from 1-7/8 in. per sec can be selected. This unit allows the firm's PS-200 recorder to be used for delay applications and spectrum analysis of up to 14 channels of data. The magazine is compact in size.

Precision Instrument Co., Dept. ED, San Carlos, Calif.

Solving switch problems fast...

your job... and **Centralab's**



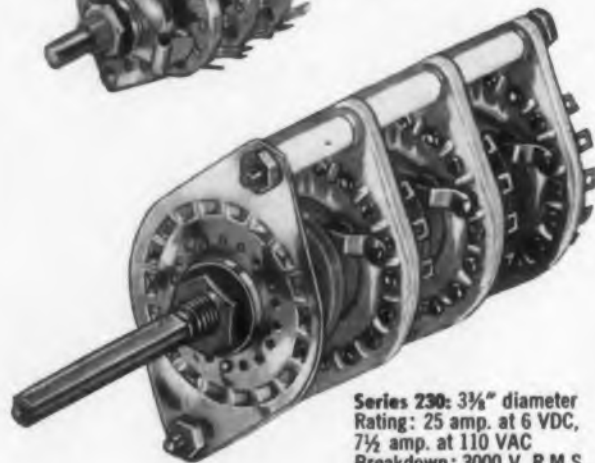
Series 100: 1/8" diameter
Rating: 0.5 amp. at 6 VDC,
100 ma at 110 VAC
Breakdown: 750 V. R.M.S.
Up to 12 positions/section



Series 20: 1/8" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 12 positions/section



Series 275: 1/8" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 23 positions/section



Series 230: 3/8" diameter
Rating: 25 amp. at 6 VDC,
7 1/2 amp. at 110 VAC
Breakdown: 3000 V. R.M.S.
Up to 24 positions/section

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

DESIGN AIDS FOR ENGINEERS

CENTRALAB's unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

ELECTRONICS DIVISION OF GLOBE-UNION INC.
960C E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto 17, Ont.

NEW PRODUCTS

Miniature Servo Indicators 618

Have modular construction



The modular construction of these miniature servo indicators utilizes standard stock parts and is suitable for prototype and limited production applications. The basic module is the gear-box in which up to seven shafts measuring 0.0937 in. in diameter are mounted in ABEC-7 ball bearings. Gear ratios up to 65,000:1 can be obtained using precision 2-stock gears. The component module uses standard plates for mounting size 8 or 10 rotating components. Indicators have these possible configurations: integrally lighted, vernier pointer and dial presentation, and high input impedance transistorized indicators. The cases conform to MS-33639. Silicon transistors, diodes, and tantalum capacitors used meet MIL-E-5272 environmental requirements.

Servo Development Corp., Dept. ED, 567 Main St., Westbury, N.Y.

Subcarrier Oscillators 629

Supplied for MIL-STD-442 bands



Both models of these transistorized subcarrier oscillators are supplied for MIL-STD-442 bands; the VC-14 for channels 7 through 18, and the VC-15 for channels A through E. The units come with a bandpass filter which prevents interchannel interference, and have a cascaded emitter-follower input to achieve high input impedance. The oscillators measure less than 3 cu in., and weigh 5 oz. They are completely sealed in an aluminum case and meet the requirements of MIL-E-5272B for vibration, shock, and acceleration.

United Electrodynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

CIRCLE 201 ON READER-SERVICE CARD ►
ELECTRONIC DESIGN • March 2, 1960

Centralab

P-5917

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VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS
CIRCLE 200 ON READER-SERVICE CARD

Video Generator

520

Wide range type



Model 1300-A wide-range beat-frequency video generator is suitable for point-to-point, transient, and sweep testing. It can also be used as a source for acoustic and ultrasonic tests as well as testing of video systems, amplifiers, discriminators, networks, and video filters. Ranges are: 20 cps to 20 kc, sine or square wave for audio and 20 kc to 12 mc, sine, and 20 kc to 2 mc, square wave, for video signal and sweep. All signals are monitored by an output voltmeter and are available from an output attenuator. Output levels are 10 v for both sine and square wave. The unit mounts in a 19-in. relay rack.

General Radio Co., Dept. ED, W. Concord, Mass.

Price & Availability: Price is \$1950 per unit. It will be available from stock in May, 1960.

Environmental Chambers

515

For wire testing



These environmental chambers are designed for testing wire and insulation breakdown in accordance with military specifications. They are constructed so that a mandrel can be installed in the upper part of the chamber. By means of outside control, the wire is wound on the mandrel without disturbing the test temperature. The cabinet measures 84 x 20 x 42 in. and the test chamber is 12 x 12 x 72 in. Units operate on 230 v and offer a temperature range of -10 to -80 F.

Cincinnati Sub Zero Products, Dept. ED, 3932 Reading Road, Cincinnati 29, Ohio.

Now

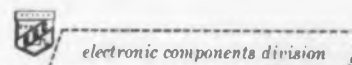
AMERICA'S LARGEST MANUFACTURER OF COMMERCIAL VIDEO TRANSFORMERS

In just two years the Electronic Components Division of ESC has become the nation's leading supplier of quality custom-built and stock Video Transformers.

ESC Video Transformers are designed and manufactured to meet the requirements of simultaneous transmission of both low and high frequencies commonly encountered in television, computers, scatter transmission, atomic instrumentations, etc.

Additional applications include interstage coupling, phase inversion, isolation and pulse applications requiring extremely wide range in pulse width of good waveform.—Bandwidths from audio to above 10 mc.—available cased and uncased, in stock designs or to your rigid specifications.

Write today for complete technical data.



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and still AMERICA'S LARGEST PRODUCER OF CUSTOM-BUILT AND STOCK DELAY LINES

ESC was the first company devoted exclusively to the design and manufacture of custom-built and stock Delay Lines... for military and industrial applications. Whatever the requirement, ESC can

design and build precisely the Delay Line you need—easily, efficiently and exactly as specified. Write today for complete technical data.



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Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 45 ON READER-SERVICE CARD

618

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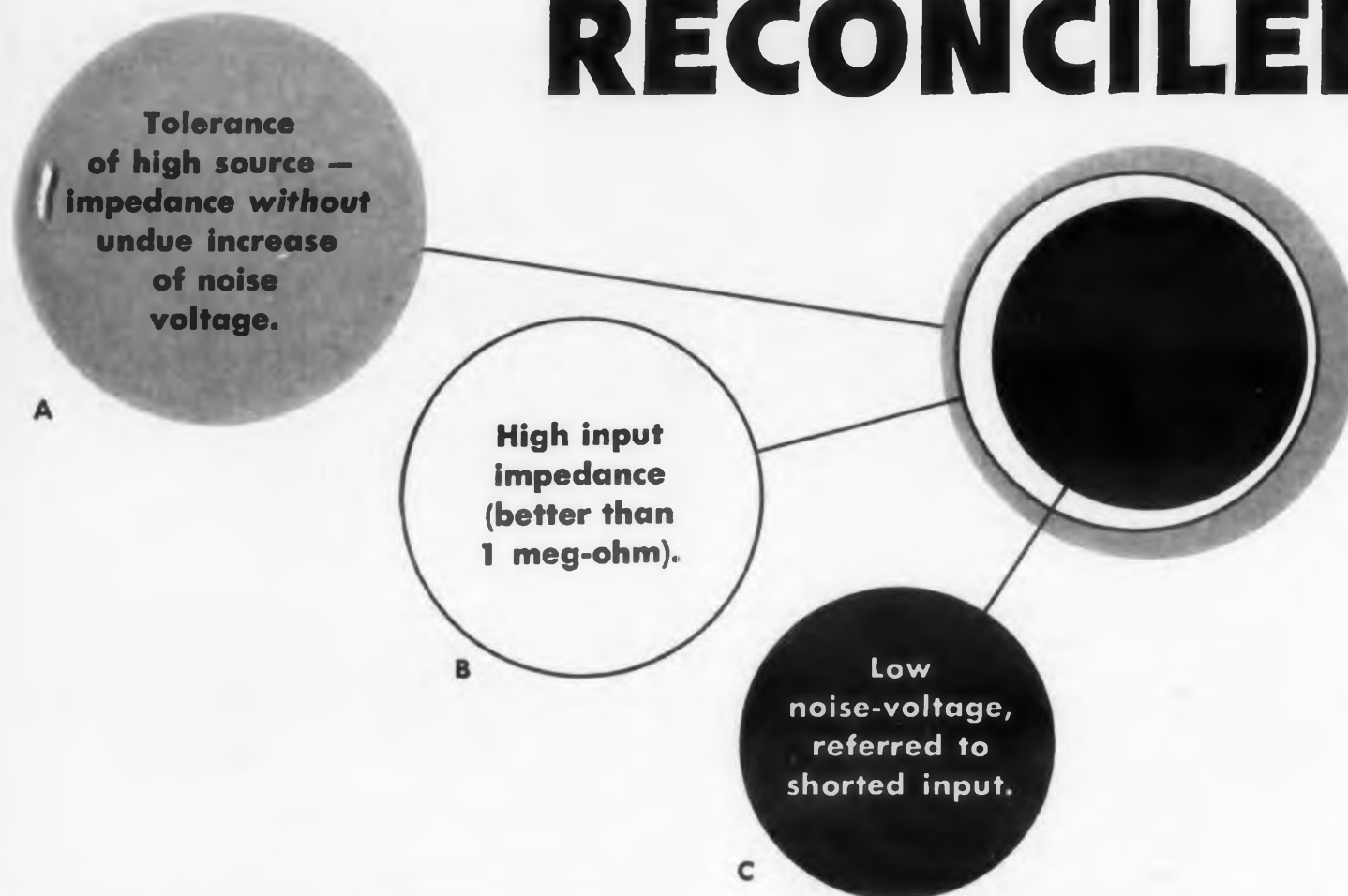
D, 200

CARD >
1960

Another breakthrough in amplifier noise reduction . . .

3 low-noise amplifier characteristics

RECONCILED



↙ VS-66A ↘	Parameter	Z Source	↙ VS-68A ↘
0 to 40, db, 5 steps	Gain	—	10 to 80 db, 8 steps
10 meg	Z _{Input}	—	selectable 10 k or 10 meg
20 cps to 2 mc	Freq. Rg.	—	20 cps to 180 kc
0.7 uV RMS	^e N-in, B=10 kc	0 ohms	0.2 uV, 10k input & 1.4 uV, 10 meg input
0.75 uV RMS	"	100 ohms	0.3 uV, 10k input & 1.5 uV, 10 meg input
0.8 uV RMS	"	500 ohms	0.8 uV, 10k input & 1.6 uV, 10 meg input
0.85 uV RMS	"	1 k	1.3 uV, 10k input & 1.7 uV, 10 meg input
1.9 uV RMS	"	10 k	4.2 uV, 10k input & 3.6 uV, 10 meg input
5.5 uV RMS	"	100 k	— — — 11.0 uV, 10 meg input
10 uV RMS	"	1 meg	— — — 20.0 uV, 10 meg input

The three amplifier characteristics illustrated (A, B and C) are often considered contradictory, even irreconcilable. True, there are amplifiers which exhibit low-noise voltage, referred to the shorted input terminals. Fact is, our VS-64A still holds the record in this field — less than 0.5 mu V RMS over a 60 kc pass band. Also, there are many high input impedance amplifiers. But never before have low-noise voltage characteristics and high input impedance been combined with a highly incompatible third stipulation: tolerance of high source impedance, without spoilage of premium shorted-input noise performance, by insertion of a comparatively large source impedance.

Two new Millivac low-noise amplifiers — the VS-66A and VS-68A — combine all 3 of these most desirable characteristics to meet the demands of the Space Age for extended communications and control ranges.

tomorrow
is our
yesterday

MILLIVAC
A DIVISION OF
COHU
ELECTRONICS, INC.

Box 997

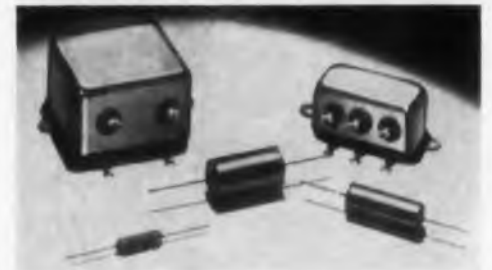
Schenectady, New York

CIRCLE 46 ON READER-SERVICE CARD

NEW PRODUCTS

Metallized Mylar Capacitors 524

Bath-tub and tubular types



These metallized Mylar capacitors are available in type AB bath-tub and type AM metal tubular designs. They have a temperature range for operation and storage of -90 to $+125$ C. Capacitance tolerances are 1%, 2%, 5%, 10%, and 20%. Dielectric absorption is low. Made to meet Mil specs, they have applications in computer circuits, audio coupling, tuned filters, oscillator circuits, power supply filters, and other devices.

Plastic Capacitors, Inc., Dept. ED, 2620 N. Clybourn Ave., Chicago 14, Ill.

Price & Availability: Price varies from \$0.54 to \$6 for units when ordered in quantities of 1000. Some are available from stock. Delivery time is a maximum of 30 days.

Power Supplies 519

For original equipment and laboratory uses



For original equipment, ground support systems, computers, and laboratory use, these power supplies provide from 6 to 50 v with currents to 1 amp, and up to 2000 v at 1 ma. Outputs can be fixed or adjustable, as specified by the user. Both ac-dc and dc-dc types are offered. Type 320, shown, operates from 115 v at 60 cps and supplies 18 to 24 v dc, adjustable. It has a regulation of 0.5% from no load to 250 ma. At full load, regulation is 0.2% for a $\pm 10\%$ change in input voltage. Maximum peak-to-peak ripple is 0.005 v.

Transistor Specialties, Components Div., Dept. ED, Terminal Drive, Plainview, N.Y.

Price & Availability: Price is \$69.50 ea. Delivery time is 10 days.

Acceleration Switch

575

Repeatability is within 0.1 g



Model 200 multi-level, uni-directional acceleration switch consists of a gas-damped seismic system with a range of 1 to 10 g, an accuracy of ± 0.1 g, repeatability within 0.1 g, and a damping ratio of 0.8:1. A single-axis switch, it successively closes four independent electric circuits with a common point, in response to preset acceleration levels. The unit operates over the temperature range of -60 to $+250$. It is normally open single-pole, four steps, with contact ratings of 100 ma each. Hermetically sealed, it weighs 20 oz and measures 3.25 x 1.75 in. Requirements of MIL-A-22145 are met.

W. L. Maxson Corp., Instruments Div., Dept. ED, 475 Tenth Ave., New York 18, N.Y.

Price & Availability: Units are made on order and are furnished in sample quantities only. They can be delivered 45 days after receipt of order. Price is \$250 ea for quantities of 1 to 10.

VHF Admittance Bridge

576

Accuracy is 2% to 300 mc



Model 978 vhf admittance bridge, using a miniature thermistor element in a servo feedback system as a conductance, has an accuracy of 2%. Range of the instrument is 30 to 300 mc. The capacitance range is ± 40 μ f and the conductance range is 0 to 50 mmhos. Two terminal measurements can be made on rf components, semiconductor components, and transmission lines. The test voltage is rarely more than 50 mv. Bridge sources and detectors can be supplied for operating the bridge, although any signal generator and receiver covering the frequency range can be used.

Measure dc currents 0.3 ma to 1 ampere with

No Breaking of Leads No DC Connection No Circuit Loading



428A CLIP-ON MILLIAMMETER.

Probe clamps AROUND wire; measures by sensing magnetic field!

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

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

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

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

Specifications

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

Accuracy: $\pm 3\% \pm 0.1$ ma.

Probe Inductance: Less than 0.5 μ h maximum.

Probe Induced Voltage: Less than 15 mv peak.

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

Power: 115/230 v $\pm 10\%$, 50-60 cps, 70 watts.

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

Probe Tip Size: Approximately $\frac{5}{16}$ " x $\frac{7}{16}$ ". Wire aperture diameter $\frac{3}{16}$ ".

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

Data subject to change without notice.

Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY

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6058

Test the new  405A DC Digital Voltmeter

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AND
NOW
THE
NEW
RCA

50FE5

FOR LOW-COST STEREO



Your answer to low-cost stereophonic or monophonic phonographs with high power-output capability is the new RCA-50FE5—the amazing beam power tube with big-league sound. Only 3 tubes—two RCA-50FE5's and one RCA-12AX7 and you have a complete, compact stereo amplifier.

At B+ voltage of only 145 volts, this 3-tube stereo amplifier can deliver up to 4.3 watts of audio output per channel with cathode bias, and up to 5.6 watts per channel with fixed bias. In a monophonic system with the same low B+ voltage and cathode bias, two RCA-50FE5 tubes in a push-pull circuit can deliver up to 8.5 watts of audio power.

So, if it's high power output at low cost you're after, design your stereophonic and monophonic circuits with the RCA-50FE5. There's a 6-volt heater type (RCA-6FE5) available too! Ask your RCA Field Representative for all the facts. For technical data, write RCA Commercial Engineering, Section C-18-DE1, Harrison, N.J.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS



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Chicago 54, Ill. WH 4-2900

WEST: 6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAYmond 3-8361

NEW PRODUCTS

Repeat Cycle Timer 544

Provides a 1-min on-off output

Model WC-605 repeat cycle timer provides a repetitive 1-min on-off output. Using an RC method of measuring the time interval, the circuit has an over-all accuracy of ± 3 sec. The dual gate output is arranged so that when one gate is closed, the other is open. The device operates from 28 v dc.

Webcor, Inc., Dept. ED, 816 N. Kedzie Ave., Chicago 51, Ill.

Power Supplies 549

Many dc types available

These modular dc power supplies are available in ten models. Models 21-101A through 21-103 unregulated supplies provide 28 v at 2 to 10 amp; each operates from an input of 0 to 125 v ac at 50 to 400 cps. Model 22-101A magnetic-amplifier supply provides 28 v at 5 amp and requires 105 to 125 v ac at 50 cps. Models 22-102A through 22-109A vacuum-tube types have outputs from 150 to 500 v at 0.07 to 0.3 amp. They require 105 to 125 v ac at 50 to 400 cps.

Dressen Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif. *Price & Availability: Units will be available from stock after March 1, 1960. Price varies from \$45.50 to \$169.50.*

Adhesive For Teflon 668

Supplied in kit form

Type 746 adhesive is supplied in kit form for laboratory and production use. Each kit includes a treating agent to prepare the Teflon surface and a bonding agent that cures in a few hours. It can be used with any grade of Teflon or other fluorocarbon plastic.

Plastic Associates, Dept. ED, 185 Mountain Rd., Laguna Beach, Calif. *Price & Availability: The kit is available from stock at a price of \$8. It is shipped two days after receipt of order.*

Potentiometer 540

Has size 9 front end mounting

The series 4 Vernistat potentiometer now comes with a size 9 front end mounting. The unit employs the standard 1-1/16 in. diam housing of the ac potentiometer, but the shaft end of the enclosure has been machined to suit BuOrd size 9 requirements. This permits retrofit application of the unit in systems designed to use conventional size 9 potentiometers.

Perkin-Elmer Corp., Vernistat Div., Dept. ED, Norwalk, Conn.

Price & Availability: Made on order only and delivered 8 to 10 weeks after order received. Price is \$625 per unit, special fabricating charges included. When ordered in quantities of 100 and up, price is \$325 per unit.

Printed Circuit Transformer 546

With relay bobbin

This printed circuit transformer, with a relay bobbin, is designed to prevent wire breakage. Lugs are embedded in nylon for permanent location. Special bobbins can be made to customer specifications.

American Molded Products Co., Engineering Dept., Dept. ED, 2727 W. Chicago Ave., Chicago 22, Ill.

Receiver-Decoder 538

Frequency is crystal controlled

Model BCR-39 receiver-decoder has crystal controlled frequency coverage over the range of 400 to 550 mc. The all transistor unit is specifically designed for missile-command, destruct use. An input of 5 μ v or less will command destruct. Dimensions of the unit are 2-1/2 x 4-1/4 x 5-1/2 in. and weight is 2 lb.

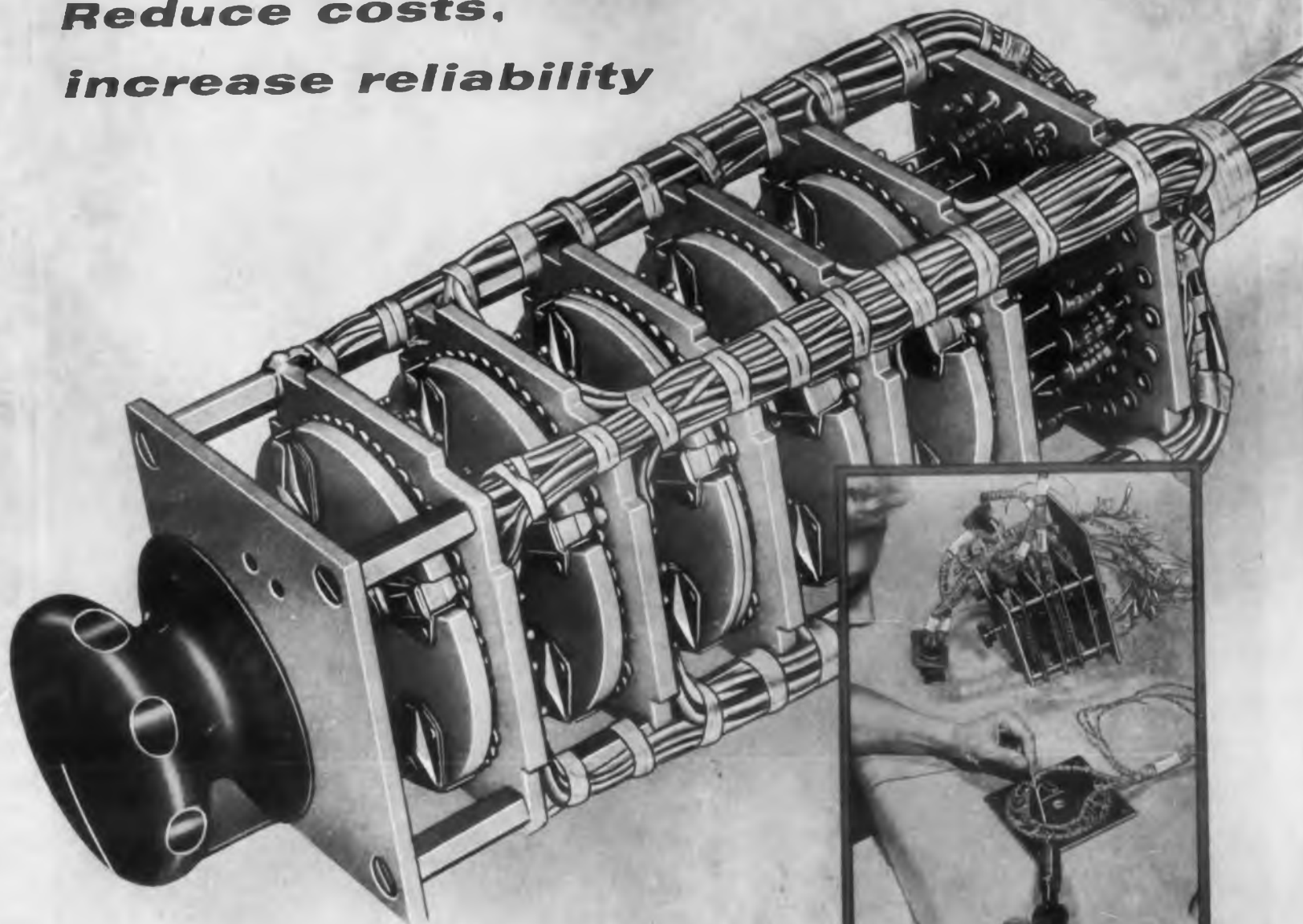
Babcock Radio Engineering, Inc., Dept. ED, 1640 Monrovia Ave., Box 344, Costa Mesa, Calif.

Price & Availability: Delivery is 120 days after receipt of order. Price on request.

CIRCLE 49 ON READER-SERVICE CARD



**Reduce costs,
increase reliability**



...with

PRE-WIRED Daven switch assemblies

Daven has established a completely new Packaged Assembly Department. This group assembles various components on Daven rotary switches, does all internal wiring, any external cabling necessary, and pre-tests the entire package. In switch wiring, it is very often easier and less time consuming to wire and make connections to switch decks before they are stacked as a complete unit.

Thus, you can now have a completely tested sub-

assembly, instead of a mixed group of components and switches which ordinarily would have to be individually checked, assembled, soldered, and tested. Daven takes complete responsibility for the design, fabrication, testing and overall reliability of this assembly package.

For more information about Daven's new Packaged Assembly Service, write today.

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

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



**Waters
new
pots
conquer
space**

Two new 1/2" Waters pots conquer a space problem for many a harassed space age engineer. Both require up to 25% less space behind the panel than pots having identical specifications. Available with terminals (shown), wire leads or printed circuit pins. Case lengths are only 3/8". The new APS 1/2 is designed for bushing-type mounting. The WPS 1/2, designed for servo mounting, is the smallest potentiometer available for general use in rugged servo applications. Both are capable of dissipating 2 watts continuously! Reliability test reports available. Write for Bulletin APS-160.



POTENTIOMETERS • SLOW TUNED COIL FORMS • RF COILS • CHOKES • POT DUCK® PANEL MOUNTS • TORQUE WATCH® RANGES • CONTROL METER/CONTROLLER • INSTRUMENTS

CIRCLE 50 ON READER-SERVICE CARD

NEW PRODUCTS

Differential Amplifier

678

Provides 10^7 to 1 common-mode rejection

Providing common-mode rejection of 10^7 to 1, type 1-102 transistorized differential dc amplifier has a true floating input and stability of 0.05%. Gain is variable in steps of 10, 20, 30, 50, 100, 200, 300, and 500. The unit operates with both input and output isolated from each other and from ground. This design eliminates the chance of accidental voltage drops.

Neff Instrument Corp., Dept. ED, 2211 E. Foot-hill Blvd., Pasadena, Calif.

Photoconductive Cell

529

For infrared use



Type 63TV photoconductive cell is designed for use in the infrared regions. Using cooled lead telluride, it has a spectral response range of 0.6 to 6 microns with a peak response of 4.2 microns. The sensitivity is 1300 v rms per w, peak-to-peak, and the signal to noise ratio is 500:1. These measurements are from a black body at 200 C; sensitivity of the cell increases rapidly with the radiation source temperature. The sensitive area is 0.1 sq cm and the minimum detectable power at 4 microns is 1.1×10^{-10} w.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

Price & Availability: Sample quantities are now available from stock.

Voltage Regulator

674

Has 30 v max output

Voltage regulator model 1807-0300 has a maximum output of 30 v and a voltage drop of 1.6 v dc at 350 ma. It is suited as a surge limiter to protect transistor amplifiers against the 80-v transient peaks encountered in the 28-v dc aircraft power supply. The unit measures 1-1/8 x 1-1/8 x 1-1/4 in. and weighs 3 oz. It meets environmental requirements of MIL-E-5400 and power requirements of MIL-E-7894.

M. Ten Bosch Inc., Dept. ED, Pleasantville, N.Y.

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WOOrth 6-5300

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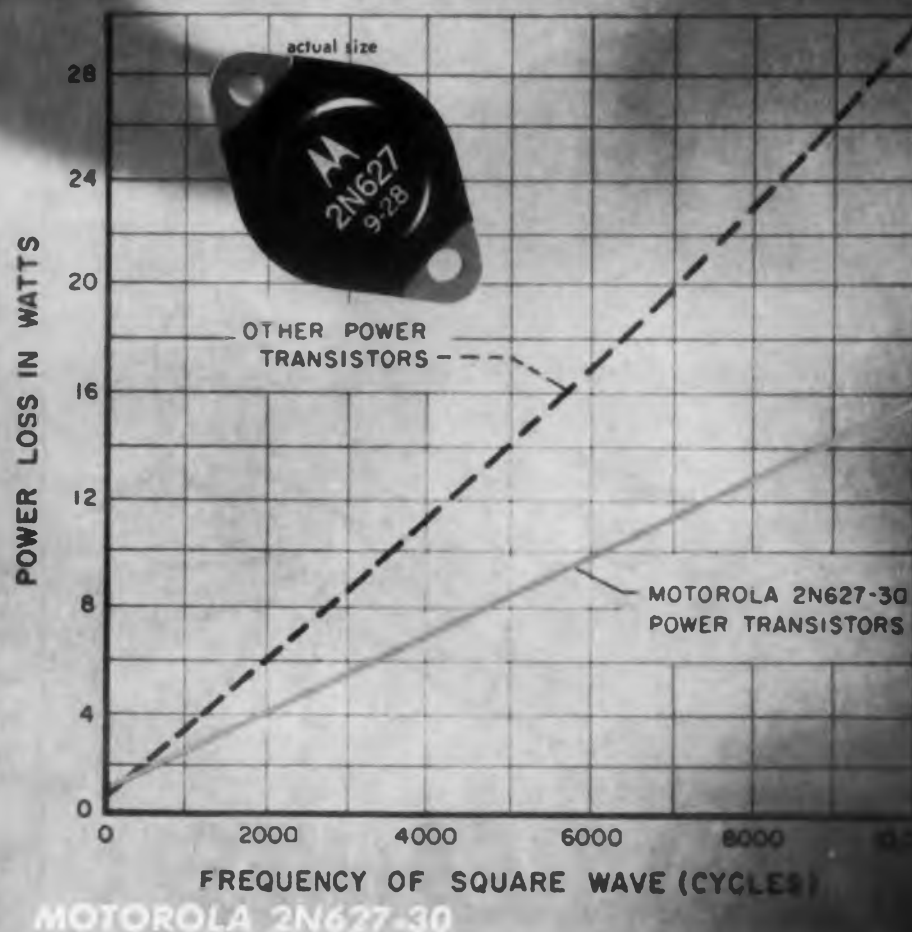


Faster switching speeds combined with low saturation resistance make Motorola 2N627-30 power transistors ideal for industrial power-switching applications. Their low power loss results in greater circuit efficiency especially for applications operating above 400 cps. In addition, these 10 amp power transistors offer: High voltage breakdown . . . flat gain vs current curve . . . and low I_{CBO} . Their high reliability is proven in more than 20 million hours of life-test data.

Motorola 2N627-30 power transistors are IMMEDIATELY AVAILABLE, in engineering quantities, from your nearest Motorola Semiconductor Distributor, who also carries a full line of Motorola mounting hardware. Call him, today!

FOR MILITARY APPLICATIONS . . . Motorola offers the 2N1120, a 10 amp power transistor designed to meet MIL-T-19500A/68 (Sig. Corps) specifications. These units are available, in quantity, through your Motorola Semiconductor district office.

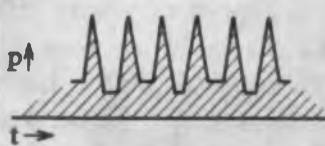
POWER LOSS vs FREQUENCY IN TYPICAL SWITCHING OPERATION



FOR MORE EFFICIENT SWITCHING

Less power loss . . . improved circuit performance

HIGH FREQUENCY POWER LOSS



HOW TO DETERMINE AVERAGE POWER LOSS

$$P_{loss} = \frac{I_c}{6T} (V_o + 2V_{ce}) (t_r + t_f) \text{ switching loss} \\ + \frac{I_c V_{ce}}{T} \left(\frac{T}{2} - t_r \right) \text{ "on" loss} \\ + \frac{I_{on} V_r}{T} \left(\frac{T}{2} - t_f \right) \text{ "off" loss}$$

Where I_c is maximum collector current.
 V_o is maximum collector voltage.
 V_{ce} is minimum collector voltage.
 I_{on} is collector cutoff current.
 T is period of square wave.
 t_r is rise time.
 t_f is fall time.

NOTE: In push pull converter operations, wave shapes are generally symmetrical because of feedback, and "storage" time can be considered as part of the "on" time.

DESIGN CHARACTERISTICS at 25° ± 3°C

	2N627	2N628	2N629	2N630	2N1120 Units
BV_{CBO} max	40	60	80	100	80 volts
BV_{CES} max	30	45	60	75	70 volts
I_c max	10	10	10	10	15 amps
T_j max	100	100	100	100	100 °C
$V_{CE(sat)}$ max ($I_c=10A, I_b=1A$)	1.0	1.0	1.0	1.0	1.0 Vdc
$f_{\alpha e}$ (typical)	8	8	8	8	8 Kc

SWITCHING TIME (based upon average of a typical production lot) @ 10A

t_r	rise time	4.1	μSEC
t_f	fall time	13.2	μSEC
t_s	storage time	2.5	μSEC
Total switching time		19.8	μSEC

FOR COMPLETE TECHNICAL INFORMATION, APPLICATIONS ASSISTANCE AND PRICE INFORMATION contact your Motorola Semiconductor district office.

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N. Y. Coliseum

March 21-24



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ENGINEERING CORPORATION

108 Springfield Road,
Union, N. J.

CIRCLE 52 ON READER-SERVICE CARD

NEW PRODUCTS

Telemetry Transmitter

513

Range is 215 to 260 mc



Designed for aircraft and missile applications, model TRPT-250 crystal-controlled transmitter operates over the frequency range of 215 to 260 mc. Other characteristics are: output impedance, 50 ohms; frequency tune-up tolerance: $\pm 0.005\%$; modulation frequency range, 100 cps to 200 kc; and power output 0.25 w. The unit measures 2.6 in. in diameter and is 1.5 in. thick; it weighs about 9 oz.

Vector Manufacturing Co., Inc., Dept. ED,
Keystone Road, Southampton, Pa.

DC Power Supply

679

Provides 200 to 250 v dc



Model PS4017 power supply delivers 200 to 250 v dc. It is designed for a nominal input of 105 to 125 v ac; input may vary ± 10 v. Regulation provides a change of less than 0.2 v in the output for load variations from 0 to 1.5 amp with the line voltage held constant. Under no-load conditions, the supply continues to operate at the preset output voltage.

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

PNP Transistors

673

Intermediate-power types

Types 2N1183, 2N1183-A, 2N1183-B, 2N1184,
2N1184-A, and 2N1184-B pnp germanium alloy-
junction transistors use the JEDEC TO-8 pack-

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Write for complete, illustrated catalog.



THERMAL AMERICAN
FUSED QUARTZ CO., INC.
18-20 Salem St., Dover, N. J.

CIRCLE 53 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960

age and are for use in intermediate-power switching and audio-frequency applications in industrial and military equipment. Applications include: dc-dc converters, choppers, solenoid drivers, and relay controls; oscillator, regulator, and pulse-amplifier circuits; and as class A and B amplifiers for servo applications. Maximum junction temperature rating is 100 C. With mounting flange in place, they dissipate 7.5 w at 25 C; without flange, 1 w at 25 C. They have low saturation resistance and low leakage currents. A wide choice of voltage ratings and beta ranges are offered.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Rotary Potentiometers

559

Are 7/8 to 3 in. in diam



These precision rotary potentiometers, called Turnquate, range in size from 7/8 to 3 in. in diam. Featured in this line are: humidity sealed units, stainless steel units for operation to 200 C, high resolution, and self-phasing without loosening screws or clamp bands. Smaller units have dual outputs or two circuits. Units measuring 2-7/8 in. in length have 10 or 20 output circuits.

Subminiature Instruments Corp., Dept. ED, 4705 Sunnyside Drive, Riverside, Calif.

Price & Availability: Most units are available from stock or will be by March 15. Price ranges from \$15 to \$70 for orders of less than 10. Quantity discounts are furnished.

Battery

676

For use in missiles

Designed for use in missiles, model P63A battery weighs 4.2 lb and measures 2.75 x 5.5 x 5 in. The 19-cell battery provides 6 amp, with a maximum current of 15 amp. Discharge time is 10 min, and activation time is 0.2 sec. The silver-zinc battery withstands vibration to 8 g, acceleration to 10 g, and shock to 30 g, in all three major axes.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

ALLIED CONTROL'S NEW LINE OF Sub-Miniature Telephone Type Relays

Now being manufactured entirely in the U.S.A., not only in its original West German design previously sold in this country by Allied Control Company, Inc. under an agreement with Siemens & Halske Company A.G. Germany but with variations to meet American requirements as well.



TYPE-T-154
H-1 3/16 • W-47/64 • L-1 11/64



TYPE-TAHG
H-2 3/16 • W-1 7/16 • L-1 5/8



TYPE-TAN
H-1 19/32 • W-61/64 • L-1 11/32



TYPE-TAF
H-1 17/64 • W-41/64 • L-1 5/16



TYPE-TADO
H-2 • W-1 13/32 • L-1 13/32

PERFORMANCE CHARACTERISTICS

Contact Arrangement

Up to 12 springs maximum form A, B or C

Contact Rating

2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c

Low level or 5 ampere contacts available on request

Standard Coil Voltages

Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

Coil Power

Nominal: 700 milliwatts

Minimum Operate Power: 125 to 300 milliwatts depending on application, contact arrangement and coil resistance.

Timing at Nominal Voltage

Operate time: 15 milliseconds maximum

Release time: 5.0 milliseconds maximum

Vibration

10-55 cps at .062 inch double amplitude

55-500 cps at a constant 10g

Shock: 25g operational

Enclosure

Open, dust cover or hermetically sealed

Weight

Open type 1.0 ounce maximum

Sealed type 2.0 ounces maximum



ALLIED CONTROL



ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, NEW YORK
CIRCLE 54 ON READER-SERVICE CARD



3

NEW CERAMIC TRANSDUCER ELEMENTS

U. S. SONICS
new transducer elements
US600, US500, and US100
are characterized by their:

•
High activity over wide temperature ranges (US500, US600)

•
High coupling coefficient (US500, US600)

•
Stability over wide temperature ranges (US500, US600)

•
Demonstrates excellent activity at temperatures to -300F.

•
Advanced production techniques assure reproducibility.

PROPERTIES

	US600	US500	US100
Dielectric Constant	1350	1200	500
Curie Temperature	310C	330C	150C
Rad. Coupling Coefficient	0.46	0.50	0.31
d Constant (d_{33}) (coulombs/volt)	-120×10^{-12}	-170×10^{-12}	-62×10^{-12}
g Constant (g_{33}) (volts/meter)	25.3×10^{-4}	38×10^{-4}	31×10^{-4}

L Transducer elements are intended for use as drivers, resonators, and sensors.

Applications include: missile systems, underwater sounding, thickness detectors, depth and liquid level sensing gages, IF filters, ladder networks, microphone elements, and power drivers.

For further information write or call:

U. S. SONICS CORPORATION

625 McGRATH HIGHWAY • SOMERVILLE 45 • MASSACHUSETTS

MONument 6-5100

CIRCLE 55 ON READER-SERVICE CARD

NEW PRODUCTS

Ultrasonic Cleaner

528

Average energy level type



For applications requiring average energy levels, model 160 ultrasonic cleaner has a 13-gal tank made of stainless steel and measuring 20 x 16 x 10 in. Corners of the tank are rounded and 30% of the tank bottom is covered with crystals. Actual radiating surface is 96 sq in. The 115 v ac, single-phase, 60 cps generator delivers 500 w avg and 2000 w peak.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N.J.

Price & Availability: Available from stock, the unit is priced at \$1375.

Signal Generator

512

Drift is less than 0.001%



Type TD-1101 signal generator has a frequency drift, after warm-up, of less than 0.001% over a 10-min period. Incidental fm is less than 300 cps at any fm and modulation frequency. The unit may be internally or externally sine-wave-modulated up to 50%. Amplitude modulation is maintained within 5% over the frequency range. The generator may be externally pulse-modulated with a rise-time of better than 1 μ sec from 6 to 120 mc, and better than 0.5 μ sec from 120 to 410 mc. Frequency calibration of six bands is within 0.5% and resettability is under 0.05%. The rf output is both continuously variable, and variable in discrete steps.

Trad Electronics Corp., Asbury Park, N.J.



NEW
direct-current
**TACHOMETER
GENERATOR**
permanent-magnet

APPLICATIONS

- **SERVOS** The highly linear output and wide speed range are ideal for velocity or integrating servos. Low driving torque permits its use as a damping or rate signal in all types of servos.
- **INDICATING TACHOMETER** Matching indicating meters available from stock in various speed ranges.
- **SPEED TRANSDUCER** Ideal for use as a speed transducer in connection with fast-response direct-writing oscillographs.

FEATURES

- **SIZE** Miniature. Approx. Dia. 1 1/8".
- **OUTPUT** Various models with outputs as high as 24 v/1000 rpm.
- **LINEARITY** Linearity from 0 to 12,000 rpm is better than 1/10 of 1% of voltage output at 3600 rpm.
- **BRUSH LIFE** Better than 100,000 hours (10 years) of continuous operation at 3600 rpm.
- **BIDIRECTIONAL OPERATION** Output in either direction is held to a 1/4 of 1% tolerance.
- **RIPPLE** The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.
- **CONSTRUCTION** Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

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quantity discounts

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CIRCLE 56 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960

ABSOLUTE MAXIMUM RATINGS AT 25°C

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

SPECIFICATIONS AND TYPICAL CHARACTERISTICS
(At 25°C Unless Otherwise Stated)

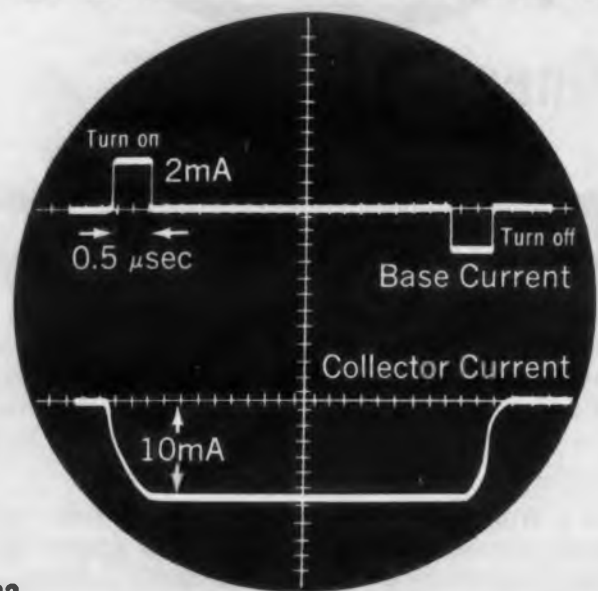
	Typical	Max.	Test Conditions
Saturation Voltage	V_s	1.0	1.5 Volts $I_c = 50$ mA
Forward Leakage Current	I_F	0.1	10 μ A $V_c = 30$ V
Reverse Leakage Current	I_R	0.1	10 μ A $V_c = -30$ V
Forward Leakage Current	I_F	20.	50. μ A at 125°C
Reverse Leakage Current	I_R	20.	50. μ A at 125°C
Gate Voltage to Switch "ON"	$V_{g\text{ On}}$	0.7	1.0 Volts $R_L = 1$ K
Gate Current to Switch "ON"	$I_{g\text{ On}}$	0.1	1.0 mA $R_L = 1$ K
Gate Voltage to Switch "OFF"	$V_{g\text{ Off}}$	1.2	4.0 Volts $I_c = 50$ mA
Gate Current to Switch "OFF"	$I_{g\text{ Off}}$	7.0	10. mA $I_c = 50$ mA
Holding Current	I_H	2.0	5.0 mA $R_L = 1$ K

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- Ring Counters
- Shift Registers
- Controlled Rectifier Driver
- Flip-Flop Equivalent
- Simplified Information Storage
- 0.3 microsecond Switching

Transitron
announces a NEW computer element
for: Greater Reliability • Circuit Simplicity

THE TRANSWITCH



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

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

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

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

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

For further information, write for Bulletin TE-1357A

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CIRCLE 57 ON READER-SERVICE CARD

New Trigger/Timer/Gap Tube Switches 1000 Ampere Pulses



The KP-130 is one of a family of subminiature, cold cathode, arc-discharge pulse tubes (Krytrons) for high-voltage, high-current switching applications. The KP-130 can control pulse discharges at voltages as high as 2500v, with currents up to 1100 amperes. The anode delay time equals 0.2usec. average, with "jitter" (variation in delay) averaging less than 0.05usec. The low, combined with the high hold-off voltages and short delay, make the KP-130 ideal for timing, triggering, and other pulse circuit uses. Unlike spark gaps, the KP-130 requires low trigger grid power, thereby eliminating large transformers. The KP-130 operates in light or total darkness and has exceptional environmental capabilities. The KP-130 has found application in pulse circuits, protective devices, precision-timed high energy switching circuits, overload devices, etc. The KP-130 eliminates circuit components and reduces input power requirements, thereby contributing to improved equipment reliability. A similar tube is available for lower power circuits, and many of these tubes are supplied to military requirements. For details, data, etc., write:

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Dept. 68, P. O. Box 562, Stamford, Connecticut
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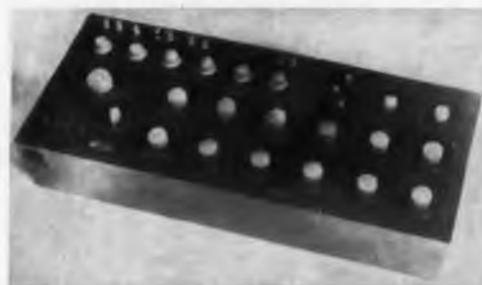
CIRCLE 59 ON READER-SERVICE CARD

NEW PRODUCTS

Microvolt Potentiometers

560

Resolution is 0.01 μ v



These single and double six-dial thermofree potentiometers are for emf measurements in the microvolt range with a resolution of 0.01 μ v. Both models have double inputs with ranges of 0 to 111,111 μ v in steps of 0.1 μ v and 0 to 11.111.1 μ v in steps of 0.01 μ v. On the double model, duplicate sets of dials permit measuring the two inputs independently. For both models the high-range limit of error is 0.01% of reading $\pm 0.1 \mu$ v, while the low range is 0.01% of reading $\pm 0.01 \mu$ v.

Minneapolis-Honeywell Regulator Co., Rubicon Instruments Div., Dept. ED, Ridge Ave. at 35th St., Philadelphia 32, Pa.

Price & Availability: Price is \$5200. Delivery requires 16 to 20 weeks.

Ratiometer

675

Provides direct reading

Designed to provide a direct reading through a dual-pointer geared head, type 3100 servo ratiometer has 0.1% linearity and resolution. The basic range is 10 mv for full scale reading. Sensitivity is 10 v and full-scale response time is 5 sec. The unit measures 6 in. in length and 3-1/4 in. OD.

M. Ten Bosch Inc., Dept. ED, Pleasantville, N.Y.

Pilot Light

563

Is mounted from front of panel



The Omni-Glow pilot light, for mounting from the front of a panel, uses four molded-in nylon ribs. It pushes through a 0.5-in. hole and snaps

SPECTROL PRECISION POTENTIOMETERS



Two valid reasons why **SPECTROL** delivers better non-linear pots *faster!*

REASON

1

COMPUTER DESIGNED



Spectrol uses an IBM 610 computer to turn out complex non-linear precision pots in record time, both single-turn and multi-turn. This in itself saves weeks of time, assures more accurate performance. Spectrol alone maintains a computer on the premises for this purpose.

How It Works. Design information in the form of X and Y coordinates or mathematical equations describing the particular parameters of a given non-linear function is entered in the computer. Previously programmed general equations automatically compute from these data points manufacturing directions in terms of winding equipment settings, cam angle and radii. An electric typewriter prints out winding machine set-up information on a form which is sent to production. Simultaneously, a punched tape is made to store data for repeat requirements.

675

into place. It can be used on panels up to 0.65 in. thick.

Industrial Devices, Inc., Dept. ED, 982 River Road, Edgewater, N.J.

Price & Availability: Price is under \$0.26 in production quantities. Delivery is four weeks or less for units made to customer specifications.

Ferrite Phase Shifter 552

Produces ± 90 deg of phase shift



Model PX 105 X-band temperature compensated ferrite phase shifter produces ± 90 deg of phase shift and maintains an absolute phase stability of within ± 15 deg from -10 to $+100$ C. The input vswr is less than 1.15:1 for all control coil current ranges over the temperature range.

Control coil impedance is 200 ohms. For maximum phase shift, 100 ma is required. The unit is rated at 2 kw peak, 2 w avg.

Rantec Corp., Dept. ED, Calabasas, Calif.

Coaxial Attenuator 551

Insertion loss is less than 0.5 db



Operating over the frequency range of 4 to 7 kmc, model AE-6 coaxial attenuator has an insertion loss of less than 0.5 db. The attenuation variation vs frequency is less than $\pm 5\%$. The unit provides up to 40 db attenuation; it has a power handling capacity of 4 w avg, and a vswr of 1.5 v max.

Merrimac Research and Development, Inc., Dept. ED, 517 Lyons Ave., Irvington 11, N.J.

Price & Availability: Price is \$285; units are available from stock.

563

from nylon snaps

I wish I knew what
Power Sources
was
up to.

POWER SOURCES, INC.
Burlington, Massachusetts
CIRCLE 60 ON READER-SERVICE CARD

GROUND-SUPPORT EQUIPMENT HOUSED IN LINDSAY STRUCTURE!



This ideal structural material is used for mobile units such as the one illustrated and in use at Edwards Air Force Base. Lindsay Structure components permit extreme elasticity in design and size—to any dimension within $\frac{1}{2}$ ".

Lindsay Structure panels provide a weather-tight exterior. Easily insulated, too, for use in any climate.

R.F.I. shielding—so important in any ground-support installation—is a natural bonus with Lindsay Structure. Leakproof doors and openings can be placed wherever desired.



**LINDSAY STRUCTURE DIVISION
INTERNATIONAL STEEL COMPANY**
1629 Edgar Street,
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CIRCLE 62 ON READER-SERVICE CARD

REASON 2 LIBRARY OF TAPES



Spectrol also maintains an extensive library of tapes with programs for the solution of general non-linear potentiometer design equations, saving hours of calculation time and providing error free results. Again, you receive a superior product sooner.

Let us know your design requirements. With Spectrol's time-saving techniques, you can expect a quote within a few days.

Contact your Spectrol representative for more details about Spectrol linear and non-linear precision potentiometers, or write direct. A 4-page specifications brochure is yours for the asking. Please address Dept. _____

SPECTROL

**ELECTRONICS
CORPORATION**

1704 South Del Mar Avenue • San Gabriel, California

CIRCLE 61 ON READER-SERVICE CARD

Tensolite

HIGH TEMPERATURE

CABLE CAPABILITIES

Our experienced Design Engineers specialize in cable and cable assemblies utilizing Teflon® insulated hook-up wire (large and small), solid core and air dielectric coaxial cable, shielded and jacketed multi-conductors—or any combination of these.

Many leading aircraft and electronic manufacturers are taking advantage of Tensolite's cable design and production facilities. Let us work with you in translating your requirements into highly reliable jumbo cables and cable assemblies.

ENAMELED PRODUCTS

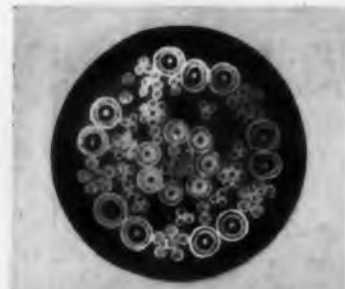
High temperature magnet wire—and other enameled wire products—must be produced under exacting dust-free conditions. To assure this, Tensolite recently set up its *Mechtron Division* in a separate and specially designed plant. Tensolite is the only manufacturer to provide this assurance of reliability and high quality.

FREE

Valuable New Catalogs! Just clip this to your calling card or letterhead!

Please RUSH me your new:

- Wire, cable, cable assembly catalog.
- Magnet wire catalog.
- For Reference Only.
- Have Representative Contact Me.



Tensolite

HIGH TEMPERATURE

WIRE AND CABLE

HOOK-UP Wire—Mil Spec & Thin Wall

Teflon—Extruded, Spiral Wrapped, and FLEXOLON wire

Types E-EE to MIL-W-16878 and NAS-703 (−90° to +250°C)

Vinyl—Extruded, and parallel wrapped

Types B-C to MIL-W-16878 and NAS-702 (−55° to +105°C)

Types LW-MW to MIL-W-76A (−40° to +80°C)

Super-flexible wire (−40° to +60°C)

COAXIAL CABLE

Solid Core and Air Dielectric

Designed to MIL-C-17B

RG Specs. (−90° to +250°C)

MULTI-CONDUCTORS

Standard and Custom Designed to Military and Industrial Specs.

AIRFRAME WIRE

Designed to MIL-W-7139

(−90° to +250°C)

MAGNET WIRE

To Meet MIL-W-19583, Type III

16 thru 50 AWG, ST, HT,

TT, & QT (−90° to +250°C)

OTHER PRODUCTS

Asbestos Wire to MIL-C-25038

Antenna Wire

Low Capacitance Cable

Wire Coated with Teflon (100X) FEP Resin

Tone Arm Wire

Ribbon Cable Shielded and Unshielded

Bondable Teflon Wire

High Strength Conductors

Nickel Plated Conductors

Hearing Aid Cordage

Tensolite

INSULATED WIRE CO., INC.

A subsidiary of Carlisle Corporation
West Main Street, Tarrytown, N.Y.

Pacific Division:
1516 N. Gardner St., Los Angeles, Calif.

©DuPont

NEW PRODUCTS

Pressure Transducer

562

Repeatability is $\pm 0.1\%$



Model 1000A potentiometer pressure transducer is available in ranges from between 0 and 15 to between 0 and 350 psig and in resistances up to 10 K. Linearity is to $\pm 0.5\%$, repeatability is held to $\pm 0.1\%$ max, hysteresis is 0.2% max, and temperature sensitivity is $\pm 0.01\%$ per deg C. The unit has virtually infinite resolution. It operates over the temperature range of -55 to $+85$ C. Acceleration of 20 g along any axis will cause less than 1% change in output.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L.I., N.Y.

Price & Availability: Price depends on customer specifications. Units can be delivered in 45 days or less.

Perforated Tape Spooler

561

Take up is 300 ft



Model 4533 spooler provides a take-up reel for a minimum of 300 ft of punched paper or Mylar tape. Having a 6-in. diam, the unit can be used with photoelectric readers with operating speeds to 300 characters per sec. It mounts on a standard 19-in. relay rack and requires 8-3/4 in. of panel space.

Digitronics Corp., Dept. ED, Albertson, L.I., N.Y.

Price & Availability: One unit is priced at \$495; for an order of 10, the price is \$450. Delivery time is four weeks.

See us at Booth 4330 at the I.R.E. Show
CIRCLE 63 ON READER-SERVICE CARD

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GENERAL INSTRUMENT semiconductors

at factory prices

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240 Wythe Avenue
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GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

silicon diodes

IN ANY COMBINATION OF CHARACTERISTICS

*high speed • high conductance • high temperature
high voltage • high back resistance
complete reliability*

Including the industry's most
versatile diode with uniform
excellence in all parameters.
(MIL-E-1/1160 Sig. C)

1N658

General Instrument semiconductor engineering has made possible these silicon diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. General Instrument also makes a complete line of medium and high power silicon rectifiers. Write today for full information.

GENERAL PURPOSE
TYPES

1N456 1N461
1N457* 1N462
1N458* 1N463
1N459* 1N464

FAST RECOVERY
TYPES

1N625
1N626
1N627
1N628
1N629
1N662†
1N663†

HIGH CONDUCTANCE
TYPES

1N482 1N484A
1N482A 1N484B
1N482B 1N489
1N483 1N485A
1N483A 1N485B
1N483B 1N486
1N484 1N486A

*JAN Types †MIL-E-1 Types

PLUS a large group of special DR numbers developed by General Instrument Corporation with characteristics that far exceed any of the standard types listed above!



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GENERAL INSTRUMENT CORPORATION

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CIRCLE 64 ON READER-SERVICE CARD

CIRCLE 65 ON READER-SERVICE CARD

what makes one
micro-miniature
relay more
reliable
than another?

answer.

**SEALED
CONTACT
CHAMBER**

NEW Couch Relay isolates Contacts from Contamination

Organic material can't contaminate the contacts in the new Couch Type 2M micro-miniature relay. They're hermetically sealed in a separate chamber — and without rosin flux.

Also contributing to reliability is Couch's patented rotary armature, pivoted on two sapphire jewels and virtually immune to present day levels of shock and vibration.

Designs like this, produced within an unusually narrow range of manufacturing tolerances, help explain why Couch relays are being called on to provide reliability in many complex systems.

Write for additional information.

ENGINEERING DATA:

Shock.....	50G Min.
Vibration.....	30G's to 2,000 CPS
Dielectric Strength.....	1000 Volts RMS Min.
Height.....	.875" max.
Width.....	.800" max.
Thickness.....	.400" max.
Weight.....	18 ± 1 gram
Contact Arrangement.....	2 form C(2 PDT)



COUCH ORDNANCE, INC.

A Subsidiary of S. H. Couch Company, Inc.

3 Arlington St., North Quincy 71, Mass. Tel.: (Boston) BLuehills 8-4147

CIRCLE 66 ON READER-SERVICE CARD

NEW PRODUCTS

Time Analyzer

553

Has 32 consecutively gated channels



Designed to count and store digital data in 32 consecutively gated channels, the system 0900 time analyzer comes complete with timer, delay provisions, count and cycle totalizers, and internal calibration program. Each of the 32 channels has 2 electronic counting units and a 4-digit mechanical register to provide storage of 106 digits. Channel widths are variable from 1 μ sec to 0.08 sec.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley 10, Calif.

Price & Availability: Can be delivered 90 days after order received. Price depends on options. Quote on request.

Signal Generator

510

Has outputs up to 400 mw



Model DY-5381 signal generator delivers a minimum power output of 250 mw from 8500 to 10,000 mc with outputs up to 400 mw in the area of 9500 mc. Types of modulation provided internally are pulse and fm, separately or simultaneously, and square wave. The pulse length is variable from 0.5 to 25 μ sec; the repetition rate is adjustable from 35 to 3500 pps. Provision is made for external pulse.

Hewlett-Packard Co., Dymec Div., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

Price & Availability: Delivery is 90 days after order received. Price is \$4835 fob, Palo Alto, Calif.

ELECTRONIC HIGH-VACUUM PUMPS



1
5
40
90
180
270
500
1000
liters per second

THE KEY TO A TRULY CLEAN VACUUM, without fluids or other contaminants, is an UlteVac electronic pump. Can operate unattended for months or years on a sealed system; requires no traps, baffles, or refrigeration. Maintains vacuums of 10^{-9} mm Hg and below; power failure does not harm system since it is sealed after UlteVac starts. Serves as its own vacuum gauge. Operates in any position; no hot filaments, no cooling water.

Series 110
1 l./sec.



Series 327 • 270 l./sec.

ULTEK CORPORATION, only manufacturer devoted exclusively to ion pump technology, offers stock pumps 1 to 1000 liters/second capacity, plus sorption pumps, foreline traps, and SealVac fittings which provide easy-connecting rotatable flanges. Ultek invites comparison of product, service, and delivery time, on either standard or modified pumps and accessories. Literature on request—specify application.

Contact ULTEK, or its exclusive representative, Kinney Mfg. Div. of The New York Air Brake Co. Sales offices in major U.S. cities.

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CIRCLE 67 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960



MRC proudly presents another series of quality products equally recognized for dependability, and performance. The Micromag, a low-level drift-free magnetic DC amplifier, completely solid state... ideally suited for instrumentation applications where temperature, strain and pressure are to be measured. DC signals in the millivolt region are amplified to the 0 to 5 volts DC range required for telemetering and recording systems.

Typical Specifications:

Power / 26-31 volts DC, 10 milliamps
 Input Signal / 0-10 millivolts DC
 Voltage Gain / 500 \pm 10%
 Output Load / 100 K ohms
 Linearity / \pm 2%
 Gain Stability / \pm 3% from 0°C to +65°C
 Common Mode Rejection / At DC, 10°
 At 60 cps, 10°
 At 400 cps, 10°

For additional information on MRC's complete line of Micromags, write for Data File No. MA1001.



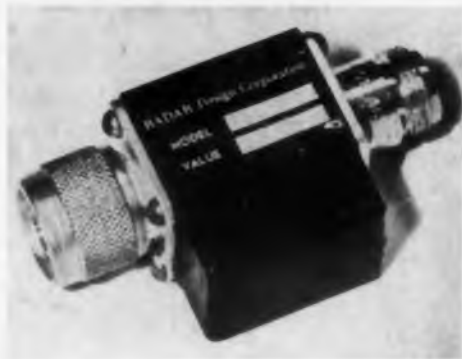
MAGNETIC RESEARCH CORP.
 3160 West El Segundo Blvd.
 Hawthorne, California

CIRCLE 68 ON READER-SERVICE CARD
 ELECTRONIC DESIGN • March 2, 1960

Coaxial Attenuators

522

Range is dc to 2000 mc



Designed to meet requirements for high strength and low mass, model RDA-2 coaxial attenuator has a sensitivity of 0.05 db per db max from dc to 2000 mc. Available in values of 3, 6, 10, and 20 db, they have a maximum vswr of 1.1.

Radar Design Corp., Dept. ED, 1001 Pickard Drive, Syracuse 11, N.Y.

Price & Availability: Price is \$30 ea, prices for quantity order is quoted on request. Delivery is from stock to four weeks.

Epoxy Header

556

Replaces glass-to-metal hermetic seals



This all-epoxy header, for use with epoxy shells or conventional metal cases, replaces glass-to-metal hermetic seals in a variety of electronic applications. Since the header leads are embedded in cured, molded epoxy, there is no danger of cracked glass, no broken seals, and no coefficient of expansion during the soldering operation. In addition to conventional straight-through leads, headers are available where the leads take a bend while passing through the body of the header. Header leads fit a standard 7-pin miniature socket. Epoxy formulations for use with copper, brass, silver, and gold-plated metals are offered.

Epoxy Products, Inc., Dept. ED, 13 Coit St., Irvington, N.J.

Price & Availability: Types having 3/4-in. diam are available from stock in 3, 7, 8, and 9-pin sizes. Price of 3-pin type is \$0.21 ea for up to 250 units. Prices are quoted on request. Various other sizes are made on order and are delivered in 30 to 45 days.



THE MAGIC ALPHABET



Students of alphabetology will recognize these letters to be "M.R.C." written in the magic alphabet. Engineers everywhere recognize MRC for quality, reliability and outstanding performance.

The airborne power supply shown below is one of a series of highly

reliable stable power sources designed to operate from a 115 volt, 400 cycle line and supply well regulated and filtered DC power. Dual magnetic regulation, an exclusive feature of this series, suppresses line transients and compensates for changes in load.

The use of magnetic amplifier circuitry with tantalum capacitors, silicon diodes and rectifiers... coupled with inherent short circuit protection... combine to achieve a degree of reliability unattainable in other types of circuits.

SPECIFICATIONS:

Model 40-103-0 is a typical 5 watt supply used extensively in missile instrumentation:

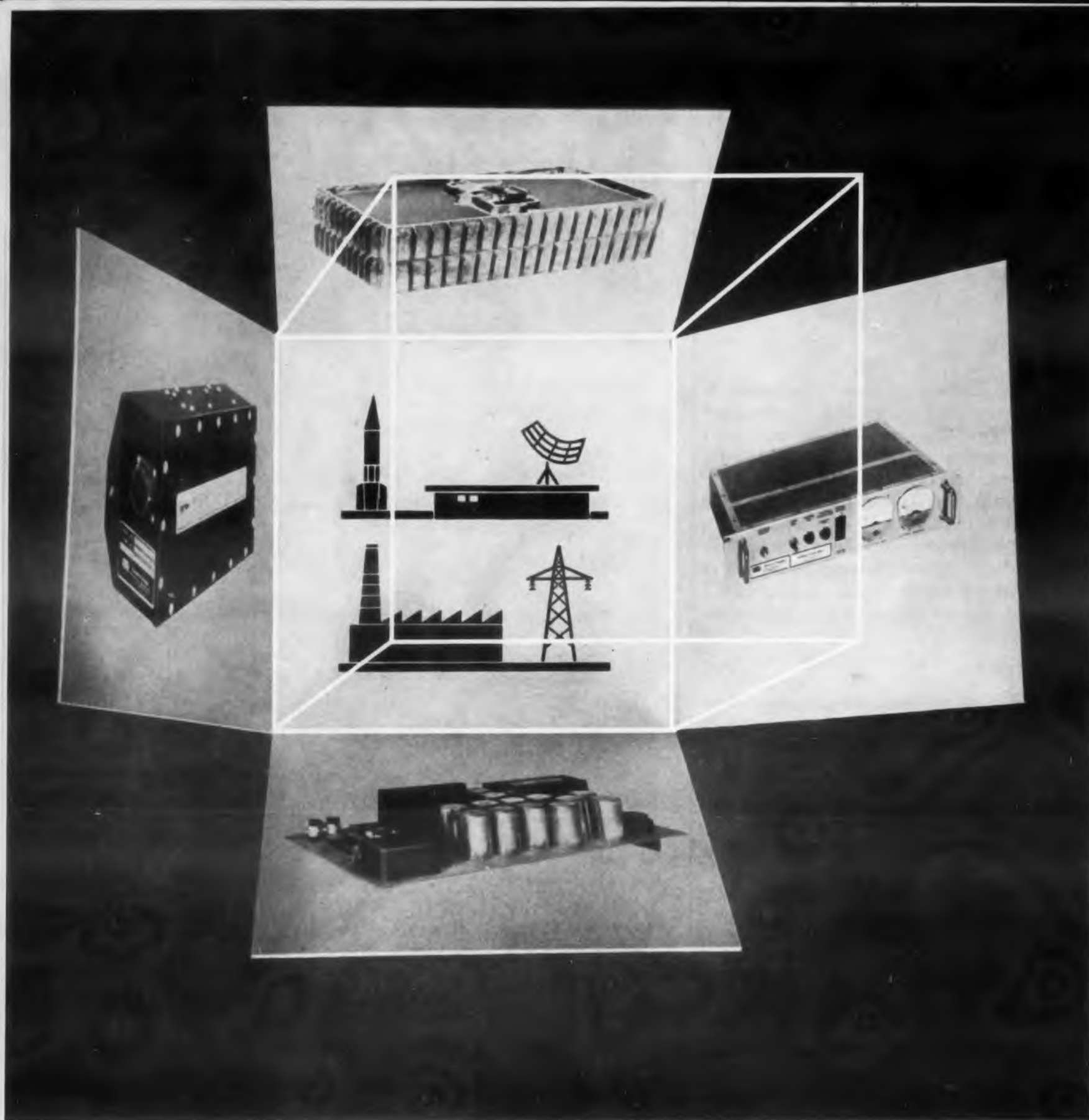
Input / 95-125 V; 380-420 cps
 Output / 4.75 to 5.25 V DC (Adjustable), 0 to 1 amp
 Regulation / \pm 0.1%
 Ripple / 0.5% rms max. at full load

For additional information on MRC's complete line of airborne power supplies, write for Data File PS 1000.

MAGNETIC RESEARCH CORPORATION

3160 West El Segundo Boulevard, Hawthorne, California

CIRCLE 69 ON READER-SERVICE CARD



The Many Sides of Solid State Power

There are many examples of Western Design solid state power supplies . . . regulated multiple-outlet units with a maximum of 3% distortion, less than 1° phase shift and regulation as tight as $\pm .5V$ at 130V, 400 cps . . . economy-priced single-outlet units regulated to .3%, with extremely low heat-generation and 100 microsecond response. ■ Features such as these are typical of Western Design's power conversion capability in airborne, ground support and industrial applications. Backed by long, complementary experience in the

electro-mechanical field . . . strong corporate financial back-up . . . excellent field service . . . no one offers quite so reliable a package of solid state power as Western Design. ■ For detailed information, contact your Western Design representative or write us for Data File ED-1020-1.

Western Design

DIVISION OF U.S. INDUSTRIES, INC.

SANTA BARBARA AIRPORT, GOLETA, CALIFORNIA



NEW PRODUCTS

Insulation Tape 612

Has controlled low shrinkage

Specified to show no more than 2% change in any dimension when heated free at 730 F for 15 min, this Teflon tape has controlled, low shrinkage. It comes in thicknesses from 1 mil up, and widths from 1/4 to 12 in. Tensile strength for the 1-mil tape is 3000 psi; dielectric strength is 3800 v per mil. At 5 mil, tensile strength is 4000 psi, and dielectric strength is 2200 v per mil.

Dixon Corp., Dept. ED, Bristol, R.I.

Price & Availability: Made on order only and delivered 1 week to 10 days after order is received. Standard teflon tape price.

Thermistor 613

Used in liquid nitrogen range

Engineered to operate in liquid nitrogen temperature ranges, type 05A8 bead thermistor has a resistance of 100,000 ohms at $-195.8^{\circ}C$ and is hermetically sealed in a glass probe. Its time constant in liquid nitrogen is less than one second. The thermistor measures 4 in. in length, and can withstand pressures greater than 10,000 psi.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N.J.

Price & Availability: Available from stock. Price is \$17.50.

Brake Clutches 614

Multiple disc and toothed types

This line of electro-magnetic clutches includes a multiple disc type and a toothed type. Disc type clutches range from 4 to 21 in. in diameter, weigh from 4 to 660 lb, and have torque capacities from 10 to 12,000 ft-lb. The toothed clutches come in diameters from 3 to 9 in., weigh from 1-5/8 to 53 lb, and have torque capacities from 40 to 4000 ft-lb. Both types can operate dry or in oil.

Bendix Aviation Corp., Eclipse Machine Div., Dept. ED, Elmira, N.Y.

◀ CIRCLE 70 ON READER-SERVICE CARD

Temperature Probe 616

Is a thermistor bead on an aluminum disc

Type G312 surface-temperature probe consists of a thermistor bead mounted on an aluminum disc 0.25 in. in diameter by 0.005 in. thick. All units in the line have identical RT curves from 0 to 350 F, and meet the company's EMD-31 curve (4000 ohms at 25 C). They are supplied with a 48 in., Teflon-insulated ribbon wire, and can be cemented, taped, potted, or held on to any surface.

Fenwal Electronics, Inc., Dept. ED, 51 Mellen St., Framingham, Mass.

Price & Availability: Made on order only and delivered in 4 weeks. Price is \$45 per unit in quantities of 1 to 19; when ordered in quantities of 20 or more, price is \$27.

Solenoids 615

Operate without rectification

Available in two sizes, these solenoids operate without rectification from a 400-cps power source. They have an externally adjustable stroke length and linear action that may be either push or pull. Model 175 weighs 1.3 oz and consumes 13 w; model 375 weighs 5.1 oz and uses 40 w. Both sizes operate continuously at temperatures from -65 to +450 F.

B. H. Hadley, Inc., Dept. ED, Special Projects Office, 10681 Santa Monica Blvd., Los Angeles 25, Calif.

Relays 617

Automatically monitor 3-phase power

Available in three mounting and hook-up configurations, and four frequency and voltage ranges, these phase sequence relays offer automatic monitoring of three-phase power.

Master Specialties Co., Dept. ED, 956 E. 108th St., Los Angeles 59, Calif.

Price & Availability: Delivered 14 to 21 days after order received. Price is \$66.32 per unit.

New Product Announcement



STEMCO TYPE MX* THERMOSTATS

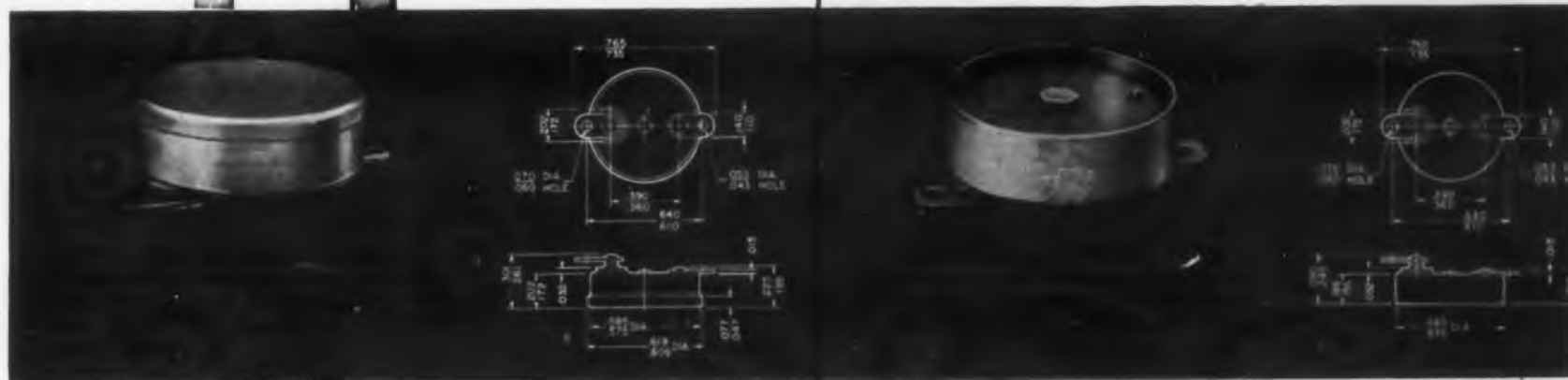
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to open on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . at a production price.

* 2° to 6°F differentials available



AA-7286

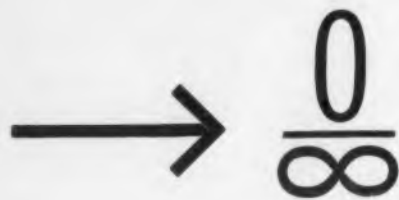
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STEVENS manufacturing company, inc.
Mansfield, Ohio

STEMCO

THERMOSTATS

IT'S NOT
"HOW THIN"



BUT
HOW EXACT!

With the recent trend in strip metal towards thinner and thinner gauges, Somers, a pioneer in thin strip for nearly 50 years, is naturally among the leaders in rolling ultra-thin strip. But in addition to rolling production quantities of strip as thin as can be obtained anywhere in the world, Somers utilizes exclusive techniques and equipment to make sure that every foot of metal is up to the most exacting standards.



1. Accu-Ray nuclear gauging to assure absolute uniformity of thickness throughout.



2. Unique rolling mill for strip from .001" down, makes possible extremely close control of the final pre-anneal temper, and uniform accuracy of the final temper.

3. Experience exclusively with thin strip metals gives Somers an unmatched background in engineering ultra-thin strip to meet all special requirements.

NEARLY
FIFTY
YEARS

FOR EXACTING STANDARDS ONLY
Somers

Somers Brass Company, Inc.
116 BALDWIN AVE., WATERBURY, CONN.
CIRCLE 72 ON READER-SERVICE CARD

NEW PRODUCTS

Strip Chart Recorder

554

Response time is 1 sec



This rectilinear strip chart recorder is sensitive to 1 ma full scale and has a response time of 1 sec. The six-channel model provides six independent, non-overlapping and continuous records. It is suitable for recording volts, milliamperes, or other variables available as outputs from electrical systems. The unit is compact, measuring 12-3/4 x 9-13/16 x 8-3/4. Models having two, three, four, and five channels are offered. Chart speeds can be from 1/2 in. per hr to 24 in. per min. Each unit has interchangeable pens for ink or inkless recording.

Curtiss-Wright Corp., Princeton Div., Dept. ED, Princeton, N.J.

Variable Delay Line

558

Provides delays to 0.79 μ sec



Model 443B3 variable delay line box provides delays up to 0.79 μ sec with an accuracy of 0.8% of the maximum delay by means of binary switching. Rise time is 0.05 μ sec for the maximum delay and decreases as lesser delays are used. Impedance is 100 ohms and attenuation is 3.5%. Dimensions are 3 x 3 x 5 in. The unit may be connected into a circuit to determine the specifications of the delay line that will provide optimum circuit characteristics or, as a substitute until a production prototype delay line can be supplied.

Valor Instruments Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

Price & Availability: Price is \$170 per unit. For orders of five or more, price is \$160. Units are available from stock.

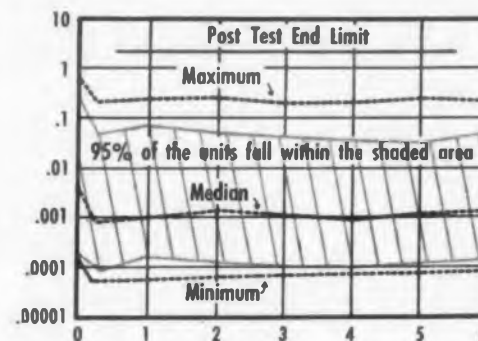
Now in mass production for more than 4 years...

TI 2N337 SERIES USE-PROVED IN ADVANCED APPLICATIONS!

Now get advanced application information and complete reliability and life-test data on TI grown-junction silicon transistors—based on four years' experience.

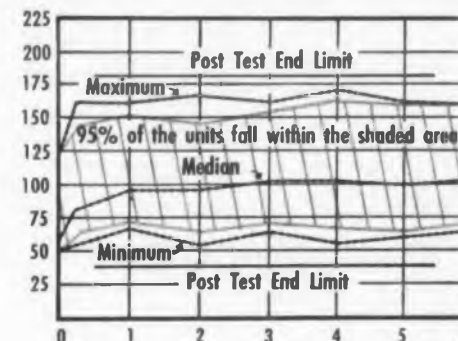
PARAMETER TEST CONDITIONS AND LIMITS

PARAMETER MEASURED	TEST CONDITIONS	ACCEPTANCE LIMIT	
		MIN	MAX
I_{CBO}	$V_{CB} = 20$ vdc $I_E = 0$ $T_A = 25^\circ\text{C}$	—	2 μ a



PARAMETER TEST CONDITIONS AND LIMITS

PARAMETER MEASURED	TEST CONDITIONS	ACCEPTANCE LIMIT	
		MIN	MAX
h_{FE} pulse	$V_{CE} = 5$ vdc $I_C = 10$ ma $T_A = 25^\circ\text{C}$	45	150



I_{CBO} and h_{FE} characteristics of a sample of 60 TI 2N337 and 2N338 units over a 6-week period. These tests are conducted by TI's independently operated Quality Assurance Branch, and are representative of the complete parameter behavior test information in the Silicon Transistor Reliability Data brochure listed below.

PUSH-PULL TRANSISTORIZED SERVO AMPLIFIER

Description of a 2-watt transistorized servo amplifier which, using unfiltered rectified a-c for the collector supply, has high collector efficiency.

TRANSISTORIZED VOLTAGE REGULATOR CIRCUIT

Description of a circuit which can regulate the voltage to loads demanding up to 600 ma.

HIGH-INPUT-IMPEDANCE AMPLIFIER USING SILICON TRANSISTORS

Amplifier described has input impedance of 8 megohms, voltage gain of 40 db, and output impedance of 600 ohms.

HIGH-FREQUENCY CHARACTERISTICS OF GROWN-DIFFUSED SILICON TRANSISTORS

Description of characteristics of 2N338 switching and general-purpose unit and 3N34 and 3N35 very-high-frequency tetrodes.

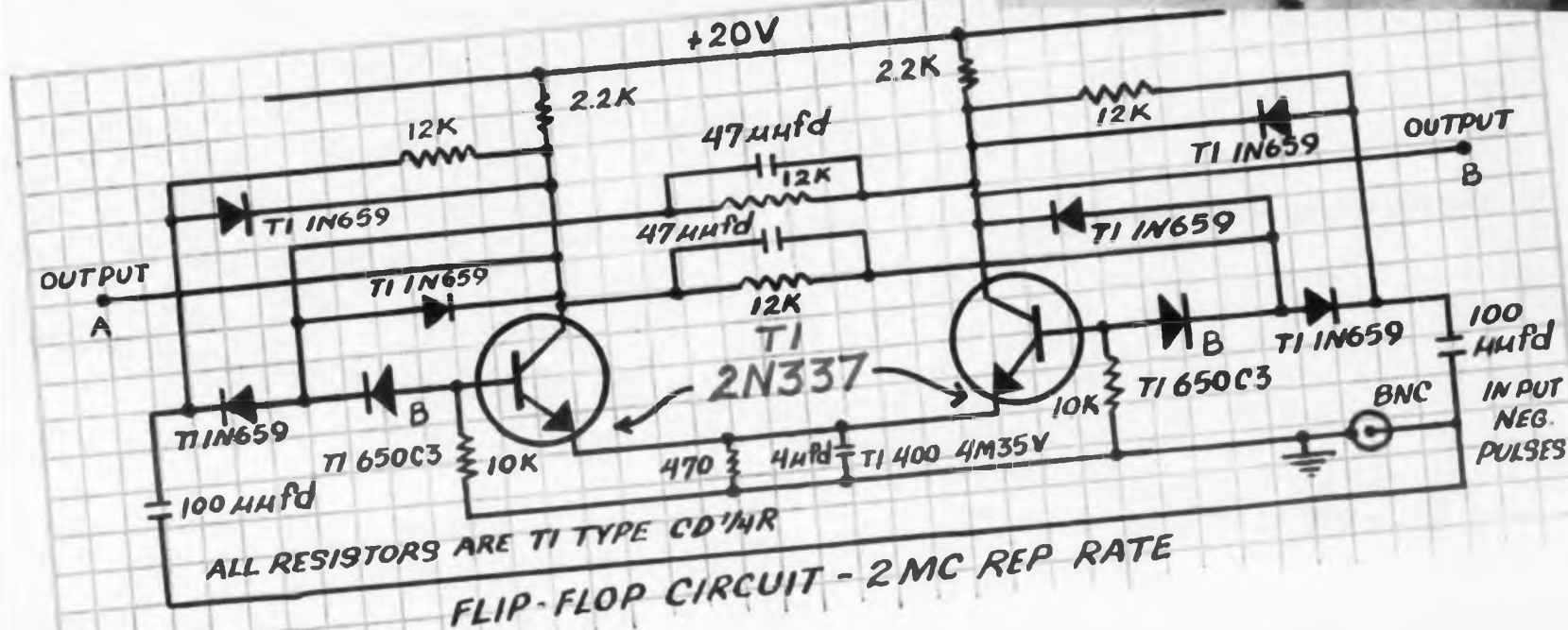
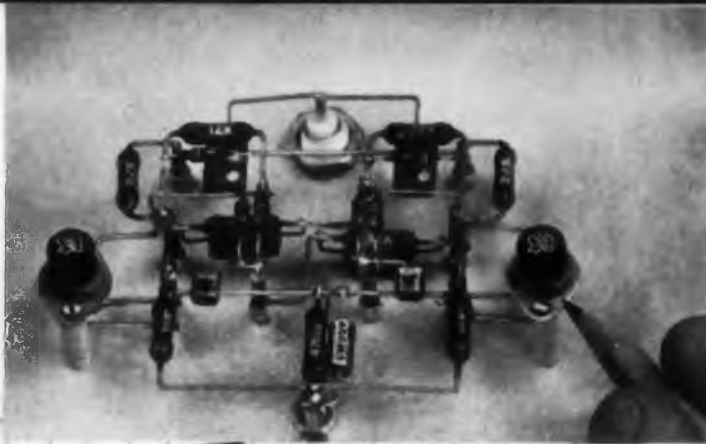


SILICON TRANSISTOR RELIABILITY DATA

Complete parameter analysis of TI 2N332 through 2N343 — a graphic presentation of parameter behavior with time when one type transistor from a series is subjected to stated tests. The graphs above are representative of this data.

These reports are available by writing on your letterhead to your nearest TI sales office, and are not available through magazine reader service cards.

HIGH SPEED SWITCHING



... with reliable TI silicon transistors

New improved TI 2N337 and 2N338 specifications provide greater design flexibility for your switching circuits . . . nuclear counters . . . pre-amplifiers . . . RF amplifiers . . . 455 KC IF amplifiers . . . and many other high frequency applications.

You get high gain at low current levels with TI diffused silicon transistors. High alpha cutoff . . . 10 mc min for 2N337, 20 mc min for 2N338 . . . and extremely low collector capacitance assure optimum

performance in your switching and high frequency amplifier applications.

Over four years of mass production and successful use in the most advanced military and industrial applications have proved the value of the TI 2N337 series. Consider TI's guaranteed specs when you select devices for your next transistor circuit. These units are immediately available in production quantities or from large stocks at all authorized TI distributors.

design characteristics at 25° C ambient (except where advanced temperatures are indicated)

	test conditions	2N337			2N338			unit
		min	design center	max	min	design center	max	
I_{CBO}	Collector Cutoff Current at 150°C	$V_{CB} = 20V$ $I_E = 0$	—	—	1	—	—	μA
BV_{CBO}	Breakdown Voltage	$V_{CB} = 20V$ $I_{CB} = 50\mu A$	45	—	100	—	—	μA
BV_{EBO}	Breakdown Voltage	$I_{EB} = 50\mu A$ $I_C = 0$	1	—	—	1	—	V
h_{ib}	Input Impedance	$V_{CB} = 20V$ $I_E = -1mA$	30	50	80	30	50	Ohm
h_{ob}	Output Admittance	$V_{CB} = 20V$ $I_E = -1mA$	—	0.2	1	—	0.2	μmho
h_{fb}	Feedback Voltage Ratio	$V_{CB} = 20V$ $I_E = -1mA$	—	200	2000	—	300	2000
h_{fb}	Current Transfer Ratio	$V_{CB} = 20V$ $I_E = -1mA$	0.95	0.985	—	0.975	0.99	—
h_{FE}	DC Beta	$V_{CE} = 5V$ $I_C = 10mA$	20	35	55	45	80	150
f_{cb}	Frequency Cutoff	$V_{CB} = 20V$ $I_E = -1mA$	10	20	—	20	30	—
C_{ob}	Collector Capacitance*	$V_{CB} = 20V$ $I_E = -1mA$	—	1.2	3	—	1.2	3
R_{cs}	Saturation Resistance†	$I_B \ddagger$ $I_C = 10mA$	—	75	150	—	75	150
h_{fe}	Current Transfer Ratio	$V_{CB} = 20V$ $I_E = -1mA, f = 2.5mc$	14	22	—	20	24	—
t_r	Rise time§		—	0.05	—	—	0.06	—
t_s	Storage Time		—	0.02	—	—	0.02	—
t_f	Fall time		—	0.08	—	—	0.14	—

* Measured at 1 mc

† Common Emitter

‡ $I_B = 1mA$ for 2N337, 0.5mA for 2N338

§ Includes delay time (t_d)



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26 ISSUES IN '60

ELECTRONIC DESIGN • March 2, 1960

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This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1 1/2", with adjustable timing ranges starting at .030 and as high as 120 seconds.

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ELECTRONIC DESIGN • March 2, 1960

NEW PRODUCTS

Holders and Clamps 564

For short run welding, soldering, and brazing, they are offered in these three types: adjustable holders with clamping faces that can be set to any angle, right angle type, and straight angle type with clamp faces aligned for butt joints.

Wales-Strippit, Inc., Dept. ED, 223 S. Buell Rd., Akron, N.Y.

Price & Availability: The products will be available from stock by March 31, 1960. Price is furnished on request.

Coupling and Slip Clutch 565

Type T14 in-line coupling and slip clutch has spring slip torques of 0.5 to 50 oz-in. Shaft to shaft misalignment is up to 0.01:1, angular misalignment is up to 1 deg. and backlash is 10 min max.

Pic Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N.Y.

Price & Availability: Price is \$24 to \$26 ea. Available from stock, units can be delivered in 10 days or less.

Plugs 566

Silent Plugs No. 49 and No. 169 are designed to eliminate amplifier open-circuit noises. Adapter No. 341 has a 2-conductor jack input to a 2-conductor plug outlet.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Price & Availability: The plugs are priced at \$1.50 and \$1.75; price of the adapter is \$2.95. All items are immediately available.

Silicon Rubber Tape 567

This guide line tape is permanently resilient, self-adhering, and self-fusing. It is resistant to corona, oils, weathering, and abrasion.

L. Frank Markel & Sons, Dept. ED, Norristown, Pa.

Price & Availability: Complete price information is furnished on request.

Potting Compound 568

For electronic hardware use, type 0308 stands 4500 F for 5000 hr, 5000 F for 1 hr, and 4000 F continuously. Types 0307 and 0306 stand a maximum of 3000 F and 2000 F respectively.

Technical Industries Corp., Dept. ED, 389 Fair Oaks Ave., Pasadena, Calif.

Price & Availability: Available from stock, types 0306, 0307, and 0308 are priced at \$11.25, \$47.50, \$95 per lb. Prices are \$8, \$32.25, and \$62 per lb when quantities of 25 lb or more are ordered.

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A: By writing for a new brochure called "Kodak Ektron Detectors."



Write to:

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EASTMAN KODAK COMPANY, Rochester 4, N. Y.
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NEW PRODUCTS**High-Q Rejection Filters**

557

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T T Electronics, Inc., Dept. ED, P.O. Box 180, Culver City, Calif.

Price & Availability: Price is about \$35. Units are shipped about 7 days after order is received.

Clutches and Brakes

555

Miniature



Series 6 and series 8 miniature clutches and brakes are for applications in computer, control and servo positioning. They feature no backlash, no end-play, and need no slip rings. Clutching and braking are accomplished without angular displacement or axial motion. They require about 1.2 w at 24 v dc and meet the following requirements: MIL-E-005272, MIL-E-5400, MIL-STD-202, MIL-E-4158, and MIL-E-8189.

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ELECTRONIC DESIGN • March 2, 1960

Strip-Chart Recorder

573

Has six chart speeds



Model 80A strip chart recorder provides instant selection of chart speed by front panel push buttons. Speeds of 2, 4, 6, 8, 15, and 60 in. per min are available. The instrument has a full scale sensitivity of 0.05% and a resolution and accuracy of 0.2%. The input range of 5 mv to 100 v is covered in 10 steps or by vernier for completely continuous span voltage control. The input resistance is 200,000 ohms per v through 10 v, and 2 meg on higher ranges. Pen speeds to 0.25 sec for full scale are provided. Standard 120 ft chart rolls are used.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price & Availability: Price is \$1750 ea. Units can be delivered in 30 days.

Cases for Electronic Components 574

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These high temperature epoxy-molded cases come in round, square, and rectangular shapes in a wide range of sizes. Serving as molds during the potting of electronic components, they simplify assembly line operations. They have high dielectric characteristics, low moisture absorption, good mechanical strength, and other characteristics of epoxies. The cases become integral with the encapsulated component.

Plastronic Engineering Co., Dept. ED, 721 Boston Post Road, Marlborough, Mass.

Price & Availability: Most sizes are available from stock. Maximum delivery time is three weeks. Prices are quoted on request.

Preview the products of interest to you—see them in **ELECTRONIC DESIGN's** March 16th IRE Show issue.

TYPE	SIZE	CAPACITANCE (uuf)	DCVW	TC	MAX. CASE SIZE
CY uuf for uuf, the smallest, most stable axial lead capacitor you can buy. Probably 1/3 smaller than you're used to. After load life tests at 125° with 150% of rated voltage, average change in capacitance is less than 0.4% for 1,000 hrs., less than 0.6% for 10,000 hrs. They exceed all requirements of MIL-C-11272A.	CY10	1 to 150 151 to 240	500 300	140±25ppm/°C. from -55°C. to +125°C. at 100 kc or 1 mc	1/2 x 1/4 x 3/4
	CY15	151 to 510 511 to 1,200	500 300		1/2 x 1/4 x 3/4
	CY20	511 to 3,300 3,301 to 5,100	500 300		4/4 x 2/4 x 3/4
	CY30	3,301 to 6,200 6,201 to 10,000	500 300		4/4 x 3/4 x 3/4
Medium-power transmitting style	CY60	Up to 56,000	Ratings to 4000 peak volts	140±25ppm/°C. from -55°C. to +125°C. at 100 kc or 1 mc	1 x 1 1/8 x 3/4
	CY70	Up to 150,000	Ratings to 6000 peak volts		1 1/2 x 1 3/4 x 3/4
CYF Fusion sealed. Similar to CY, but with glass encapsulation fusion sealed to capacitor and leads to make seal tight against moisture and corrosives. Insures reliable performance under extreme environmental conditions. Guaranteed four times better than MIL specs for moisture resistance.	CYF10	1 to 150 151 to 240	500 300	140±25ppm/°C. from -55°C. to +125°C. at 100 kc or 1 mc	1/2 x 1/4 x 3/4
	CYF15	151 to 510 511 to 1,200	500 300		1/2 x 1/4 x 3/4
W, WL Wafers with or without leads. Smallest high stability capacitor available. Up to 10,000 uuf in .061 sq. in. of PCB area. Electrodes sealed to dielectric sheets in such a way that seal cannot be broken without destroying capacitor. Meets the performance requirements of MIL-C-11272A.	W, WL5	1 to 560	300	140±25ppm/°C. from -55°C. to +125°C. at 100 kc or 1 mc	.281 x .218 x .090
	W, WL4	561 to 1,000	300		.281 x .312 x .090
	W, WL3	1,001 to 2,700	300		.531 x .312 x .090
	W, WL2	2,701 to 4,300	300		.531 x .453 x .090
	W, WL1	4,301 to 10,000	300		.531 x .812 x .090
HT High temperature dielectric and radiation-tolerant metal electrodes with tab leads. Dielectric strength is twice rated voltage applied from one to five seconds. Insulation resistance in ohm x farads is 100 at 175° C., 25 at 250° C., 1 at 300° C., and .05 at 350° C.	HT1	1 to 1,000	300	0-250° C. 115±25	1/2 x 3/8 x 3/8
	HT2	1,001 to 3,000	300	0-300° C. 140±35	1/2 x 3/8 x 3/8
	HT3	3,001 to 10,000	300	0-350° C. 160±45	1/2 x 1 x 3/8

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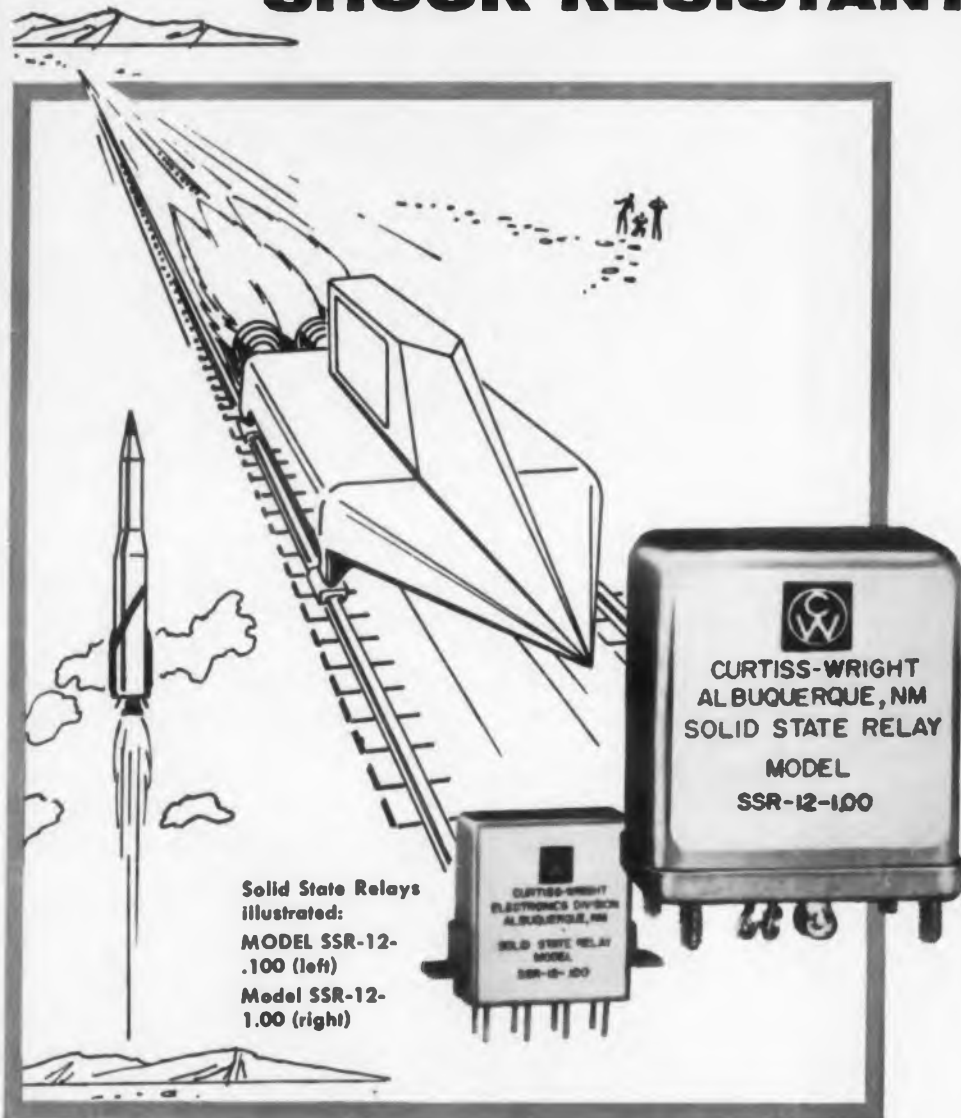
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CIRCLE 85 ON READER-SERVICE CARD

NEW LITERATURE

Rotary Solenoids

86

Two data sheets, two pages each, describe the F size, 300 in.-lb.-deg, and the C size, 70 in.-lb.-deg rotary solenoids. Four stock models of each are available in packaged adaptations complete with switching elements or other mechanical attachments. The data sheets contain torque charts, engineering drawings, and solenoid torque characteristics. Pacsol Div. of Illinois Tool Works, 3155 El Segundo Blvd., Hawthorne, Calif.

RF Chokes

87

The firm's complete line of subminiature rf chokes are described in a two-page data sheet. Called Wee-Ductors, the chokes come in a range of inductances from 0.10 μ h to 56,000 μ h. The bulletin lists parameters for 70 units. Essex Electronics, Div. of Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N.J.

Hermetically Sealed Terminals

88

A complete selection guide for the firm's line of hermetically sealed terminals appears in this six-page bulletin. Voltage ratings, installation data, and outline drawings are included. Electrical Industries, Div. of Philips Electronics & Pharmaceutical Industries Corp., 691 Central Ave., Murray Hill, N.J.

Hydraulic Feeds

89

Bulletin No. AH-4 contains information on two models of hydraulic feeds for punching, clamping, or pressing metals or plastics. The units are powered by a shop's own air supply. Model 250A has an adjustable feed-rate control, and model 250B has individual feed-rate controls. Performance ratings and schematic drawings are included in the bulletin. Superior Screw & Manufacturing Co., Box 436, Commercial Road, Crystal Lake, Ill.

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CIRCLE 90 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960

Drafting Aids

This 32-page booklet is entitled "Tips-Techniques and Drafting Aids." It is divided into the following headings: Helpful Drawing Techniques, Simplifying Drafting Practices, Protecting Prints and Drawings, Tips for Drawing Lines and Curves, Modifying Equipment for Extended Use, and Getting the Most from Drawing Instruments. Send 50¢ to Alvin & Co., Inc., Dept. ED, 611 Palisado Ave., Windsor, Conn.

Thermal Testing

97

Model B210, thermal test unit for use with the Thermion tube, is described in this bulletin, No. 210-10-9, two pages. Photographs, operating characteristics, and applications of the unit are included. Research Council Inc., 1062 Main St., Waltham 54, Mass.

Relay Analyzer

98

Model 140 relay analyzer is described and illustrated in this two-page data sheet. The instrument evaluates relay operating characteristics under actual contact loading. Specifications and accessory data are included in the bulletin. Schmeling Electronics, 20 First St., Keyport, N.J.

Tape Wound Cores

99

This 16-page bulletin contains data on the operating characteristics and typical circuit applications of the firm's round and square Hy Mu 80 tape-wound cores. Maximum and minimum gain-limit curves and tables are included in the booklet. Magnetics Inc., Butler, Pa.

Printed Circuit Connectors

Standard card receptacles, terminal strips, contact strips, and miniature series EC coaxial connectors are described in this 36-page catalog. In addition, 12 pages illustrate and give design and engineering data on printed circuit connectors for special applications. General specifications include details of construction and description of materials and terminations. Write on company letterhead to H. H. Buggie Div., Burndy Corp., Dept. ED, Toledo 1, Ohio.

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Other systems have been developed with separate units for data display, decoding, storing, and electrical readout. These separate units cost more and occupy more room. Market response confirms the need for *one, small, inexpensive* unit that does all three jobs. The Readall instrument serves the purpose.

We'd like to discuss possible applications for the Readall instrument with you. If you want information as to possible applications you have in mind for this remarkable instrument, please fill in the coupon.

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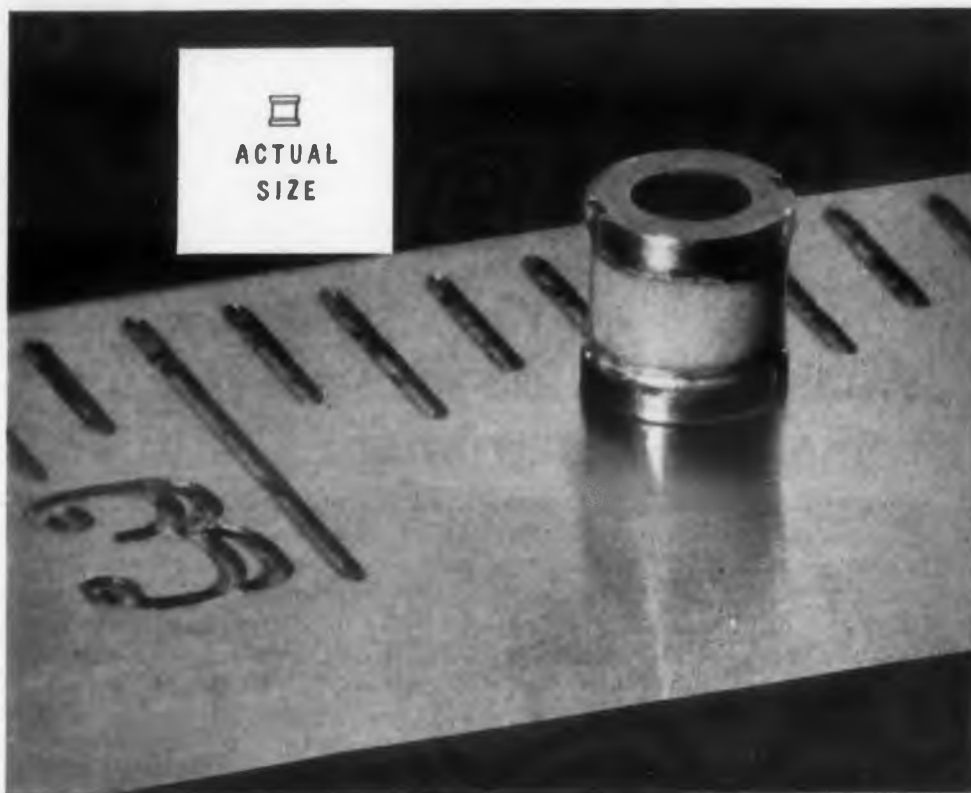
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	MA-4255X	0.5-1.4 μf	60-80
	MA-4256X	1.2-2.5 μf	50
	MA-4257X	2.5-4.0 μf	30

*Package shunt capacitance $\sim 0.2 \mu\text{f}$. Series lead inductance $<10^{-9}$ henries.

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CIRCLE 105 ON READER-SERVICE CARD



NEW LITERATURE

Slit Insulation 106

Thicknesses, widths, tolerances, and coil and core sizes of slit electrical insulation are given in table form in this four-page bulletin, No. 33. Conversion tables are included to enable users to translate area to lineal foot per pound. Inmanco Div. of Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Magnetic Shielding 107

Data sheet No. 152 explains how nonshock sensitive nonretentive Netic-Co-Netic magnetic shielding can be used to isolate the fields generated by toroidal devices and how shielding prevents pickup or inter-action between adjacent coils. Magnetic Shield Div. of Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

Time Delay Relays 108

Bulletin No. 5905, eight pages, describes the firm's complete line of electronic time delay relays. Units are available with overlapping time delay ranges, each capable of a 20 to 1 adjustment range. Data on circuit design, sizes, specifications, mounting arrangements, and terminal styles are included. Tempo Instrument Corp., Box 338, Hicksville, N.Y.

Vibration Test Systems 109

Four-page bulletin No. 59-5 describes the series 70 vibration test systems. System performance, components, and accessories are covered. A complete description and dimensions of the 400-lb force shaker are given. Unholtz-Dickie Corp., 2994 Whitney Ave., Hamden 18, Conn.

Resin Color Concentrates 110

Recommended applications, high temperature test results, and color chips of epoxy resin color concentrates are included in this folder. The user may perform his own coloring, or obtain already colored resin. Resin Formulators, Inc., 8956 National Blvd., Los Angeles 34, Calif.

Components 111

The firm's complete electronic instrument line is contained in this 54-page catalog. Oscillators covering a range of 0.001 to 520,000 cps, band-pass and rejection filters, power supplies having ultra-high regulation, and low distortion amplifiers are shown. Nomographs and tables for aid in measurements are included. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.

TUBE PROBLEM:

When the 6AF4 tube was replaced in UHF TV tuners, servicemen sometimes got a big surprise. Reason: the tubes were not standardized, and a replacement was likely to bring in one channel where another should have been.

SONOTONE SOLVES IT:

First, Sonotone set up extremely tight controls on all materials going into the 6AF4 components. Second, Sonotone used a more thorough exhaust process.

RESULT:

The Sonotone AF4 family of reliable tubes has been accepted by the industry as standard for initial production and replacement.

Let Sonotone help solve *your* tube problems, too.

Sonotone.

Electronic Applications Division, Dept. T23-30
ELMSFORD, NEW YORK

Leading makers of fine ceramic cartridges, speakers, microphones, electronic tubes.

In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 115 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960

Clutches and Brakes

116

Type 125 electro-magnetic clutches and brakes are described in bulletin No. AIM 959, four pages. The units are for control component use with multi-speed devices, direction changers, and machine tool controls. Dimensional data and specifications are included. Autotronics Inc., Dept. 22, Box 208, Florissant, Mo.

Synchro Components

117

This brochure on size 8 synchro components contains general specifications for torque receivers, torque transmitters, control transformers, resolver transmitters, vector resolvers, linear transformers, and control differentials. The design options and mechanical characteristics are also listed. Induction Motors of California, 6058 Walker Ave., Maywood, Calif.

Transistor Stampings

118

Solder-clad base tab stampings used in making ohmic junctions to germanium or silicon junction transistors are described in bulletin No. Z-102, one page. A photo of typical stampings is included. Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N.Y.

Resin Fluxes

119

Printed circuit resin fluxes that meet the requirements of MIL F-14256 are described in this three-page bulletin. Information on five available grades include solderability value, corrosion potential, and specific gravity. Printed in color, the bulletin can be used as a reference chart for selecting a proper flux. London Chemical Co., Inc., Dept. EI-2, 1535 N. 31st Ave., Melrose Park, Ill.

Metal Crystals

120

Entitled "Large Single Metal Crystals," this 11-page bulletin, No. 102, describes standard specimens as well as unusual shapes and special crystal orientations. Data on each metal is tabulated individually. Flow Corp., 85 Mystic St., Arlington 74, Mass.

Wafer Capacitors

Glass dielectric wafer capacitors for printed circuit, modular or encapsulated assemblies are described in this four-page data sheet. The capacitors meet the requirements of MIL-C-11272A. Characteristics and performance curves are included in the bulletin, No. CE-1.02. Write on company letterhead to Corning Electronic Components, Corning Glass Works, Dept. ED, Bradford, Pa.



WT-110A AUTOMATIC ELECTRON-TUBE TESTER

Fast, accurate, punched-card tube tester. Tests for gas, shorts, interelectrode leakage, and overall tube quality. Supplied with 253 punched cards, 24 blank cards, punch, and data for over 1000 types. \$199.50*



WV-98A SENIOR VOLTOHMYST®

Accurately measures ac and dc voltage as well as resistance from 0 to 1,000 megohms. Measures peak-to-peak values of complex waveforms—large 6½-inch meter. Includes special dc/ac-ohms shielded probe and cable. \$79.50*



WV-38A VOLT-OHM- MILLIAMMETER

New RCA VOM includes special 1-volt and 0.25-volt scales for transistor circuit servicing, fuse-protected ohms-divider network, extra-large 5¼-inch meter, polarity-reversing switch, standard dbm ranges. \$43.95* (Also available as WV-38A(K) Kit—\$29.95*)



WT-100A ELECTRON-TUBE MICROMHOMETER

Precision lab instrument: for measuring true transconductance (accuracy better than ±3%—control-grid-to-plate (gm) and suppressor-grid-to-plate; electrode currents—plate, suppressor-grid, screen-grid, and control-grid; heater-cathode leakage current; voltage drop across low-voltage rectifier types; forward and reverse currents in small dry-disc rectifiers, and crystal diodes. For production-line testing, equipment design and development, quality control programs, preventive maintenance. Accommodates variety of bases and envelopes. Tests tubes at published ratings or at ratings under which the tube is expected to operate. \$1,075.00*



WV-84C ULTRA-SENSITIVE DC MICROAMMETER

Battery-operated vacuum-tube microammeter measures down to 0.0002 microampere. Designed for general industrial, chemical, and critical laboratory applications. Especially useful in measuring "dark currents" in vidicons and phototubes, as well as minute currents in image orthicons. \$110.00*

*User price (Optional)



WV-77E VOLTOHMYST®

Famous RCA VoltOhmyst performance at a new low price with new in-use convenience features—separate 1½-volt and 4-volt peak-to-peak scales for accuracy in low ac voltage measurements, fuse-protected ohms-divider network, handle storage holder for ultra-slim probes and extra-flexible leads... and more! \$49.95* (Also available as WV-77E(K) Kit—\$29.95*)



WO-33A SUPER-PORTABLE OSCILLOSCOPE

Small, compact, and portable—only 14 lbs.—this new general purpose 3-inch scope is ideal for TV and color TV servicing, low-level audio work square wave testing of audio and ultrasonic equipment, radio-TV broadcast station maintenance, industrial shop and lab applications. Amazing gain and bandwidth characteristics! \$129.95* (Also available as WO-33A(K) Kit—\$79.95*)

RCA

ELECTRONIC INSTRUMENTS

*Reputation and Reliability
in Industrial Measuring*

Check RCA—for your industrial test equipment requirements—whether you're engaged in laboratory and production testing, or research and service. Factory-wired and calibrated RCA Test Equipment can provide the accuracy and dependability required in many industrial electronic applications.

Call your Authorized RCA Test Equipment Distributor for complete technical details and fast delivery!



RADIO CORPORATION OF AMERICA
Electron Tube Division
Harrison, N. J.

...IT GLOWS when
the FUSE BLOWS!

NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES



ACTUAL
SIZE



- 1 New patented knob design to assure high degree of illumination for instant blown fuse indication.
- 2 Positive finger grip for knob extraction.
- 3 Quick service bayonet lock.
- 4 Constant tension beryllium copper coil & leaf spring for positive contact & lower millivolt drop.
- 5 Optional—at extra cost—neoprene "O" ring to assure splash-proof feature.
- 6 New high degree vacuum neon lamp for greater brilliance & visibility.
- 7 Impact black phenolic material in accordance with MIL-M-14E type CFG.
- 8 One piece brass hot tin dipped non-turning bottom terminal.
- 9 Double flats on body to permit mounting versatility.

SPECIFICATIONS:



PART #	VOLTAGE RANGE
344006	2½ - 7 volts
344012	7 - 16 volts
344024	16 - 32 volts
344125	90 - 125 volts
344250	200 - 250 volts

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 2⅜" with fuse inserted • Front of panel length 1⅜" • Back of panel length 1⅜" • Panel area front 1⅜" dia. • Panel area back 1⅜" dia. • Mounting hole size (D hole) ⅝" dia. flat at one side.

TERMINAL—Side—one piece, .025 brass—electro-tin plated • Bottom—one piece, lead free brass, hot tin dipped.

KNOB—High temperature styrene (amber with incandescent bulbs—2½ thru 32 volts—and clear with high degree vacuum neon bulbs—90 thru 250 volts) • Extractor Method—Bayonet, spring grip in cap.

HARDWARE—Hexagon nut—steel, zinc cronak or zinc iridite finish • Interlock lock washer—steel, cadmium plated • Oil resistant rubber washer.

MILITARY SPECIFICATIONS—MIL-M-14E type CFG. Fungus treatment available upon request per Jan-T-152 & Jan-C-173.

TORQUE—Unit will withstand 15 inch lbs. mounting torque.



LITTELFUSE

DES PLAINES, ILLINOIS

CIRCLE 125 ON READER-SERVICE CARD

IDEAS FOR DESIGN

RC Pairs Provide VFO With Quadrature Outputs

TWO SIMPLE and easily built circuits were devised for obtaining accurate quadrature outputs from a variable frequency oscillator. The same negative feedback amplifier, Fig. 1, having a large open loop gain and with a tungsten lamp age, was used in each circuit.

The first scheme, Fig. 2, uses two capacitors and two variable resistors to form a modified Wien Bridge selective network. This network provides a positive feedback loop around the circuit of Fig. 1. Two RC sections would provide only zero and -45 deg outputs. Hence a third RC section is used to obtain a +45-deg output. The voltage amplitude and phase at each output

point are indicated on the figure. Note that the feedback amplifier is adjusted for a gain of 3. For equal amplitudes, the outputs must be amplified through identical amplifiers, to maintain the exact 90 deg phase difference, with gains in the ratio of 3 to 2.

The second scheme, Fig. 3, uses four resistor-capacitor pairs, but it provides two outputs at angles of +90 deg and -90 deg from a reference signal. The amplifier must now have a gain of 9. Again, for equal amplitudes, the outputs must be amplified through identical amplifiers having the proper gain ratios.

In either scheme, the relative position of the

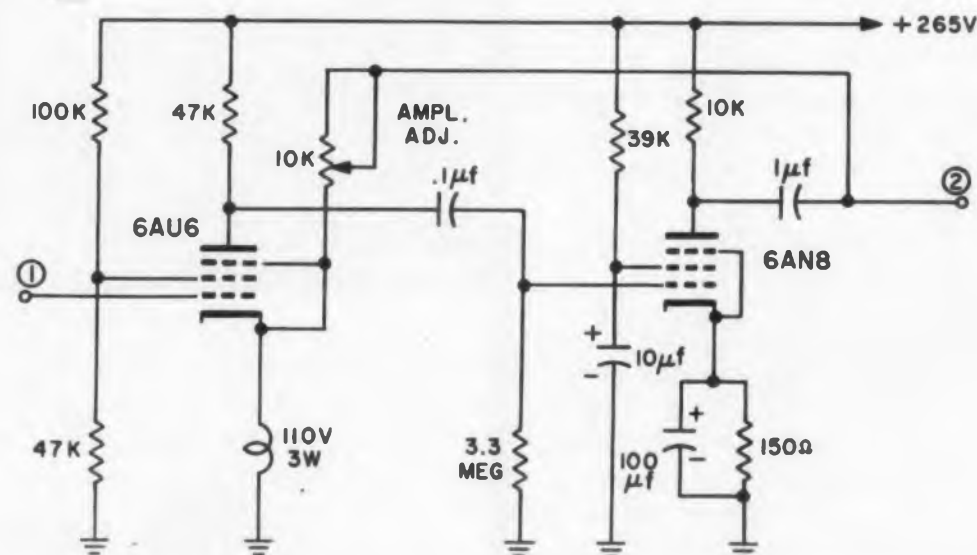


Fig. 1. This feedback amplifier is the core of a variable frequency oscillator with quadrature outputs.

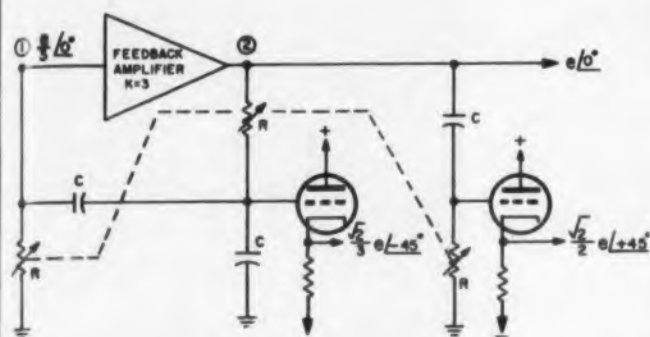


Fig. 2. A modified Wien Bridge arrangement provides the frequency selection. The third RC section is necessary for the $+45$ deg output.

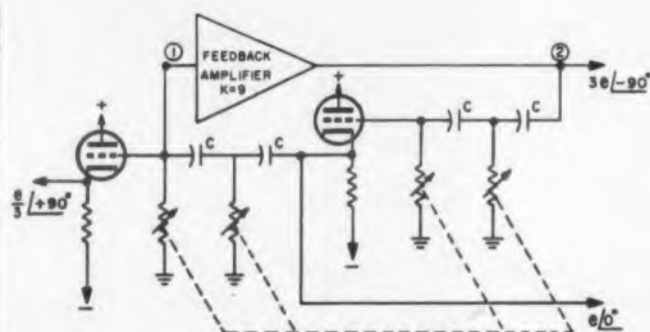


Fig. 3. Four RC pairs provide outputs at ± 90 deg from a reference, 0 deg, signal.

capacitors and resistors can be interchanged, if it is convenient. The oscillation frequency will still be $\frac{1}{2\pi RC}$

For a frequency range of 2.5 kc to 31.8 kc, capacitor C was 1000 μf , $\pm 1\%$. Variable resistors R were ganged precision potentiometers varying between 62.4 K and 5.00 K for the frequency extremes.

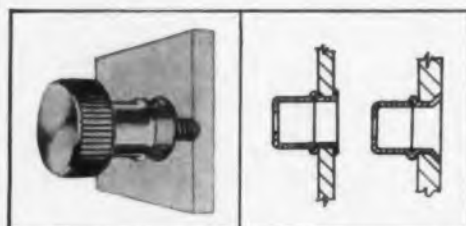
Sergio Bernstein-Bervery, Chief Engineer, Optimized Devices, Thornwood, N. Y.

Credit Risk

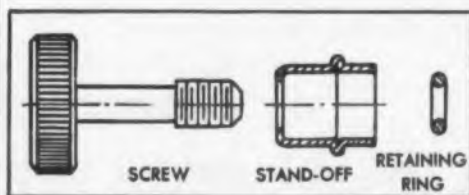
The article "High Input Impedance Transistor Monitor" by J. T. Moses (ELECTRONIC DESIGN, Jan. 20, 1960, p 116) was actually coauthored by Mr. Moses and by Mr. E. R. Jenkins, Sonar Engineering Unit, General Electric Co., Syracuse, N.Y.

SELECT CLOSURE HARDWARE TO IMPROVE UTILITY, APPEARANCE, AND TO LOWER COST

QUICKLY INSTALLED SOUTHCO CAPTIVE PANEL SCREWS END MISALIGNMENT PROBLEM...



Simplicity of design contributes to clean, distinctive appearance and fast, low-cost installation. Stand-off is slipped into panel hole and secured by flaring. Screw is passed through stand-off and made captive by vinyl o-ring. "Floating" screw design eliminates costly close tolerance manufacture and permits easy engagement regardless of panel distortion encountered under adverse use conditions.



SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic. Overall length of screw: $1\frac{3}{16}$ " Depth of screw head: $\frac{1}{4}$ "

Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
$\frac{3}{4}$ "	$\frac{1}{4}$ -20
$\frac{5}{16}$ "	$\frac{1}{4}$ -20, 12-24
$\frac{7}{16}$ "	10-24, 10-32

Length of thread: $\frac{3}{8}$ "

Screw head is supplied plain, as shown, or slotted for screw driver.

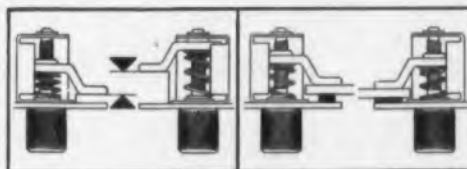
PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE



This neat, compact Southco panel and door fastener is supplied assembled, requires but two rivets or bolts for low cost installation. It is available in three models—large, intermediate and midget.

The unique feature of Southco Pawl Fasteners is the fact that, by merely turning the knob, the pawl is adjusted to a wide range of frame thicknesses. This assures a tight grip without precision setting regardless of variations in frame or door dimensions or changes that are produced by wear or warping of sheets.

Pressure exerted by the pawl on the frame is controlled in the same way, by merely turning the knob. Against gasketed frames, pressure can be easily applied to compress the gasket.



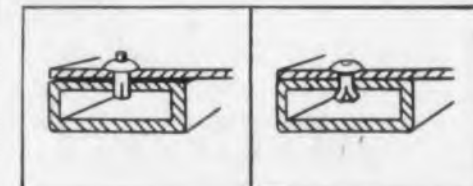
SPECIFICATIONS

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	$\frac{7}{8}$ "	$\frac{5}{8}$ "	$1\frac{1}{2}$ "
Total width	$2\frac{1}{2}$ "	$1\frac{3}{4}$ "	$1\frac{1}{2}$ "
Total height	$1\frac{3}{4}$ "	$\frac{7}{8}$ "	$\frac{3}{4}$ "
Back of panel depth	$1\frac{3}{32}$ "	$1\frac{1}{4}$ "	$\frac{7}{8}$ "
Knob length	$1\frac{1}{2}$ "	$1\frac{1}{4}$ "	$\frac{7}{8}$ "

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME



You "hit-the-pin" and the rivet's in. No special tools to limit production or require maintenance, no bucking, no finishing. For blind or open applications, Southco Drive Rivets save time, reduce costs.

Automatic "pull-up" action assures uniform, tight grip.

Southco Rivets are made of aluminum or cadmium plated steel with cadmium plated or stainless steel pins. Diameters are from $\frac{1}{8}$ " to $\frac{1}{4}$ ", grip range is from $\frac{1}{16}$ " to $\frac{3}{8}$ ".

Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

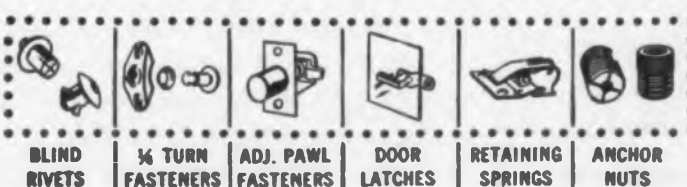
FREE!

Fastener Handbook



Send for your free copy of Handbook No. 9, just released. Gives complete data for designers on these and many other specialty fasteners. 48 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.



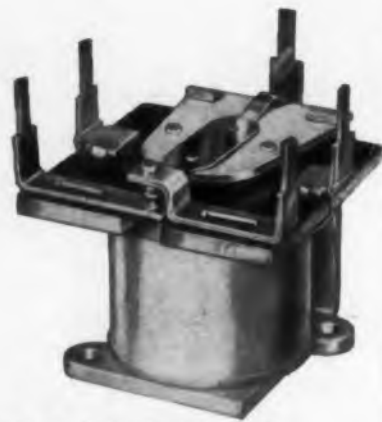
BLIND RIVETS | 1/4 TURN FASTENERS | ADJ. PAWL FASTENERS | DOOR LATCHES | RETAINING SPRINGS | ANCHOR NUTS

SOUTHCO FASTENERS
©1957
LION

CIRCLE 126 ON READER-SERVICE CARD

Plan your itinerary for the IRE Show... Preview all the New Products in ELECTRONIC DESIGN's March 16th Show issue.

For Printed Circuitry



Price PRESENTS
STYLE 1005

MIDGET DC RELAY

Cut your material and direct labor costs with this small, inexpensive, mass-produced relay for use in printed circuitry where the relay is self-supporting. Designed for simple plug-in installation.

The Style 1005 Relay is a single-pole, double-throw relay, light in weight yet capable of withstanding severe operating conditions and rough handling.

TYPICAL APPLICATIONS

Remote TV Tuning, Control circuits for recording instruments, Radiosonde, Auto headlight dimming, etc.

GENERAL CHARACTERISTICS

STANDARD OPERATING VOLTAGES.....	3 to 32 VDC
MAXIMUM COIL RESISTANCE.....	13,000 ohms
SENSITIVITY.....	0.05 watt at standard contact rating; 0.3 watt at maximum contact rating
CONTACT COMBINATION.....	SPDT
CONTACT RATING.....	Standard 1 amp.; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC
MECHANICAL LIFE EXPECTANCY.....	10,000,000 operations minimum
DIELECTRIC STRENGTH.....	500 VRMS minimum



Also available with solder lugs in open or hermetically sealed styles.

STYLE 1001



For Details, call or write

PRICE ELECTRIC CORPORATION
304 E. Church Street
MONument 3-5141

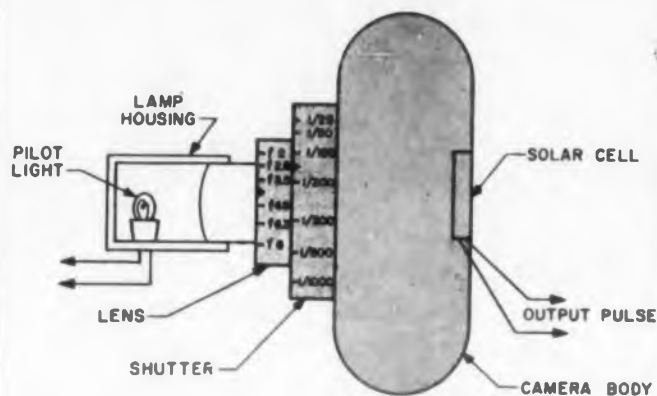
FREDERICK, MARYLAND
TWX: Frederick, Md. 565-U

IDEAS FOR DESIGN

Camera Lens and Solar Cell Make Pulse Generator

A production test set-up called for a pulse generator with an adjustable pulse width and amplitude. Using readily available equipment, the arrangement shown in the figure was used with great success.

A metal tube, closed at one end and housing a



small pilot bulb, was slipped over a camera lens. A solar cell was mounted inside the camera, facing the lens. When the shutter is snapped, light passes through the lens onto the solar cell, generating a pulse whose duration and intensity are determined by the shutter and lens settings.

Joseph Leeb, Project Engineer, Bulova Watch Co., Jackson Heights, N. Y.

A Low Repetition Rate Timer

A timer was required to generate fast rise, low impedance pulses at low repetition rates of from 0.01 to 100 per second. Many schemes, such as blocking oscillators, multivibrators and thyatron-type solid-state components, were tried, but suffered severely in stability, especially at the lower rates, because of dc triggering level jitter.

It was decided to investigate the stability of a simple neon tube RC oscillator using the stabilized Ne76. Firing voltage of this tube is held to close tolerances by including a small quantity of radio-active material in the envelope. The repetition period of the neon oscillator at low frequen-

cies is given closely by $RC \log \left[\frac{V - E_F}{V - E_E} \right]$, in

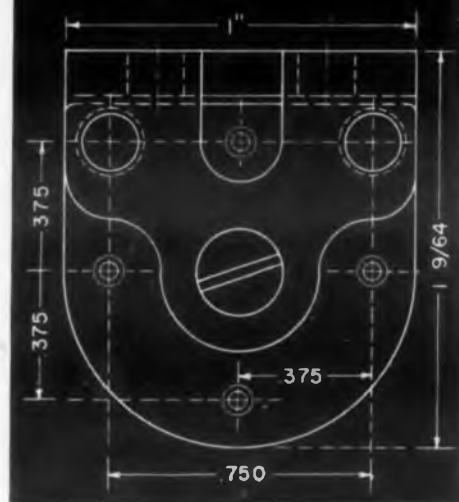
which RC is the resistor and capacitor time constant, V is the supply voltage, E_F and E_E the neon tube firing and extinguishing voltages respectively.

Because of the log function of voltages, pulse rates of such an oscillator are very insensitive to V, E_F , or E_E changes. Generally, E_F is 72 v, while E_E is 50 v. The circuit shown capacitively couples



Telephone Relay

interchangeable with
many other makes



Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays—of "telephone quality"—interchangeable with the brands you have been using. Costs are competitive and expanded production means prompt delivery.

Welcome engineering features of the telephone type "E" relay are—
Contact spring assembly: maximum of 20 Form A, 18 B, 10 C per relay.

Coil: single or double wound, with taper tab or solder type terminals at back of relay.

Operating voltage: 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 116 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 128 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960

NOISE!
NOISE!
NOISE!
NOISE!

**ANALYZE NOISE WITH
 AN ALLISON FILTER**

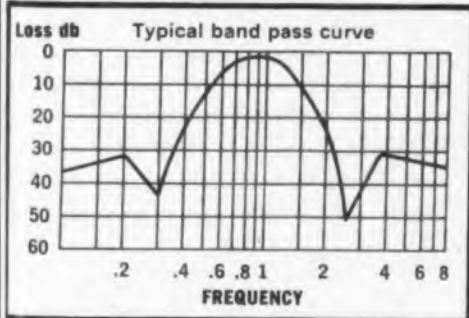


MODEL 420 FILTER

You can evaluate the amount of a noise and its frequency characteristics with an Allison Filter. You can make this evaluation regardless of whether the noise is continuous or intermittent, or whether it has sharp peaks. Allison Filters do not ring on transient noises. This analysis can be very important in testing equipment, preventing hearing loss, and controlling harmful or irritating industrial noises.

420 FILTER SPECIFICATIONS

Continuously variable frequency range from 20 cps to 20,000 cps.
 20 db attenuation in first octave.
 Passive network—no power supply.
 No vacuum tubes.
 Dynamic range, 120 db.
 Impedance (in and out), 600 ohms.
 Plug-in input-output transformers for other impedances.
 Maximum input for minimum distortion, 2 volts.
 Low loss, approximately 2 db in pass band.
 Low pass signals from DC to cutoff frequency.
 Minimum band width approximately 1/2 octave.
 Size, excluding knobs and handle, 17" long, 5 3/4" deep, 8" high.

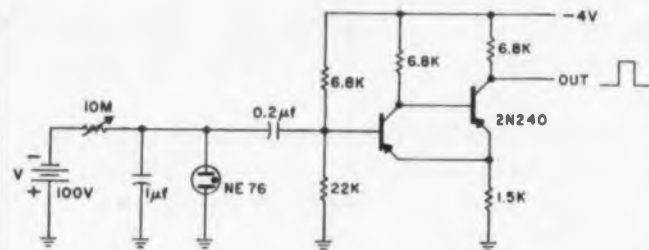


Write today for complete literature and prices

Allison Laboratories, Inc.

11301-B OCEAN AVENUE
 LA HABRA, CALIFORNIA

CIRCLE 129 ON READER-SERVICE CARD



Pulse timer designed to give 0.02- μ sec rise-time Pulses at intervals of up to 10 sec. Repetition rate is variable by adjusting RC time constant of neon tube circuit.

the neon timer to a transistorized Schmitt circuit. Silicon 2N240's are used, mainly to conserve space. Negative or positive going pulses are obtainable by simply inverting the neon tube voltage V and resetting the dc base bias of the input transistor.

The circuit met the following specifications: subminiaturization, ruggedness, low power, simplicity, an output spike of 3 v at 0.02 μ sec rise time. It had a repetition accuracy of better than 2 per cent at 10 sec, even after 100,000 flashes at a neon bulb temperature of 150 C, under high radiation intensities.

Patrick F. Howden, Electronics Engineer, Consolidated Systems Corp., Los Angeles, Calif.

Resistors for High Reliability Designs

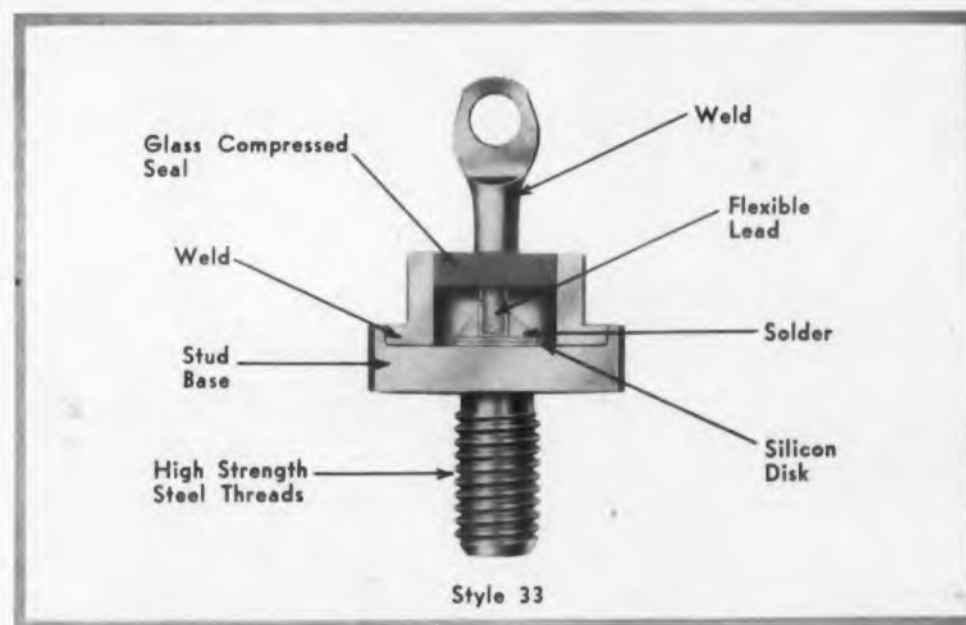
Carbon resistors are known to be a source of noise in high-gain amplifiers, especially when used as plate resistors. This noise is approximately proportional to the dc voltage drop across the resistor and is usually between 0.1 and 1 μ v per v. The normal noise for a good carbon plate resistor is about 50 μ v. This may be quite negligible in high-level amplifiers except that this noise figure frequently increases several orders of magnitude after many hours of use.

A noisy resistor is quickly located and replaced, but what is often overlooked is that many not-quite-so-noisy resistors can cause a deterioration of the signal-to-noise level. Such noise may remain undetected for long periods of time. Where high-reliability and good signal-to-noise ratios are required, the carbon resistors should be used only in high-level stages. In high-reliability equipment it is wise to design on the assumption that carbon resistor conduction noise may be as high as 100 μ v per volt.

Wirewound and metal-film type resistors are normally free of the conduction noise problem.

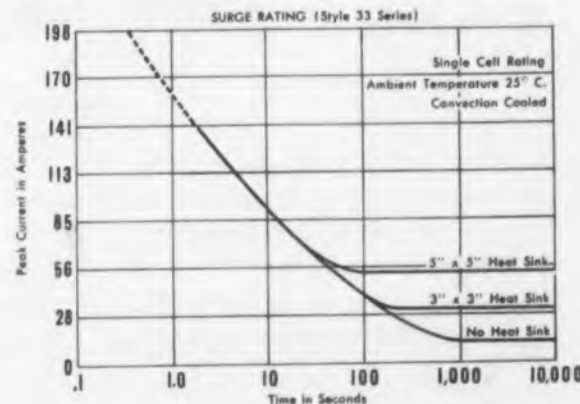
Lawrence G. Cowles, Electronic Design Engineer, The Superior Oil Co., Bellaire, Texas.

Specify reliable
 all STEEL construction
Silicon Rectifiers
 by
SYNTRON



SYNTRON'S exclusive all STEEL

assembly—high
 tensile strength
 100% welded
 construction



100 inch pound mounting torque for maximum heat transfer—less corrosion—greater reliability—better contact. Mechanically and electrically superior.

Write for information and specifications

SYNTRON RECTIFIER DIVISION

Subsidiary of Link-Belt Company

283 Lexington Avenue Homer City, Pa.

Sales Engineers in New York, Chicago, Cleveland, Los Angeles and Canada

CIRCLE 130 ON READER-SERVICE CARD



CARRY A RECORDER *anywhere!*

Now you can record test data on-the-spot. In both lab and field you get accuracies equal to or better than big, rack mounted units. Just pick up and move a multi-channel (up to 14) PI tape recorder/reproducer as you would any other item of test equipment.

Instead of 1,000-lb. cabinets, requiring 1000 watts, you're working with recorders 10 times smaller and lighter, using 250 watts or less.

In the field, you get laboratory performance under the most difficult environments. PI fits many places where 19-inch racks won't go. One man can carry a rugged PI recorder to virtually any test site.

How did PI put precision in a small package? By combining transistorized electronics with unique stacked reel tape magazines. PI recorders use standard tapes and heads, are compatible in every way with standard recording practices and other recording equipment.

May we suggest you call your PI representative to arrange a demonstration? If you are uncertain who he is, please write direct. Address Dept. 19-3

Precision Is Portable



PRECISION INSTRUMENT COMPANY

1011 COMMERCIAL STREET • SAN CARLOS, CALIFORNIA • PHONE: LYTELL 1-4441

CIRCLE 131 ON READER-SERVICE CARD

5

PATENTS

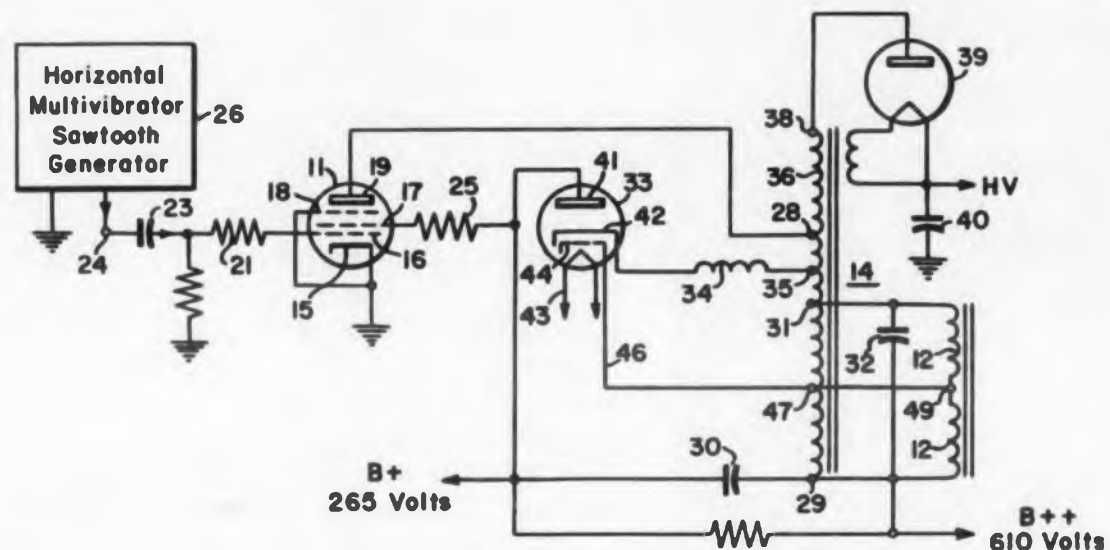
Cathode Ray Deflection System

Patent No. 2,917,660. B. R. Corson.
(Assigned to Westinghouse Electric Corp.)

In the television flyback scanning system, the cathode-heater insulation of the clamper diode is increased by means of a helical electrostatic shield, coated with a ceramic, placed between the cathode and heater. With the shield voltage set at one

half the pulsed cathode voltage, the heater may be operated at ground potential without internal voltage breakdown.

In the conventional circuit illustrated, the invention lies in the addition of shield 44 between cathode 42 and heater 43. The shield is then conductively joined to tap 47 of flyback transformer 14.



Federal Stock #RSAI-002-1013



Model NFB
FOR HEAVY DUTY
SERVICING!

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Fast-action Heinemann circuit breaker safeguards equipment

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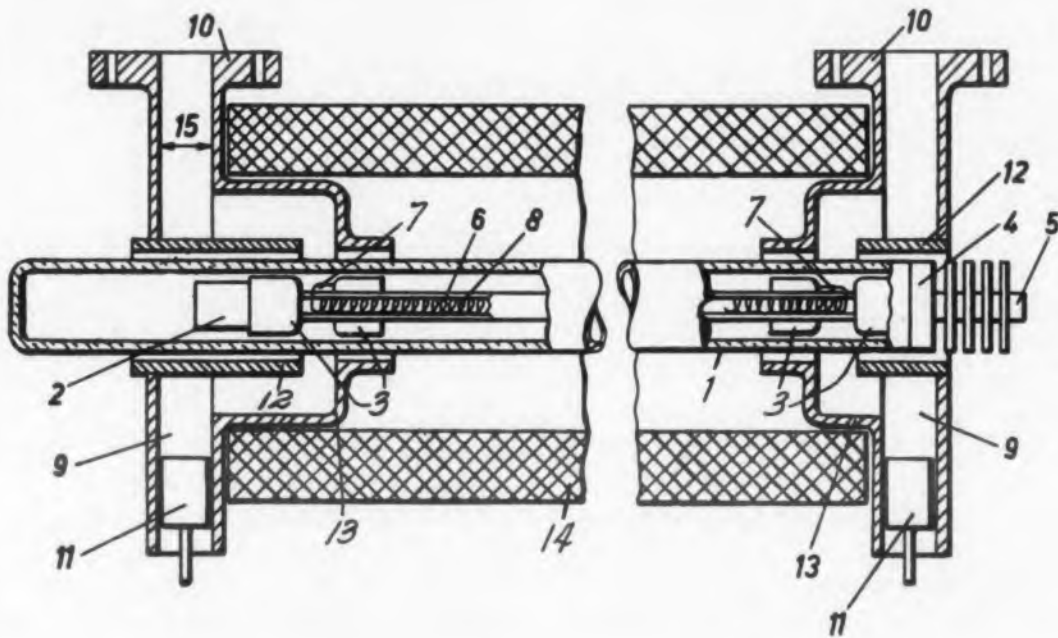
Coupling Arrangement for TWT's

Patent No. 2,908,843. W. Klein, W. Friz and G. Osswald. (Assigned to International Standard Electric Corp.)

Radio frequency energy is coupled from a waveguide to the TWT helix through a coaxial cable which drives the helix capacitively. At the tube output, the helix connects to a coaxial line which trans-

forms to a waveguide.

Waveguide 9, having height 15 and tuned by plunger 11, is changed to a coaxial line having inner conductor 12 and outer shield 13. Coupling to helix 8 is by means of antenna 7. For wideband matching, the spacing of the coaxial conductors should approximate the height of the waveguide.



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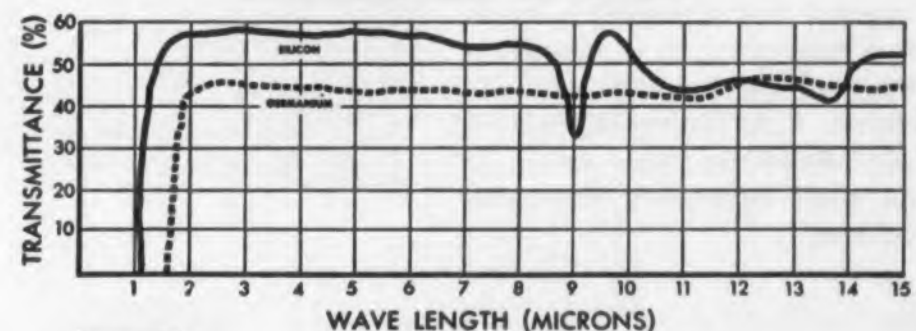
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• Melting point	1420°C Excellent	958°C Fair
• Density	2.3 gm/cm ³	5.34 gm/cm ³
• Ease of finishing	Excellent—very hard	Good
• Transmission cut-off	About 20 microns Excellent	About 23 microns Excellent
• Reaction to Thermal Shock	Good	Good
• Thermal conductivity	Excellent	Excellent

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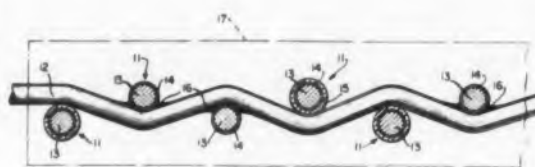
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PATENTS

Diode Matrix

Patent No. 2,915,686. E. J. Schubert. (Assigned to Burroughs Corp.)

A compact array of diode or insulated junctions, 64 cross-overs per inch, is formed by depositing semiconductive material at selected junctions to internally form electrical diodes. In the example shown, core wire 14, aluminum or nickel, is coated by the semiconductor which is

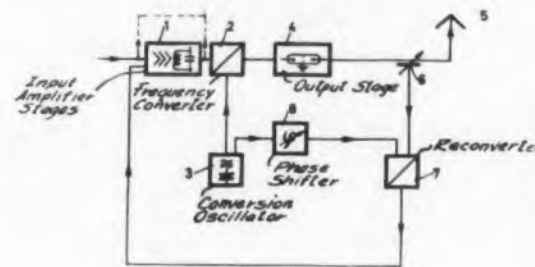


then heated to form a diode with cross-over wire 12. Other cross-overs are conveniently insulated. The assembly is subsequently potted in an insulating material which hermetically houses the matrix in a solid insulating block.

Transmitter Linearized by Negative Feedback

Patent No. 2,912,570. H. Holzwarth et al. (Assigned to Siemens and Halske, Germany)

In a single sideband transmitter, a portion of the power output is mixed with the converter oscillator voltage. This oscillator voltage is conveniently phase-shifted in order to produce a signal corresponding in frequency to that applied to the input amplifier. This signal is then fed



back to the input stage to linearize the overall transmitter amplification.

The signal-to-input stage 1 beats with the oscillator to develop the modulated signal at aerial 5 which is driven by grounded grid stage 4. Capacitor 6 picks



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ELECTRONIC DESIGN • March 2, 1960

of a portion of the output which mixes in reconverter 7 with the phase shifted oscillator voltage. The proper voltage is then fed back to linearize amplifier 1.

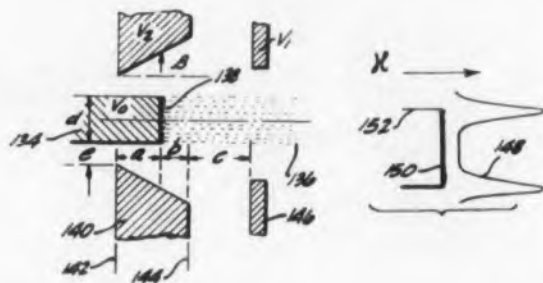
Low Noise Electron Gun

Patent No. 2,914,699. M. R. Currie. (Assigned to Hughes Aircraft Co.)

A 3-db noise figure electron gun, similar to the velocity jump type, produces a highly non-uniform current density across the cross section of the electron beam. Undesired velocities are discriminated against and shot current is reduced.

Essentially, the structure produces a potential profile which, in combination with an axial magnetic field, causes a voltage jump near the cathode followed by a region in which the voltage increases very slowly.

A low noise gun is illustrated in Fig. 1. Cathode 134, at ground potential, emits electrons in the direction of accelerator 146 set at a positive voltage. Placed about the cathode is a profile shaping electrode, 140. This is tapered as shown and set at a higher positive voltage than the accelera-



tor. Typical voltages and dimensions for this structure are tabulated.

The relative electron current density versus position across the cathode is shown in Fig. 2. The density is a maximum near the edge of the cathode and a minimum in either direction away from the edge.

In operation, the profile shaping electrode tends to pull electrons radially from the cathode. However, the axial magnetic field causes these electrons to spiral and to travel forward to the accelerator. From there the electrons see a long, gradient-free drift region which reduces velocity and shot current fluctuations to improve the noise figure. (See Nevins and Curries, letter to editor, *Proc. IRE*, Nov. 1959, pages 2015-2016.)



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SPECIFICATIONS (applicable to all motors described above)

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Nominal No Load R.P.M.*	Gear Ratio	Intermittent Rated Load (oz.-in.)	Minimum Starting Torque (oz.-in.)	†Power (Watts) Loaded	Current (amp) Loaded	Temp. Rise °F
330	4.4:1	4	10	11.5	0.11	70
144	10:1	5	23	11.5	0.11	70
48	30:1	15	56	11.5	0.11	70
23	60:1	30	105	11.5	0.11	70

Synchronous

R.P.M.*	Gear Ratio	Pull-In Torque Minimum (oz.-in.)	Continuous Torque (oz.-in.)	Power (Watts) Loaded	Current (amps) Loaded	Temp. Rise °F
180	10:1	12	12	24.0	0.21	100
180	10:1	2	2	11.5	0.11	65
90	20:1	14	12	11.5	0.11	65
60	30:1	21	18	11.5	0.11	65
30	60:1	42	36	11.5	0.11	65

*1/6 less at 50 cycles
†Field winding 11.0 watts, balance in amplifier winding
Note: Some speeds available at 25 cycles

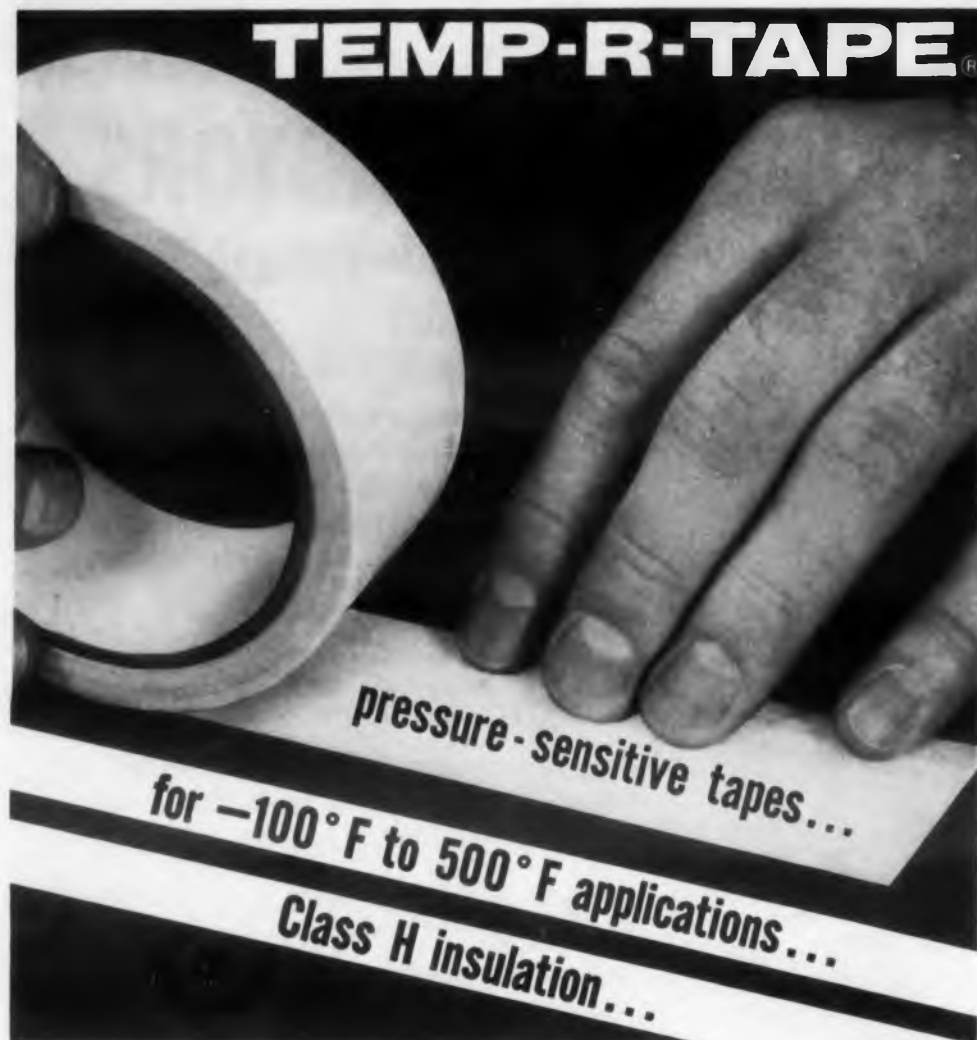
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The Cathode-Ray Tube And Its Applications

G. Parr, M.I.E.E., and O. H. Davie, M.I.E.E., Rheinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 433 pp, \$9.50.

The third edition of this book, first published in 1937, has been completely revised and enlarged to reflect the recent changes made in oscillography. Primarily, the book has been planned as a guide to the operation and use of the cathode-ray tube as "one of the most versatile measuring instruments that has ever been devised." Only superficial treatment is given to the theory and design of the electron gun and tube structure. Instead, emphasis

is placed on the circuitry associated with the cathode-ray tube in order to make it function as an indicating and measuring device. Also, considerable space is devoted to the application of the tube in various phases of electrical and mechanical engineering, radio engineering, television measurements, and other fields where it can be of use. Chapter headings include Power Supplies, Amplifiers, Linear Time-bases, Frequency Bases, Photographic Recording Transducers, Mechanical and Electrical Engineering Applications—transmission measurements, waveform display, radio reception, and Applications to General and Nuclear Physics.



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ELECTRONIC DESIGN • March 2, 1960

Electron Physics

C. Klemperer, Ph.D., Academic Press Inc., Publishers, 111 Fifth Ave., New York 3, N.Y., 248 pp, \$7.00.

Fundamental for the whole subject of electron physics is the study of the properties of the free electron, and that is the subject of this book. Starting with some introductory notes on the history of electron physics, it goes on to discuss the main problems of electron motion, electron optics, electron flow in dense space charges and the statistical fluctuations in low intensity beams. A short discussion of experimental methods for the detection of free electrons concludes the first part of the book.

Part II deals with the fundamental properties of the free electron: its charge, mass, wavelength, spin and magnetic moment. The discovery of these properties and their study by highly precise quantitative methods is described.

Basically, the text is an extension of the lecture courses which the author delivered at the University of London. As such it is a text for undergraduate stu-

dents though, to make it as comprehensive as possible, some graduate level sections have been included.

Exploding Wires

Edited by William G. Chace and Howard K. Moore, Plenum Press, Inc., 227 W. 17 St., New York 11, N.Y., 373 pp, \$9.50.

This is a collection of the papers presented at the Conference on the Exploding Wire Phenomenon conducted by the Air Force Cambridge Research Center in Boston, Mass., on April 2 and 3, 1959. The papers are divided into three broad sections. Section one deals with theoretical and experimental studies made on the exploding wire phenomenon, section two discusses the shock waves built up while this phenomenon is taking place, and section three relates the practical applications to which the previous studies have led. Among the organizations which presented papers at the conference were the Sandia Corporation, the California Institute of Technology, the Los Alamos Scientific Laboratory, and the Aerojet General Corporation.



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BOOKS

Computers and People

J. A. Postley, McGraw-Hill Book Co., 327 W. 41st St., New York 36, N.Y., 251 pp, \$6.00.

What modern computers can mean to readers whom these machines are designed to serve—such as businessmen, managers, and other non-technical people—is explained in this newly published book. It gives a practical picture of electronic devices that can lead to new techniques for business operation and control.

A clear discussion of the economics of computers and related equipment is presented in terms designed to be grasped by non-specialists. Compromises that the data processing specialist must make in behalf of the organization he serves are described, as well as the decision-making aspects of computers and the changes that must be made by business to utilize data processing most effectively.

Future equipment and capabilities of computers are predicted, and the role that computer manufacturers should play

in maximizing benefits to users is also discussed. The book treats the social problems created by modern data processing equipment and includes an illustrative review of some present and forthcoming computer applications.

Masers

Gordon Troup, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 168 pp, \$2.75.

The title is the commonly used form for the devices employed in producing Microwave Amplification and Oscillation by Stimulated Emission of Radiation. A discussion of the stimulated emission process is followed by a brief outline of methods used to obtain the conditions necessary for amplification. The effects of various physical processes upon amplifier efficiency, and upon the effective frequency response of a molecular transition used to amplify, are described. The book goes on to give derivations of the gain,

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bandwidth, and noise factor of the traveling-wave line type of stimulated emission amplifier, and of the resonant cavity type of amplifier.

A review of the experimental work on masers is given, together with a comprehensive bibliography.

Nuclear Technology For Engineers

R. Hobart Ellis, Jr., McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 284 pp, \$9.50.

This is a practical text for all engineers and technicians confronted with nuclear problems in their own fields, or who are now working in nuclear energy. The four major areas of nuclear engineering—radio-tracer technology, radiation, fission energy, and nuclear fusion are covered. Mathematics is used only to illustrate important points, and is not essential to a sound understanding of the subject matter.

Found here is a concise explanation of the structure of the atomic nucleus and the ways in which unstable nuclei disintegrate to produce rays of particles and

photons. How modern technology makes use of these rays is discussed, including both radiotracer methods and the irradiation of materials.

The book proceeds from low-level radiation (radiotracer work) to high-level radiation, which is of interest in radiation processing and radiation-damage studies. It treats in illustrative detail the effects and uses of radiation as well as radiation dose and its measurement. A section on fission and the chain reaction answers questions on what fission is, how it is used to produce a chain reaction, how a chain reaction is controlled, and many more. A discussion on using fission reactors takes up the engineering problems of building a power reactor, explains reactor components, describes eight modern power-reactor types, and treats other topics such as auxiliary functions and nuclear economics.

A practical introduction to fusion technology is also included in the book, bringing details on the techniques of plasma physics, fusion devices, and the advantages of fusion reactors.



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GERMAN ABSTRACTS

E. Brenner

Frequency Stability of Cylindrical Cavities

RESONANT cavities used as wavemeters or to control the frequency of microwave oscillators must have high-frequency stability. The resonant frequency of a cavity depends on the geometry and the material that fills it. Temperature variations have a direct influence on the cavity geometry. They affect the dielectric constant of air-filled cavities indirectly through pressure and humidity variations.

The effect of geometry on the resonant frequency of a cylindrical cavity, radius R and length L , for the E_{011} mode is given by

$$\frac{\Delta f}{f} = \frac{\left(\frac{a}{R}\right)^2 \frac{\Delta R}{R} + \left(\frac{\pi}{L}\right)^2 \frac{\Delta L}{L}}{\left(\frac{a}{R}\right)^2 \left(\frac{\pi}{L}\right)^2} \quad (1)$$

where a is the first zero of the Bessel function of the first kind, zero order, $J_0(a) = 0$. If the entire cavity is made of one material then $\Delta f/f = \alpha$, the temperature coefficient of the material. For invar, $\Delta f/f = -2 \times 10^{-6}$ per deg C. In the band 7.1 to 7.75 mc this corresponds to a frequency change of -14.2 kc per deg C at the lower frequency limit and -15.5 kc per deg C at the upper frequency limit of the band.

By using different materials for the cavity walls

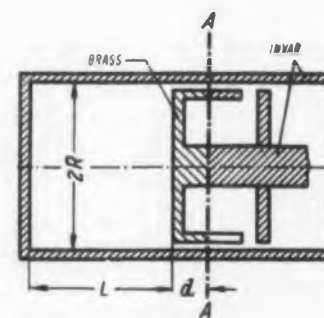


Fig. 1. Cavity resonator of invar. Temperature dependence is compensated for by means of the brass plunger.

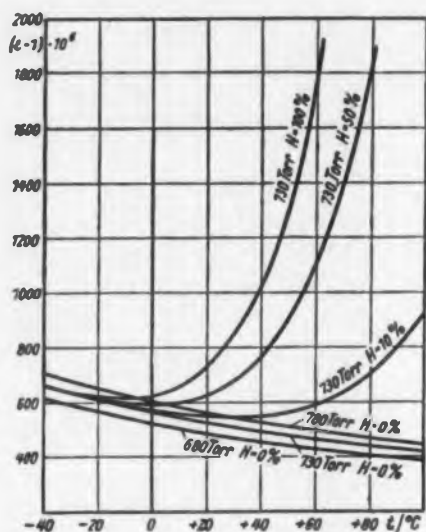


Fig. 2. Dependence of dielectric constant of air as a function of temperature with various values of air pressure and relative humidity, H .

and for the plunger, Fig. 1, for example invar and brass respectively, and assuming no fields to the right of reference plane A-A, it can be shown that

$$\frac{\Delta f}{f} = -\alpha_i + \frac{(\alpha_b - \alpha_i) \left(\frac{\pi}{L}\right)^2 d}{\left(\frac{a}{R}\right)^2 + \left(\frac{\pi}{L}\right)^2} \quad (2)$$

where α_i and α_b are the temperature coefficients of invar and brass respectively. It is then possible to compensate completely for the temperature effect at a mean frequency and to choose d so that equal errors occur at frequency band extremes. For the example cited above, $\Delta f/f$ equal to $\pm 0.48 \times 10^{-6}$ per deg C applies at the lower (+ sign) and upper (- sign) limits of the band. Thus the minimum improvement over the band is a factor of four.

Materials in the cavity have an influence independent of geometry. The additional frequency increment is

$$\frac{\Delta f}{f} = \frac{1}{2} \left(\frac{\Delta \epsilon}{\epsilon} + \frac{\Delta \mu}{\mu} \right) \quad (3)$$

For air, $\Delta \mu = 0$. The influence of air pressure and humidity can only be eliminated by hermetically sealing the cavity after it is filled with dry air. Otherwise, changes in relative dielectric constant of up to 0.2% can, at temperatures above 20 deg C, result in frequency deviations of the order of 10^{-6} per deg C. Numerical results for various pressures and relative humidity can be calculated with the aid of Fig. 2 using Eq. 3 with $\Delta \mu = 0$.

Abstracted from an article by H. J. Oberg, *Telefunken Zeitung*, Vol. 32, No. 126, Dec. 1959, pp 265-268.

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1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
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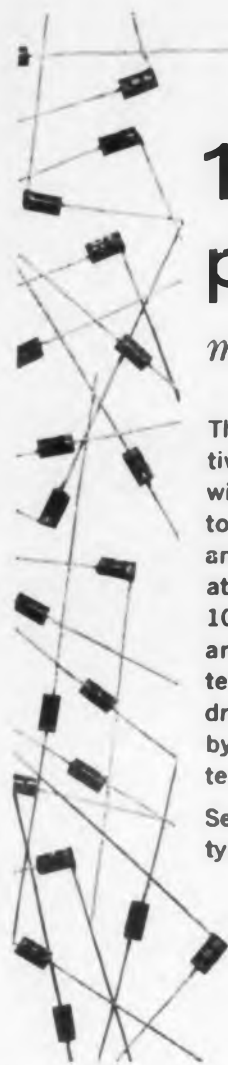
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STANDARDS AND SPECS.

Microfilming Drawings Will Be Required By Military Agencies

In the not too distant future, companies who furnish reproducible copies of engineering data to military agencies will be required to furnish microfilm in an aperture of an EAM tabulating card. In addition, according to R.F. Franciose, in the October-November issue of Standards Engineering, EAM techniques will be used for data retrieval. Mr. Franciose, reporting on the activities of the Department of Defense, stated that with the advent of microfilm, industry in general will need to discipline itself in the preparation of engineering drawings. This is necessary so that the drawings will be suitable for the microfilm requirements under consideration by the proposed DOD unified microfilm spec. For example, the quality of drawings will need to be upgraded. Character heights must be increased to compensate for the highest reduction ratios which will be encountered. Line quality and spacing will need to be given closer attention. Photo-generations of drawings to produce new drawings will need to be kept at a minimum. Preparation of tracings will have to be given closer attention to eliminate retracing by hand when microfilming.

Three sizes of so-called microfilm are being commonly used in industry to record reproductions of engineering drawings: 35mm, 70mm, and 105mm. The military has decided to standardize on 35 and 105mm.

Connectors

Multicontact, molded body, electrical-plug and receptacle connectors are covered by this spec. In this spec the term connector means the connector (plug or receptacle) and its applicable accessories. For airborne applications, connectors covered by this spec are intended for use only for internal connections within the same equipment container. They should not be used for external connection to a container or between containers. A typical type designation for a connector meeting this spec is UMO1R14FH2A. MIL-C-8384B, General Specification for Connectors, Plug and Receptacle, Electrical (Molded Body); and Accessories.

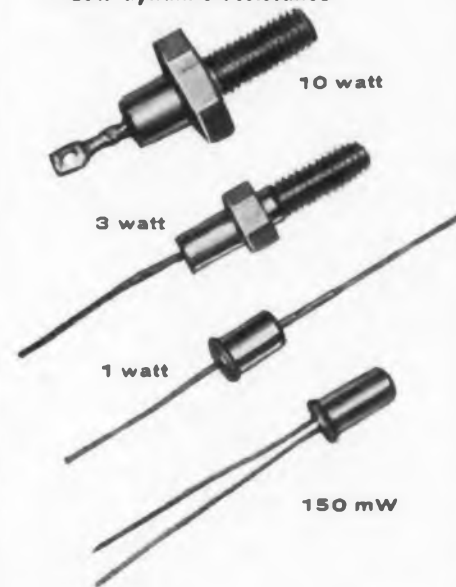
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Electrical Insulating Materials

This spec covers class L, low dielectric constant (12 or under) ceramic, electrical, insulating materials. The materials covered are intended for use as electrical-insulating elements in components and parts, or as insulators in subassemblies and equipments. This spec establishes minimum requirements for those materials, and grades them according to their performance. MIL-I-10A, Insulating Materials, Electrical, Ceramic, Class L.

National Electric Code

The 1959 edition of the National Electric Code, approved as American Standard C1-1959, includes not only many changes in substance, but also a new numbering system. Because of this new numbering system, an appendix is included providing cross references with the 1956 edition, Sections which have been revised since then are indicated in bold face in this appendix. The code sets up minimum requirements for safety in the use of electricity for light, heat, power, radio signals, etc., primarily in buildings. Copies of the National Electric Code, ASA C1-1959, are available at \$1.00 per copy from the American Standards Association, 70 E. 45 St., New York 17, N.Y.

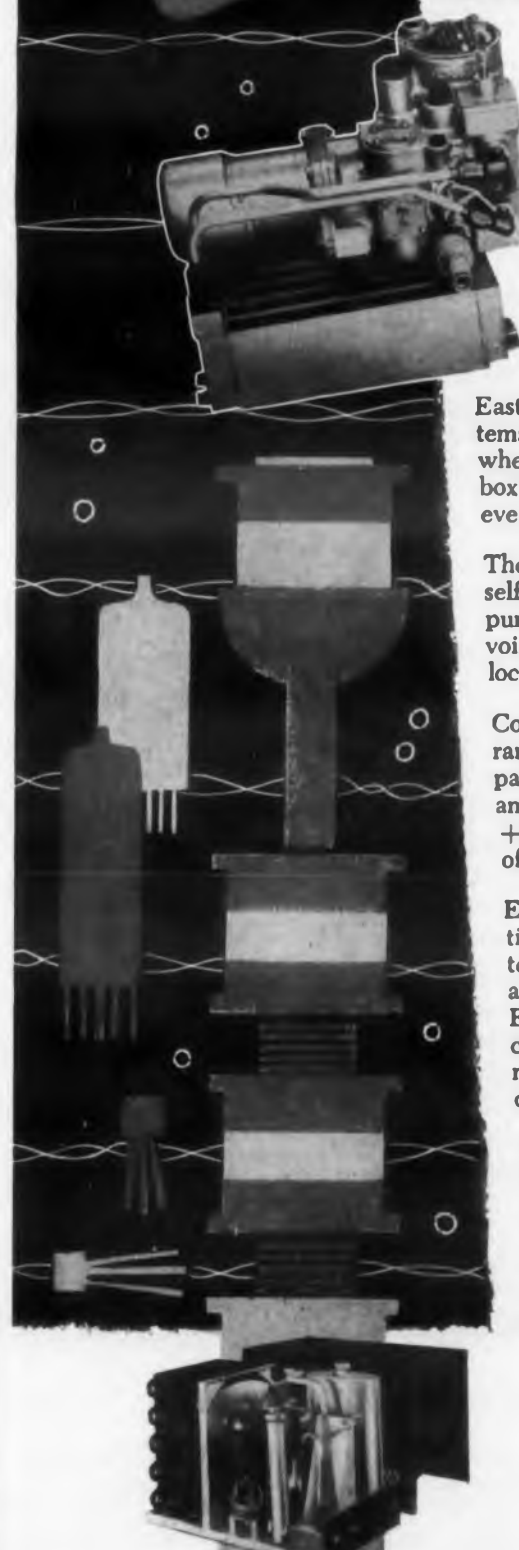
Minimum Performance Standards

A minimum performance standard is that threshold of performance which an electronic equipment must achieve in a prescribed operational environment. A minimum performance standard is limited to threshold performance requirements, not optimum requirements. Threshold requirements are the least restrictive values which will satisfy the operational environment of the equipment. These standards confine themselves to performance. They do not include design specs which might limit manufacturers in achieving an end product. Request Paper 149-59/DO-97 and enclose 20 cents per copy for a complete report on Aircraft Electronic Equipment Minimum Performance Standards—Their Purpose and Application. Available from The Radio Technical Commission for Aeronautics, 16th & Constitutional Avenue, N.W., Washington 25, D.C. Also issued by RTCA were three new minimum performance standards. Airborne Weather and Ground Mapping Radar Operating Within the Frequency 5250 to 5440 and 9300 to 9500; price 50 cents. Airborne Doppler Radar Ground Speed and or Drift Angle Measuring Equipment, price 40 cents. Airborne DMET Operating Within Range of 960-1215 MC, price 50 cents.

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Regional Lectures

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This seminar will be of interest to those who are responsible for initiating projects and evaluating final results. It will focus on: reviewing outside requests for assistance; reviewing alternative courses of action; establishing an order of priority; analyzing the capacity of the engineering department; planning realistic work loads; scheduling the workload; establishing controls; and evaluating performance.

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Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

March 15: Deadline for 200-400 word abstracts for the **5th Annual Conference on Non-Linear Magnetics and Magnetic Amplifiers** scheduled for Oct. 26-28 to be held at the Bellevue-Stratford Hotel, Philadelphia, Pa. Possible topics include: computer magnetics—magnetic memory components, devices and systems; magnetic logic elements and circuits; combined semiconductor and nonlinear magnetic devices; and theory design and application of magnetic amplifiers. *Send to: David Katz, Technical Program Chairman, Bell Telephone Laboratories, Whippany, N.J.*

March 15: Deadline for 500 word abstracts for the **2nd Annual Bay Areas Reliability Seminar** scheduled for May 6-7 in Monterey, Calif. Papers are solicited on the following topics: a theory of error; criteria for selection of policies for reliability; and appraisals of policies for reliability. *Send to: L. Fein, 431 Ferne Ave., Palo Alto, Calif.*

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Robert DeFloria was a principal engineer at Ford Instrument Division of Sperry Rand Corp. until he became associate editor of **ELECTRONIC DESIGN** in September 1959. He received his BS in Physics from Fordham in 1949, and has studied engineering at the University of Rochester, Harvard, MIT, and Brooklyn Polytechnic Institute.

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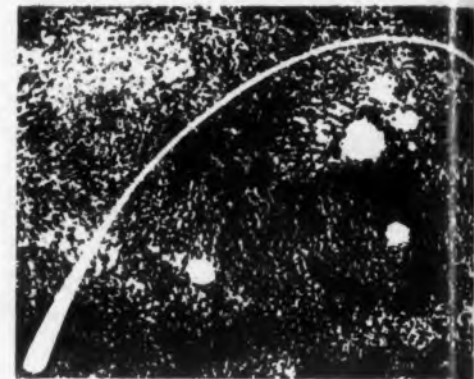
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